No. A144815

IN THE COURT OF APPEAL
OF THE STATE OF CALIFORNIA
FIRST APPELLATE DISTRICT
DIVISION TWO

THE POST SUSTAINABILITY INSTITUTE, et al.,
Plaintiffs and Appellants,
v.
ASSOCIATION OF BAY AREA GOVERNMENTS, et al.,
Defendants and Respondents.

On Appeal from the Superior Court of Alameda County
Case No. RG13699215, Hon. Evelio Grillo, Presiding

RESPONDENTS' REQUEST FOR JUDICIAL NOTICE

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Attorneys for Defendants and Respondents **Association of Bay Area Governments, et al.**	

TO ALL PARTIES AND THEIR COUNSEL OF RECORD:

PLEASE TAKE NOTICE that Respondents ASSOCIATION OF BAY AREA GOVERNMENTS ("ABAG") and METROPOLITAN TRANSPORTATION COMMISSION ("MTC") (collectively, the "Agencies") hereby request that the California Court of Appeal, First Appellate District, take judicial notice of the following documents (hereafter, "Subject Documents"):

A. State of California Air Resources Board (CARB), *First Update to the Climate Change Scoping Plan Building on the Framework Pursuant to AB 32 The California Global Warming Solutions Act of 2006*, May, 2014, a true and correct copy of which is attached as Exhibit A to this Request and can be accessed on the CARB website through the following link: http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf

B. California Strategic Growth Council, Staff Report, October 15, 2015, a true and correct copy of which is attached as Exhibit B to this Request and can be accessed on the Strategic Growth Council website through the following link: http://www.sgc.ca.gov/docs/Item_6__Proposed_Fall_2015_AHSC_Notice_of_Funding_Availability_FINAL.pdf

C. City of Daly City Planning Commission, Agenda Report, November 4, 2015, a true and correct copy of which is attached as Exhibit C to this Request and can be accessed on the City of Daly City website through the following link: http://209.234.104.30/sirepub/cache/2/12zzc2u1xbibnhyftlvudgiu/5100549112020151112581 24.PDF

D. CARB Executive Order G-14-028, "Association of Bay Area Governments' (ABAG) and Metropolitan Transportation

Commission's (MTC) Sustainable Communities Strategy (SCS) ARB Acceptance of GHG Quantification Determination," a true and correct copy of which is attached as Exhibit D to this Request and can be accessed on the CARB website through the following link: http://www.arb.ca.gov/cc/sb375/mtc_exec_order.pdf

E. CARB "Technical Evaluation of the Greenhouse Gas Emissions Reduction Quantification for the Association of Bay Area Governments and Metropolitan Transportation Commission's SB 375 Sustainable Communities Strategy," dated April 2014 and attached as "Attachment A" to CARB Executive Order G-14-028, a true and correct copy of which is attached as Exhibit E to this Request and can be accessed on the CARB website through the following link: http://www.arb.ca.gov/cc/sb375/mtc_scs_tech_eval_final0414.pdf

This request for judicial notice is based on the grounds that the Subject Documents may be judicially noticed pursuant to Evidence Code sections 452 and 453. This request for the Subject Documents to be judicially noticed is based on the following Memorandum of Points and Authorities.

MEMORANDUM OF POINTS AND AUTHORITIES IN SUPPORT OF REQUEST FOR JUDICIAL NOTICE

The court should take judicial notice of the Subject Documents pursuant to Evidence Code Sections 452 and 453. (Evid. Code, §§ 452, 453.) Evidence Code section 453 requires that a court "shall" take notice of any matter specified in Evidence Code Section 452, provided that the party requesting notice: (a) gives each adverse party sufficient notice of the request to enable that party to respond to the request, and (b) furnishes the court with sufficient information to enable it to take judicial notice of the matter. (Evid. Code, § 453.) This request, and the Subject Documents

attached hereto, satisfy the requirements of Evidence Code section 453 by providing all parties with notice adequate to enable them to respond to the request; by providing the court with the materials in their entirety for which notice is requested; and also by providing a detailed argument concerning the propriety of taking judicial notice of the Subject Documents pursuant to Evidence Code section 452.

I. The Subject Documents Are Relevant.

The Subject Documents are relevant to address arguments raised by Appellants in their Opening Brief as follows.

A. Exhibits A, B, and C are relevant to show that implementation of Plan Bay Area is achievable, despite the need for legislative change.

Appellants argue that, because the Plan and the Feasibility Report acknowledge legislative changes will be required to achieve the Plan's ultimate goals, it must be infeasible. (AOB, pp. 24-26.) Exhibit A, CARB's updated Scoping Plan, reflects the States evolving strategy for reducing greenhouse gas emissions, which acknowledges that a change from the "business-as-usual" approach will be necessary to achieve the State's goals, and Exhibits B and C tend to show that funding for development is becoming available and projects consistent with the Plan are being considered by local governments. Specifically, Exhibit B reflects a proposal from the Strategic Growth Council to make additional funding available for transit oriented development and Exhibit C reflects the City of Daly City's Planning Commission consideration of a project located in a Priority Development Area that relied on the provisions of SB 375 for streamlined CEQA reviewing, showing that development consistent with Plan Bay Area is feasible. Exhibits A, B, and C are therefore relevant to address arguments made by Appellants related to the feasibility of Plan Bay Area, and to show that the state of the law is fluid and not static.

B. Exhibits D and E are relevant to show that CARB accepted the Agencies' determination that the Plan can feasibly achieve the greenhouse gas emission reduction targets.

CARB Executive Order G-14-028 and the Technical Evaluation appended thereto as Attachment A, are relevant because SB 375 entrusts CARB with the responsibility to review a metropolitan planning organization's sustainable communities strategy or alternative planning strategy and accept or reject "the metropolitan planning organization's determination that the strategy submitted would, if implemented, achieve the greenhouse gas emission reduction targets established by the state board." (Gov. Code, § 65080, subd. (b)(2)(J)(ii).) Consistent with this requirement, once the Agencies adopted their SCS, CARB reviewed it and issued CARB Executive Order G-14-028 accepting the Agencies' conclusion that "the SCS would, if implemented, achieve the 2020 and 2035 GHG emission reduction targets established by [C]ARB." (Executive Order G-14-028, p. 3.) CARB attached its "staff's technical review of ABAG/MTC's GHG reduction quantification … [as] Attachment A" to its Executive Order. (*Ibid.*; see also AR 43009-43103.)

In considering Appellants' arguments regarding whether the Agencies complied with the requirements of SB 375, "[c]onsiderable weight should be accorded to an executive department's [here, CARB's] construction of a statutory scheme it is entrusted to administer." (*City of Arcadia v. State Water Resources Control Bd*. (2006) 135 Cal. App. 4th 1392, 1412.) Moreover, "excessive judicial interference with [CARB's] quasi-legislative actions would conflict with the well-settled principle that the legislative branch is entitled to deference from the courts because of the constitutional separation of powers." (*Western States Petroleum Assn. v. Superior Court* (1995) 9 Cal.4th 559, 572.) Therefore, Exhibits D and E are not only relevant, but consideration of them is necessary to ensure that

the holding in this case accords proper deference to CARB's interpretation of the statutory scheme the Legislature entrusted it to administer.

II. The Court Should Take Judicial Notice of the Subject Documents as "Official Acts" of Subdivisions of the State of California, Pursuant to Evidence Code Section 452, Subdivision (c).

Evidence Code section 452, subdivision (c) authorizes the court to take judicial notice of "[o]fficial acts of the legislative, executive, and judicial departments of the United States and of any state of the United States[,]" including local governments. (Evid. Code, § 452, subd. (c); see *Garcia v. Four Points Sheraton LAX* (2010) 188 Cal App 4th 364, 377, fn. 8 [appropriate for reviewing court to take judicial notice of official local government actions].) Official acts include records, reports and orders of administrative agencies. (*Hogen v. Valley Hospital* (1983) 147 Cal.App.3d 119, 125; *McGlothlen v. Department of Motor Vehicles* (1977) 71 Cal.App.3d 1005, 1015-1016; *Agostini v. Strycula* (1965) 231 Cal.App.2d 804, 806; *Rodas v. Spiegel* (2001) 87 Cal.App.4th 513, 518.)

Exhibits A, D, and E reflect actions taken by CARB, a part of the California Environmental Protection Agency, an organization which reports directly to the Governor's Office in the Executive Branch of California State Government. Exhibit B reflects actions considered by the Strategic Growth Council, a cabinet level committee formed by State legislation to coordinate various State agency activities, and Exhibit C reflects action considered by the City of Daly City Planning Commission, a subdivision of the State. All of the Subject Documents are therefore records of actions considered or taken by administrative agencies. (Evid. Code, § 200 ["public entity" includes cities, counties, districts, public authorities, public agencies, or any other political subdivision or public corporation]; *Garcia v. Four Points Sheraton LAX* (2010) 188 Cal App 4th 364, 377, fn. 8

[appropriate for reviewing court to take judicial notice of official local government actions].)

The Subject Documents are judicially noticeable as acts of administrative agencies. (See *Casella v. SouthWest Dealer Services, Inc.* (2007) 157 Cal.App.4th 1127, 1137 [judicial notice appropriate for government agency publications]; *Gillis v. Dental Bd. of California* (2012) 206 Cal.App.4th 311, 316, fn. 3 [judicial notice appropriate for board guidelines]; *Rodas v. Spiegel* (2001) 87 Cal. App. 4th 513, 518 (2001) ["Official acts include records, reports and orders of administrative agencies."]; *Monk v. Ehret* (1923) 192 Cal. 186, 193; *Kaufman & Broad Communities, Inc. v. Performance Plastering, Inc.* (2005) 133 Cal.App.4th 26, 30; *Sockup v. Law Offices of Herbert Hafif* (2006) 39 Cal.4th 260, 280, fn. 9 [legislative and regulatory history is the proper subject matter of judicial notice pursuant to Evidence Code section 452, subdivision (c)].)

III. The Court Should Take Judicial Notice of the Subject Documents as Matters Not Reasonably Subject to Dispute, Pursuant to Evidence Code Section 452, Subdivision (h).

The Subject Documents are subject to judicial notice pursuant to Evidence Code section 452, subdivision (h), in that the documents are "capable of immediate and accurate determination by resort to resources of reasonably undisputed accuracy." (Evid. Code, § 452, subd. (h).) Specifically, each of the Subject Documents is available via the administrative agencies' official websites, as identified above. Reports and records made available on an agency's official website are judicially noticeable. (*Shaw v. People ex rel. Chiang* (2009) 175 Cal.App.4th 577, 606, fn. 10 [judicially noticing content located on an agency's website as "official acts and public records"]; *In re Sodersten* (2007) 146 Cal.App.4th 1163, 1171, fn. 1 [granting judicial notice of records posted on a public entity's "official Web site"].) The accuracy of the Subject Documents is not reasonably subject to dispute, and the accuracy of the Subject

Documents is immediately determinable by visiting the agencies' websites identified above. Therefore, the court should take judicial notice of Subject Documents pursuant to Evidence Code section 452, subdivision (h).

For each of these reasons, the Agencies respectfully request this Court take judicial notice of the Subject Documents attached hereto.

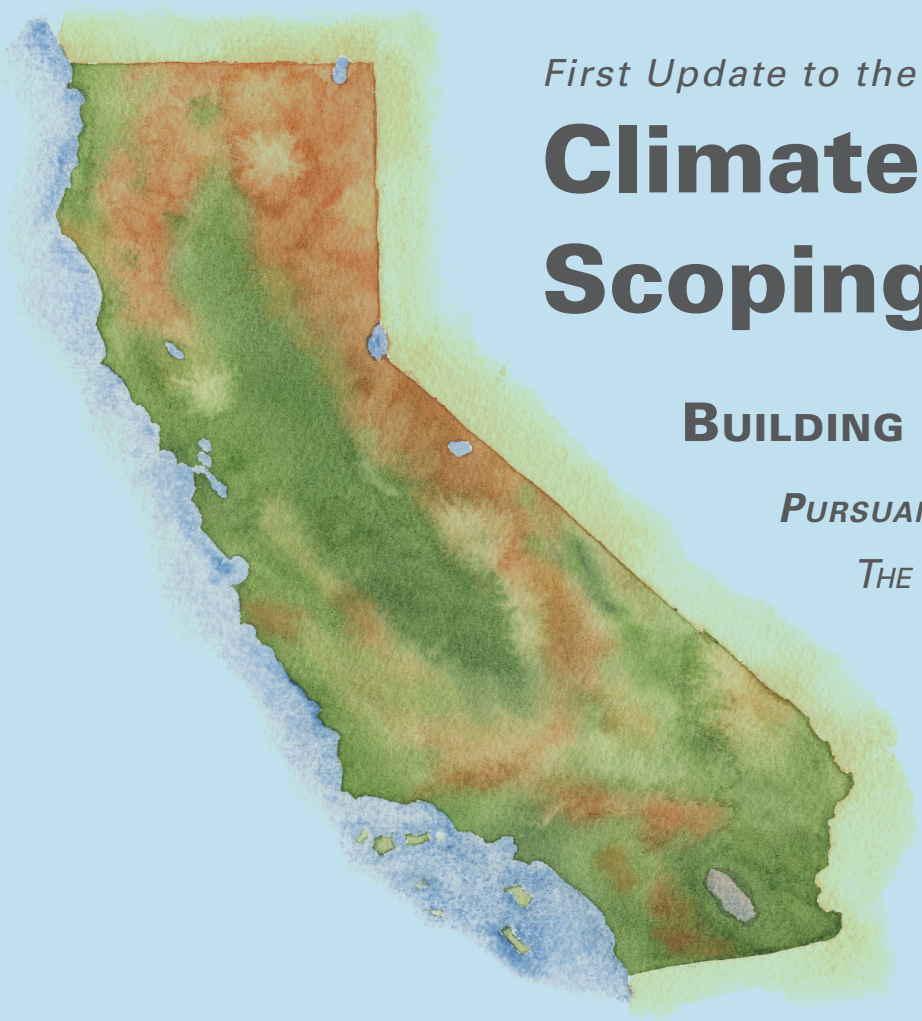
Dated: November 23, 2015

Tina A. Thomas
Amy R. Higuera
THOMAS LAW GROUP

By: _____/s/_____
Tina A. Thomas
Attorneys for Respondents

EXHIBIT A

May 2014



First Update to the

Climate Change Scoping Plan

Building on the Framework

Pursuant to AB 32

The California Global Warming Solutions Act of 2006

First Update to the

Climate Change Scoping Plan

Building on the Framework

Pursuant to AB32
The California Global Warming Solutions Act of 2006

Edmund G. Brown Jr.
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Matt Rodriquez
Secretary, California Environmental Protection Agency

Mary D. Nichols
Chairman, Air Resources Board

Richard W. Corey
Executive Officer, Air Resources Board

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Executive Summary

California is a collection of farmers, surfers, factory workers, outdoor enthusiasts, tech geeks, truckers, world-class researchers, celebrity actors, and many more—who come from all around the world to live and work in one of the most beautiful, vibrant, and ecologically and culturally diverse places on Earth. We are sustained, in more ways than one, by the mountains, deserts, rivers, streams, forests, farmlands, rangelands, coastline, and temperate climate that form our natural environment and characterize our great State.

These resources, and their natural beauty, enable our continued economic and cultural growth. They attract a wide array of businesses and workers who want to live here. They are a primary reason that California is: the eighth largest economy in the world; home to the most small businesses, Fortune 500 companies, and fastest-growing businesses in the United States; the national leader in global trade and direct investment; and tops in the United States in many economic sectors, including agriculture, biotech, clean energy, entertainment, high-tech, manufacturing, tourism, and more.

Accordingly, Californians of all backgrounds and political persuasions have supported policies and planning to protect our natural environment and the high quality of life it provides. The result is a decades-long, broad commitment to ensuring clean air and water, an efficient and productive use of energy and resources, a healthy workforce, and vital cities and towns. Our collective will to protect the environment is a valuable resource in itself, whose benefits enhance economic growth and prosperity in our state and help shape California's distinct identity.

With climate change threatening our resources, economy, and quality of life, California is squarely focused on addressing it and protecting our natural and built environments. Just as California has done dozens of times before on other environmental issues, it is leading on climate change, with an approach that will enable better, lasting economic growth and allow the California lifestyle to endure.

The 2006 adoption of Assembly Bill 32 propelled California further into an international leadership role in the fight against global climate change. By building on decades of successful actions to cut pollution and promote cleaner and more efficient energy, AB 32 solidified California's commitment to tackling climate change in a comprehensive way.

Since 2006, the State has continued to steadily implement a set of actions that are driving down greenhouse gas (GHG) emissions, cleaning the air, diversifying the energy and fuels that power our society, and spurring innovation in a range of advanced technologies. These efforts have put California on course to achieve the near-term 2020 emissions limit, and have created a framework for ongoing climate action that can be built upon to maintain and continue reductions beyond 2020 as required by AB 32.

California's approach to climate change is not simply about reducing greenhouse gas emissions. It is built upon the principle that economic prosperity and environmental sustainability are one and the same. And it continues the State's long and successful legacy of building a world-class economy in concert with some of the most effective environmental and public health policies on the planet.

By remaining steadfastly committed to this approach, we can not only do our part to tackle climate change, we can also forge a cleaner, healthier, and more sustainable future for all Californians.

In the words of Governor Brown, our collective challenge is to "build for the future, not steal from it." That is what this Plan is designed to do.

First Update to the Climate Change Scoping Plan

This First Update to California's Climate Change Scoping Plan (Update) was developed by the Air Resources Board (ARB) in collaboration with the Climate Action Team and reflects the input and expertise of a range of state and local government agencies. The Update reflects public input and recommendations from business, environmental, environmental justice, and community-based organizations provided in response to the release of prior drafts of the Update, a Discussion Draft in October 2013 and a draft Proposed Update in February 2014.

Progress to Date

California is on track to meet the near-term 2020 greenhouse gas limit and is well positioned to maintain and continue reductions beyond 2020 as required by AB 32. The set of actions the State is taking is driving down greenhouse emissions and moving us steadily in the direction of a cleaner energy economy. Many of these actions have been bold, ambitious, and truly trail-blazing. Some are more recent, while others precede the passage of AB 32.

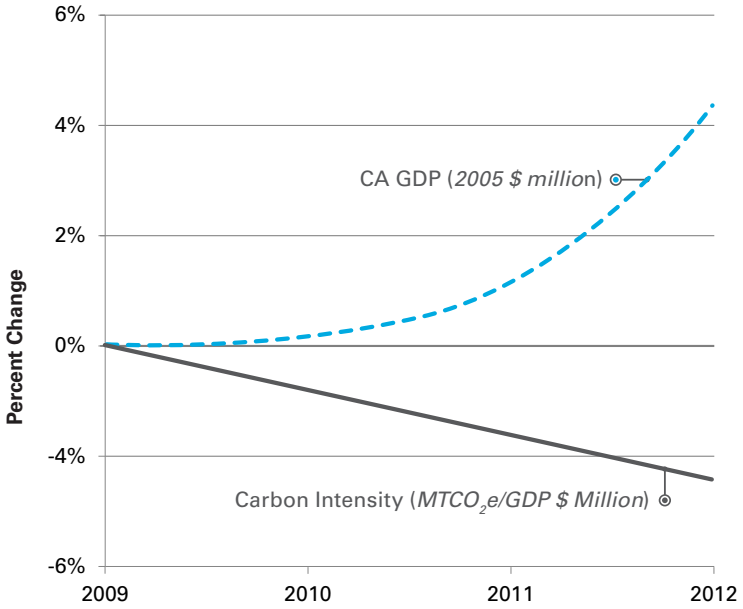
Collectively, these actions are evidence of California's ability to show that it is possible to break the historical connection between economic growth and associated increases in energy demand, combustion of carbon-intensive resources, and pollution. We have shown it is possible to break this chain by relying on cleaner technologies, more efficiency, and more renewable energy sources. And we know that preventing the worst impacts of climate change will require accelerated development and diffusion of these technologies across the world. Stable, flexible, yet durable policies like those developed under AB 32 are key.

Cleaner and More Efficient Energy

California continues to be a global leader in energy efficiency. Since energy efficiency efforts began 40 years ago, Californians have saved $74 billion in reduced electricity costs. As the State's first priority for providing for its energy needs, ongoing efficiency efforts—like new green building standards now in effect for homes and businesses and new standards for appliances, televisions, and other "plug loads"—continue to reduce energy use and emissions, make our businesses and economy more efficient, and cut energy costs.

California has also made tremendous strides in harnessing its abundant renewable energy resources. Currently, about 23 percent of the State's electricity comes from renewable power. This will increase to at least 33 percent by 2020 under new requirements set in place by Governor Brown and the Legislature in 2011. Renewable energy is rapidly coming down in cost and is already cost-effective in California for millions of homes and businesses, and in certain utility applications. Once thought of as exotic and alternative, renewable energy technologies have now become an integral part of California's energy mix.

Figure ES1: 2009-2012 CA GDP & Carbon Intensity Trends



'Carbon Intensity,' the amount of carbon pollution related to the State's economy, has fallen steadily over the last three years. California is getting more economic growth for each ton of greenhouse gases emitted overall.

Source: DOF & 2012 GHG Inventory

Cleaner Transportation

California has taken a number of innovative actions to cut emissions from the transportation sector. Collectively, the State's set of vehicle, fuels, and land use policies will cut in half emissions from passenger transportation and drivers' fuel costs over the next 20 years.

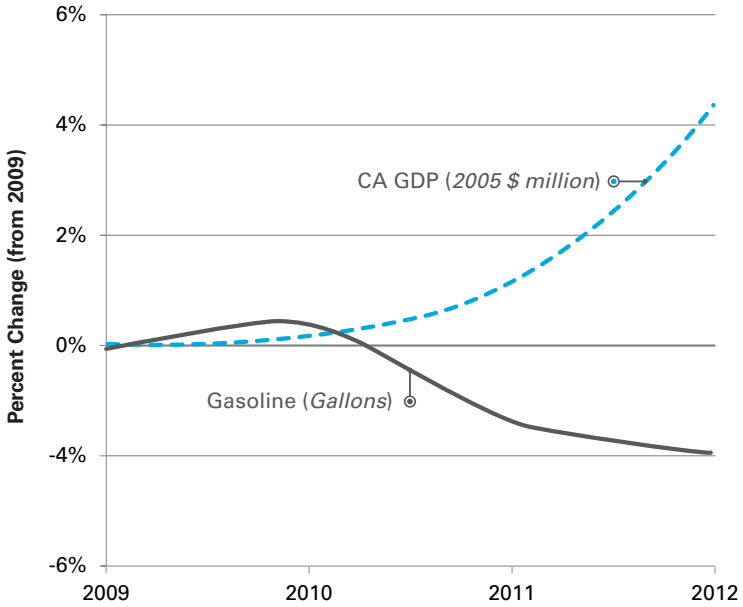
California's Low Carbon Fuel Standard (LCFS) is beginning to drive the production of a broad array of cleaner fuels. Since its launch in 2011, the regulation has generated a multitude of unique approaches for cleaner fuels. The LCFS is driving the necessary transition to cleaner fuels and is providing California businesses and consumers with more choices for the fuels they use. Companies in California and elsewhere are rising to the challenge by finding innovative ways to produce cleaner, low carbon fuels.

The cars on California's roads are also undergoing a transformation. California's vehicle GHG standards—authorized by AB 1493 (Pavley) in 2002, first approved in 2004, and extended in 2012—are delivering both carbon dioxide (CO_2) reductions and savings at the pump. These standards are now federal law and the benefits of California's policies will be realized nationwide, dramatically scaling up emission reductions. The transition to a fleet of lower-emitting, more-efficient vehicles in California will continue beyond 2020, as these rules cover model years through 2025, and turnover of the fleet will deliver additional benefits from these rules for many more years. Most recently, ARB is working with the U.S. EPA and the U.S. Department of Transportation's National Highway Traffic and Safety Administration (NHTSA) on national GHG standards and corresponding fuel efficiency standards for medium- and heavy-duty trucks.

California's pioneering zero emission vehicle (ZEV) regulation is also driving a transformation of the fleet. As a result of ARB's ZEV program and Governor Brown's Executive Order B-16-12, California will see 1.5 million zero emission vehicles on the State's roads by 2025. Each day, more and more zero emission vehicles and cleaner, more efficient cars are driving on our streets and highways—visible signs of the transformation of California's transportation sector.

California is also making major strides toward reducing the number of miles people drive, through more sustainable local and regional housing, land use, and transportation planning. To date, seven Metropolitan Planning Organizations have adopted Sustainable Community Strategies. In addition to helping drive GHG emission reductions, these plans will help create more livable communities that offer greater housing and transportation options; improved access to resources and services; safer, more vibrant neighborhoods; and healthier lifestyles where people can live, work, and play without having to travel long distances or sit through congestion.

Figure ES2: 2009-2012 CA GDP & ON-Road Gasoline Use Trends



The amount of gasoline used in California has steadily declined since 2009 while the the State's economy grew by five percent over the same time period.

Source: DOF & BOE

Cap-and-Trade Program

Last year, California successfully launched the most comprehensive greenhouse gas Cap-and-Trade Program in the world. As the emissions cap is gradually reduced over time, and as additional sources are brought under the cap to include the vast majority of emissions in the State, the program will ensure that California remains on track to continually reduce emissions and meet the 2020 limit. Looking out into the future, the Cap-and-Trade Program will play a critical role in keeping California on the right emissions reduction trajectory to meet ongoing reduction targets at the lowest possible cost. The program is also sending a clear signal that investment in clean, low carbon technologies will pay off. This includes the millions of households and small business customers of the State's largest electric utilities who will see a twice a year "Climate Credit" on their electricity bills. In April 2014, this credit averaged $35 throughout the State. Investing this credit in simple items that improve energy efficiency, such as energy efficient LED light bulbs, can help customers save even more.

On January 1, 2014, California linked its Cap-and-Trade Program with Québec's. By successfully linking cap-and-trade programs across jurisdictions and increasing opportunities for emission reductions, this linkage represents another important step in California's efforts to collaborate with other partners around the globe to address climate change.

Building on the Framework

Through AB 32, California has established an effective framework for climate action. This Update includes an in-depth discussion of climate change science, reflecting the Intergovernmental Panel on Climate Change's recently released Fifth Assessment and input from a distinguished team of scientific expert reviewers. The science clearly highlights the need for action—greenhouse gas emissions must be cut 80 percent below 1990 levels by mid-century to stave off the worst impacts of climate change. Setting a mid-term target and sector-specific targets will help guide our path.

Reaching our ultimate objective—reducing California's greenhouse gas emissions to the scientifically recognized level necessary for climate stabilization— will require California to keep building on the framework by continuing to pursue the maximum technologically feasible and cost-effective actions that will steadily drive down greenhouse gas emissions over the coming decades. It is also clear that many of these same actions are needed to reduce emissions of smog-forming and toxic pollutants to meet federal air quality requirements and ensure that all Californians have healthful air.

This Update lays out a set of new actions that will move the State further along the path to a low-carbon, sustainable future, including specific recommended actions with lead agency assignments and anticipated due dates. Some of the actions are near-term, while others are focused on longer-term efforts that will provide major benefits well into the future.

Every major economic sector in the State will need to play an increasing role in this effort. Success will require the creation of new policies in some sectors, and expanding and refining existing policies in others. We must continue working to find the right combination of policy-based "push" and incentive-based "pull" to accelerate commercial markets for clean energy and efficiency. And we have to coordinate and align public investments in ways that most effectively leverage private resources.

The Great Unifier

Climate change presents an unprecedented set of challenges for California. We are already experiencing its impacts and know that they will only increase. But it can also be a great unifier. It gives us the opportunity to focus on doing more with less; to work across programmatic, policy and political boundaries; and to figure out ways to achieve various goals more quickly and more effectively. The task is to continue building on the steps we have already taken by further integrating climate thinking and sustainability programming into the range of actions we take to grow the economy, protect the environment and public health, and plan for the future.

The strategies we pursue to cut greenhouse gas emissions from our cars, trucks, buses, trains and industries can support ongoing efforts to improve air quality up and down the State, especially in our most heavily impacted communities. Efficiency and conservation programs in the water sector needed to cut emissions will also drive critically needed efforts to enhance supply and reliability priorities. We can cut emissions from our waste stream while also increasing home-grown sources of low-carbon energy and fuels. And we can manage our natural lands and valuable agricultural resources in ways that both achieve climate objectives and enhance their long-term sustainability.

With strategic investment and coordinated policy-making, California can slash emissions from trucks and trains while at the same time building a world-class goods movement and freight-delivery system. We can modernize our rail and passenger transportation systems to move people in ways that both reduce greenhouse gases and increase mobility options and safety. We can take actions to cut emissions of potent short-lived climate pollutants that will also deliver key public health benefits. And we can align strategies that both support reduction goals and bolster our ability to deal with the impacts of climate change already underway.

The reality is that while climate change demands it, these and myriad other examples described in this Update are exactly the types of actions California must take in any case to build for our future.

Mid-Term Target

As supported by many of California's climate scientists and economists, a key step needed to build on California's framework for climate action is to establish a mid-term statewide emission reduction target. Cumulative emissions drive climate change, and a continuum of action is needed to reduce emissions not just to stated limits in 2020 or 2050, but also every year in between. The target will ensure that the State stays on course and expands upon the successes we have achieved to date so that we can achieve our long-term objective of reducing California's greenhouse gas emissions to the scientifically recognized level necessary for climate stabilization. A mid-term target, informed by climate science, will be critical in helping to frame the additional suite of policy measures, regulations, planning efforts, and investments in clean technologies that are needed to continue driving down emissions. It will also send a clear signal that California is solidifying its commitment to a low-carbon future, giving businesses the long-term certainty they need to plan for the future.

Each of the major sectors highlighted in this Update must play a role in supporting the statewide effort to continue reducing emissions. As steps are taken to develop a statewide target, sector targets will also be developed that reflect the opportunities for reductions that can be achieved through existing and new actions, policies, regulations and investments.

Sector-Specific Actions

Energy

The actions outlined in this Update support California's efforts to build a state-of-the-art energy generation, supply and distribution system that is clean, affordable and reliable. Many of the actions expand upon existing policy frameworks that have made our State a global leader in areas like energy efficiency, demand response, and renewable energy generation. Others reflect the need to incorporate new and rapidly evolving technologies like energy storage, demand response, and a smarter grid into the fabric of California's energy system.

A core element of the Update is the development of a comprehensive greenhouse gas reduction program for the State's electric and energy utilities by 2016. This approach will enable California to pull together and coordinate a range of policies, technologies, and investments needed to achieve the most cost-effective emission reductions across the sector, in line with meeting mid-term and long-term statewide targets. It also will give utilities, electricity providers and a range of other businesses the flexibility and the right incentives to pursue the most innovative strategies to cut emissions.

Transportation, Land Use, Fuels, and Infrastructure

Over the past several decades, California has pioneered a host of innovative policies in the transportation sector that have cut air pollution and greenhouse emissions. This Update builds on a set of existing policies and lays out new strategies that will continue to push down emissions and scale up clean, advanced technologies across the entire transportation sector. It calls for targeted investment in critical infrastructure projects that will be necessary to keep California on track to meet our ongoing climate objectives. And it recognizes the need to closely integrate climate planning with efforts to meet California's air quality goals.

Meeting California's long-term air quality and climate objectives will require the State to continue building on efforts underway to put more low and zero-emission vehicles on the road. These efforts also need to be expanded to include an increasing focus on cleaner medium- and heavy-duty vehicles. At the same time, we must continue working to figure out the right mix of policies and incentives for increasing reductions in the carbon content of transportation fuels. And we must invest in building the cleanest, most advanced systems and infrastructure to move people and goods in the State. Key approaches to this include high speed rail and the Sustainable Freight Initiative.

Agriculture

California's agricultural industry provides hundreds of thousands of jobs and tens of billions of dollars in economic value to the State each year. The long-term sustainability of the sector is vital to California's economic future. This Update describes a set of actions to ensure California's agricultural sector continues to thrive in the face of a changing climate and plays a key role in the State's efforts to continue reducing greenhouse emissions.

There is a range of opportunities for greenhouse gas emission reductions and sequestration in the agriculture sector. Technological advancements allow for more precise irrigation techniques, which cut energy costs and preserve valuable water resources. Strategic approaches to conservation will keep valuable agricultural lands in operation and help eliminate greenhouse gas emissions that result from conversion. And capturing methane from agriculture operations will provide climate benefits while also affording opportunities to produce bioenergy and biofuels. The coordinated effort to develop the right mix of policies and incentives described in this Update will help keep California's agriculture sector thriving into the future.

Water

Water is the lifeblood of our State and economy, and integrally connected to our food supply and energy systems. With the declaration of a drought emergency, the State needs to employ a range of approaches that will cut emissions, maximize efficiency and conservation, and enhance water quality and supply reliability, while also addressing growing climate resiliency requirements.

A greater focus on integrated policy design in the water sector is needed as California implements strategies that will support our State's longer-term climate objectives. State policy and regulatory frameworks must be developed that allow for, and incentivize, effective regional integrated planning and implementation. We need to employ pricing policies that will maximize efficiency and conservation efforts in the water sector, and put in place mandatory conservation measures to reduce greenhouse gas emissions and maintain water supply reliability during drought periods.

Waste

California's goal of reaching 75 percent recycling and composting by 2020 provides an opportunity to achieve substantial GHG emission reductions across the waste sector, while providing other significant economic and environmental co-benefits. Much of what is traditionally considered "waste" can be a resource for other uses. California must take advantage of waste materials to generate energy to power our homes and cars, and to improve our working lands.

Compostable organics represent over a third of California's disposed waste, and are the primary source of fugitive methane emissions at landfills. A new organics management approach for California that will divert this material to minimize emissions at landfills and provide feedstock for critically needed alternatives to agricultural amendments and for low carbon fuel manufacturing.

Achieving the 75 percent waste diversion goal will require substantial expansion of the collection, recycling, and manufacturing industries within California. This Update sets forth a series of actions to support this industrial growth and calls on California to manage its waste at home in ways that will support greenhouse gas emission reductions, environmental co-benefits, and job growth.

Natural and Working Lands

Three-quarters of California's landmass comprises biologically diverse landscapes such as forests, woodlands, shrublands, grasslands and wetlands. These natural and working lands provide a multitude of economic and environmental benefits, and must play an increasingly important role in California's efforts to prepare for and adapt to the impacts of climate change. Natural and working lands must also play a key role to help achieve California's long-term climate objectives. We have to start investing now in strategies that ensure these lands are managed in ways that maximize their carbon benefits while also ensuring landscape resilience; protecting and enhancing the State's water supplies; safeguarding the State's wildlife, fish, and plants; and promoting sustainable rural communities.

This Update describes a series of policies, actions, and strategic investments to enhance, protect, and conserve California's natural and working lands in ways that will provide important climate benefits as well as a more resilient California that is better prepared for climate risks such as more frequent and severe wildfires, varying and unpredictable water availability, and stressors on species and natural communities. A key element of this approach is the development of a "Forest Carbon Plan" by 2016 that will set mid and long-term greenhouse gas reduction planning targets, and identify funding and investment needs.

Short-Lived Climate Pollutants

Over the past several decades, California's actions to improve air quality and protect public health have resulted in significant reductions in potent short-lived climate pollutants, which include black carbon, methane, and hydrofluorocarbons. These pollutants remain in the atmosphere for shorter periods of time and have much larger global warming potentials compared to CO_2.

While we must continue taking steps to rapidly reduce CO_2 emissions, additional efforts to cut emissions of short-lived climate pollutants can yield immediate climate benefits. In addition, fast and sustainable actions to reduce these emissions can help to achieve other benefits though avoided impacts on agriculture, water availability, ecosystems, and human health. The reduction of methane would reduce background tropospheric ozone concentrations, which would help with progress towards healthy air quality and avoid crop yield losses and forest damage due to the direct action of ozone on plant growth. Black carbon impacts cloud formation and precipitation, and black carbon deposits on glaciers and snowpack accelerate melting. Reducing black carbon and methane emissions will help reduce the risk for premature deaths, air pollution-related hospitalizations, and associated medical expenses each year.

California is committed to continuing to reduce emissions of short-lived climate pollutants, particularly where efforts will result in air quality and public health co-benefits. ARB will develop a short-lived climate pollutant strategy by 2015 that will include an inventory of sources and emissions, the identification of additional research needs, and a plan for developing necessary control measures.

Green Buildings

Buildings in California represent a significant source of greenhouse gas emissions. Over the past five years, California has solidified its commitment to green building; leading the way with State buildings, improving building standards, continuing to raise the bar with voluntary programs at the local level, and greening existing buildings. We must continue to build on this approach by ensuring successful implementation of current initiatives and expanding the long term focus towards zero-carbon buildings.

This Update describes a set of actions to continue cutting emissions from California's building sector including the development of a comprehensive greenhouse gas emission reduction program for new construction, existing building retrofits, and operation and maintenance. This Update describes a set of actions to continue cutting emissions from California's building sector including the development of a comprehensive greenhouse gas emission reduction program for new construction, existing building retrofits, and operation and maintenance of certified green buildings.

Courage, Creativity, and Boldness

Climate change has presented us with unprecedented challenges—challenges that cannot be met with traditional ways of thinking or conventional solutions. As Governor Brown has recognized, meeting these challenges will require "courage, creativity, and boldness."

It will require California to continue to lead the world in pioneering effective strategies toward a cleaner, more sustainable economy. It will require us to continue sharing our successful approaches to climate policy with others, including continuing to partner and collaborate with other state, national, and global leaders as we work toward common goals. And it will require further engaging California's citizens, businesses, and its most creative minds to continue building a state that provides low carbon, high-quality lifestyles.

As we take these steps, we understand that we don't have all of the answers today. But, we are on the right path. We have a framework for action in place that is driving down emissions, spurring innovation across a range of clean and advanced technology sectors, improving the air Californians breathe, and creating more livable communities. By building on this framework with the set of actions outlined in this Update, we can do our part to meet the challenge of global climate change, and in the process, continue to build the clean, sustainable future that all Californians deserve.

I. Introduction: Building on the Framework

This Scoping Plan Update builds upon the successful framework established by the initial Scoping Plan by outlining priorities and recommendations for the State to achieve its long-term climate objectives. The unified approach in this Update describes actions for California to undertake to ensure it continues on a path toward a cleaner, more sustainable and prosperous future. This approach is designed to ensure the State is able to meet its long-term climate objectives that will achieve continual emission reductions in the most cost-effective ways, while simultaneously supporting a range of economic, environmental, water supply, energy security, environmental justice, and public health priorities.

Assembly Bill 32 (AB 32), the California Global Warming Solutions Act of 2006 (AB 32, Statutes of 2006, Chapter 488) declares that global warming poses a serious threat to the economic well-being, public health, natural resources, and environment of California and charges the California Air Resources Board (ARB) with "monitoring and regulating sources of emissions of greenhouse gases that cause global warming in order to reduce emissions of greenhouse gases" (Health and Safety Code section 38510). AB 32 provided initial direction on creating a comprehensive multi-year program to limit California's greenhouse gas (GHG) emissions at 1990 levels by 2020 and initiate the transformations required to achieve the State's long-range climate objectives. One specific requirement is to prepare a "scoping plan" for achieving the maximum technologically feasible and cost-effective GHG emission reductions by 2020 (Health and Safety Code section 38561(a)). ARB is required to update the plan for achieving the maximum technologically feasible and cost-effective reductions in GHG emissions at least once every five years (Health and Safety Code section 38561(h)). The language of AB 32 is included in Appendix A.

The initial Scoping Plan was approved in 2008, as required by AB 32, and reapproved in 2011. The initial Scoping Plan contained a mix of recommended strategies that combined direct regulations, market-based approaches, voluntary measures, policies, and other emission reduction programs calculated to meet the 2020 statewide GHG emission limit and initiate the transformations needed to achieve the State's long-range climate objectives. The passage of the Global Warming Solutions Act, and its ongoing implementation, has put California on a path to continually reduce GHG emissions by adopting and implementing regulations and other programs to reduce emissions from cars, trucks, electricity production, fuels, and other sources.

While the path to limit emissions to 1990 levels by 2020 is transformative in its own right, reducing emissions to meet the State's long-range objectives will require continued progress toward efficient clean energy in every sector of the economy and new opportunities to value and integrate agricultural, natural, and working lands into a comprehensive climate policy framework. The State's 2050 objective of reducing emissions to 80 percent below 1990 levels, as reflected in Executive Order S-3-05 and Governor Brown's Executive Order B-16-2012 (which is specific to the transportation sector), is consistent with an Intergovernmental Panel on Climate Change (IPCC)[1] analysis of the emissions trajectory that would stabilize atmospheric GHG concentrations at 450 parts per million carbon dioxide equivalent (CO_2e) and reduce the likelihood of catastrophic climate change.

1 The IPCC is the leading international body for the scientific assessment of climate change established in 1988 under the auspices of the United Nations.

Continuing progress to the 2050 objective requires California to maintain and build upon its existing programs, scale up deployment of clean technologies, and provide more low-carbon options to accelerate GHG emission reductions, especially after 2020.

A. AB 32: California's Global Warming Solutions Act

Under AB 32, California has established a unique, broad program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective GHG emission reductions. Since 2006, ARB has carried out the following specific tasks required by AB 32:

- **Determine the 1990 GHG emission level to serve as the 2020 emission limit:** In December 2007, the Board approved the 2020 limit of 427 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) GHG emissions.
- **Adopt a regulation requiring GHG emission reporting:** In December 2007, the Board approved a regulation requiring the largest industrial sources in California to report and verify their GHG emissions.
- **Identify and adopt regulations that could be enforceable by January 1, 2010:** In 2007, the Board identified nine discrete early action measures, which have all been adopted.
- **Develop a scoping plan for achieving the maximum technologically feasible and cost-effective GHG emission reductions by 2020 and update the report every five years to continue to consider future achievement of maximum technologically feasible and cost-effective GHG emission reductions:** The first Scoping Plan was approved by the Board in 2008 and reapproved in 2011. This report is the first update to the Scoping Plan.
- **Maintain and continue GHG emission reductions beyond 2020:** This first update presents the priorities and recommendations for achieving the State's longer-term emission reduction objectives.

Meeting the State's climate objectives requires a coordinated and cohesive statewide strategy based on informed decisions that draw upon research, technology, infrastructure, the State's policy priorities, and potential co-benefits. Planning must continue to further align the State's longer-term GHG reduction strategies with other State policy priorities, including those related to economic development, water, waste, natural resources, agriculture, clean energy, transportation, and land use.

B. Building on California's Environmental Legacy

Just as California has done time and again over the past 40 years, the State is decoupling economic growth from pollution and waste. Continually, California has implemented rational, well-supported policies that have—among many other accomplishments—dramatically cut pollution from new cars, made its new buildings and appliances the most efficient in the country, phased out lead from gasoline and created the cleanest-burning transportation fuels in the world, phased out dirty coal- and oil-burning power plants, and brought entire new industries to life and clean technologies to market.

This progress did not come without battles, debates, or skepticism. But in each case, armed with strong scientific backing, California persevered, prevailed, and ultimately provided a case study to the world that proved a conventional wisdom false: Economic growth is not inherently linked to pollution, increasing energy consumption, or consumption of fossil resources.

California has successfully pioneered dozens of new energy and environmental policies that repeatedly demonstrate that economic growth does not have to be one of a set of trade-off considerations or come at a cost to future generations.

California's policy successes derive from the fact that, when faced with the certainty of reasonable policy, businesses innovate and successfully cut pollution with consumer-oriented solutions that drive their markets forward and continue economic growth. The result is fewer emissions, improved public and environmental health, and better products that allow industries and businesses to grow and flourish.

Many others throughout the world look to adopt or mimic California's leading policies and build similar markets for clean technologies. California is regarded as a global leader for developing successful policy solutions to deal with pressing environmental problems—whether it is other states or the federal government adopting California vehicle and fuel standards; subnational governments in Canada and Mexico looking to do the same; or delegations from countries in Europe, Asia, and Australia visiting to learn how we monitor and control air pollution, improve vehicle and building efficiency, develop smarter communities, and build markets for clean energy and fuels.

Through the Global Warming Solutions Act, California is continuing to lead with effective policies to address global climate change. Once again, we are proving conventional wisdom wrong, and showing that we can dramatically reduce emissions of GHGs while growing our economy.

Since the initial Scoping Plan was released, California has put in place a number of measures that have already led to significant emission reductions, and a transformation to a strong, stable low-carbon economy in California is under way. We are on the right path. Our actions are reducing GHG emissions, spurring innovation across a range of clean and advanced technology sectors, improving the air Californians breathe, and creating more livable communities. All the while, our economy continues to grow, and we continue to add jobs more quickly than the rest of the country. By continuing down this path, California will do its part to meet the challenge of global climate change, and in the process, continue to build the clean, sustainable future all Californians deserve.

SUCCESS STORY

Propel Fuels Moves to California

Propel Fuels is a renewable biofuels company which relocated to California specifically because of the economic opportunities created by AB 32's Low Carbon Fuel Standard (LCFS). The LCFS encourages investment in a wide variety of alternative transportation fuels, and Propel specializes in providing E85 (ethanol) flex fuel and other fuels. Part of Propel's unique business model involves placing its fuel pumps at already-existing gas stations. The company supplies individual motorists, truck operators and commercial vehicle fleets. Propel had $4.5 million in revenue in 2012, and was 42nd on Forbes Magazine's list of "Most Promising Companies".

However, we know we need to do more, and we need to move faster. The world is watching, just as it always has, and is banking on our success to spur broader action. It is critical that California continues to lead and implement successful policies that can expand beyond our borders.

C. Initial Scoping Plan

With the development of the initial Scoping Plan, California became the first state in the nation with a comprehensive set of GHG emission reduction strategies involving every sector of the economy. The measures and policies in the Scoping Plan set California on a trajectory toward a clean-energy future. The recommended reduction measures drive innovation, improve the environment, enhance public health, and support the growth of clean energy technologies and businesses. By moving first, California is well-positioned to lead in the race to develop the clean technology products, patents, and projects the global market demands and needs to address climate change.

The comprehensive approach in the initial Scoping Plan addressed key criteria, including technological feasibility, cost-effectiveness, overall societal benefits, and impacts on specific sectors such as small business and disproportionately impacted communities. The thorough planning process underlying the initial Scoping Plan and this Update helps to ensure that California meets its GHG reduction targets in a way that promotes and rewards innovation, helps to foster economic growth, and delivers improvements to the environment and public health, including in the most affected communities.

Key elements of the initial Scoping Plan included the following:

- Expand and strengthen energy efficiency programs, including building and appliance standards.
- Increase electricity generation from renewable resources to at least 33 percent of the statewide electricity mix by 2020.
- Establish targets for passenger vehicle-related GHG emissions for regions throughout California and pursue policies and incentives to achieve those targets. Included with this strategy is support for the development and implementation of a high speed rail system to expand mobility choices and reduce GHG emissions.
- Adopt and implement measures pursuant to existing State laws and policies, including California's clean car standards and the Low Carbon Fuel Standard.
- Develop a cap-and-trade program to ensure the target is met, while providing flexibility to California businesses to reduce emissions at low cost.

The initial Scoping Plan identified specific GHG emission reduction measures that would assist the State in meeting the 2020 limit. A discussion of the status of all of the Scoping Plan measures is included in Appendix B.

D. Purpose of Update

This Update identifies the next steps for California's leadership on climate change. While California continues on its path to meet the near-term 2020 greenhouse gas limit, it must also set a clear path toward long-term, deep GHG emission reductions. This report highlights California's success to date in reducing its GHG emissions and lays the foundation for establishing a broad framework for continued emission reductions beyond 2020, on the path to 80 percent below 1990 levels by 2050.

This first Update to the initial AB 32 Scoping Plan (Update) describes progress made to meet the near-term objectives of AB 32 and defines California's climate change priorities and activities

for the next several years. It also frames activities and issues facing the State as it develops an integrated framework for achieving both air quality and climate goals in California beyond 2020. Specifically, this Update covers a range of topics:

- An update of the latest scientific findings related to climate change and its impacts, including short-lived climate pollutants.
- A review of progress-to-date, including an update of Scoping Plan measures and other state, federal, and local efforts to reduce GHG emissions in California.
- Potential technologically feasible and cost-effective actions to further reduce GHG emissions by 2020.
- Recommendations for establishing a mid-term emissions limit that aligns with the State's long-term goal of an emissions limit 80 percent below 1990 levels by 2050.
- Sector-specific discussions covering issues, technologies, needs, and ongoing State activities to significantly reduce emissions throughout California's economy through 2050.
- Priorities and recommendations for investment to support market and technology development and necessary infrastructure in key areas.
- A discussion of the ongoing work and continuing need for improved methods and tools to assess economic, public health, and environmental justice impacts.

Progressing toward California's long-term climate goals will require that GHG reduction rates be significantly accelerated. Emissions from 2020 to 2050 will have to decline at more than twice the rate of that which is needed to reach the 2020 statewide emissions limit.

In addition to our climate objectives, California also must meet federal clean air standards. Emissions of criteria air pollutants, including ozone precursors (primarily oxides of nitrogen, or NO_x) and particulate matter, must be reduced by, a currently estimated, 90 percent by 2032 to comply with federal air quality standards. The scope and scale of emission reductions necessary to improve air quality is similar to that needed to meet long-term climate targets. Achieving both objectives will align programs and investments to leverage limited resources for maximum benefit.

Accelerating progress on this scale will require both continuation of existing policies and implementation of new ones to help significantly scale market adoption of the cleanest, most-efficient technologies. It will require a new approach to energy production and utilization, and strong mid-term targets to measure and guide the State's progress. This document outlines the challenges we face to achieve this vision, which will be the subject of ongoing climate and investment planning efforts in California in the coming years.

E. Process for Developing the Update

This Update was developed with input from State and local agencies, community and environmental justice organizations, and other interested stakeholders in an open and public process.

ARB held an initial public workshop in June 2013 to discuss preliminary concepts for this Update. As part of the workshop, ARB and other State agency representatives provided a vision for each focus area for 2050 and challenges that must be addressed to meet that vision. ARB and other State agencies also co-hosted public regional workshops with local air districts and metropolitan planning organizations throughout the State (Bay Area, South Coast, and San Joaquin Valley). The workshops were convened to discuss preliminary concepts for this Update (similar to the initial workshop) and to provide a local/regional perspective on both progress to date and regional priorities for California's climate program.

A discussion draft of the Update was released for public comment on October 1, 2013. The discussion draft was presented at a public meeting and a Board hearing later that month to further solicit public input. After consideration of comments received, staff released a draft Proposed Update on February 10, 2014, and presented it to the Board for discussion at its February 20, 2014, meeting. At that meeting, the Board directed staff to make specific changes to the draft report. A draft environmental analysis (EA) of the Proposed Update was released for a 45-day public comment period on March 14, 2014. After considering public comments received and Board direction, ARB staff released a final First Update, along with the summary of comments received on the draft EA and ARB's responses to those comments, and the final EA on May 15, 2014.

Under the guidance of the Climate Action Team, ARB and other State agencies collaborated during the development of the Update to identify and describe a long-term vision and near-term activities to put California on the path to its 2050 emission reductions goal. To help guide in this effort, ARB identified six key focus areas comprising major components of the State's economy to evaluate and describe the larger transformative actions that will be needed to meet the State's more expansive emission reduction needs by 2050.

Climate Action Team

California Environmental Protection Agency

Governor's Office of Planning and Research

California Air Resources Board

Business, Consumer Services, and Housing Agency

Government Operations Agency

California Natural Resources Agency

California Department of Public Health

Office of Emergency Services

California Transportation Agency

California Energy Commission

California Public Utilities Commission

Department of Food and Agriculture

Department of Forestry and Fire Protection

Department of Fish and Wildlife

Department of Transportation

Department of Water Resources

Department of Resources, Recycling and Recovery

State Water Resources Control Board

The focus areas include:

- Energy
- Transportation (Vehicles/Equipment, Sustainable Communities, Housing, Fuels, and Infrastructure)
- Agriculture
- Water
- Waste Management
- Natural and Working Lands

State agency focus area workgroups were created in 2013 to conduct these evaluations. Various State agencies took lead roles. For example, the California Energy Commission (CEC) took the lead for the energy sector and ARB took the lead for transportation. Each workgroup developed a working paper which formed the foundation upon which the agencies, with stakeholder input, identified recommendations for policy or program priorities for the next five years. Recommended action items for meeting the longer-term GHG emission reduction goals are presented in Chapter IV. The working papers are included in Appendix C.

AB 32 requires ARB to convene an Environmental Justice Advisory Committee (Committee) to advise it in developing the Scoping Plan and any other pertinent matters in implementing AB 32 (Health and Safety Code section 38591). The Board convened the Committee in 2007 to advise it

on the development of the initial Scoping Plan. The Board reconvened the Committee to advise it on the development of this Update. The Committee met four times from June 2013 to April 2014 to discuss the Update. The Committee focused their discussions on each Scoping Plan sector and developed comprehensive recommendations that ARB considered in drafting this Update. The Committee's "Final Recommendations on the Proposed AB 32 Scoping Plan" provided recommendations for each Scoping Plan sector and overarching environmental justice policy. The final recommendations included the need for monitoring and assessing potential impacts of the State's climate programs; a call for a 2030 target of, at a minimum, 40 percent reduction from 1990 levels and a 2040 target of, at a minimum, 60 percent reduction from 1990 levels; a call for California to reduce its energy use and transition to 100 percent renewable energy; financial support for transportation in disadvantaged communities; and amendments to the Cap-and-Trade Regulation that would exclude direct allocation and offset credits. The Committee's final recommendations are included in Appendix E.

ARB also convened a panel of economic experts to serve as advisors during the development of this Update and provide recommendations for evaluating the economic impacts associated with AB 32. The advisors were invited to participate in teleconferences, review draft documents, and provide feedback to ensure that the economic impacts of programs implemented under AB 32 are analyzed with the best available data and methods. ARB consulted with the advisors on the best means of assessing economic impacts to date, as well as estimating future impacts of existing or new emission reduction strategies. ARB will continue to seek expert economic advice in the evaluation of the impacts of AB 32 and the Scoping Plan on California's economy as the program continues to be implemented.

In addition, a group of distinguished scientists with expertise in observed climate change in California, projection of future climate change impacts, and short-lived climate pollutants, provided input on the latest climate science discussion in the Update.

ARB also held numerous meetings and conference calls with individuals and stakeholder groups such as industry associations, environmental groups, tribes, and small businesses on specific issues or recommendations to address in this Update.

II. Latest Understanding of Climate Science

The latest climate science further underscores the urgent need to accelerate GHG emission reductions to avoid the most severe impacts of climate change. Focusing on additional measures to reduce emissions of climate-warming pollutants with shorter atmospheric lifetimes (known as short-lived climate pollutants) could provide immediate air quality and public health benefits while helping to slow the rate of human-caused climate change.

Scientific Expert Reviewers

Dr. Daniel Cayan	*Scripps Institution of Oceanography, UC San Diego and U.S. Geological Survey*
Dr. Michael Prather	*UC Irvine*
Dr. V. Ramanathan	*Scripps Institution of Oceanography, UC San Diego*

Climate scientists agree that global warming trends and other shifts in the climate system observed over the past century are almost certainly attributed to human activities and are proceeding at a rate that is unprecedented when compared with climate change that human society has lived through to date. Climate change is measured by examining recent shifts in the features (statistics, including extremes) that are associated with average weather, such as temperature, wind patterns, and precipitation, plus long-term trends in the great ice sheets, Arctic sea ice, and mean sea level. Since the development of the Scoping Plan, even stronger scientific evidence continues to mount that document that the climate is changing and that its impacts are widespread and occurring now. This evidence includes rising temperatures, shifting snow and rainfall patterns, and increased incidence of extreme weather events. To ensure that this new evidence on the impacts of climate change is accurately summarized, this chapter was reviewed by a group of distinguished scientists with expertise in observed climate change in California, projection of future climate change impacts, and short-lived climate pollutants.

The recently released Summary for Policymakers (SPM)[2] portion of Working Group I (WGI), the first in a series of reports comprising the IPCC Fifth Assessment Report (AR5), affirms that the planet is warming, that human beings are "extremely likely" (indicating 95 percent certainty) to be the primary cause, and that some of the impacts of greatest concern, such as glacial melting, are accelerating at a faster pace than documented in previous assessments.

This understanding of the climate system in AR5 results from combining observations, theoretical studies of feedback processes, and model simulations. Compared to earlier reports, more detailed observations and improved climate models now enable the attribution of detected changes to human influences in more climate system components and at higher spatial resolution. The consistency of observed and modeled changes across the climate system, including regional temperatures, the water cycle, the global energy budget, sea ice, and oceans (including ocean acidification) point to global climate change resulting primarily from human-caused increases in GHG concentrations.

2 *www.climate2013.org/images/report/WG1AR5_SPM_FINAL.pdf*

The IPCC report notes a continued rate of global warming along with the increasing radiative forcing driven by greenhouse gases. The rate of global surface air temperature warming over the past 15 years—about 0.05°C per decade—has been slower than the average rate since 1951, but the last decade is still the warmest observed, and each of the last three decades has been successively warmer than any preceding decade since 1850. The key findings include:

Increased certainty on humans' role: Scientists are now more certain than ever that observed warming can be attributed primarily to human activities such as exploitation of fossil fuels and deforestation. The report underscores the growing body of scientific evidence confirming the serious detrimental impacts of increasing atmospheric GHG burden.

Accelerating impacts of climate change: Several indicators of climate change are advancing faster than found in previous assessments.

- ***Ice Loss:*** Arctic summer sea ice retreat was unprecedented and sea surface temperatures were anomalously high in comparison to at least the last 1,450 years. The melting of ice sheets over the past decade is happening several times faster than it was in the 1990s. Glacial melt has accelerated as well. There is high confidence that current glacier extents are out of balance with current climatic conditions, indicating that glaciers, ice sheets, and sea ice will continue to shrink in the future even without further temperature increases.
- ***Sea-Level Rise:*** The rate of sea level rise since the mid-nineteenth century has been larger than the mean rate during the previous two millennia. Over the period 1901 to 2010, global mean sea level rose by 7.48 inches (19 centimeters). Global mean sea level will continue to rise during the twenty-first century, and the rate of sea level rise will exceed that observed during 1971 to 2010 due to increased ocean warming (leading to the thermal expansion of the water) and increased loss of mass from glaciers and ice sheets.
- ***Ocean Acidification:*** Due to excess carbon dioxide in the atmosphere, the pH of seawater has decreased. This increased acidity poses risks to ocean ecosystems—the development of many shellfish, plankton, and other forms of ocean life—as well as to people who depend on oceans for their livelihood.
- ***Heat Waves:*** It is likely that human influence has already contributed to the observed changes in the frequency and intensity of daily temperature extremes on the global scale since the mid-twentieth century, and has significantly increased the probability of occurrence of heat waves in some locations.
- ***Air Quality:*** There is high confidence that warming is decreasing baseline surface ozone globally, but higher methane emissions are counteracting and overriding this impact. There is medium confidence that locally higher surface temperatures in polluted regions will increase peak levels of ozone and particulate matter 2.5 microns or smaller ($PM_{2.5}$), but a no confidence level is attached to the overall impact of climate change on $PM_{2.5}$.

As documented in the AR5 report, accumulating observations underscore the fact that the important parts of the climate system have a long memory. Continued emissions of GHG will cause further warming and changes in all components of the climate system. Cumulative emissions of CO_2 largely determine global mean surface warming by the late twenty-first century and beyond. Most aspects of climate change will persist for many centuries, even if CO_2 emissions are radically reduced. This represents a substantial multi-century climate change commitment created by past, present, and future CO_2 emissions. Limiting climate change will require substantial and sustained reductions of GHG emissions.

California is a large state that is particularly vulnerable to the effects of climate change. The State is facing a range of impacts, including increases in extreme heat, wildfires, drought, extreme storms, coastal flooding, and erosion, and reductions in the Sierra Nevada springtime snowpack. Climate change also threatens to affect water availability. Climate and hydrological models indicate that warming will likely diminish river discharge in the Colorado Basin as global

climate change advances over the next several decades. A new study[3] suggests that both the California drought and the polar vortex, two persistent extreme weather outcomes observed this past winter season, may be linked to the same underlying cause: climate change as a result of warming from the accumulation of GHGs. California's efforts to reduce GHG emissions and avoid the worst impacts of climate change must occur in parallel with planning for and adaptation to climate change that is already occurring, as well the climate change that is already in the pipeline out to 2050 and beyond, immaterial of future mitigation.

The climate effects of emissions from different climate-forcing pollutants vary in terms of both magnitude and duration. There is growing recognition, both from a scientific and regulatory perspective, that mitigation of short-lived climate pollutants would lead to immediate reductions in the rate of climate change. Although there is no precise definition of short-lived climate pollutants, these include pollutants such as black carbon, tropospheric ozone, methane, and hydrofluorocarbons, all of which will decay in the atmosphere on the order of days to decades. These timescales are much shorter than centennial time scale for CO_2, where about 40 percent of currently emitted CO_2 will remain in the atmosphere by 2100 and affect climate for centuries beyond. Black carbon (as a component of $PM_{2.5}$) and ozone are air pollutants with substantial health effects, and reducing their emissions can offer significant improvements in air quality and public health. In addition to the short-lived, local ozone precursors (NO_X, VOCs), methane is a global source of tropospheric ozone.

A. Continuing Evidence of Climate Change in California in Agreement with Projected Changes

Important climate change impacts are already being detected in California. California's Office of Environmental Health Hazard Assessment recently published the report, *Indicators of Climate Change in California*, which tracks trends in GHG levels, changes in the state's climate, and the impacts of climate change on California's environment and people.

Climate change is already affecting California's infrastructure, natural resources, and communities, with even larger impacts projected in the future.

Heat: More extreme hot days, fewer cold nights, and shifts in the water and growing cycles are already being observed in California. Sheridan and Kalkstein[4] project a marked increase in the number and duration of heat waves over the remainder of this century. For example, historically, in the populated areas of California, 14-day heat waves have occurred no more than once per year, with most locations not having any. By 2050, the frequency of 14-day heat waves is projected to increase up to tenfold. These increases will require a major effort to avoid heat-related death and illness, and will have a substantial effect on water and energy usage. Increases in ambient air temperature and the frequency of extreme heat events will reduce the efficiency of conventional power plants burning fossil fuels, and increase peak electricity demand for major cities for air conditioning.

Air Quality: Many Californians still experience air pollution levels that exceed health-based air quality standards. Climate warming would slow progress toward attainment of ozone air quality standards and increase pollution control costs by increasing the potential for high ozone days. A study[5] found that California could experience as many as six to thirty more days with ozone concentrations that exceed federal clean-air standards, depending on the extent of increased temperatures. In the southern California region, projected changes in ozone concentrations due

3 Wang, S.-Y., L. Hipps, R. R. Gillies, and J.-H. Yoon (2014), Probable causes of the abnormal ridge accompanying the 2013–2014 California drought: ENSO precursor and anthropogenic warming footprint, Geophys. Res. Lett., 41, doi:10.1002/2014GL059748. *http://onlinelibrary.wiley.com/doi/10.1002/2014GL059748/pdf*

4 Sheridan, S., and L. Kalkstein. 2011. A Spatial Synoptic Classification Approach to Projected Heat Vulnerability in California under Future Climate Change Scenarios. ARB contract #07-304. *www.arb.ca.gov/research/apr/past/07-304.pdf.*

5 Kleeman, M. J., S.-H. Chen, and R. A. Harley. 2010. Climate change impact on air quality in California: Report to the California Air Resources Board. *www.arb.ca.gov/research/apr/past/04-349.pdf*.

to climate change in the year 2050 could increase by 9 to 18 parts per billion. These studies reflect the increased efficiency of ozone production in a warmer climate, the potential for increased biogenic VOC emissions driven by higher temperatures, and increased tropospheric ozone levels due to higher methane emissions.

Wildfire Risks: Forest and wildland fires are becoming more frequent and intense, in part because dry seasons have started earlier and ended later. Since 1950, annual acreage burned in wildfires has been increasing in California. The three largest fire years occurred in the last ten years.[6] A recent study[7] estimated future wildfire activity over the western United States during the mid-twenty-first century (2046–2065). The results show that the fire season is expected to lengthen by 23 days in the warmer and drier climate at mid-century. Besides the damage to natural and managed systems, it was indicated that wildfire emissions would increase levels of summertime short-lived climate and air pollutants such as black carbon and $PM_{2.5}$.

Sea Level Rise: Sea levels have risen by six inches or more along much of the California coast over the last century, increasing erosion and pressure on the State's infrastructure, water supplies, and natural resources.[8] A 2012 report by the California Climate Change Center presented the state of the climate affairs in California, and discussed their impacts on the State's natural resources.[9] The report noted that, in addition to sea level rise and associated seawater intrusions, possible flooding from increased storm runoff from mountain catchments, and storm surges threaten freshwater supplies in the Sacramento–San Joaquin River Delta. Flooding also threatens existing levees and many low-lying areas in the Delta and Central Valley.[10] Critical infrastructure such as roads and highways, ports, harbors, airports, wastewater treatment facilities, and power plants are located in low-lying coastal areas. Coastal habitats such as beaches, dunes, cliffs, and bluffs could be lost to erosion, while groundwater aquifers could be impacted more widely than today by seawater intrusion and wetlands and bays could face permanent inundation.[11]

Sea level rise and increased storm frequency and intensity could also affect the operations of coastal power plants and coastal petroleum, natural gas, and transportation-related fuels infrastructure.

Agriculture: Agriculture is especially vulnerable to altered temperature, changing rainfall patterns, and new pest problems. Several scientific studies have been conducted that document the adverse impact that climate change is likely to have on crops and food supply. California agriculture is a nearly $40 billion dollar industry, and it generates at least $100 billion in related economic activity.[12]

Water Supply: Increased temperatures with decreased winter snowfall, as well as earlier snowmelt and greater rainwater runoff occurring earlier in the year, threaten the State's major water supply—the Sierra Nevada snowpack and timed downstream reservoir releases. Reduced snowpack puts greater pressure on the State's other major storage components, including water stored in reservoirs and groundwater aquifers. Lowering groundwater levels in turn create a greater energy demand to pump water from deeper wells and further reduce groundwater

6 Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. Indicators of Climate Change in California. August 2013. *www.oehha.ca.gov/multimedia/epic/2013EnvIndicatorReport.html*.

7 Yue, Xu et al. 2013. "Ensemble projections of wildfire activity and carbonaceous aerosol concentrations over the western United States in the mid-21st century." Atmospheric Environment 77: 767-780.

8 National Research Council Report. 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. National Academies Press. *www.nap.edu/catalog.php?record_id=13389*.

9 California Climate Change Center. 2012. Our Changing Climate 2012, Vulnerability & Adaptation to the Increasing Risks from Climate Change in California. California Climate Change Center. *www.energy.ca.gov/2012publications/CEC-500-2012-007/CEC-500-2012-007.pdf*.

10 Knowles, N. 2010. "Potential inundation due to rising sea levels in the San Francisco Bay region." San Francisco Estuary and Watershed Science 8:1.

11 Cayan, D., M. Tyree, and S. Iacobellis. 2012. Climate Change Scenarios for the San Francisco Region. California Energy Commission. Publication number: CEC-500-2012-042.

12 Jackson, L. E., et al. 2011. "Case study on potential agricultural responses to climate change in a California landscape." Climatic Change 109 (Suppl 1): S407–S427.

contribution to rivers and streams exacerbating other impacts. Reduced Sierra Nevada snowpack and diminished runoff and water flows in late spring and summer will adversely affect hydroelectric generation and operation of the California State Water Project.[13]

As California continues to reduce GHG emissions, it is also taking steps to prepare for the impacts of climate change. In 2009, the California Resources Agency developed the first Climate Change Adaptation Strategy for California in response to Executive Order S-13-2008. The Agency released a draft of California's climate adaptation strategy in December 2013.[14] The update summarizes current science on potential climate change impacts in California and outlines possible solutions that can be implemented within and across State and local agencies.

To effectively address the challenges that a changing climate will bring, policies to reduce emissions and prepare for climate impacts should be coordinated and complementary. In fact, some of the same strategies provide both mitigation and adaptation benefits. For example, better forest management reduces the incidence of catastrophic wildfire, which reduces emissions of GHGs and also increases the carbon sequestration capacity of the forests.

B. Achieving Climate Stabilization

Scientific research indicates that an increase in the global average temperature of 2°C (3.6°F) above pre-industrial levels, which is only 1.1°C (2.0°F) above present levels, poses severe risks to natural systems and human health and well-being. Considering knowledge from the paleo-climate record with changes currently observed in the Greenland and Antarctic ice sheets, we can expect substantial sea level rise, 0.4 to 0.8 meters, with upper end uncertainties approaching one meter above present day during the 21st Century and continued substantial increase after 2100 even with stringent mitigation of emissions to achieve 2°C stabilization. Increased climate extremes, already apparent at present day climate warming (~0.9°C), will no doubt be more severe. To have a good chance (not a guarantee) of avoiding temperatures above those levels, studies focused on a goal of stabilizing the concentration of heat-trapping gases in the atmosphere at or below the 450 parts per million (ppm) CO_2-equivalent (CO_2e, a metric that combines the climate impact of all well-mixed GHGs, such as methane and nitrous oxide, in terms of CO_2).

The CO_2e target is a somewhat approximate threshold, and the exact level of CO_2e is not precisely known because the sensitivity of the climate system to GHGs has uncertainty. Different models show slightly different outcomes within this range. An example of a pre-IPCC assessment study (Meinshausen et al. 2009)[15] which has synthesized many studies on climate sensitivities, concluded that we would need to stabilize at about 400 ppm CO_2e in order to likely avoid exceeding the 2°C threshold (even at that stabilization target, there is still about a 20 percent chance of exceeding the temperature target). Further, a recent paper by an international team of scientists (Hansen et al. 2013)[16] asserts that the widely accepted target of limiting human-made global climate warming to 2°C above preindustrial levels is likely too high and may subject future generations and nature to irreparable harm. Recognizing this fact, the international community agreed in meetings in Cancun in 2012 to review, by 2015, progress to the 2°C target and consider whether it should be strengthened to a 1.5°C threshold.

What is important to recognize in these studies of warming thresholds is the critical importance of non-CO_2 gases, particularly the short-lived climate pollutants. For example, to avoid 2°C warming at a 66 percent confidence level, total carbon emissions (as CO_2e) must be kept to

13 California Energy Commission. 2009. Potential Impacts of Climate Change on California's Energy Infrastructure and Identification of Adaptation Measures. January. CEC-150-2009-001.

14 Safeguarding California: Reducing Public Risk Plan, public draft available at *http://resources.ca.gov/climate_adaptation/docs/Safeguarding_California_Public_Draft_Dec-10.pdf*.

15 Meinshausen, M., N. Meinshausen, W. Hare, S. C. B. Raper, K. Frieler, R. Knutti, D. J. Frame, and M. Allen. 2009. "Greenhouse-gas emission targets for limiting global warming to 2 °C." Nature 458:1158 1162.

16 Hansen, J., P. Kharecha, M. Sato, V. Masson-Delmotte, F. Ackerman, et al. 2013. "Assessing 'Dangerous Climate Change': Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature." PLoS ONE 8(12): e81648. doi:10.1371/journal.pone.0081648.

1000 GtC. Considering that we have already emitted about 500 GtC, which leaves 500 GtC to be divided up among nations. If the non-CO_2 gases are included then the total CO_2e emissions are at 790 GtC, leaving only 210 GtC to be emitted. Thus, there is a compelling case to reduce the short-lived climate pollutants.

In early May 2013, the Mauna Loa monitoring station, which has been shown to provide excellent measurements of CO_2 throughout the global atmosphere, recorded atmospheric CO_2 of 400 ppm,[17] substantially higher than the 316 ppm recorded when the station made its first measurements in 1958. The monitoring station offers the longest-running record of atmospheric CO_2 measured directly from the air. This recent reading will take a few years to become the international average; however, reaching 400 ppm at Mauna Loa is significant and has surpassed a worrisome milestone.

Although stabilizing atmospheric GHG concentration below 450 ppm CO_2e is important, it does not mean that once that level is reached, temperatures will immediately level off. Because of time lags inherent in the Earth's climate, the initial warming that occurs in response to a given increase in the concentration of CO_2 ("transient climate change") reflects only about half the eventual total warming ("equilibrium climate change").

Observational data reveal that, in recent decades, some climate extremes are already increasing in response to relative modest warming; these extremes would likely increase considerably with warming of 2°C or more. While the findings suggest that even at relatively low levels of global warming the world will have to face significant sea level rise, the studies also demonstrate that the potential impacts are substantially greater if we allow warming to reach a level as high as 2°C. If they occur, changes such as these would not rapidly reverse, as even if the atmospheric CO_2 amount declines, it would take many centuries for the deep ocean to cool.

To prevent exceeding 450 ppm CO_2e, developed countries must substantially reduce their emissions in the near term. The 2008 World Energy Outlook suggests that Organisation for Economic Co-operation and Development (OECD) countries must reduce emissions by about 40 percent below 2006 levels by 2030.[18] The Union of Concerned Scientists has suggested a 2030 emissions target for the United States of 56 percent below 2005 levels (44 percent below 1990 levels).[19] A governmental study from the Netherlands finds that Europe would have to reduce emissions by 47 percent below 1990 levels and the United States would have to reduce emissions by 37 percent below 1990 levels by 2030.[20] The International Energy Agency comes to a similar conclusion, finding that the United States would have to reduce emissions by about 38 percent below 1990 levels by 2030.[21] Note that percent reductions by 2030 depend on the assumed overall trajectory of emissions, including the amount after 2030.

Because of the cumulative effects of GHG emissions and resultant changes to the earth's energy balance and the inertia in the climate system, delaying efforts to reduce emissions will likely mean that global average temperature will increase by more than 2°C, increasing the costs associated with combatting climate change. Reducing the global concentration to 450 ppm CO_2e after delaying mitigation actions for ten more years is estimated to cost an additional $3.5 trillion, compared to levels of investment needed now if low-carbon strategies were to be adopted immediately.[22]

17 R. Monastersky (2013). Global carbon dioxide levels near worrisome milestone. Nature News: *www.nature.com/polopoly_fs/1.12900%21/menu/main/topColumns/topLeftColumn/pdf/497013a.pdf*.

18 IEA. 2008. World Energy Outlook 2008. International Energy Agency. *www.worldenergyoutlook.org/publications/2008-1994/*.

19 Cleetus, R. et al. 2009. Climate 2030: A National Blueprint for a Clean Energy Economy. Union of Concerned Scientists. May. *www.ucsusa.org/blueprint*.

20 Hof, A. et al. 2012. Greenhouse gas emission reduction targets for 2030. Conditions for an EU target of 40%. The Hague: PBL Netherlands Environmental Assessment Agency. *www.pbl.nl/sites/default/files/cms/publicaties/PBL_2012_Greenhouse-gas-emission-reduction-targets-for-2030_500114023.pdf*.

21 IEA, 2012. Energy Technology Perspectives 2013: Pathways to a Clean Energy System. International Energy Agency. *www.iea.org/etp/etp2012/*

22 IEA. 2013. Redrawing the Energy Map: World Energy Outlook Special Report. International Energy Agency. June 10. *www.worldenergyoutlook.org/energyclimatemap*.

C. Climate Pollutants

The standard definition of greenhouse gases includes six substances identified in the Kyoto Protocol – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) – plus chlorofluorocarbons and other chlorine or bromine-containing gases phased out under the Montreal Protocol. Other GHGs include synthetic gases recently added to the IPCC's AR5 report such as nitrogen trifluoride (NF_3) and sulfuryl fluoride (SO_2F_2). Tropospheric ozone (O_3), a short-lived, not-well-mixed gas, and black carbon are also important climate pollutants. Carbon dioxide is undoubtedly the most important GHG, and collectively CO_2, CH_4, and N_2O amount to 80 percent of the total radiative forcing from well-mixed GHGs.

Carbon dioxide, methane and nitrous oxide concentrations have increased in the atmosphere since pre-industrial times, and this increase is the main driver of climate change. Globally, CO_2 increased by 40 percent from 278 ppm circa 1750 to 390.5 ppm in 2011. During the same time interval, CH_4 increased by 150 percent, from 722 ppb[23] to 1,803 ppb, and N_2O by 20 percent, from 271 ppb to 324.2 ppb in 2011. The increase of CO_2, CH_4, and N_2O is caused by anthropogenic emissions from the use of fossil fuel as a source of energy, fertilizer usage, and from land use and land use change—in particular, agriculture.

For each GHG, a global warming potential (GWP) has been calculated to reflect how long emissions remain in the atmosphere and how strongly it absorbs energy on a per-kilogram basis relative to CO_2. GWP is a metric that indicates the relative climate forcing of a kilogram of emissions when averaged over the period of interest (both 20-year and 100-year horizons are used for the GWPs shown in Table 1). Other important climate-forcing species not listed under the Kyoto Protocol with large human sources are tropospheric ozone and particulate matter (PM, including black carbon and other absorbing organic carbon aerosols).

Tropospheric ozone can act as a direct GHG and as an indirect controller of GHG lifetimes. Ozone is not emitted directly into the atmosphere, but rather formed by photochemical reactions. Its average atmospheric lifetime of a few weeks produces a global distribution highly variable by season, altitude, and location. The radiative forcing of tropospheric ozone is primarily attributed to emissions of methane, but also to carbon monoxide, volatile organics, and nitrogen oxides that eventually form ozone.

Unlike other GHGs, the three main categories of fluorinated gases (HFCs, PFCs, and SF_6) have no natural sources and only come from human-related activities. Chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) are also potent climate-forcing fluorinated gases, but they are regulated under the Montreal Protocol because of their role in the destruction of the protective stratospheric ozone layer. The fluorinated gases are used as refrigerants, foam-blowing agents, or for a variety of industrial processes such as aluminum and semiconductor manufacturing. Many fluorinated gases have very high GWPs relative to other GHGs, so relatively low atmospheric levels can have large effects on global temperatures. They can also have long atmospheric lifetimes, lasting thousands of years in the case of SF_6. Recently, two new climate pollutants were added to the list of climate pollutants of concern in the IPCC's AR5 report. These gases are NF_3, used in the electronics industry, and SO_2F_2, used as a fumigant to replace methyl bromide. Both have rapidly increasing emissions (growing from almost zero in 1978), but they currently contribute only about 0.0001 watt per square meter (W/m^2) and 0.0003 W/m^2, respectively, to anthropogenic radiative forcing. For comparison, industrial era radiative forcing for CO_2 alone is about 1.82 W/m^2 and CO_2 is the component with the largest global mean radiative forcing.

23 Note: one part-per-million (ppm) = 1,000 parts-per-billion (ppb)

Globally, CO_2 is the fastest increasing GHG in terms of absolute CO_2-equivalents. In California, since CO_2 emissions are decreasing due to AB 32 and other regulations, the fastest growing sector of GHG emissions are the high-GWP substitutes to ozone-depleting substances, primarily the HFCs. An important outcome of conducting a state or regional specific F-gas emission inventory (rather than relying on scaled-down national estimates) was highlighted by the discovery of a regional anomaly of relatively high GHG emissions in California from sulfuryl fluoride. In 2006, the reported SO_2F_2 pesticide use in California represented 37–56 percent of the global usage estimate and 41–75 percent of the U.S. usage estimate.[24] Gallagher, et al.[25] estimated that, in 2008, SO_2F_2 contributed 4.6 $MMTCO_2e$, or nine percent of all Fgas emissions in California (51.0 $MMTCO_2e$). Nitrogen trifluoride's contribution was only 0.17 $MTCO_2E$, or 0.3 percent of all F-gas emissions in California.

Short-Lived Climate Pollutants: As mentioned above, GHGs have different atmospheric lifetimes, ranging from less than a year to thousands of years (see Table 1). Some GHGs, such as CO_2 and N_2O, are long-lived GHGs, and so contribute to long-term climate change. Other substances have shorter atmospheric lifetimes because they are removed fairly quickly from the atmosphere. Therefore, their effect on the climate system is similarly short-lived. Together, these short-lived climate forcers are responsible for a significant amount of current climate forcing from anthropogenic substances.

The differentiation between long- and short-lived GHGs is not well defined, and here we define it to be gases with lifetimes less than 20 years so that a substantial fraction of emissions (>60 percent) decays within a 20-year horizon, and thus mitigation of emissions will rapidly reduce the warming caused by these chemical species. Properties of these short-lived climate pollutants (SLCP)—including black carbon, methane, and some hydrofluorocarbons (HFCs)—are contrasted with the other Kyoto GHGs in Table 1. Key SLCPs are described in more detail in the following sections.

24 Mühle, J., J. Huang, R. F. Weiss, R. G. Prinn, B. R. Miller, P. K. Salameh,C. M. Harth, P. J. Fraser, L. W. Porter, B. R. Greally, S. O'Doherty,and P. G. Simmonds. 2009. Sulfuryl Fluoride in the Global Atmosphere. J.Geophys. Res. 114.D5: D05306.

25 Gallagher, G.; Zhan, T.; Hsu, Y-K.; Gupta, P.; Pederson, J.; Croes, B.; Blake, D. R.; Barletta, B.; Meinardi, S.; Ashford, P.; Vetter, A.; Saba, S.; Slim, R.; Palandre, L.; Clodic, D.; Mathis, P.; Wagner, M.; Forgie, J.; Dwyer, H.; Wolf, K. 2014. High-global Warming Potential F-gas Emissions in California: Comparison of Ambient-based versus Inventory-based Emission Estimates, and Implications of Refined Estimates. Environ Sci. Technol., 48, 1084–1093.

Table 1: Global Warming Potential for Selected Greenhouse Gases*

Pollutant	Lifetime (years, except for BC)	Global Warming Potential (20-year)	Global Warming Potential (100-year)*
Long-Lived			
Carbon dioxide	~100**	1	1
Nitrous oxide	121	264	265
Nitrogen trifluoride	500	12,800	16,100
Sulfur hexafluoride	3,200	17,500	23,500
Perfluorocarbons	3,000–50,000	5,000–8,000	7,000–11,000
Short-Lived (<20 years)			
Black Carbon***	days to weeks	270–6,200	100–1,700
Methane	12	84	28
Hydrofluorocarbons****	(<1 to >100)	~100–11,000	~100–12,000

* The 20- and 100-year global warming potential estimates are from the IPCC 2013 Fifth Assessment Report (AR5),[26] which includes the independent scientific assessment of the black carbon radiative forcing published early this year.[27]

** CO_2 has a variable atmospheric lifetime and cannot be readily approximated as a single number.

*** BC climate effects are highly uncertain, in large part because they depend on the conditions under which they are emitted (i.e., location and time of year). This type of uncertainty does not apply to the Kyoto greenhouse gases.

**** HFCs have a wide range of lifetimes—some long, some short by this definition. Correspondingly, they have a wide range of GWPs.

Mitigation of the four SLCPs (methane, HFCs, tropospheric ozone, and black carbon), even if we are restricted to available technologies, can reduce the probability of exceeding the 2°C barrier before 2050 to less than ten percent, and before 2100 to less than 50 percent.[28,29] In addition, mitigation of CO_2 along with SLCPs can keep the twenty-first century warming below 2°C and 21th Century sea level rise below one meter.[30] However, the most immediate health and climate benefits would accrue regionally to the nations undertaking actions to mitigate SLCPs. For example, reducing black carbon emissions would help to minimize soot deposition on snowpacks and glaciers, which is known to accelerate snowmelt from the Sierra Nevada snowpack.[31,32]

26 Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza, T. Nakajima, A. Robock, G. Stephens, T. Takemura, and H. Zhang. 2013. Anthropogenic and Natural Radiative Forc¬ing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T. F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 659–740.

27 Bond, T. C., S. J. Doherty, D. W. Fahey, et al. 2013. "Bounding the role of black carbon in the climate system: A scientific assessment." Journal of Geophysical Research: Atmospheres doi:10.1002/jgrd.50171.

28 Ramanathan, V., and Y. Xu. 2010. "The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues." Proc. Nat. Acad. Sci. 107 (18) 8055–8062. *www-ramanathan.ucsd.edu/files/pr175.pdf*.

29 UNEP/WMO. 2011. Integrated Assessment of Black Carbon and Tropospheric Ozone. Available at *www.unep.org/dewa/Portals/67/pdf/BlackCarbon_report.pdf*.

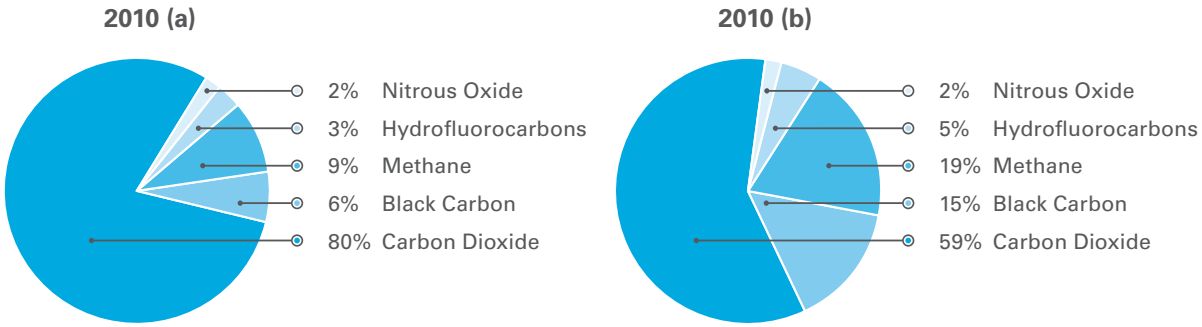
30 Hu, A., Y. Xu, C. Tebaldi, W. M. Washington, and V. Ramanathan. 2013. "Mitigation of short-lived climate pollutants slows sea-level rise." Nature Climate Change 3(5): 1–5, doi:10.1038/nclimate1869. *www-ramanathan.ucsd.edu/files/pr194.pdf*.

31 Hadley, O. L., C. E. Corrigan, T. W. Kirchstetter, S. S. Cliff, and V. Ramanathan. 2010. "Measured black carbon deposition on the Sierra Nevada snow pack and implication for snow pack retreat." Atmos. Chem. Phys. 10: 7505–7513, doi:10.5194/acp-10-7505-7513.

32 Qian, Y., W. I. Gustafson, Jr., L. Y. R. Leung, and S. J. Ghan. 2009. "Effects of soot-induced snow albedo change on snowpack and hydrological cycle in western United States based on Weather Research and Forecasting chemistry and regional climate simulations."Journal of Geophysical Research D. (Atmospheres) 114:D03108. doi:10.1029/2008JD011039.

Figure 1 shows the relative GWP-weighted contributions of 2010 California emissions of different climate pollutants for 100-year and 20-year time horizons. Note that Figure 1 does not include other SLCPs such as NO_X, CO, VOCs, and organic aerosols, which have both positive and negative GWPs, as described in the 2013 IPCC AR5. Use of a global annual average GWP for BC may significantly over- or under-estimate the contribution of California's BC emissions. Individual HFC species are aggregated according to their specific emissions and GWPs. The 20-year GWP is a better reflection of what can be achieved in the near term by mitigation.

Figure 1: Carbon Dioxide Equivalent Climate Pollutant Emissions for 2010 in California Using (a) 100-year and (b) 20-year Horizon GWPs



Many short-lived climate pollutants are already regulated by ARB, either as part of the air quality and toxics program or under the Scoping Plan. The following sections describe the major short-lived climate pollutants and ARB's past programs to reduce emissions. For many of these pollutants, ARB is proposing additional action to investigate and potentially require additional emission reductions prior to 2020. In addition to actions under way, described in Chapter IV, ARB will develop a short-lived climate pollutant strategy by 2015 that will include an inventory of sources and emissions, the identification of additional research needs, and a plan for developing necessary control measures. ARB will consult with external experts in the development of this strategy.

1. Black Carbon

Black carbon is the most strongly light-absorbing component of particulate matter (PM) emitted from burning fuels such as coal, diesel, and biomass. ARB identified diesel PM as a toxic air contaminant in 1998, and PM that can be inhaled (PM_{10} and $PM_{2.5}$) is a criteria pollutant, which is regulated by both the U.S. Environmental Protection Agency (U.S. EPA) and ARB. Black carbon contributes to climate change both directly by absorbing sunlight and indirectly by depositing on snow and by interacting with clouds and affecting cloud formation. Reducing black carbon emissions globally can have immediate economic, climate, and public health benefits.[33, 34, 35]

Short-lived species, like BC, vary spatially and, consequently, it is very difficult to quantify their global-warming forcing. Due in large part to the difference in lifetimes between BC and CO_2, the relative weight given to BC as compared to CO_2 (or other climate forcers) is very sensitive to the formulation of the metric used to make the comparison. Several leading scientists have reported

33 UNEP and WMO. 2011. Integrated Assessment of Black Carbon and Tropospheric Ozone. United Nations Environment Programme (UNEP) and World Meteorological Organization (WMO).

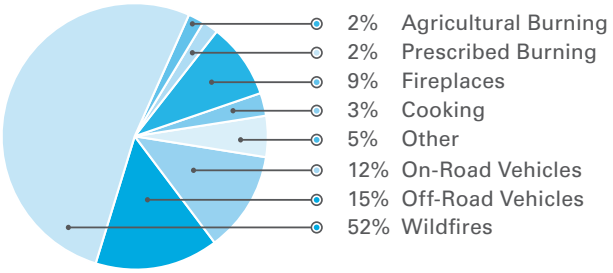
34 Shindell, D., J. C. I. Kuylenstierna, E. Vignati, R. van Dingenen, M. Amann, Z. Klimont, S. C. Anenberg, N. Muller, G. Janssens-Maenhout, F. Raes, J. Schwartz, G. Faluvegi, L. Pozzoli, K. Kupiainen, L. Höglund-Isaksson, L. Emberson, D. Streets, V. Ramanathan, K. Hicks, N. T. K. Oanh, G. Milly, M. Williams, V. Demkine, and D. Fowler. 2012. "Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security." Science 335 (6065): 183–189. doi: 10.1126/science.1210026.

35 Wallack, J., and V. Ramanathan. 2009. "The Other Climate Changes, Why Black Carbon Also Matters." Foreign Affairs Sept/Oct 2009: 105–113. *www-ramanathan.ucsd.edu/files/pr168.pdf*.

estimates of the GWP for BC emissions from different sources. Most of the regional differences in GWP are caused by differences in the lifetime of BC. In general, in the published literature, there are significant variations in the GWP values for BC emissions assigned to different regions. This indicates that the role of BC in warming requires close attention to the geography of emissions. Black carbon may also indirectly cause changes in the absorption or reflection of solar radiation through changes in the properties and behavior of clouds, e.g., BC localized warming in the lower atmosphere can prevent cloud formation.

Figure 2 shows the statewide contribution from black carbon emissions sources in 2010. The main sources of black carbon in California are wildfires, off-road vehicles (locomotives, marine vessels, tractors, excavators, dozers, etc.), on-road vehicles (cars, trucks, and buses), fireplaces, agricultural waste burning, and prescribed burning (planned burns of forest or wildlands). Wildfires are a highly intermittent but significant source—almost 50 percent of the total black carbon emissions. Emissions in this category may grow significantly in the future if climate change results in increased wildfires, as predicted in many climate model scenarios. Projections suggest that the frequency and size of forest fires is expected to increase, perhaps several fold, by the end of the century.

Figure 2: California Black Carbon Emissions Sources (2010)



California has been an international leader in reducing emissions of black carbon, with close to 95 percent control expected by 2020 due to existing programs that target reducing PM from diesel engines and burning activities.

Due to the health concerns from PM exposures, both ARB and local air districts have developed programs to reduce emissions from these sources (Table 2). These efforts have concurrently resulted in significant reductions of black carbon and GHG emissions.

ARB estimates that the annual black carbon emissions in California decreased about 70 percent between 1990 and 2010, in direct proportion to declining diesel PM emissions—a benefit of ARB's regulations on diesel fuel and engines. PM emissions from other categories of diesel engines, such as off-road (e.g., agricultural and construction equipment), building equipment, generators, ships, and harbor craft are also projected to decline significantly by 2020. Continued efforts to better manage agricultural, forest, and range land burning operations are also expected to continue to reduce black carbon emissions.

Table 2: Programs Resulting in Black Carbon Emission Reductions

Program Area	Adoption Dates
Prescribed and Agricultural Burning (ARB, Districts)	1970, 1972, 1973, 1974, 1976, 1991, 1997, 2004
Fireplaces and Fire Pits (Districts)	1986, 1993, 1995, 1996, 2004, 2006, 2008, 2013
Heavy-Duty On-Road Engine Particulate Standards (ARB, U.S. EPA)	1987, 1997, 2000, 2001
Diesel and Gasoline Fuel Specifications (ARB, U.S. EPA)	1988, 1991, 1999, 2003
Low Emission Vehicle Programs (LEV I, II, III) (ARB)	1990, 1998, 2012
Off-Road Engine Standards (ARB, U.S. EPA)	1994, 1997, 1998, 1999, 2002, 2004, 2006, 2008, 2009
Smog Check Program (ARB and Bureau of Automotive Repair)	1984,1998, and 2013
Local Commercial Charbroiling Rules (South Coast, San Joaquin Valley, and Ventura Air Districts)	1997, 2002, 2004
Diesel Clean-up Incentive Programs – Carl Moyer, AB 118 Air Quality Improvement Program, Proposition 1B (ARB, Districts)	1998, 2007
In-Use Fleet Rules (Drayage and Truck/Bus) (ARB)	2000, 2003, 2005, 2007, 2009
Ship Engine and Fuels Standards (ARB and U.S. EPA)	1999, 2002, 2007, 2008, 2010
Federal Diesel Emission Reduction Act (DERA) Incentive Programs (U.S. EPA)	2008
Federal Environmental Quality Incentives Program (EQIP) (U.S. Department of Agriculture)	2008

California is committed to continuing to reduce emissions of black carbon, to meet ongoing air quality and climate targets. Regulations requiring diesel particulate retrofits and legacy fleet turnover are critical for obtaining necessary reductions. However, advanced technologies in the freight system, including zero- or near-zero emission vehicles and fuels, will also be needed to meet future air quality and climate goals.

2. Methane

Methane (CH_4) is the principal component of natural gas and is also produced biologically under anaerobic conditions in ruminants, landfills, and waste handling. Atmospheric methane concentrations have been increasing as a result of human activities related to agriculture, fossil fuel extraction and distribution, and waste generation and processing. The radiative efficiency of CH_4 per unit concentration is relatively large in comparison to CO_2, and coupled to the significant increase in its concentration, methane is the second most important anthropogenic GHG in the atmosphere. Anthropogenic warming will likely lead to enhanced CH_4 emissions from both terrestrial and oceanic clathrates, but it is unclear if this will significantly increase atmospheric CH_4 abundances.

Methane contributes to background tropospheric ozone levels. Photo-oxidation of both methane and carbon monoxide lead to net production of global ozone. With multi-decadal full-chemistry transient simulations in the MOZART-2 global model of tropospheric chemistry model, Fiore et al[36] show that tropospheric ozone responds approximately linearly to changes in CH_4 emissions. Controlling methane emissions may be a promising means of simultaneously mitigating climate

36 Fiore, A.M., J.J. West, L.W. Horowitz, V. Naik, and M.D. Schwarzkopf (2008), Characterizing the Tropospheric Ozone Response to Methane Emission Controls and the Benefits to Climate and Air Quality , J. Geophys. Res. , 113, D08307, doi:10.1029/2007JD009162.

change and reducing global ozone concentrations.[37, 38]Tropospheric ozone can also act as a direct GHG and as an indirect controller of GHG lifetimes. Concentrations of ozone have risen by around 30 percent since the pre-industrial era and it is now considered by the IPCC to be the third most important greenhouse gas after carbon dioxide.[39]

As noted in Table 1, the current methane GWP for a time horizon of 20 years is 84 (from the IPCC 2013 Fifth Assessment Report), which, combined with its large emissions, makes it an attractive target for near-term climate mitigation policies. Although the methane GWP traditionally includes the methane indirect effects on the concentrations of ozone and stratospheric water vapor, it does not take into account the production of carbon dioxide from methane oxidation. Recent studies argue that this CO_2-induced effect should be included for fossil sources of methane, which adds about three to the GWP values for all time horizons. Boucher et al. recommend somewhat larger values for the methane GWP than suggested by the IPCC 2007 Fourth Assessment report (AR4).[40] When the methane comes from fossil sources, the 100-year GWP would be about 30. Holmes et al. also provide a new estimate of the indirect components of methane climate forcing.[41] Tropospheric ozone contributes 30–50 percent of the direct methane climate forcing, compared to 25 percent that has been used in previous IPCC assessments. Hence, accounting for the indirect effect of methane emissions could have an even larger relative impact. In the IPCC AR5 report, when feedbacks are included, the GWP for methane was increased, from 25 to 28 over a 100-year timespan, and from 72 to 84 over a 20-year timespan.

The State's largest anthropogenic methane-producing sources are enteric fermentation (belching by animals), manure management, landfills, natural gas transmission, and wastewater treatment (Figure 3). Methane emissions also come from non-anthropogenic sources such as wetlands, oceans, forests, fires, terrestrial arthropods (such as termites), and geological sources (such as submarine gas seepage, micro seepage over dry lands, and geothermal seeps). Methane gas from production and distribution is a growing source of emissions in many countries, including the United States, due to increased exploration and use of natural gas for energy.

Methane is generated in landfills during the natural process of bacterial decomposition of organic material. Many factors influence the quantity and composition of the gas generated, including the types and age of waste buried in the landfill, the quantity and types of organic compounds in the waste, and the moisture content and temperature of the waste. California has adopted several measures focused on controlling methane emissions from landfills and other sources (Table 3). Local air districts have adopted rules to implement the federal New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants for municipal solid waste (MSW) landfills, which also require installation of gas collection and control systems. These district rules target reductions in ozone precursors and hazardous air pollutants, but also provide supplemental methane reductions. In 2009, ARB adopted a regulation to reduce methane from MSW landfills. The regulation requires owners and operators of certain uncontrolled MSW landfills to install gas collection and control systems, and requires existing and newly installed gas and control systems to operate in an optimal manner. Complementary to the control of methane emissions from landfills themselves, the Mandatory Commercial Recycling Regulation

37 Anenberg S, Schwartz J, Shindell D, Amann M, Faluvegi G, Klimont Z, Janssens-Maenhout G, Pozzoli L, Van Dingenen R, Vignati E, et al. Global Air Quality and Health Co-benefits of Mitigating Near-Term Climate Change through Methane and Black Carbon Emission Controls. ENVIRON HEALTH PERSP. 2012;120 (6):831-839.

38 Shiri Avnery, Denise L. Mauzerall, Arlene M. Fiore. Increasing global agricultural production by reducing ozone damages via methane emission controls and ozone-resistant cultivar selection Glob Change Biol, Vol. 19, No. 4. (1 April 2013), pp. 1285-1299, doi:10.1111/gcb.12118.

39 Kirtman, B., S. B. Power, J. A. Adedoyin, G. J. Boer, R. Bojariu, I. Camilloni, F. J. Doblas-Reyes, A. M. Fiore, M. Kimoto, G. A. Meehl, M. Prather, A. Sarr, C. Schär, R. Sutton, G. J. van Oldenborgh, G. Vecchi, H. J. Wang. 2013. Chapter 11: Near-term Climate Change: Projections and Predictability. In: Climate Change 2013: The Physical Science Basis. Contribution of WGI to the 5th AR of the IPCC [Stocker, T. F., D. Qin, G.-K. Plattner, M. Tignor, S. K.]

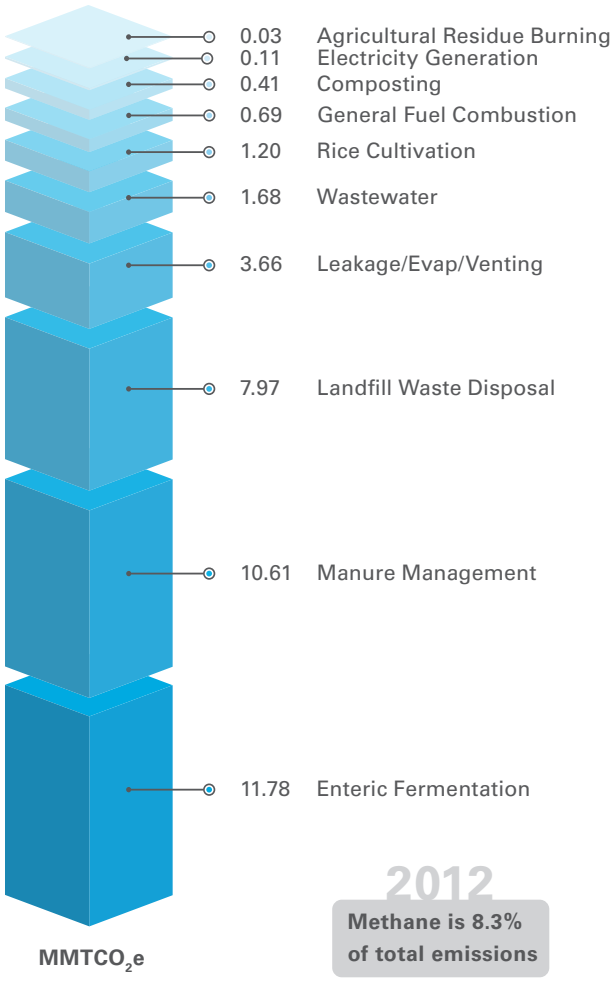
40 Holmes, C. D., M. J. Prather, O. A. Sovde, and G. Myhre. 2013. "Future methane, hydroxyl, and their uncertainties: Key climate and emission parameters for future predictions." Atmospheric Chemistry and Physics 13: 285–302.

41 Boucher, O., P. Friedlingstein, B. Collins, and K. P. Shine. 2009. "The indirect global warming potential and global temperature change potential due to methane oxidation." Environmental Research Letters, 4, 044007.

(AB 341; Chesbro, Chapter 476, Statutes of 2011) was adopted in 2012 to further reduce landfill methane emissions via upstream organic material diversion from landfill disposal. ARB and CalRecycle continue to assess new information on landfill methane emissions to determine whether additional actions in support of GHG emissions and the 75 percent goal are warranted.

Methane is also emitted from oil production and the natural gas industry. Natural gas transmission involves high-pressure, large-diameter pipelines that transport gas long distances from field production areas to distribution systems for ultimate customer use. Methane is emitted from venting and leaks of processing equipment and pipelines.

Figure 3: California Methane Emission Sources (2012)



ARB's Cap-and-Trade Program includes an offset protocol to reduce methane from dairies. The Compliance Offset Protocol Livestock Projects provides methods to quantify and report GHG emission reductions associated with the installation of a biogas control system for manure management on dairy cattle and swine farms. The protocol is designed to ensure complete, consistent, transparent, accurate, and conservative quantification of GHG emission reductions associated with a livestock digester project for generating ARB offset credits.

In addition, ARB's Low Carbon Fuel Standard incentivizes the capture and use of natural gas from landfills and digesters for transportation fuel.

Table 3: Programs Resulting in Methane Emission Reductions

Program Area	Adoption Dates
Control of landfill emissions (local air districts)	Varies
Standards of Performance for Municipal Solid Waste Landfills (U.S. EPA)	1996
Landfill Methane Control Measure (ARB)	2009
Methane inclusion in Low Carbon Fuel Standard (ARB)	2009
Dairy digester protocol for offsets in Cap-and-Trade Program (ARB)	2011
Landfill waste diversion, Assembly Bill 341 (CalRecycle)	2011
Proposed oil and gas production, processing, and storage regulation (ARB)	In progress, expected 2014

Several recent analyses of atmospheric measurements suggest that actual methane emissions may be 1.3 to 1.7 times higher than estimated in ARB's emission inventory.[42, 43] Recent research suggests that methane emissions from a broad variety of sources could be higher than previously expected, including leaks in natural gas distribution systems, oil and gas extraction facilities, and natural seeps such as the La Brea Tar Pits. Underestimations may explain the discrepancies between the inventory and atmospheric measurements. With the greater GWP assessed in recent IPCC and other studies, reductions in methane emissions will have greater benefits.

ARB is continuing to research potential sources of methane emissions to determine the source of higher-than-expected ambient methane measurements, and whether additional controls are technologically feasible and cost-effective.

42 Y.-K. Hsu, T. VanCuren, S. Park, C. Jakober, J. Herner, M. FitzGibbon, D. R. Blake, and D. D. Parrish. 2010. "Methane emissions inventory verification in southern California." Atmospheric Environment 44: 1 7.

43 S. M. Miller, S. C. Wofsy, A. M. Michalak, E. A. Kort, A. E. Andrews, et al. 2013. Anthropogenic emissions of methane in the United States. PNAS doi/10.1073/pnas.1314392110.

SUCCESS STORY

Only 24 ounces of the most commonly used automobile air conditioning refrigerant captures as much heat in the atmosphere as a ton of carbon dioxide. Thanks to California's regulations, automakers are now beginning to use a refrigerant for vehicle air-conditioning system that is 350 times less damaging to the climate. The 2004 Pavley regulations—the first standards designed to reduce GHGs from vehicles—created credits for less climate-damaging coolants. The European Union later followed suit. As a result, Du Pont developed "HFO-1234yf," a refrigerant with a global warming potential only four times that of carbon dioxide. The new refrigerant is now being introduced by General Motors and Chrysler, including models such as the 2014 Dodge Dart, Dodge Charger, Chrysler 300 and Ram 1500.

3. Hydrofluorocarbons

Hydrofluorocarbons are synthetic gases used in refrigeration, air conditioning, insulating foams, solvents, aerosol products, and fire protection. They are primarily produced for use as substitutes for ozone-depleting substances which are being phased out under the Montreal Protocol. Currently, HFCs are a small fraction of the total climate forcing (<1 percent), but their emissions are growing relatively more rapidly than those of CO_2. Recent scientific studies project substantial growth in the use of HFCs in the coming decades, primarily driven by the increased demand for refrigeration and air conditioning in developing countries. Recently, the United States, China, and 24 other countries agreed to work to phase out the use of HFCs.

ARB has implemented several measures to reduce HFC emissions (Table 4). These include low-GWP requirements for aerosol propellants, a deposit-return recycling program for small cans of motor vehicle air-conditioning (AC) refrigerant, and the Refrigerant Management Program. In addition, beginning with 2017 model year vehicles, the national Clean Cars Initiative is expected to significantly reduce motor vehicle air-conditioning refrigerant emissions.

Table 4: Programs Resulting in HFC Emission Reductions

Program Area	Adoption Dates
Semiconductor regulation (ARB)	2007
Refrigerant Management Program (ARB)	2009
High global warming potential gas ban for non-essential consumer products (ARB)	2009
Regulation for small containers of automotive refrigerant (ARB)	2009
Ozone depleting substance protocol for offsets under the Cap-and-Trade Program (ARB)	2011
Advanced Clean Car credit for mobile air-conditioning systems (ARB)	2012

D. Greenhouse Gas Monitoring Efforts

Monitoring and measurement efforts are a crucial component of the regulatory process, because they provide objective measures to identify the need for regulatory action and to verify the performance of implemented regulations.

Since the adoption of the original Scoping Plan, ARB has spearheaded and participated in various measurement-based research studies to verify statewide GHG emission inventory, identify and understand unknown GHG emission sources and under-inventoried sectors, identify possible measures for emission mitigation, and evaluate program effectiveness through monitoring long-term trends. The most significant part of these efforts is the Greenhouse Gas Research Monitoring Network that was initiated by ARB in 2010. Network participants evaluate the regional and statewide inventories to support the AB 32 program and study the regional GHG emissions trends throughout the state and provide data at a regional level to monitor AB 32-related reductions and effectiveness. The network currently has seven ARB-operated monitoring stations, and four additional stations are operated by leading researchers throughout the state. The network captures real-time GHG data throughout the state in high temporal and spatial resolution and uses high-precision analyzers to study CH_4, N_2O, and CO_2 emissions.

Data from this network have been used for monitoring and verification, and for inverse receptor-oriented modeling to estimate natural and anthropogenic sources and sinks of GHGs. These types of highly accurate and consistent measurements have been immensely valuable to evaluate and improve ARB's GHG emission inventory. For example, the results suggested that the current CH_4 inventory may be underestimated by a factor of 1.3 to 1.7, and the current N_2O inventory may be underestimated by a factor of up to 2.7. A range of research studies in the state have also identified potential sources of under-estimation in the inventory. Those studies suggest that

livestock and landfills may be the largest sources of underestimated GHG emissions in California's Central Valley; whereas, the fossil fuel sector, primarily from natural gas transmission and distribution systems, may be responsible for a larger fraction of CH_4 emissions in the South Coast.

ARB is also actively participating in the Megacities Carbon Project[44], which plans to develop and test methods for monitoring GHG emissions from megacities, with the ultimate aim of establishing a global urban monitoring framework. The Megacities project relies on sustained monitoring of the various GHGs and applies scientifically robust analyses for linking monitored concentrations to emission activity. The goal is to provide decision makers with critical information for assessing the ultimate efficacy of emission mitigation policies, and to review the progress in reducing carbon emissions from cities. The Megacities team has partnered with ARB to use the GHG Research Monitoring Network data in the South Coast Air Basin. ARB is also helping the Megacities team coordinate project planning, identify potential sites for adding their monitoring locations, and analyze concentration trends.

ARB has also expanded its Mobile Measurement Platform program to monitor and measure GHGs from various under-reported and un-inventoried sources to improve the existing emissions inventories. These efforts include quantifying GHG emission fluxes from various sources in the field, developing and comparing emission factors against the inventory data, and providing emissions data for ARB inventory groups for regulatory and mitigation planning. In the recent past, this program has been successful in verifying GHG emission rates of complex sources such as natural gas compression stations and landfills. ARB is also expanding the program to include flux chambers and controlled tracer release studies to study large area sources such as landfills, wastewater treatment plants, oil and gas extraction fields, natural gas leakage from pipelines, and other fugitive emission sources. These wide-ranging collaborations and the integration of various methods will continue to provide a comprehensive approach to evaluate and validate the California GHG inventory and identify possible measures for emission mitigation in the future.

E. Adjusting the 2020 Statewide Limit

The Scoping Plan relied on the IPCC's 1996 Second Assessment Report (SAR) to assign the global warming potentials (GWPs) of greenhouse gases. Recently, in accordance with the United Nations Framework Convention on Climate Change (UNFCCC), international climate agencies have agreed to begin using the scientifically updated GWP values in the IPCC's Fourth Assessment Report (AR4)[45] that was released in 2007. ARB is beginning to transition to the use of the AR4 100-year GWPs in its climate change programs. ARB has recalculated the 1990 GHG emissions level with the AR4 GWPs to be 431 $MMTCO_2e$, therefore the 2020 GHG emissions limit established in response to AB 32 is now slightly higher than the 427 $MMTCO_2e$ in the initial Scoping Plan. More information is provided in Chapter IV, Section B(3). The IPCC AR5 was just completed (September 2013), and the scientific updates have again altered the GWPs, as discussed above. Use of AR5 GWPs will be considered in subsequent reports.

44 More information on the Megacities Carbon Project is available at: *http://megacities.jpl.nasa.gov/portal*.

45 IPCC Fourth Assessment Report (AR4), Climate Change 2007: Synthesis Report;

GWP values and lifetimes from 2007 IPCC AR4	Lifetime (years)	GWP time horizon		
		20 years	100 years	500 years
Methane	12	72	25	7.6
Nitrous oxide	114	289	298	153
HFC-23 (hydrofluorocarbon)	270	12,000	14,800	12,200
HFC-134a (hydrofluorocarbon)	14	3,830	1,430	435
Sulfur hexafluoride	3200	16,300	22,800	32,600

www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

III. California's Approach to Climate Change

California's commitment to addressing climate change is born of necessity. As described in Chapter II, our State, economy, and rural and urban communities are especially vulnerable to the impacts of climate change. Many studies have shown that the costs of inaction or delayed action to reduce GHG emissions far outweigh the costs—and come with none of the benefits—associated with reducing emissions today by deploying clean technologies, diversifying energy supplies, and strengthening and preserving natural lands. But our commitment is not just a defensive one focused on minimizing the costs or inevitable impacts of climate change within our State.

California is taking a proactive approach to climate change policy, through integrated policy and planning that will build a higher-quality, resilient economy while continually reducing GHG emissions. The State is continuing its legacy of creating a future where a strong economy, environmental protection, improved public health, and a higher quality of life increasingly reinforce one another. After decades of progress, the realization of a clean energy economy is the enviable future that we must create if we are to adequately address climate change.

California has asserted, and reasserted, its commitment to responsible climate policy and planning through the passage and implementation of AB 32, the overwhelming rejection of Proposition 23 in 2010, and through numerous other state and local policies, corporate commitments, and individual actions to reduce emissions.

Climate change is a continuous, global phenomenon, defined by cumulative emissions, rather than emissions at a given point in time. Policies and measures put in place and implemented today – and the continued implementation of already adopted measures – will affect emissions levels after 2020; additional planning is needed now to begin designing policies to continue reducing GHG emissions in order to achieve our long-term climate goals. With climate change already upon us and scientific consensus-based targets only sufficient to avert its very worst impacts, a continuum of action is needed to achieve the maximum technologically feasible and cost-effective emission reductions available at any given time—and to work toward near-zero emissions as soon as possible. Each incremental, cost-effective emission reduction puts California closer to its essential, sustainable future—where economic growth is unencumbered by environmental, resource, or health constraints.

California is not alone in its commitment to reduce emissions. Many other states— including Oregon, Washington, the northeast states in the Regional Greenhouse Gas Initiative, and others—are taking concrete steps to reduce GHG emissions. The United States is on track to meet the goals of the Obama Administration to reduce emissions to 17 percent below 2005 levels by 2020, and numerous other national and subnational governments in Canada, Mexico, China, Australia, Europe, and elsewhere are pricing carbon emissions, establishing markets for clean energy technologies, and taking other steps to reduce GHG emissions.

But California is alone in its depth of vision, scope of planning, and degree of leadership in demonstrating effective climate policies to decouple GHG emissions from economic growth and ensuring the State reduces emissions at a rate consistent with scientifically based targets on an ongoing basis. California's approach is one firmly grounded in science and public process, built from coordinated, integrated planning and cost-effective policy design, and accomplished through consistent, fair policy implementation. Continuing to build on this successful framework will foster broader action and continued progress on a global scale to address climate change—and deliver even greater benefits to California's economy, environment, and quality of life.

A. Preserve the California Lifestyle

California is a collection of farmers, surfers, factory workers, outdoor enthusiasts, tech geeks, truckers, world-class researchers, celebrity actors, and many more—who come from all around the world to live and work in one of the most beautiful, vibrant, and ecologically and culturally diverse places on Earth. We are sustained, in more ways than one, by the mountains, deserts, rivers, streams, forests, farmlands, rangelands, coastline, and temperate climate that form our natural environment and characterize our great State.

These resources, and their natural beauty, enable our continued economic and cultural growth. They attract a wide array of businesses and workers who want to live here. They are a primary reason that California is: the eighth largest economy in the world; home to the most small businesses, Fortune 500 companies, and fastest-growing businesses in the United States; the national leader in global trade and direct investment; and tops in the United States in many economic sectors, including agriculture, biotech, clean energy, entertainment, high-tech, manufacturing, tourism, and more.

Accordingly, Californians of all backgrounds and political persuasions have supported policies and planning to protect our natural environment and the high quality of life it provides. The result is a decades-long, broad commitment to ensuring clean air and water, an efficient and productive use of energy and resources, a healthy workforce, and vital cities and towns. Our collective will to protect the environment is a valuable resource in itself, whose benefits enhance economic growth and prosperity in our state and help shape California's distinct identity.

SUCCESS STORY

THE CITY OF BENICIA CALIFORNIA

The City of Benicia

How can Government work to reduce GHG emissions in a manner that does not burden business with onerous regulations? The City of Benicia has found a solution. Benicia has budgeted $625,000 to incentivize businesses to make resource and management improvements to reduce energy, water, solid waste, recycling, and fuel costs. The program furnishes businesses a comprehensive energy assessment, and if the energy savings are great enough, can provide grants and loans to help with recommended improvements. As of November 2013 the program has assisted ten businesses for annual cumulative annual savings of nearly $140,000 while reducing annual GHG emissions by 135 metric tons.

With climate change threatening our resources, economy, and quality of life, California is squarely focused on addressing it and protecting our natural and built environments. Just as California has done dozens of times before on other environmental issues, it is leading on climate change, with an approach that will enable better, lasting economic growth and allow the California lifestyle to endure.

B. Foster Resilient Economic Growth

We are addressing climate change head on because we must, but the necessity of action should not imply lost opportunity or economic compromise. The supposition that the status quo, characterized by relatively inefficient use of finite fossil resources, represents a preferred or lower-cost energy system is a false one. The imperative of climate change and an unwavering commitment to meet the challenge through innovation will drive technology development and advance social progress. They provide clear signals that encourage businesses to grow and invest in ways that do not come at the expense of future generations, but instead, provide even more opportunity for growth in the future. Investments that allow us to do more with less and unlock the availability of clean, renewable energy only push out the boundary of our future potential.

The transition to a clean energy future presents us with a tremendous opportunity to continue economic growth. In particular, since the adoption of AB 32, California's clean energy companies have grown faster and shown greater resilience than the State's overall economy.[46] We have emerged as the national dominant player in both clean energy jobs and clean energy investment.[47, 48, 49] These jobs offer better-than-average wages and provide needed employment opportunities in the construction and manufacturing sectors.[50, 51, 52] California's policy approach to climate change is supporting continued growth in these sectors, and the good, high-paying jobs that it brings.

Through AB 32 and related policies, California has implemented a suite of policies that is reducing emissions by both reducing energy demand and cleaning up energy supply. Taken together, our efficiency and clean energy policies are reducing not only GHG emissions, but also energy costs for consumers. For example, while the State moves toward 33 percent renewable energy in its electricity supply mix, it continues to outpace the rest of the country on energy efficiency. The State's building and appliance energy efficiency standards have saved Californians $74 billion in energy costs since 1977. California has the fourth lowest per-capita energy-related GHG emissions in the country and produces twice as much economic value for every unit of electricity used. California households also pay the ninth lowest electricity bills in the country (see Figure 4).

46 Next 10, 2013. 2013 California Green Innovation Index, Figure 35, Employment Growth Relative to 2001, pp. 42, 51, 55. Available at *http://next10.org/2013innovation* and *www.greeninnovationindex.org*

47 U.S. Bureau of Labor Statistics, 2013. "Employment in Green Goods and Services – 2011," USDL-13-0476. Available at *www.bls.gov/ggs*

48 Thomson-Reuters, 2012. "National Venture Capital Association Yearbook."

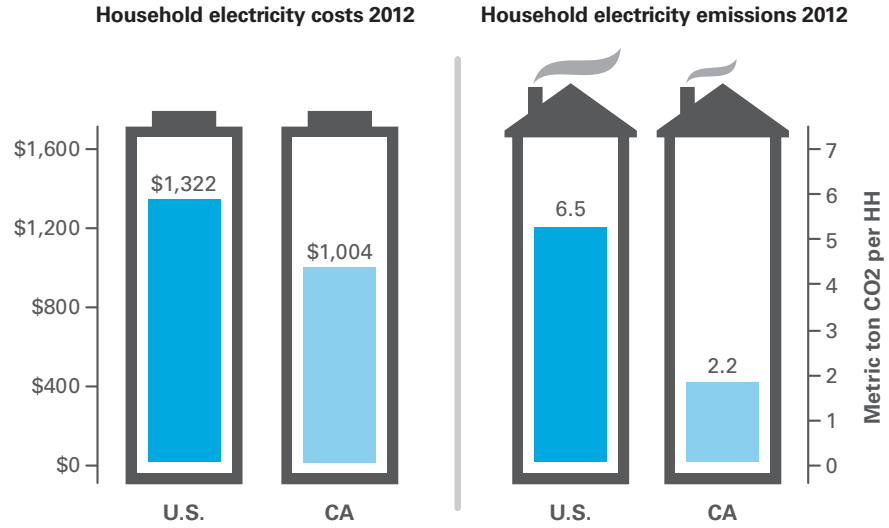
49 Pricewaterhouse Coopers, "National Venture Capital Association MoneyTree Report."

50 Brookings-Battelle, 2010. "Sizing the Clean Economy: A National and Regional Green Jobs Assessment."

51 Next 10, 2013. 2013 California Green Innovation Index, Figure 40, p. 46. Green Establishments Database, Data analysis: Collaborative Economics.

52 Collaborative Economics, 2012. "Seven Growth Sectors Driving California's Clean and Efficient Economy," May 2012. Available at *www.edf.org/sites/default/files/EDFSevenSectors-5.24.2012pdf.pdf*

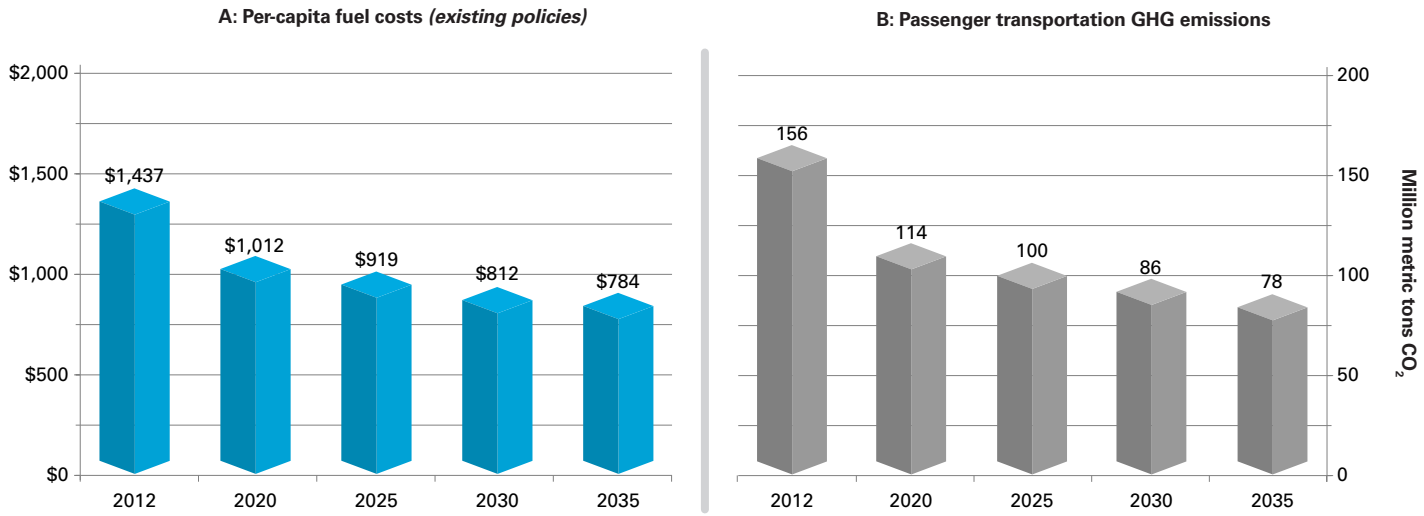
Figure 4: Average Household Expenditures on Electricity and Associated GHG Emissions in the United States and California[53]



Sources: U.S. Energy Information Administration [EIA] and ARB

The same holds true for the transportation sector. The results of California's collection of clean vehicles and fuels policies are dramatic reductions in GHG and criteria air pollution, technology innovation, and declining transportation costs. The combination of California's vehicle GHG and Zero Emission Vehicle (ZEV) standards and policies adopted under AB 32—including the Low Carbon Fuel Standard, SB 375, and Cap-and-Trade—will reduce per-capita fuel costs and GHG emissions from light-duty vehicles and fuel use by about 30 percent from current levels in 2020, and by about 50 percent in 2035 (see Figure 5). Additional measures to reduce emissions could further reduce fuel costs, as well.

Figure 5: (a) Per-Capita Fuel Costs and (b) Passenger Transportation GHG Emissions in California as a Result of the Existing Suite of California Climate Policies



53 California GHG emissions include imported electricity.

This is not to say that there are no costs associated with transitioning to clean technologies. Any technology or infrastructure change comes with initial costs. And pricing GHG emissions, as California's Cap-and-Trade Program does, inherently adds a cost at sources of pollution.

But many of the technologies needed to meet our current policies are already cost-competitive today, and prices continue to decline. In some parts of the country, new renewable power generation is competitive with new fossil generation, and in some cases, even competitive with existing fossil generation. For millions of households and businesses in California, adding rooftop solar is already reducing their energy costs. With attractive lease prices, electric vehicles are among the most affordable new cars on the market for consumers today. Multiple studies confirm that plug-in cars are already more affordable than conventional vehicles on a total cost of ownership basis.[54] And the cleaner alternatives to gasoline and diesel that are available on the market today either cost about the same as petroleum fuels (in the case of biodiesel, ethanol, and renewable gasoline and diesel), or cost far less than the petroleum fuels they replace (in the case of natural gas, renewable natural gas, or electricity).

As costs of these technologies continue to decline and additional energy efficiencies are achieved, energy costs for consumers will continue to fall, along with GHG emissions.
Avoided energy costs are pumped back into the economy elsewhere, boosting growth further.

Many more opportunities exist to capture additional efficiencies and productivity gains that will create new businesses and industries, save consumers money, and make many existing businesses and industries in California more competitive. Multiple studies show that businesses in the U.S. could collectively cut GHG emissions by more than one gigatonne (Gt) annually by 2020, representing more than 20 percent of current energy-related emissions, and generate several hundreds of billions of dollars in net savings.[55, 56] The National Academies found

54 For example, see: EPRI. 2013. Total Cost of Ownership Model for Current Plug-In Electric Vehicles. Electric Power Research Institute.

55 WWF and CDP. 2013. The 3% Solution. World Wildlife Fund and the Carbon Disclosure Project. *http://worldwildlife.org/projects/the-3-solution*.

56 McKinsey & Company. 2009. Unlocking Energy Efficiency in the U.S. Economy. McKinsey & Company. *www.mckinsey.com/client_service/electric_power_and_*

SUCCESS STORY

Anheuser-Busch InBev

Anheuser-Busch's Fairfield, California facility is covered by the Cap-and-Trade Program. Cap-and-Trade is designed to encourage energy efficiency and clean energy development. Anheuser-Busch is the world's largest operator of Bio-Energy Recovery Systems that turn the nutrients in wastewater from the brewing process into renewable biogas. The use of biogas at the Fairfield brewery accounts for 15 percent of on-site fuel needs. In addition, the Fairfield brewery has installed a large (1.5 MW) wind turbine on site and estimates about 11 percent of the plant's electricity is wind power. A planned second turbine will approximately double that supply. The turbines join a system which includes a 1.3 MW solar array. The company estimates the plant will get about 25 percent of its power from renewable sources with completion of the entire project. Over the next 20 years the shift will reduce greenhouse gas emissions by six million tons and save $2.5 million.

that U.S. manufacturing could reduce industrial energy usage by as much as 22 percent in 2020, using only technologies that yield at least a ten percent internal rate of return or a return that is greater than the company's cost of capital plus a risk premium.[57] And the Alliance Commission on National Energy Efficiency Policy has found that trillions of dollars of cost-effective energy efficiency potential is available in the United States, and that capturing it could double energy productivity by 2030, save households over $1,000 annually, add over one million jobs, and cut CO_2 emissions by one-third.[58]

Reducing GHG emissions is good business because it not only saves on energy costs, but also cuts maintenance costs, improves productivity and safety, and provides value as a hedge against future fluctuating energy prices.[59] It builds competitive, resilient businesses that are less exposed to risk from volatile energy prices and are better situated to provide lasting economic value and growth. And it diversifies energy supplies and reduces the costs that oil dependence imposes on our economy—up to half a trillion dollars per year across the United States in lost productivity and wealth transfer, alone.[60]

The Obama Administration has set a goal to double energy productivity in the United States by 2030. California is well on its way to achieve this goal as one of the most energy productive states in the country. Our commitment and approach to address climate change will continue to make our economy more efficient and productive; it will keep us ahead, while reducing emissions.

C. Strengthen the Natural Environment

In California and elsewhere, climate policy has primarily focused on reducing the energy-related GHG emissions from the built environment that account for over 85 percent of the GHG emissions in California and the United States. This includes all the buildings, cars, trucks, tractors, machines, and industrial operations that make our economy go. Accordingly, since AB 32 was passed, California has begun to build an effective framework for reducing energy-related emissions on an ongoing basis.

California has a number of policies and incentives in place to reduce emissions from agriculture, water management, and natural and working lands, as well. But additional research and policy development is needed to adequately and fairly incorporate the natural environment into an effective, lasting climate policy framework. California is committed to strengthening the role of the natural environment in climate policy. Continued work among agencies, researchers, stakeholders, and others is needed to further incorporate agriculture, natural, and working lands into the State's policy framework.

Moving forward, as energy-related emissions continue to decline in California and the developed world, the role of the natural environment in managing GHG emissions will only increase. Still, whatever its fraction of total GHG emissions, the importance of incorporating the natural environment into climate policy and planning outstrips its contribution to the State's GHG inventory. In addition to preserving California's lifestyle and economy, natural capital provided by our environment is crucial for providing safe and reliable water supplies, clean air, ecological habitat, and protection against climate change impacts. Strong and healthy coastlines, forests, waterways, marshlands, agricultural lands, and rangelands are crucial not only to support our agricultural and tourism-based economies, but also to reinforce and buffer our State from the

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natural_gas/latest_thinking/unlocking_energy_efficiency_in_the_us_economy.

57 NAS. 2009. America's Energy Future: Technology and Transformation. National Academies Press. *www.nap.edu/catalog.php?record_id=12091*.

58 ASE. 2013. Energy 2030. Alliance to Save Energy. *www.ase.org/policy/energy2030*.

59 PwC. 2013. Less and be more: better for the bottom line and the environment. 10Minutes series on eco-efficiency. *www.pwc.com/en_US/us/10minutes/assets/pwc-10minutes-eco-efficiency.pdf*.

60 Greene. 2013. "Low Carbon Transportation: A Crucial Link to Economic and National Security." *www.arb.ca.gov/research/lectures/speakers/greene/greene.htm*.

increasing impacts of climate change, including drought, flood, and forest fires. Strengthening our natural environment makes it, and consequently our economy, more resilient to the impacts of climate change and protects our built environment.

Adequately accounting for the natural environment in our climate framework requires an integrated approach that values natural resources, not just as emission sources or sinks, but also for the other values they provide. It requires coordinating plans to reduce emission impacts from the natural environment with plans to strengthen it and prepare for climate change impacts. This is the approach California will take as we continue to build our climate policy framework. The approach will not only contribute emission reductions and build emission sinks necessary to manage climate change, but also strengthen the natural environment that drives our economy and supports our quality of life.

D. Improve Public Health and Social and Environmental Justice

The impact of climate change and California's policy approach to address it reaches beyond environmental protection and economic opportunity. If done appropriately, addressing climate change provides tremendous opportunity to improve the health and well-being of all of California's citizens and to help unravel many of the patterns of environmental, health, and social inequalities within our communities.

Cleaner and more efficient power plants, industrial facilities, cars and trucks, modernized freight systems, and reduced travel demand are already greatly reducing air pollution and cancer risks in California, particularly in environmental justice communities. Strengthening our natural environment, including those areas surrounding the most impacted urban and rural communities, will further improve public health.

Ongoing planning to create more sustainable communities in the State is providing expanded mobility options, including greater access to walking and biking facilities, increased access to employment and services, and more vibrant surroundings. Energy efficiency, green buildings, and other clean energy technologies and climate policies are creating more comfortable, safer homes and transportation options, and are saving families money. Efforts to improve industrial, manufacturing, and agricultural efficiency and productivity will strengthen these sectors and make the communities and jobs they support more resilient to national or global economic downturns and climate impacts. All of these aspects of California's climate policy approach bring economic, health, and other benefits to all of California's communities.

Yet, innovative public policy brings unknowns. As California continues to lead on climate change and pioneer new policy and technology strategies to avert the worst impacts of global warming, we must continue to monitor and assess the health and environmental justice impacts of our programs and policies, making changes when necessary to maximize benefits. Capturing the opportunities of climate policy to improve health and quality of life in all of California's communities is a critical aspect of our leadership and is building a successful and lasting climate policy framework. Delivering on those opportunities will serve to expand policy action beyond the State's borders.

E. Rely on Science and Foundational Research

California's environmental policy successes are built on a strong foundation in science. Successfully addressing climate change and planning to achieve targeted emission reductions over time similarly requires a dependence on foundational research.

Climate policy in California has been supported, and advanced, by our State's world-class research institutions, which have made California perhaps the most studied region in the world when it comes to GHG emissions and climate policy. As a result, we have a strong sense of the mix of technologies needed to reduce emissions through 2050, especially in the energy sector, and a valuable research apparatus to support ongoing policy planning and implementation.

A number of studies look to 2050 in California and provide a snapshot of the mix of technologies necessary to reduce energy-related emissions in California to 80 percent below 1990 levels by 2050.[61] They share many common conclusions, including the overarching conclusion that the 2050 emissions target is achievable, mostly with technologies that are commercially available today.

Together, they show that achieving the 2050 target will require energy demand reduction through efficiency and activity changes; large-scale electrification of on-road vehicles, buildings, and industrial machinery; decarbonizing electricity and fuel supplies; and rapid market penetration of efficiency and clean energy technologies that requires significant efforts to deploy and scale markets for the cleanest technologies immediately. The studies agree that large efficiency

61 For example, see: Greenblatt, J., et al. 2011. California's Energy Future, The view to 2050: Summary report. California Council on Science and Technology (CCST). *www.ccst.us/publications/2011/2011energy.pdf*.
Williams, J. H., et al. 2011. "The Technology Path to Deep Greenhouse Gas Emissions cuts by 2050: The pivotal role of electricity." Science Express 335 (6064): 53–59. [E3] *www.sciencemag.org/content/335/6064/53*.
Wei, M., et al. 2013. "Deep carbon reductions in California require electrification and integration across economic sectors." Environmental Research Letters 7: 1–9. *http://iopscience.iop.org/1748-9326/8/1/014038/*.
[LBNL-1] Wei, M., et al. 2012. "California's Carbon Challenge (CCC): Scenarios for Achieving 80% Emissions Reduction in 2050." Lawrence Berkeley National Laboratory. October 31. *http://rael.berkeley.edu/sites/default/files/California%20Carbon%20Challenge%20Report%20Nov%201_2012.pdf*. [LBNL-2]
Jacobson, M. Z., et al. 2013. Evaluating the technical and economic feasibility of repowering California for all purposes with wind, water and sunlight. *www.stanford.edu/group/efmh/jacobson/Articles/I/CaliforniaWWS.pdf*. [Stanford]
McCollum, D., et al. 2012. "Deep greenhouse gas reduction scenarios for California – Strategic implications from the CA-TIMES energy-economic systems model." Energy Strategy Reviews 1(1):19–32. *http://www.sciencedirect.com/science/article/pii/S2211467X11000083*. [UCD-1]
Yang, et al. 2009. "Meeting an 80% reduction in greenhouse gas emissions from transportation by 2050: A case study in California." Transportation Research Part D 14. *www.internationaltransportforum.org/pub/pdf/10FP03.pdf*. [UCD-2]

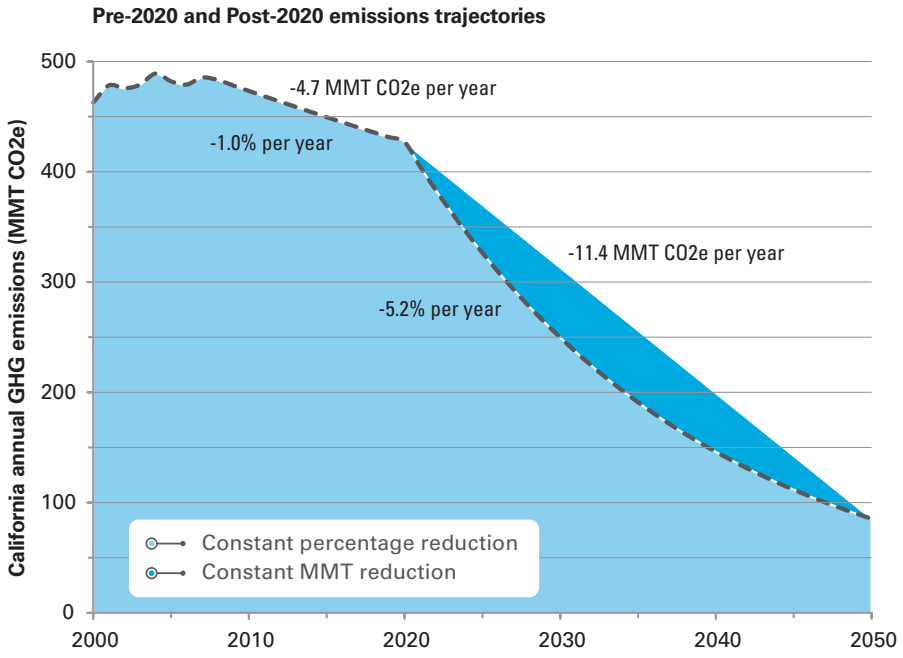
improvements can be achieved in transportation, buildings, and industry; that the electricity sector will have to be essentially zero carbon; and that electricity or hydrogen will have to power much of the transportation sector, including almost all passenger vehicles, and that near-zero carbon biofuels will have to power most other vehicles. They recognize a need for the natural environment to play an important role, providing carbon sinks to offset emissions, and a need to integrate and coordinate policy across a number of objectives and planning processes.

The studies vary in several important assumptions, however, which offer opportunities to pursue additional emission reductions or select alternative policy and technology paths forward—depending on population and economic growth in the State, technology and market development, and changing activity and behavior patterns. California will need to monitor the market and technology progress alongside emissions, and continue to rely on strong supporting research as it builds on its climate policy framework. One thing is clear; many prominent California scientists and economists support a mid-term target to meet California's long term climate goals.[62]

F. Charting a Path to 2050

Achieving the low-carbon future described in these studies will require that the pace of GHG emission reductions in California accelerate significantly. Emissions from 2020 to 2050 will have to decline several times faster than the rate needed to reach the 2020 emissions limit (Figure 6).

Figure 6: Framing the Path to 2050



Ultimately, climate change is affected by cumulative emissions. As described in Chapter II, the world must keep within scientifically determined "carbon budgets" to achieve climate stabilization. Accordingly, different paths to the same 2050 emissions levels will result in different climate impacts. Tackling global warming requires us to reduce and minimize total emissions, not just reach stated targets.

62 An Open Letter on Climate Change from California Climate Scientist and Economists: *www.arb.ca.gov/lists/com-attach/10-proposed-sp-ws-AHUFYFIgVCkEcIQw.pdf*

Appropriate action on climate change requires a continuum of action to capture cost-effective emission reductions opportunities wherever possible, on an ongoing basis. We need to meet strict, science-based targets not just in 2020 and 2050, but at every point in between, as well. California's leadership will be defined not just by its emissions level in 2050, but also by the pathway it takes to get there.

As described in Chapter IV, California will develop a mid-term target to frame the next suite of emission reduction measures and ensure continued progress toward scientifically based targets. This target should be consistent with the level of reduction needed in the developed world to stabilize warming at 2°C (3.6°F) and align with targets and commitments elsewhere. The European Union has adopted an emissions reduction target of 40 percent below 1990 levels by 2030. The United Kingdom has committed to reduce its emissions by 50 percent below 1990 levels within the 2022–2027 timeframe, and Germany has set its own 2030 emissions target of 55 percent below 1990 levels. The United States, in support of the Copenhagen Accord, pledged emission reductions of 42 percent below 2005 levels in 2030 (which, for California, translates to 35 percent below 1990 levels).

This level of reduction is achievable in California. In fact, if California realizes the expected benefits of existing policy goals (such as 12,000 megawatts [MW] of renewable distributed generation by 2020, net zero energy homes after 2020, existing building retrofits under AB 758, and others) it could reduce emissions by 2030 to levels squarely in line with those needed in the developed world and to stay on track to reduce emissions to 80 percent below 1990 levels by 2050.[63] Additional measures, including locally driven measures and those necessary to meet federal air quality standards in 2032, could lead to even greater emission reductions.

Setting a strong mid-term target that aligns with scientifically established needs is an important next step in California's climate policy leadership. Such a target will provide greater levels of market certainty in the near term, while allowing flexibility to review and adjust our course based on future technology and market conditions. Planning and effectively implementing policies to achieve a mid-term target in a manner that advances economic growth, public and environmental health, and quality of life in all of the State's communities will further demonstrate California's successful policy approach and create an enviable framework that others will look to follow.

63 Greenblatt, J. 2013. Estimating Policy-Driven Greenhouse Gas Emissions Trajectories in California: The California Greenhouse Gas Inventory Spreadsheet (GHGIS) Model. Lawrence Berkeley National Laboratory. *http://eetd.lbl.gov/publications/estimating-policy-driven-greenhouse-g*

IV. Accomplishments and Next Steps

California must continue to build on the framework established in the initial Scoping Plan as we look toward meeting our long-term climate goal of GHG emissions of 80 percent below 1990 levels by 2050. A mid-term statewide emission limit will ensure that the State stays on course to meet our long-term goal and continues the success it has achieved thus far in reducing emissions. The mid-term statewide limit will help frame the additional suite of policy measures, planning efforts, and investments in clean technologies that California will need to continue to drive down emissions and grow a cleaner, more sustainable economy.

This chapter provides a discussion of GHG emission reduction mitigation strategies for each of California's major economic sectors. It identifies the activities, policies, and other accomplishments, primarily over the last five years, that address climate change to reduce GHG emissions to meet the 2020 statewide limit. It also identifies longer-term strategies that the State must undertake to continue to reduce GHG emissions into the future to ultimately meet our long-term climate goal.

Each major sector highlighted in this chapter must play a role in supporting the statewide effort to continue to reduce emissions. Planning must begin now in order to implement our longer-term strategies. Specific recommendations for steering the State down this path are summarized, by sector, at the end of this chapter. As the statewide mid-term target is developed, sector targets will also be developed that reflect the opportunities for reductions that can be achieved through existing and new measures, actions, and investments.

A. Key Economic Sectors

The initial Scoping Plan recommended specific GHG emission reduction measures in nine major economic sectors to better define, organize, and determine control strategies for each. In this Update, six key areas of the State's economy were identified (energy, transportation, agriculture, water, waste management, and natural and working lands), along with short-lived climate pollutants, green buildings, and the Cap-and-Trade Program. The subsections below describe our progress in reducing GHG emissions and what will be required to better evaluate GHG emission reduction actions within California's broad economy to meet the State's more expansive longer-term emission reduction goals.

These key areas have overlapping and complementary interests that will require careful coordination in the State's future policies and strategies. The areas were chosen based on their ability to address concerns that underlie all sectors of the economy. As such, each focus area is not contained to a single economic sector, but has far-reaching impacts within many sectors. For example, much of the transportation sector will need to be electrified in the future. This creates demand for more electrical generation, but also provides an opportunity to take advantage of broader systems efficiencies as sectors interact in new ways.

Another example is the interaction between water delivery and energy use in California. Since water delivery is very energy-intensive, implementing programs that strongly support water conservation can reduce GHG emissions in the electricity sector by reducing the need for electricity to move, treat, and heat water. Water conservation is also critical to making the State's water supply more reliable and drought resistant. Producing electricity requires large volumes of water. Promoting a system that maximizes appropriate cooling technologies (e.g., reclaimed water and dry cooling towers), energy efficiency, and conservation can greatly reduce water demands and make those water savings available for agriculture and other essential needs. The way that communities and infrastructure are designed and built can significantly reduce California's impact on natural lands, minimize vehicle miles traveled, reduce water needs, and provide many other benefits for the State as a whole.

1. Energy

California's energy sector includes a complex system of electricity and natural gas production, transmission and distribution, utility service operations, and consumption by diverse end users—including residential, commercial, and industrial activities. Energy is a common thread that runs through all sectors of California's economy. It's also one of the State's largest contributors to GHG emissions. Presently, about 50 percent of the State's total GHG emissions are associated with the energy sector; therefore, efforts to reduce energy-related emissions are a key component of the Scoping Plan. Additionally, energy-sector emission reduction efforts will become increasingly important as more economic activities such as transportation and freight movement are electrified.

Reducing energy-sector emissions to near zero over the long-term will require wholesale changes to the State's current electricity and natural gas systems. The energy sector will generally need to adapt to a system consisting of near-zero carbon buildings (refer to Section 8 of this chapter for more discussion of zero net carbon buildings), highly efficient businesses and industry, low-carbon electricity generation, sustainable bioenergy systems, smarter and localized generation, a flexible and modernized transmission and distribution system, more compact land use, and electricity substitutes for fuels currently used for transportation, space heating, and industrial processes.

Achieving these emission reduction goals will require that a number of important administrative, financial, and technological changes are undertaken to guide energy investments and planning toward the most appropriate combination of conservation, efficiency, and clean-energy technologies to decarbonize the State's energy systems at the lowest cost.

Electricity and Natural Gas

California has made remarkable progress in developing and implementing new policies and strategies to reduce GHG emissions within the State's energy sector. California has a track record of decades of rigorously evaluated, cost-effective energy efficiency improvements across all sectors of the economy. The initial Scoping Plan continued these priorities by advancing a host of innovative and aggressive building, appliance, electronic, and water-efficiency standards that are certain to maintain California's leadership in this area.

An example of California's leadership in the energy sector is SB 1368 (Perata, Chapter 598, Statutes of 2006), which created the nation's first emission performance standard for centralized power generation. SB 1368 prevents the State's electric utilities from making long-term investments in high GHG-emitting baseload power plants. The U.S. EPA is following California's lead by proposing a GHG emission performance standard for the nation's power plants.

Consistent with the State's loading order,[64] the California Energy Commission (CEC) and California Public Utilities Commission (CPUC) have adopted several programs and regulations since 2008 that are driving efforts to reduce electricity-sector GHG emissions. Many of these programs are implemented at the local electric utility level. Below is a discussion of efforts being undertaken to reduce GHG emissions from the energy sector in accordance with the State's loading order.

Energy Efficiency

A variety of appliance (including electronics) and building energy efficiency programs and initiatives represent the State's top priority in reducing the need to develop new energy resources to meet California's electricity and natural gas demand. The CEC continues to provide a leadership role in developing and adopting new appliance and building efficiency standards for the State. Building efficiency standards were updated in 2013 and are now 25 percent more efficient for residential construction and 30 percent more efficient for non-residential construction.[65] The CEC also adopted aggressive energy efficiency standards for televisions in 2009, and first-in-the-nation energy efficiency standards for battery chargers in 2012.[66]

The CEC is currently considering additional appliance categories to cover under its appliance energy efficiency standards. Those under consideration include consumer electronics, lighting, water appliances, and several others. Future updates to these standards and collaborative work with the U.S. Department of Energy should focus on realizing both cost-effective energy savings and incorporating features that can assist in grid resilience and responsiveness.

In addition to the State's energy efficiency Standards, California's investor-owned utilities (IOUs) regulated by the CPUC have a long history of implementing energy efficiency programs that target both residential and non-residential sectors. The State's self-regulated publicly owned utilities (POUs) also have energy efficiency programs. The POU programs vary significantly between the individual utilities, but in some cases can be more aggressive than the IOU goals.

The CPUC's evaluation activities have focused on verifying utility savings claims and improving savings estimates via field-based research. Findings and recommendations from these studies have been critical to continued improvement of energy efficiency programs in the State. The CPUC has recently opened a new rulemaking in which it has signaled its intent to provide grid planners and efficiency markets with greater certainty regarding the State's commitment to these programs. Similar progress and initiatives should be made in all POU territories.

Funding from the California Clean Energy Jobs Act (Proposition 39), approved by California voters in November 2012 and subsequently refined through Senate Bill 73 (Skinner, Chapter 29, Statutes of 2013), will provide a significant source of new revenue (an estimated $2.5 billion over five years) to support energy efficiency and clean energy projects in California's public schools (K–12) and community colleges.

At the local government level, several communities have created property-assessed clean energy financing districts (PACE programs) that allow residential and commercial property owners to finance renewable on-site generation and energy efficiency improvements through voluntary property tax assessments.

Governor Brown took specific action in 2012 to improve the energy efficiency of state-owned buildings through Executive Order B-18-12, which directs State agencies to reduce their grid-based energy purchases by at least 20 percent by 2018. This Executive Order also directs State agencies to reduce the GHG emissions associated with the operating functions of their

64 The "loading order" is California's preferred sequence for meeting electricity demands: energy efficiency and demand response first; renewable resources second; and clean and efficient natural gas-fired power plants third.

65 Computed from California Energy Demand, 2012–2022 Final Forecast, June 2012, Form 2.2 on Committed Energy Impacts.

66 CEC. 2013. California Energy Commission 2012 Accomplishments. *www.energy.ca.gov/releases/2013_releases/2012_Accomplishments.pdf*.

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Kaiser Permanente

Between 2010 and 2011, Kaiser Permanente installed solar panels that increased its on-site renewable generation capacity to 11 megawatts at 12 facilities across California, creating one of the largest health care solar installations in the country. The panels generate clean, renewable energy for Kaiser Permanente hospitals and buildings, avoiding approximately 7,600 metric tons of CO_2 emissions annually since 2012. Kaiser Permanente also deployed four megawatts of natural gas-powered fuel cell generation capacity, thus avoiding approximately 5,700 metric tons of CO_2 emissions in 2012, while reducing the organization's reliance on the public electric grid and helping to diversify energy sources.

buildings by ten percent by 2015, and 20 percent by 2020.[67] State agencies have been able to achieve a four percent reduction in total energy use despite a 12 percent increase in building space since 2003.

Fifty-five percent of existing residential buildings and 40 percent of non-residential buildings were constructed before California's building energy efficiency standards were established. California's legislature recognized the opportunity and importance of upgrading existing residential and commercial buildings and passed Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009), which requires the CEC to develop and implement a comprehensive energy efficiency plan for all of California's existing buildings. The CEC is currently drafting an AB 758 Action Plan to accomplish the following:

- Improve code compliance rates with Title 24 Building Standards for existing building upgrade projects.
- Develop energy disclosure approaches and programs that build on existing efforts and expand the types of applicable buildings, including State buildings in alignment with Governor Brown's Executive Order B-18-12.
- Collaborate with the real estate and property management industries to craft aggressive, but practical, solutions to achieve efficiency upgrades in existing buildings.
- Enhance usability of Title 24 Building Standards as applied to additions and alterations of existing buil dings.

Achieving the State's zero net energy (ZNE) building goals is an important effort under way to assist with achieving climate targets. In 2008, the CPUC set forth ZNE goals in its long-term Energy Efficiency Strategic Plan and implementation roadmap for the Big Bold Energy Efficiency Strategies, which was later updated in 2011. The CPUC's Big Bold Energy Efficiency Strategies set policy goals to achieve ZNE in all new residential buildings by 2020, and all new commercial buildings by 2030.

The CEC has made progress toward achieving the State's ZNE goals for new residential and new commercial buildings through triennial updates to the State's building energy efficiency standards.

67 Executive Order B-18-12, issued on April 25, 2012. See *http://gov.ca.gov/news.php?id=17508.*

Working with the CPUC, the CEC adopted a definition for ZNE code-compliant buildings that was published in the 2013 Integrated Energy Policy Report. Building on this effort, ARB and CEC should analyze[68] zero and near-zero GHG alternatives for heating, cooking, and commercial energy use and assess the potential economic and technological barriers to switching to these alternatives. ARB is committed to building upon the recent policies and goals adopted by the CPUC and CEC and supporting the development of statewide programs, such that all new residential and commercial buildings are zero net energy by 2020 and 2030, respectively.

Recent efficiency initiatives that overlap across agencies, such as American Recovery and Reinvestment Act of 2009 (ARRA)-funded whole-house upgrades and Proposition 39 schools-focused activities, have revealed inconsistencies in the accounting and evaluation methods for estimating, verifying, and valuing energy efficiency savings across State agencies. These differences may be driven by the historic policy drivers for the energy efficiency activities. Since the methods of measuring, verifying, and valuing energy efficiency can impact the scope of future efficiency programs and the resulting GHG savings, efforts should be undertaken to improve the efficacy of these efforts by emphasizing consistency, transparency, credibility, and timeliness.

Demand Response

Demand response is also at the top of California's loading order for meeting the State's electricity demand. Demand response is provided primarily by utilities or third-party demand-response providers (DRPs), also known as aggregators, through programs or contracts that are supported by $1 billion in ratepayer funding (over three years). Demand response has traditionally been used to reduce peak demand and there is currently approximately 2,000 MW of demand-response capacity in IOU territories. Some programs are used to mitigate emergency situations, while others are used to address economic conditions, such as high wholesale energy prices

The CPUC recently initiated a new rulemaking[69] for demand response for the purpose of enhancing its role in meeting the State's resource planning needs and operational requirements. Specifically, the rulemaking states that demand response needs to improve its reliability and usefulness as the State's grid needs continue to evolve. For example, demand-response resources are not bid into California Independent System Operator (CAISO) wholesale energy markets, thereby reducing their visibility and dispatchability to CAISO's grid operators. The CPUC's rulemaking and its concurrent efforts to approve "direct participation" rules in 2014 (also known as Rule 24) are the first steps of many that will lead to the bidding of demand response resources into wholesale markets.

The rulemaking also recognizes that demand response has potential value as a flexible capacity resource for renewable integration (through increasing or decreasing demand), a balancing energy and ancillary service resource, and an alternative to transmission upgrades. Demand response as a renewable integration resource carries significant implications for GHG reduction goals. Renewable resources such as wind and solar are variable, and thus grid operators must rely on load-following resources to maintain grid stability. Those load-following resources are typically quick-start fossil-fuel generation plants. If demand response can provide the needed reliability for variable renewable resources, the State will have less need for quick-start fossil-fuel generation plants.

However, existing demand response resources do not yet have the speed, flexibility, or reliability to achieve this potential. One purpose of the CPUC rulemaking is to determine, in close collaboration with CAISO, the specific qualities demand response resources will need in order to address these new grid needs. Once these qualities have been set, market participants can then be directed to provide the "next generation" of demand-response resources through appropriate procurement mechanisms. The CAISO's Flexibility Resource Adequacy Criteria and Must-Offer

68 The CEC is required by Title 24 to use a lifecycle cost-effectiveness analysis methodology.

69 R.13-09-011, issued on September 25, 2013: *http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M077/K151/77151993.PDF*

Obligation (FRACMOO) stakeholder process and its anticipated demand response Standard Capacity Product stakeholder process are key CAISO initiatives in setting specific design and operational details for future demand response resources.

While development of DR as a renewable integration resource is a critical next step for California, the CPUC rulemaking also signals the importance of refining demand-response resources that cannot be bid into CAISO markets but are beneficial to the State's goals of reducing energy consumption during peak hours. These resources, referred to as load-modifying demand response, can reduce California's demand curve over time through strategies such as time-of-use rates and permanent load-shifting programs. The impact of these programs could potentially reduce the need for gas-fired generation resources in future planning processes. Additionally, the rulemaking will be exploring how demand response can be better coupled with other demand-side resources such as energy efficiency and distributed generation, so that retail customers see all their options and make well-informed decisions, thereby expanding demand-side resources collectively.

Renewable Energy

In 2011, the Legislature passed and Governor Brown signed a bill creating the nation's most aggressive renewables portfolio standard (RPS) program. The program requires California's investor-owned and publicly owned electric utilities, as well as all other retail sellers of electricity, to serve 33 percent of their customers' electricity needs with clean renewable energy by 2020. As part of his Clean Energy Jobs Plan, Governor Brown set an aggressive target of adding 8,000 MW of centralized, large-scale renewable facilities (of which 3,900 MW has come online since 2010) and 12,000 MW of distributed renewable generation by 2020. Of the 12,000 MW distributed renewable generation goal, 4,400 MW has already come online.

California has made substantial progress in developing new renewable resources to support the RPS and the governor's goals. The large investor-owned utilities report that they have met the 20 percent RPS goal for 2011–2013, are on track to meet the requirement of 25 percent renewables by 2016, and are well-positioned to meet the 33 percent target by 2020. The publicly-owned utilities have also contributed to meeting these targets and are progressing about as fast, and in some cases faster, than the investor-owned utilities.

Approximately 2,000 MW of new renewable capacity came online in 2012;[70] 1,600 MW of which is wind generation. Another 3,300 MW of renewable capacity is estimated to have come online statewide before the end of 2013. A total of 3,500 MW of solar (thermal and photovoltaic, or PV) and 5,700 MW of wind has been installed to date. California is now the nation's second largest producer of wind power.[71]

California leads the nation in the amount of solar PV capacity.[72] In 2012, California became the first state to install more than 1,000 MW of new solar capacity in a single year, from a combination of utility-scale projects and customer installations.[73] In 2013, the State added over 2,600 MW of solar PV; 2,300 MW from wholesale solar PV and 300 MW from self-generation PV. Solar PV programs[74] codified by Senate Bill 1 in 2006 (SB 1, Murray, Chapter 132) are driving much of the self-generation installation in California. SB 1 set a target for 3,000 MW of self-generation solar,

70 California Public Utilities Commission. 2012. Renewables Portfolio Standard Quarterly Report, 3rd and 4th Quarter 2012. *www.cpuc.ca.gov/NR/rdonlyres/2BC2751B-4507-4A38-98F5-F26748FE6A95/0/2012_Q3_Q4RPSReportFINAL.pdf*

71 Wiser, Ryan, and Mark Bolinger. 2012. 2011 Wind Technologies Market Report. Lawrence Berkeley National Laboratories. U.S. Department of Energy. DOE/GO-102012-3472. August.

72 Dutzik, Tony, and Rob Sargent. 2013. Lighting the Way: What We Can Learn From America's Top 12 Solar States. Environment America Research and Policy Center. July. *www.environmentamericacenter.org/sites/environment/files/reports/Lighting_the_way_EnvAM_scrn.pdf*

73 Marshall, J. 2013. California Still Tops in Renewable Energy Rankings. *www.pgecurrents.com/2013/08/22/california-still-tops-in-renewable-energy-rankings/*. Accessed August 23, 2013.

74 California's solar PV programs include the CPUC's California Solar Initiative, the Energy Commission's New Solar Homes Partnership, and publicly owned utility solar incentive programs.

including solar water heating, by 2017, of which 1,570 MW have been installed. Additionally, about 300 MW were installed prior to SB 1 as result of the Emerging Renewable Program, the Self Generation Incentive Program, and POU solar incentive programs. In total, about 1,900 MW of self-generation solar was installed in California by the end of 2013.

Energy Storage

While taking steps to minimize integration needs, the State must also advance energy storage technologies to help integrate increasing amounts of renewable resources. An energy storage device is a technology capable of absorbing energy, storing it for a period of time, and dispatching the energy as needed. Energy storage devices can store energy during times of low demand or over-generation and can then provide energy stored back into the grid during times of peak demand or when the grid is stressed.

Storage technologies can be applied on transmission and distribution systems and can help maintain a reliable and efficient transmission grid. Storage can also provide load-following capabilities to manage frequent and wide variations in solar and wind energy due to their fast ramp rates (megawatts of power delivered per minute). Storage can also complement demand response programs. In October 2013, the CPUC adopted an energy storage procurement framework and design program which requires the investor-owned utilities to procure 1,325 MW of energy storage by 2024.[75]

Combined Heat and Power

Combined heat and power systems (CHP), also referred to as cogeneration, generate on-site electricity and useful thermal energy in a single integrated system. Combined heat and power systems are typically used in industrial, commercial, and institutional applications where both electricity and steam are required. Governor Brown set a goal for 6,500 MW of additional CHP capacity by 2030 as part of his Clean Energy Jobs Plan. This goal builds upon the Scoping Plan's goal for emission reductions equivalent to 4,000 MW of new CHP generation by 2020.

Through the implementation of the 2007 Waste Heat and Carbon Emissions Reduction Act (also known as AB 1613, Blakeslee, Chapter 713, Statues of 2007), the CEC and CPUC have taken steps to create efficiency guidelines and market pricing incentives for small (<20 MW) CHP system owners. The CPUC also adopted the CHP "Settlement Agreement" in 2010,

75 CPUC. Decision Adopting Energy Storage Procurement Framework and Design Program. October 17, 2013. *http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M078/K912/78912194.PDF*.

SUCCESS STORY

California's electric grid is becoming more efficient through improved communications and control software that allow operators to check energy flow every few seconds and more accurately balance supply and demand. This also improves the ability of California grid operators to bring more energy from renewable sources into the state's electricity mix. Other in-building "smart" technology developments allow for more efficient energy usage and for real-time communication between consumers, their appliances, and electricity suppliers. A study by the Pacific Northwest National Laboratory estimated that these "smart grid" improvements can reduce GHG emissions from electricity generation by as much as 12 percent by 2030.

which created a new CHP program requiring that California's three largest investor-owned electric utilities procure a minimum of 3,000 MW of CHP capacity until 2015 and reduce greenhouse gas emissions by 4.8 $MMTCO_2e$.

Despite these policy actions and incentives for CHP, significant installation barriers for CHP systems still remain and very few new CHP systems have been installed since the initial Scoping Plan was released. Indeed, due to older system retirements, the State's overall CHP capacity may be lower now than it was in 2008. ARB is committed to working with the CPUC, CEC, and CAISO to assess existing barriers to expanding the installation of CHP systems and propose solutions that help achieve climate goals. A future CHP measure could establish requirements for new or upgraded efficient CHP systems.

Industry

In the initial Scoping Plan, the industry sector was discussed in a separate sector; however, in this Update it has been included within the energy-sector discussion because its GHG emissions are primarily due to energy use.

California industry includes a broad and diverse range of sources, including cement plants, refineries, power plants, glass manufacturers, and oil and gas production facilities. Industrial sources play a significant role in the State's vast economy and accounted for about 20 percent of California's total GHG emissions.

Most emission reductions from industry will be realized through California's Cap-and-Trade Program, which includes large industrial sources (i.e., sources emitting more than 25,000 $MTCO_2e$ per year). (See Section 9 of this chapter for a discussion of the Cap-and-Trade Program.) As with other activities covered by the Cap-and-Trade Regulation, ARB also assessed the potential for direct regulation measures that could be implemented at these facilities. In addition, fugitive emissions from industrial facilities (primarily methane emissions) are not part of the Cap-and-Trade Program. Therefore, direct regulations were also considered for industrial sources with significant fugitive GHG emissions—oil and gas extraction, natural gas transmission, and refineries.

Carbon capture and sequestration (CCS) is another option to reduce emissions from electricity generation and industrial emitters. ARB is currently working with researchers from the Lawrence Berkeley National Laboratory (LBNL) to evaluate existing quantification methodologies related to the sequestration portion of CCS in the context of California geological and regulatory considerations. ARB will continue to work with the Division of Oil, Gas & Geothermal Resources (DOGGR), CEC, and CPUC for future development of a quantification methodology for California GHG emissions sources.

In 2010, ARB approved the energy efficiency assessment regulation requiring California's largest industrial facilities to conduct a one-time assessment of the facility's fuel and energy consumption and emissions of GHGs, criteria pollutants, and toxic air contaminants. The assessments were to include the identification of potential energy efficiency improvement projects. ARB subsequently received assessment reports from 43 industrial facilities covering five industrial sectors: refinery, cement, hydrogen production, power generation, and oil and gas/mineral production. ARB is currently developing public reports for each industrial sector, summarizing the information provided by the facilities. ARB will use these findings to identify the best approaches to secure energy efficiency improvements and the associated emission reductions at California's largest facilities.

Regarding fugitive emissions, ARB undertook a survey of the oil and gas extraction sector, on items such as compressor seals, storage tanks, valves, flanges, and connectors, to improve the emission inventory. The key findings of this survey are influencing ARB's approach to developing a new measure in 2014 to reduce fugitive GHG emissions from these operations.

Current data indicate that methane emissions in California may be undercounted and that one potential source of these emissions is the natural gas transmission and distribution system. Based on a 2008 survey, the vast majority of the GHG emissions from this sector are expected to come from distribution pipeline leaks. Field measurements of fugitive emissions from natural gas distribution pipelines in California are currently being conducted to update the emission factors for this sector. The field study is expected to be completed by 2015. ARB will use the study results to determine the cost-effectiveness of developing a regulation to reduce fugitive GHG emissions from these operations.

Methane has historically been exempt from the local air districts' volatile organic compound (VOC) regulations, such as refinery leak detection and repair regulations, because it has very low photochemical reactivity and, thus, does not contribute significantly to smog formation. However, because methane is a powerful GHG and short-lived climate pollutant, ARB is working with local air district staff to determine the benefits of incorporating amendments to their existing leak detection and repair rules to include methane leaks from refineries and other industrial sources with a potential for fugitive methane emissions.[76]

Oil and Natural Gas Production

California has a significant oil and natural gas industry. Currently, our existing rules (LCFS, Cap-and-Trade and others) and proposed new measures, such as for hydraulic fracturing (fracking), oil and gas production, and other short-lived climate pollutants measures, will lead to best-in-industry practices to minimize GHG, criteria and toxic pollutant emissions associated with the production and refining of oil and gas.

Maintaining Momentum

California will be unable to achieve the needed GHG emissions within the energy sector by simply continuing or modestly expanding upon current energy conservation, efficiency, and generation decarbonizing program efforts. In addition, no single agency or entity has complete responsibility for the energy sector. As previously noted, a reworked and comprehensive State program will be required that addresses all affected energy entities and is specifically designed to ensure that the proposed emission reductions are achieved.

For example, in addition to calling for more localized generation and smart grid technologies, the energy sector should support "smarter generation." This includes advanced energy technologies and distributed generation, as well as regional grid management to allow for pooling of diverse resources. Planning for regional (west-wide) grid management is occurring through the Energy Imbalance Market (EIM), led by CAISO. It allows California to use a regional approach to increase grid reliability by allowing the State's energy system to pull from a more diverse set of resources to meet demand and renewable integration needs.

At the electricity distribution level, actions to expedite the deployment of small-scale storage systems, as well as microgrid and "smart-grid" technologies, are essential to maximize renewable and distributed resource integration. Strengthening and expediting California's policies for ZNE homes and businesses and maximizing energy conservation and demand-response participation in the consumer electricity market should also be a priority. The role and functions of utilities may need to evolve as California increasingly shifts toward more renewable and distributed energy integration.

The State will need a comprehensive and aggressive (but flexible) program to drive energy utilities toward providing zero and near-zero GHG energy resources. At the same time, the State will need to ensure that new or expanded economic development activities are designed to incorporate the most advanced energy-efficient technologies and energy-conserving practices.

76 In addition, CEC is mandated by AB 1257 (Bocanegra, Chapter 749, Statutes of 2013) to identify strategies for evaluating the lifecycle GHG emissions from the natural gas sector every four years.

State agencies should collaborate toward developing a comprehensive and enforceable GHG emission reduction program for the State's electric and energy utilities. The CEC, CPUC, and ARB will all have a role in developing and implementing the most technologically appropriate and cost-effective suite of strategies to achieve the State's emission reduction goals.

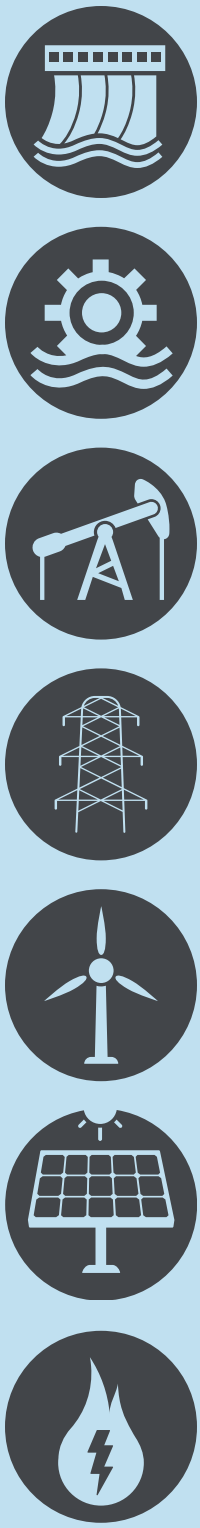
The program should maintain consistency with the State's broader energy policies, such as those articulated in the loading order and the initial Scoping Plan, and be designed to further advance key State energy programs and needs such as energy efficiency and demand-response efforts, renewable energy development, energy storage systems, smart-grid and microgrid deployment, and distribution and transmission system upgrades and expansion.

The program should contain monitoring mechanisms to ensure reasonable progress is being made in achieving emission reduction goals and broader energy policies. The program should include mid-term targets (including a GHG emission target and other targets that support meeting broader energy policies) designed to spur and gauge progress toward meeting a final 2050 GHG emission target and broader energy policies. The program should be established through a process which includes extensive stakeholder and public input.

In addition to facilitating the creation of the comprehensive emission reduction program, the State's energy agencies should pursue a series of key proceedings to further advance energy efficiency and conservation programs that hold great potential for reducing GHG emissions within the energy sector.

Several key actions are summarized below to drive the State toward developing and deploying the most appropriate market, resource, technology, and design options to achieve longer-term GHG emission reductions within the energy sector.

Key Recommended Actions for the Energy Sector



State agencies will develop comprehensive and enforceable GHG emission reduction requirements for the State's electric and energy utilities to achieve near-zero GHG emissions by 2050. Program development to be completed by end of 2016, and incorporate the following principles:

- Thoroughly account for the carbon intensity and air quality impacts of various energy resources, generation technologies, and associated fuels.
- Maximize local and regional benefits of energy facilities.
- Minimize emissions of criteria and toxic air pollutants.
- Avoid disproportionate impacts to disadvantaged communities.
- An enforceable program for all energy and electricity service providers.
- Recordkeeping and reporting mechanisms to monitor and enforce the GHG emission reduction requirements.

State's energy agencies pursue a series of key proceedings, including the following:

- Develop criteria and rules for flexible demand response resources to participate in wholesale markets and integrate variable renewable resources, reducing the need for new flexible fossil generation.
- Expand participation of regional balancing authorities in the CAISO Energy Imbalance Market and other potential methods of balancing authority cooperation, which provide low-cost, low-risk means of achieving real-time operational efficiency and flexibility needed for greater penetration of variable renewable resources, while ensuring support for greenhouse gas emission reduction programs.
- Through the AB 758 process, CEC will develop a plan to encourage energy assessments—particularly when done at the time a building or unit is sold or by a predetermined date—as well as energy use disclosure requirements.
- Enhance energy efficiency and demand response programs, including development of education/outreach programs, and develop robust methodologies to monitor and evaluate the effectiveness of these programs. Methodologies developed by end of 2015 with the enhanced program proceedings completed by end of 2016.
- A CPUC proceeding to continue to streamline state jurisdictional interconnection processes to create a ministerial low-cost interconnection process for distributed generation completed by the end of 2015. The CEC to explore similar streamlined processes for interconnecting distributed generation in publicly owned utility systems. The CPUC and CEC consult as appropriate with the CAISO as part of these proceedings.
- ARB will assess existing barriers to expanding the installation of CHP systems and propose solutions (in consultation with the State's energy agencies) to achieve the Governor's objectives and that of the initial Scoping Plan for CHP to reduce GHG emissions. A future CHP measure could establish requirements for new or upgraded efficient CHP systems.
- Evaluate the potential for CCS in California to reduce emissions of CO_2 from energy and industrial sources. Working with DOGGR, CEC and CPUC, ARB will consider a CCS quantification methodology for use in California by 2017.

2. Transportation: Vehicles/Equipment, Sustainable Communities, Housing, Fuels, and Infrastructure

California's transportation system accounts for about 36 percent of California's GHG emissions and is the primary source of smog-forming and toxic air pollution in the State. Mandatory regional criteria pollutant reduction targets will be established in the 2016 State Implementation Plans (SIPs) with expected reductions on the order of 90 percent below 2010 levels in the South Coast and similar reductions in the San Joaquin Valley by the year 2032. Many of the strategies employed to reduce GHG emissions will also work to meet the national ambient air quality standard for ozone in 2032.

Achieving California's long-term criteria pollutant and GHG emissions goals will require four strategies to be employed: (1) improve vehicle efficiency and develop zero emission technologies, (2) reduce the carbon content of fuels and provide market support to get these lower-carbon fuels into the marketplace, (3) plan and build communities to reduce vehicular GHG emissions and provide more transportation options, and (4) improve the efficiency and throughput of existing transportation systems.

As one of the most significant sources of GHG and criteria pollutant emissions, the transportation system represents one of the greatest needs for emission reductions in California, and one of the greatest opportunities to build an economy that aligns stable economic growth with the need for ever-improving public health and environmental protection. Reducing transportation emissions, including those from heavy-duty diesel engines, will have dramatic air quality and public health benefits—especially in many of California's environmental justice communities. Improving vehicle efficiency will continue to cut consumer fuel bills. Diversifying fuel supplies will further decouple economic growth in California from volatile global oil prices and keep more of Californians' fuel expenditures in our own communities. Planning and building communities to reduce travel demands and designing more productive transportation systems will cut transportation costs for California's workers and make the State's freight distribution system more competitive in the global marketplace.

Building on California's Existing Policy Framework

California already has many of the elements necessary for an effective framework to address transportation emissions. The actions identified in this Update represent a natural extension of existing policies, including targeted investment, strategic market support, and coordinated planning for more sustainable development. These recommendations are based on technologies currently available or expected in the near term, and on planning and investment steps that can be taken now. However, to achieve the needed transportation GHG emission reductions and the corresponding 2032 ozone standards, the market uptake of advanced technologies will need to be accelerated. Additional strategies are needed over the next five years to define the paths for longer-term change. As all these actions and policies are implemented, they will need to be consistent with principles and criteria, as recommended by the Environmental Justice Advisory Committee (EJAC), that ensure access, equity, and benefits to vulnerable communities.

To illustrate these additional paths toward significant emission reductions, a number of forward-looking strategies are described in this chapter. These paths envision the use of technologies that require further development. In addition, the market structures, investment strategies, businesses models, regulatory actions, and financial resources to support the very large-scale transition to these technologies need to be identified and put in place.

California's regulatory programs and planning efforts provide a basic foundation to build lasting markets where vehicle/equipment manufacturers, suppliers, and fuel providers who make large, smart investments are handsomely rewarded for developing leading technologies. Standards should drive technologies to higher volumes, lower prices, and ultimately, become market-winning solutions, rather than compliance approaches.

Efficient Vehicle and Engine Technology and Zero Emissions Technology Development

California has made tremendous progress pushing clean vehicle technologies. This progress has led to emission reductions throughout the United States and has pushed market development for clean and zero emission technologies throughout the world. California was the first state in the nation to require reductions of GHGs from motor vehicles when, in 2004, ARB adopted what is commonly referred to as the Pavley regulations resulting from Assembly Bill 1493 (Pavley, Chapter 200, Statutes of 2002). These regulations formed the foundation for the federal GHG and fuel-economy programs for light-duty vehicles for the 2012–2016 model years.

California continues its leadership through ARB's Advanced Clean Cars program, which was developed in part through collaboration with the U.S. EPA and National Highway Traffic Safety Administration (NHTSA). This set of regulations will reduce GHG emissions from new light-duty vehicles by about 4.5 percent per year, from 2017–2025, such that by 2025 a new vehicle will emit about half the GHG compared to today's fleet mix. The Advanced Clean Cars program also included tighter criteria pollutant requirements which, in 2025, will result in cars emitting 75 percent less smog-forming pollution than the average new car sold today.

SUCCESS STORY

Broadband Internet service is now used to save vehicle miles driven for medical care in the South Lake Tahoe area. The California Telehealth Network (CTN), a service available statewide, has collaborated with the UC Davis Health System to upgrade broadband and bring telemedicine equipment to Barton Memorial Hospital. CTN now averages more than 200 patient consultations each month.

As part of the Advanced Clean Cars program, the Zero Emission Vehicle (ZEV) Regulation requires about 15 percent of new cars sold in California in 2025 to be a plug-in hybrid, battery electric, or fuel cell vehicle. Ten other states have adopted California's ZEV Regulation, increasing the reach of California's policy to about a quarter of the U.S. vehicle market. California currently has 60,000 ZEVs (primarily light-duty vehicles, including battery electric, plug-in hybrid, and fuel cell vehicles) on its roadways—more than any other state. Continuing to support and develop zero emission vehicle markets within California and elsewhere is critical to achieving California's emissions reduction requirements. California has outlined several steps in the State's *ZEV Action Plan*,[77] to further support the market and accelerate its growth. Committed implementation of the actions described in the plan will help meet Governor Brown's 2012 Executive Order (EO) B-16-12, which—in addition to establishing a more specific 2050 GHG target for the transportation sector of 80 percent from 1990 levels—called for 1.5 million ZEVs on California's roadways by 2025.

Continuing progress on light-duty vehicles beyond the scope of the Advanced Clean Cars program with a LEV IV standard targeted at achieving additional GHG emission reductions of about five percent per year beyond 2025 would reduce new vehicle emission standards to about 125 grams of carbon dioxide equivalent per mile (gCO_2e/mi) in 2030 and to below 100 gCO_2e/mi by 2035. Furthermore, commercially available technologies, such as fuel efficient passenger vehicle tires, can be utilized by both new and in-use vehicles in the near-term to achieve GHG emission reductions. Deployment of fuel efficient vehicle tires for in-use vehicles could include limited incentives, followed by ratings and then standard setting to permanently shift the market.

Achieving our long-term climate goal and 2032 ozone standards will require a much deeper penetration of ZEVs into the fleet. As outlined in the 2009 ZEV Review[78] and the 2012 Vision for

77 The ZEV Action Plan can be found at *http://opr.ca.gov/docs/Governor%27s_Office_ZEV_Action_Plan_%2802-13%29.pdf*.

78 *www.arb.ca.gov/msprog/zevprog/2009zevreview/2009zevreview.htm* (Refer to Attachment B)

Clean Air,[79] and several independent studies (See Chapter III), the light-duty vehicle segment will need to become largely electrified by 2050 in order to meet California's emission reduction goals.

For the heavy-duty segment, ARB recently approved a regulation establishing GHG emission reduction requirements for all medium- and heavy-duty vehicles and engines manufactured for use in California, harmonizing with the GHG emission reduction rule adopted by the U.S. EPA in 2011. For Class 8 heavy-duty vehicles, this "Phase I" GHG standard will reduce new vehicle emissions by four to five percent per year from 2014–2018.

ARB is working with U.S. EPA on Phase 2 GHG standards for heavy-duty vehicles to continue these reductions beyond 2018. U.S. EPA is planning to finalize Phase 2 standards in 2016. ARB believes additional annual improvements of around five percent through 2025 can be achieved from Class 8 heavy-duty vehicles using commercially available technologies and advanced transmissions, hybridization, improved trailer aerodynamics, and other technologies. In addition, significant, ongoing vehicle efficiencies can be achieved in Class 3–Class 7 trucks during the same time frame. These efficiencies will be partly enabled by improvements in light-duty vehicles; the challenge is to move these technologies from the light-duty sector to the heavy-duty on-road and off-road sectors in order to reach commercialization in the necessary time frame. ARB is working to ensure Phase 2 standards are set at the lowest feasible levels, to accelerate the introduction and deployment of the advanced technologies necessary to meet the State's air quality and climate policy objectives.

While the Phase 2 standards will be an important next step in reducing GHG emissions from heavy-duty trucks, significantly greater reductions will be needed to meet California's climate change goals. To continue reducing emissions, zero and near-zero emission technologies will need to be deployed in large numbers. In addition to clean NG trucks, BEV and FCV technology could be deployed in urban fleet applications and medium-heavy classifications. This is particularly true for fleets that have a central fueling hub. For the heavier classifications with moderate range, strategies could include plug-in hybrid technology with catenary electric infrastructure along transport corridors. For heavy, long-range applications where electrification is not practical, low-carbon sources of energy, such as renewable fuels and hydrogen FCVs, will be necessary.

For successful implementation of these strategies, California needs to make similar commitments to develop zero emission vehicle markets for heavy-duty vehicles and equipment. Many zero emission technologies for trucks have progressed at least to the demonstration phase, and in the case of smaller trucks, battery-powered vehicles are available commercially in small volumes. However, ZEV technology for Class 7 and 8 vehicles, which account for most of heavy-duty vehicle emissions, has not progressed as far as it has for light-duty vehicles. Where the technology is available or being demonstrated, near-term challenges exist in terms of cost, vehicle range, payload, and the need for associated infrastructure. ARB is proposing larger efforts to demonstrate, pilot, and deploy ZEV technologies for heavy-duty vehicles with Cap-and-Trade auction proceeds.

Low-Carbon Fuels

California has an effective, scalable framework in place for fuels to ensure ongoing emission reductions. The Low Carbon Fuel Standard (LCFS), adopted in 2009, requires the carbon intensity of transportation fuels to be reduced by at least ten percent in 2020. While the primary goal is reducing carbon intensity and concomitant greenhouse gas emissions, implementation will also necessarily diversify the fuel portfolio, reducing the economic impact in California from gasoline and diesel price spikes resulting from volatile global oil price changes. As a result of California's leadership, other states and countries are pursuing the development of carbon-intensity fuel measures. In addition, fuels will come under California's Cap-and-Trade Program in 2015. Together, LCFS and Cap-and-Trade provide a structure to ensure that necessary emission reductions are achieved and provide an effective market signal to accelerate innovation and

79 *www.arb.ca.gov/planning/vision/vision.htm*

development of cleaner fuels. Continuing these policies beyond 2020 will ensure that fuel carbon intensity continues to decline and that low-carbon alternatives to petroleum are available in sufficient quantities in the long term. Research that further refines our understanding of fuel carbon intensity is similarly important and should include an assessment of methane emissions from natural gas systems. Achieving the GHG and air quality goals will require a renewable portfolio of transportation fuels—including electricity and hydrogen—well beyond the current policy trajectories. Accordingly, in 2014 ARB will consider extending the LCFS, with more aggressive targets for 2030.

Transportation, Land Use, and Housing

As a result of Senate Bill (SB) 375 (Steinberg, Chapter 728, Statutes of 2008), the Sustainable Communities and Climate Protection Act of 2008, California has developed a critical, unique policy mechanism for reducing transportation-sector GHG emissions. Regional and local planning agencies are responsible for developing Sustainable Communities Strategies (SCS) as part of the federally required Regional Transportation Plan (RTP), and also responsible for developing State-required general plan housing elements to help meet these targets. The goal of SB 375 is to reduce GHG emissions from passenger vehicles through better-integrated regional transportation, land use, and housing planning that provides easier access to jobs, services, public transit, and active transportation options.

Sustainable Communities Strategies promote more travel and housing choices through greater access to alternative forms of transportation (including public transit, biking, and walking) and development patterns where people can live, work, and play without having to drive. All seven metropolitan planning organizations (MPOs) that have adopted SCS so far have met or exceeded the ARB-set targets. Successful implementation of these SCS is the critical next step in achieving the associated GHG emission reductions.

Implementation of these strategies hinges on local actions to realize the GHG emission reductions envisioned in the regional SCS. The State must encourage new and targeted strategies to reduce emissions throughout California's diverse communities. The State's role is to provide ongoing support, through access to financial resources and incentives, guidance documents, housing element certification, planning tools, and other forms of technical assistance. California has a number of important planning tools available to reduce vehicle travel demand, expand mobility options, and improve goods movement; however, these tools will need to be enhanced and new tools will need to be developed, including but not limited to land use models, health models, and scenario planning tools. With appropriate coordination among local and State agencies—including ARB, the California Department of Transportation (Caltrans), the Strategic Growth Council (SGC), and the Department of Housing and Community Development (HCD)—California can ensure that the expected GHG emission reductions are achieved or exceeded. The State must also support integration of the planning, development, and funding of transportation systems, including recognition of the impacts and interactions between passenger and freight transportation.

In 2014, ARB will review the advancements in data, models, analytical methodologies, and technologies that have taken place since 2010 to inform the need for and timing of revised MPO targets. This technical review will provide the foundation for a future target revision, consistent with each MPO's time frame for updating its RTP under federal law. Future updates to SCS targets, along with other new transportation strategies, will help provide further emission reductions needed to achieve long-range reductions in transportation-related emissions.

Coordinated, comprehensive planning is critical to achieving deep emission reductions in the transportation sector, and must include the development of the 2014 California Freight Mobility Plan (Caltrans), the 2014 Sustainable Freight Strategy (ARB), the 2040 California

Transportation Plan in 2015 (Caltrans), the 2016 SIP (ARB, SCAQMD,[80] SJVAPCD[81]), and all future regional sustainable community strategy and Regional Transportation Plan development and implementation. These planning efforts will need to identify the infrastructure, including fueling and intelligent transportation infrastructure, needed to support full-scale deployment of advanced technologies, improved throughput, and expanded access to rail, public transit, and active transportation.

As State agencies proceed with GHG emission reduction planning, it is necessary to integrate the need for significant NO_x reductions by 2032 to meet the national ambient air quality standards for ozone. Tools developed to support these planning efforts should emphasize the needs of vulnerable communities, as recommended by EJAC. These needs include, but are not limited to: access to affordable public transit, electric vehicle charging, or other low-carbon fueling infrastructures; accessible affordable housing; and localized public health benefits.

California is implementing a large-scale rail modernization program, which includes the nation's first true high-speed rail (HSR) system. Europe's experience with high-speed rail is illustrative of its mode-shift potential; after high-speed rail launched in Europe, air trips were cut in half from Paris to London. In Spain, for the 315-mile trip from Barcelona to Madrid, more than 60 percent of air travelers have switched to the 2½-hour rail ride. The first construction contract to begin California's high-speed rail system was awarded in August 2013, for work in the Central Valley. Additionally, environmental work is proceeding to electrify the Caltrain corridor in the Bay Area by 2019 as part of the high-speed rail system. High-speed rail will provide a new, clean, interregional transportation option and increase ridership on integrated regional rail and local transit systems, reducing single-occupancy vehicle trips.

Systems Efficiencies

California is at the forefront of developing additional strategies to reduce emissions from existing vehicles and systems. In fact, many system efficiency strategies identified in the initial Scoping Plan have been implemented or are still under development such as ship electrification at ports, tire pressure, fuel-efficient tires, and low friction motor oils. These strategies go beyond just vehicle improvements; for example, Caltrans has initiated several strategies that achieve GHG emission reductions from the existing system, including modification to concrete specifications, alternative asphalt pavements, and adoption of the Caltrans Complete Streets Implementation Action Plan[82], which spurred a series of comprehensive edits to its Highway Design Manual.

However, California must do more to capture significant potential emission reductions from existing systems that could also improve safety, reduce congestion, and improve economic productivity and workforce and businesses competitiveness. For example, improved pavement engineering—including surface smoothness, rigidity, and durability—can reduce GHG emissions through improved fuel efficiency. Smart phone and vehicle "apps" that provide real-time travel information and eco-routing or eco-driving suggestions can reduce emissions from existing vehicles. Coordinating signal timing and providing real-time information to drivers about signal status can reduce emissions in urban driving by up to ten percent. Utilizing adaptive cruise control, a global positioning system (GPS), and camera technologies to enable truck "platooning" can reduce GHG emissions and fuel consumption from those vehicles by about 15 percent.

Myriad existing and emerging technologies will lead to an increasingly connected and automated transportation system and could have dramatic efficiency and emissions benefits. Many automakers and others have committed to bring varying levels of automation to new vehicles over the next five years, and the NHTSA is beginning to take steps to enable vehicle-to-vehicle and vehicle-to-infrastructure communications. The degree to which markets for these vehicles grow—and how local, State and federal rules shape and support them—will determine the

80 South Coast Air Quality Management District
81 San Joaquin Valley Air Pollution Control District
82 *www.dot.ca.gov/hq/tpp/offices/ocp/complete_streets_files/CompleteStreets_IP03-10-10.pdf*

level of emissions impact from these technologies. Early studies show that vehicle automation could enable dramatic emissions decreases, or emissions increases, depending on the level of increased vehicle and systems efficiency they enable, how the vehicles integrate with an alternative fuels infrastructure, and the degree to which they may induce additional vehicle travel.

Over the next five years, it will be critical to begin planning for these vehicles on our roads and to maximize their benefits and potential for GHG emission reductions. California is already a leader in this emerging space, and the California Department of Motor Vehicles has issued the nation's first draft rules regulating the testing of autonomous vehicles on California's roads, pursuant to Senate Bill 1298 (Padilla, Chapter 570, Statutes of 2012). Many are also looking to California's I-710 corridor to begin demonstrating and deploying intelligent transportation system technologies for heavy-duty trucks. Additional research is needed to better understand the impacts these vehicles will, or can, have on GHG emissions in California's transportation sector, and how to best integrate automated vehicles within the State's existing and evolving vehicle, fuel, and planning policy framework. The next Scoping Plan Update will include additional detail on the role of existing systems improvements and vehicle automation in meeting California's transportation-sector emissions reduction goals.

Integrated Policy Planning in the Sustainable Freight Strategy

California has already made significant progress reducing emissions from its freight system, while supporting our ports and goods movement industries as some of the most critical to the State's economy. Through regulations, incentives, enforcement agreements, port and industry initiatives, project mitigation and land use decisions, California has reduced diesel PM emissions—along with the associated health risks—by 70 percent at the largest ports and about 50–70 percent at the highest-risk railyards since 2005. However, much more needs to be done to continue to reduce the impacts from air pollution, including diesel PM at the local level, ozone at the regional level, and GHGs at the global level. The ongoing planning, policy foundation, financial incentives, and state commitment to reduce PM and NO_x emissions from the freight system provide a foundation from which to develop a similar framework to reduce GHG emissions.

Over the past decade, public and private stakeholders across California have increasingly recognized the need to plan and implement multi-pollutant emission reduction strategies that achieve transformational changes resulting in significant reductions of near-source toxic, regional criteria pollutant, and global GHG emissions. SB 375 uses this integrated, multi-pollutant approach to reduce passenger vehicle GHG emissions through strategies that impact land use and housing decisions, transportation infrastructure funding, and regional criteria pollutant analyses.

A parallel effort to SB 375 needs to reside in the freight sector, with its highly complex international logistics system and incredibly diverse set of stakeholder groups. To achieve our multi-pollutant goals, over the long-term California must transition from a diesel-dependent system into one with significant numbers of zero and near-zero emission engines for trucks, locomotives, cargo-handling equipment, ships, and aircraft. California must also support the parallel development of the necessary supporting infrastructure, and implement logistical/efficiency improvements to reduce the emissions impact of moving freight. In short, the freight sector must become a system that is efficient, reliable, clean, and low carbon.

The Sustainable Freight Initiative[83] (Initiative) is a broad, multi-decade effort to develop, fund, and implement the changes necessary to achieve a sustainable freight system. The Initiative will be informed by an ongoing, transparent process that engages all freight stakeholders. These include, but are not limited to: industry (such as retailers and other cargo owners, shipping, trucking, rail, and warehousing), ports, labor, environmental groups, business leaders, venture capitalists, community representatives, technology developers, air districts, and representatives from local, State, and federal government.

83 *www.arb.ca.gov/gmp/sfti/sfti.htm*

The 2014 Sustainable Freight Strategy (Strategy) is a concentrated, one-year effort to produce a document developed in the context of the broader Initiative and represents the next milestone in defining what is necessary to move California toward a sustainable freight system. Building a coalition of freight stakeholders is a primary focus of the Strategy, and will ultimately be a significant driving force behind affecting change in areas outside of ARB's sphere of influence, including advocating at the federal level and acquiring public and private funding for implementation.

The South Coast Zero-Emission Freight Transport Technology Symposium and ARB's Haagen-Smit Symposium in mid-2013 provided early input into the sustainable freight effort. Currently, there are a number of existing venues led by both public and private entities where California freight issues are being discussed. These are critical to ARB's public process for the sustainable freight effort, and were some of the earliest points of engagement in the process.

ARB will work with stakeholders on the Strategy throughout 2014, with the ultimate goal of setting California on the path to move freight more efficiently and with zero/near-zero emissions. This work must recognize the equally important priorities of transitioning to cleaner, renewable energy sources, providing reliable velocity and expanded system capacity; integrating with the national and international freight system; and supporting clean air and healthy communities. The Initiative should also recognize the value of: keeping California's ports and logistics industry competitive; supporting the delivery of California's products locally and to other states and countries; creating jobs in California and training local workers to support the new transport system; increasing energy security; and improving mobility.

The 2014 Strategy will include several key elements that together will provide a holistic look at the freight system and identify actionable next steps through 2020. The Strategy will: identify near-term actions resulting from assessments of each of the freight sectors and the system, prioritize efficiency improvements, include principles and criteria for transportation infrastructure projects, and begin to answer the following questions:

- What actions and changes must take place within California's freight system to address air quality and climate requirements?
- What are the technology gaps?
- What research and demonstration is needed?
- What incentives are needed to drive technology, infrastructure and efficiency improvements?

To that end, ARB is working with agency partners to expand upon existing and ongoing technology assessments in all the major freight-related source categories, including: trucks, locomotives, ocean-going vessels, commercial harbor craft, cargo equipment, and air cargo/airports. These assessments will draw from technology expertise in the public and private sector, and will lay the framework for identifying and prioritizing the next steps, including accessing and leveraging funding, near-term implementation strategies, and longer-term actions that could be included as measures in upcoming SIPs.

This technical effort will also provide an opportunity to evaluate the types and availability of data and how they could be collected and ultimately used to quantify the emission reduction potential of future measures for each sector. Technology-specific objectives include, but are not limited to, the following:

- Accelerate the introduction and deployment of zero and near-zero emission trucks, including trucks capable of zero-emission miles.
- Continue improving the efficiency of trucks (both engines and vehicles).
- Support development and introduction of locomotives capable of zero emission track miles.
- Accelerate cleanup of the existing locomotive fleet.

- Increase near-dock rail in Oakland/Los Angeles/Long Beach.
- Reduce GHGs and criteria pollutants from ocean-going vessels.
- Build on the work done by the U.S. Department of Defense on cleaner fuels/aircraft design to reduce GHGs and criteria pollutants from air cargo.
- Identify efficiency improvements on all levels (equipment, sector, and system).
- Showcase strategies and best practices.

In addition, ARB will develop principles and criteria that seek to establish air quality and climate benefits as equal to established transportation/mobility metrics in determining the priority of freight-related transportation projects and recommend inclusion of these principles and criteria in the 2014 Freight Mobility Plan. ARB is participating on the California Freight Advisory Committee and will coordinate with Caltrans staff to reflect the outcome of this effort in the California Freight Mobility Plan.

Moreover, the Strategy process provides the opportunity to begin evaluating the feasibility of a systemwide efficiency metric(s) that could track upstream and downstream impacts of implemented emission reduction and efficiency strategies. The metric could be used to set targets, prioritize funding, evaluate projects, evaluate programs, and gauge performance or progress across modes. To complement a metric, ARB will seek advice on actions that government could take to support efficiency improvements. ARB will also begin efforts to define criteria and principles for new and expanded freight infrastructure projects as a tool for local land use decision makers and community residents.

Supporting Planning and Market Development through Targeted Investments

Incentive funding is essential to encourage use of alternative transportation modes, develop and deploy low-carbon fuels, spur fleet turnover, and continue to develop advanced technologies. Through the Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer), Proposition 1B program for goods movement, and AB 118 Air Quality Improvement Program (AQIP), ARB provides funding, directly or through the air districts for technologies that reduce criteria pollutant and air toxic emissions, often with concurrent climate change benefits. A subset of these funds, about $283 million to date, are utilized for advanced technologies that achieve GHG emission reduction benefits, which include: rebates for light-duty clean cars, vouchers for hybrid and zero emission heavy-duty trucks, grants for installation of shore-based electrical power for ships, and technology demonstrations such as hybrid tugboat retrofits.

In 2013, the State extended fees for AQIP until 2024 which is expected to provide about $25 million annually for advanced technologies. Most recently, the Governor's proposed budget for Fiscal Year 2014–15 would direct $200 million from Cap-and-Trade auction proceeds to ARB for low-carbon transportation to respond to the increasing demands for incentives of these technologies and for pre-commercial demonstration of advanced freight technology. In addition, the CEC's AB 118 Alternative and Renewable Fuel and Vehicle Technology Program invests $100 million annually (also extended until 2024) to develop and deploy alternative and renewable fuels, fueling infrastructure, vehicles, and workforce skills necessary operate and maintain these new technologies. Finally, Senate Bill 99 creates an active transportation program to increase funding of bicycle and pedestrian infrastructure, which is funded at an annual level of $129 million.

These current efforts will need to be enhanced or expanded beyond currently allocated resources. To implement this, protocols that outline funding priorities will need to be reviewed and metrics should be developed for evaluating investment opportunities. For example, existing State rebates for light-duty zero emission and plug-in hybrid vehicles are consistently oversubscribed, yet continued public commitment is necessary at this time to support full-scale commercialization and consumer acceptance of these vehicles. Furthermore, the vehicle regulations and incentives for both light- and heavy-duty vehicles must be supported through

parallel investments in infrastructure and additional policies to ensure that value is returned to consumers. These policies include setting reasonable electricity rates that encourage electrification and vehicle charging rates that strongly encourage off-peak charging or are responsive to grid operational needs and policies that manage charging to facilitate renewable energy uptake. They also include streamlining local permitting, siting, and utility interconnection for fueling infrastructure.

Additional investments will be necessary for advanced technology freight demonstration projects and pilot deployments of advanced heavy-duty vehicles and equipment in a variety of vocations. Near-term focus areas for these projects include, but are not limited to: zero emission port trucks for near-dock rail pilot projects; pilot projects to deploy zero emission and hybrid vehicles and equipment at distribution centers located in areas most affected by air pollution; and development and demonstration of advanced technology locomotives, marine vessels, and cargo handling equipment.

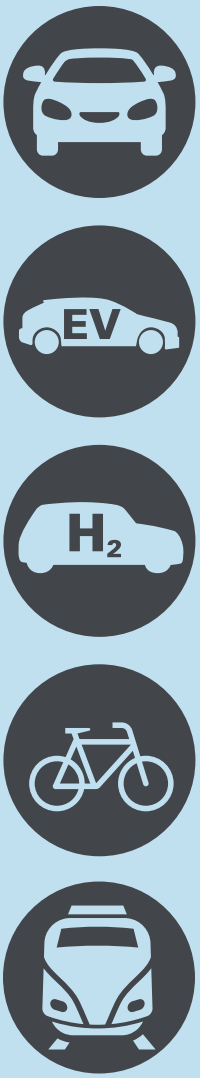
Investment throughout California in projects that modernize the passenger rail system and link seamlessly to local public transit systems will continue to build public transit ridership and shift travelers from single-occupancy vehicles to public transport. As a start, in 2008, voters approved Proposition 1A, authorizing nearly $10 billion in state bonds for the United States' first high-speed rail line, which would connect the San Francisco Bay Area with Los Angeles. Rail modernization in California will increase benefits for passengers, including improved mobility and safety, with a reduced carbon footprint. Prior to 2030, high-speed rail will reduce GHG emissions by providing a cleaner alternative to air and private car travel. It is projected to realize GHG emission reductions its first year in operation, with annual increases in GHG emission reductions as the system expands.[84]

Rail modernization infrastructure investments must be coordinated with local and regional planning to be mutually supportive. As part of the early development of high-speed rail, commuter and urban rail systems are being upgraded and expanded to provide connectivity to the future high-speed rail system. In addition, work has begun on shared-use investments that high-speed rail will ultimately access, such as the electrification of the Caltrain corridor between San Francisco and San Jose, which is scheduled to be operational in 2019. Coordination among regional and urban rail providers on issues such as schedules and integrated fare mechanisms will provide increased service, speed, and amenities that will grow this clean mode of travel and encourage transit-oriented development and infill around station locations.

Furthermore, ongoing investments are needed for local communities to plan and implement sustainable community development, including integrated public transit and high-speed rail, incentivizing transit utilization, and to address both passenger and freight transportation infrastructure needs. Active transportation and public transit alternatives, including zero-emission transit buses, are increasingly in demand and are necessary to meet ongoing emission reduction targets. Caltrans, working with local and regional agencies, will need to coordinate on transportation infrastructure funding (including construction, operation, and maintenance costs) and consider lifecycle benefits and impacts (including environmental, construction, operation, and maintenance costs) for transportation infrastructure projects.

84 *www.hsr.ca.gov/docs/programs/green_practices/HSR_Reducing_CA_GHG_Emissions_2013.pdf*

Key Recommended Actions for the Transportation System



Vehicle Technology

- The 2017 mid-term review for Advanced Clean Cars, where ARB, U.S. EPA, and NHTSA will conduct a technical assessment of vehicle technology trends, will inform future light-duty vehicle standards targeted at continuing to achieve GHG emission reductions of about five percent per year through at least 2030.
- In 2016, ARB will propose rules and/or incentives, including the "Phase 2" heavy-duty vehicle GHG standards in conjunction with U.S. EPA and NHTSA with a goal of achieving new vehicle GHG emission reductions of at least five percent per year.
- For completion by 2017, ARB will engage the Office of Planning and Research (OPR) and other stakeholders to expand upon the 2013 ZEV Action Plan for medium- and heavy-duty ZEVs.

Fuels

- In 2014, ARB will propose enhancements to strengthen the LCFS. ARB will also consider extending the LCFS beyond 2020 with more aggressive long-term targets, such as a 15 to 20 percent reduction in average carbon intensity, below 2010 levels, by 2030.
- By 2018, the CPUC, CEC, California Department of Food and Agriculture (CDFA), and ARB will evaluate and adopt the necessary regulations and/or policies to further support commercial markets for low-carbon transportation fuels, including but not limited to:
    - Reducing off-peak demand charges for electricity and plug-in vehicle charging rates that strongly encourage off-peak charging both at home and at public chargers;
    - Development of large-scale renewable and low-carbon production facilities through continued funding for infrastructure;
    - Development and adoption of performance and quality standards;
    - Streamlined local permitting and siting for hydrogen fueling and charging infrastructure and utility interconnection for charging infrastructure; and
    - Research.

Transportation, Land Use, and Housing

- In 2014, ARB will complete a technical review that will inform the need for and appropriate timing of revisions to the SB375 regional targets established in 2010.
- The High-Speed Rail Authority will work with other rail and mass transit providers to increase transit ridership both regionally and inter-regionally.
- The High-Speed Rail Authority will continue construction of the HSR system, beginning with completion of all station-area planning by 2017 followed by completion of the initial operating segment in 2022. By 2029, HSR will run from San Francisco to Los Angeles.
- ARB, Caltrans, SGC, and HCD, along with other State, local, and regional agencies, will coordinate planning and support to ensure that the expected GHG emission reductions from approved SCS are achieved or exceeded.

Sustainable Freight Strategy

- In 2014, ARB will complete the first phase of the Sustainable Freight Strategy, which will identify and prioritize actions through at least 2020 to move California towards a sustainable freight system.

Investments

- Leverage available public money to scale-up clean technology markets and strategies and ensure necessary infrastructure investments, including the following:
  - ARB, CEC, CPUC, and CDFA will support growing markets for clean passenger transportation, advanced technology trucks and equipment, and low-carbon transportation fuels and energy, including any necessary infrastructure.
  - Caltrans, working with local and regional agencies, will consider lifecycle benefits and impacts (including environmental, construction, operation, and maintenance costs) for transportation infrastructure projects.
  - Caltrans and regional transportation agencies will increase investment in expanded transit and rail services, active transportation, and other VMT-reduction strategies in their next regional transportation plans.
  - SGC will support SCS implementation, including, for example, integration of the regional transportation and Regional Housing Needs Allocation planning, as well as provision of local assistance for transit, active transportation, and affordable transit-oriented housing development; therefore offering more efficient consumer choices.
- State agencies, including ARB and Caltrans, will incorporate into ongoing GHG planning efforts strategies that help achieve significant NO_x reductions by 2032 to meet the national ambient air quality standards for ozone. The 2016 SIPs will outline attainment strategies through 2032.

3. Agriculture

Agriculture in California provides a safe, reliable, and affordable food source to support growing local, State, national, and global populations. It is also a key economic driver in the State. California has a range of climatic regions that allow for the production of a diverse variety of annual crops (such as vegetables and grains), perennial crops (such as fruits and nuts), and livestock and dairy products. As one of only five Mediterranean growing regions on Earth, California is a major contributor to the global food supply; particularly of fruits, nuts, vegetables, and dairy products.

California's agricultural GHG emission inventory includes on-site emissions from enteric fermentation (by animals), manure management, rice cultivation, energy use (including fuel combustion), crop residue burning, and soil management practices (fertilizer and manure applications). The primary GHG emissions from agriculture include methane (CH_4), carbon dioxide (CO_2), nitrous oxide (N_2O), and black carbon. In 2012, agricultural sources accounted for about eight percent of California's total GHG emissions. In addition to being a GHG emissions source, agriculture can also be a carbon sink, where carbon is stored (sequestered) in both crops and soil.

Many of the strategies to reduce GHG emissions or increase sequestration in the agriculture sector overlap and have synergies with other sectors. For example, agricultural operations are the largest water users in the State. Because water use is a significant source of GHG emissions (due to the electricity used to pump water), conservation and water delivery efficiency improvement efforts employed in agricultural operations would support GHG emission reduction goals in the water sector. Agricultural operations can also contribute to the strategies for reducing GHG emissions in the energy sector by providing biomass feedstock resources for bioenergy production (for both fuels and electricity). Reduction strategies described in the transportation, land use, fuels, and infrastructure sector could also be realized through agricultural land conservation efforts, and through operational efficiency improvements that reduce transportation emissions and fuel use.

Due to the wide diversity of crop and livestock production, the agricultural sector presents unique challenges to controlling GHG emissions. The initial Scoping Plan considered voluntary steps to reduce GHG emissions in this sector in place of regulatory measures, due primarily to costs and scientific uncertainty in measuring GHGs in many agricultural systems.

The installation of manure digesters to reduce methane emissions was included as a voluntary strategy for the agricultural sector in the initial Scoping Plan. However, voluntary installation of anaerobic digesters at dairies in California has not increased as expected. This is due to the recent economic recession, increased feed and fuel prices, lack of sufficient financial incentives, and insufficient utility contracts. ARB is working with federal, State, and local agencies, as well as with industry stakeholders, to remove obstacles to digester installations. Critical to this is the continued effort to evaluate the many co-benefits of manure management through digesters. The evaluation will examine the potential for successful voluntary efforts to be more widely adopted in California. As new information becomes available, ARB will work with stakeholders to determine whether and how the program should become mandatory and/or more strongly incentivized.

The initial Scoping Plan also called for research on baseline nitrous oxide (N_2O) emissions from the use of fertilizers to improve the GHG inventory. ARB, CEC, and CDFA have been coordinating and funding research to determine baseline N_2O emissions from a variety of soil types, crops, and farming techniques used throughout California. Research began in 2009 and is expected to be completed by the end of 2014.

A number of other potential voluntary GHG-reduction activities were mentioned in the initial Scoping Plan, including improvement of agriculture water use efficiency, increasing the efficiency of or electrification of agricultural water pumps, using biomass-based fuels, and increasing carbon sequestration on agricultural lands.

The CDFA, in partnership with scientists at the University of California (UC) at Davis, and with funding from the CEC, are evaluating the economic, beneficial environmental factors and costs of biofuel feedstock crops. Outcomes will focus on cropping systems for California with best management practice recommendations; estimates of direct environmental costs such as water use, input levels, and effects; and potential off-farm environmental consequences. The CDFA is working with ARB to expand use of biomass-based transportation fuels as a regulatory pathway under the Low Carbon Fuel Standard.

The CDFA is also supporting projects that address GHG mitigation through its Specialty Crop Block Grant Program (SCBGP). Results of funded research projects provide knowledge and tools to help growers reduce GHG emissions and increase carbon sequestration.

As discussed in Chapter II, there is increased recognition of the significant role that short-lived climate pollutants have on climate change. In response, the importance of methane emissions from agricultural operations, particularly from rice and cattle operations, has increased. Consequently, there is a need for enhanced efforts to secure additional methane reductions from agricultural operations.

Maintaining Momentum

There are many GHG emission reduction and carbon sequestration opportunities that could be realized in the agriculture sector. However, because of limited research, and the wide variety of farm sizes, animals, and crops produced, there are few one-size-fits-all emission reductions or carbon sequestration strategies for the agriculture sector.

Agricultural operations throughout the State are variable, there are a number of potential GHG sources at each operation, and a number of potential co-beneficial management practices can be used for each source. To address this complexity, one approach to reducing GHG emissions from agriculture in California is to develop agriculture-sector mid-term and long-term 2050 GHG emission reduction planning targets.

To meet GHG emission reduction planning targets, farmers and ranchers could assess their on-farm GHG emissions and determine which GHG emission reduction management practices work best for their particular situation. In many cases, pursuing the GHG emission reduction practices would build on existing efforts already in use to increase operational efficiency, reduce criteria pollutant emissions, and reduce costs.

The sections below detail some of the areas with potential emission reduction/sequestration opportunities, as well as areas that need additional research. These opportunities may yield multiple co-benefits, including cost and resource savings, to growers.

Nitrogen Management

Nitrogen fertilizers applied to crops release N_2O, a significant source of agricultural GHG emissions. Obtaining more specific data on statewide fertilizer use in agriculture

SUCCESS STORY

The broadband Internet technology driving the information revolution is also driving revolutions in energy efficiency and GHG reductions for farming. So-called M2M (machine-to-machine) technology now allows precision farming technology to more efficiently apply fertilizers and pesticides, helping reduce GHGs and other air pollutants. Wireless soil moisture sensors reduce water use, saving electricity costs for pumping and moving the water. Some growers claim crop yield increases as a result of more effective monitoring and timing of irrigation—a benefit appreciated all the more during a drought.

and nitrogen deposition on land would help ARB determine baseline emissions and improve the GHG N_2O inventory. This information would also help guide the development of potential GHG emission reduction measures. Existing nitrogen tonnage reports and new reporting requirements under development by the Regional Water Quality Control Board (RWQCB) could be utilized to improve the existing GHG N_2O inventory for fertilizer. Further examination of these data will help determine if broader statewide fertilizer use reporting is needed.

There are several practices that have been shown to reduce emissions of N_2O in agriculture, including the use of nitrification inhibitors, fertigation (the application of fertilizer through irrigation systems), and other approaches. When fertigation is combined with precision drip irrigation there are opportunities to both reduce water and nitrogen fertilizer use. Additional research is needed to evaluate the potential for GHG emission reductions.

Manure Management

Livestock manure is a significant source of methane, and approximately half of the methane generated from livestock comes from manure storage lagoons. The methane generated from those lagoons can be captured by covering the lagoons and can be used to produce energy or renewable fuel (e.g., with the use of a digester).

Soil Management Practices

Historically, tilling (loosening and turning) of soil has been a fundamental agricultural practice to suppress weeds and loosen compacted clay soils. However, tillage releases large quantities of CO_2 and N_2O from the soil into the atmosphere. Several alternative methods, including changing tillage or cropping patterns, may reduce the release of GHGs. Some soil management practices, such as reduced tilling, can also result in reduced fuel consumption by farm equipment, providing additional permanent reductions in GHG emissions, including short-lived climate pollutants.

Water and Fuel Use

A new generation of technologically advanced tools, such as remote irrigation systems, will play an important role in water conservation efforts, maximizing operational efficiency and optimizing resources that can also reduce GHG emissions. In addition, the application of precision irrigation to crops can reduce water use (in turn, reducing the GHG emissions associated with the energy needed to deliver the water), which may also reduce fertilizer use—both of which can reduce emissions and costs.

Greenhouse gases and other emissions from the operation of internal combustion engines that power farm equipment and water pumps are a concern from a regional air quality and climate change perspective. To reduce emissions, the cleanest, most-efficient, and well-maintained equipment should be used for agricultural operations.

The agriculture sector can also play an important role in producing fuels. Biofuel production is a renewable energy resource that reduces reliance on fossil-based fuels. Fueling equipment with biofuels generated on-site or nearby can also reduce emissions and fuel costs.

Land Use Planning to Enhance, Protect, and Conserve Lands in California

Recent research has shown that GHG emissions from urban areas are much greater than those from agricultural lands on a per-acre basis. As California's population increases, pressures to convert agricultural croplands and rangelands to urban and suburban development also increase. Conservation of these lands will be important in meeting our long-term climate goals. Farmland and open space conservation can be an important policy to support the objectives of the Sustainable Communities Strategies, including reducing vehicle miles traveled. This could be accomplished by using incentives for conservation easements, supporting urban growth boundaries, and maintaining agricultural zoning.

As also described in the Natural and Working Lands Sector section below, to meet the State's GHG reduction goals it is important to take an integrated and coordinated approach to local land use planning that considers all land types, including urban, agricultural, and natural and working lands, within and across jurisdictions, to create interconnected land areas and ecosystems. Local and regional land use planning actions and policies need to more fully integrate and emphasize land conservation and avoided conversion of croplands, forests, rangelands, and wetlands, as well as expansion and promotion of urban forestry, urban agriculture, and green infrastructure.

Highly Efficient Conventional and Organic Agriculture Systems

Highly efficient management systems (precision agriculture) for both conventional and organic farming may provide climate benefits through reduced GHG emissions and increased carbon sequestration. To realize such systems, a host of agricultural management practices might be required. In addition to potentially reducing GHG emissions, these strategies may also have co-benefits such as reductions in energy and fossil fuel use and improvements in soil carbon content and water quality.

Research, Technical Assistance, and Incentives

Over the past several years significant progress has been made in understanding agricultural GHG emissions and the strategies that can provide climate benefits. Through research, technical assistance, and financial incentives, farmers and ranchers have implemented many successful GHG emission reduction strategies. Priority should be placed on continued coordination and leveraging of funding between State, local, and national conservation programs to help farmers and ranchers implement GHG emission reduction practices.

Key Recommended Actions for the Agriculture Sector

- In 2014, convene an interagency workgroup that includes CDFA, ARB, CEC, CPUC, and other appropriate State and local agencies and agriculture stakeholders to:
  - Establish agriculture sector GHG emission reduction planning targets for the mid-term time frame and 2050.
  - Expand existing calculators and tools, to develop a California-specific agricultural GHG tool for agriculture facility operators to use to estimate GHG emissions and sequestration potential from all on-farm sources. The tool would include a suite of agricultural GHG emission reduction and carbon sequestration practices and would allow users to run different scenarios to determine the best approach for achieving on-farm reductions.
  - Make recommendations on strategies to reduce GHG emissions associated with the energy needed to deliver water used in agriculture based on the evaluation of existing reporting requirements and data.
- The Dairy Digester Workgroup will develop recommendations for a methane capture standard by 2016.
- Conduct research that identifies and quantifies the GHG emission reduction benefits of highly efficient farming practices, and provide incentives for farmers and ranchers to employ those practices.
- By 2017, evaluate the data reported to the RWQCB's Long Term Irrigated Lands Regulatory Programs to determine if the reported fertilizer data are adequate to establish a robust statewide GHG N_2O inventory for fertilizer used in agriculture. If existing data are not adequate to develop an inventory, then develop a mechanism to collect the necessary data.
- In 2015, OPR, the California Natural Resources Agency (CNRA), the California Environmental Protection Agency (CalEPA), CDFA, and ARB will convene an inter-agency workgroup to engage local and regional land use planning agencies in establishing a coordinated local land use program to develop recommendations and targets for incorporating farmland conservation in local and regional land use planning.
- CDFA will strengthen technical assistance programs and associated financial incentives to help agricultural operators develop carbon plans and implement GHG emission reduction practices.
- In 2015, the Bioenergy Interagency Working Group will:
  - Strengthen, refine, and implement actions contained in its Bioenergy Action Plan to promote the input of digester biogas into natural gas pipelines and bioenergy onto the electric grid.
  - Evaluate the potential biomass energy generation capacity.
  - Develop methods to quantify biomass life-cycle GHG flux.

4. Water

In addition to being an essential element for all life, a reliable, clean, and abundant supply of fresh water is a critical component of California's economy. The State's developed surface and groundwater resources support a variety of residential, commercial, industrial, and agricultural activities. Therefore, the development and management of the State's water resources has implications for each of the focus areas evaluated in the updated Scoping Plan.

More than 40 percent of California's total fresh water supply (or about 80 percent of developed water resources) is used to support the State's extensive agricultural industry and, therefore, has critical ramifications for the agricultural focus area. A significant amount of water is also used to support residential, commercial, and industrial activities within California's extensive metropolitan and suburban areas. Therefore, a reliable water supply also has important ramifications for future population growth and economic development as examined within the transportation, fuels, and land use focus area. Water is also used to cool power plants and produce hydropower, and therefore has important implications for the energy focus area.

California's water system includes a complex infrastructure that has been developed to support the capture, use, conveyance, storage, conservation, and treatment of water and wastewater. Greenhouse gas emissions from the water sector come primarily from the energy used to pump, convey, treat, and heat water. As such, water sector emission reductions are primarily associated with reducing the amount of electricity and natural gas used within the water sector.

The storage, conveyance, and treatment of water in California consume large amounts of electricity. Approximately 19 percent of the electricity and 30 percent of non-power plant natural gas consumption is used by the water sector. Water is used to grow crops, support urban and industrial needs, and produce energy. Therefore, most of the water measures included in the Scoping Plan focused on the GHG emission benefits derived from reduced energy use, and the emission benefits are reflected in those sectors.

The State is currently implementing several targeted, agricultural, urban- and industrial-based water use efficiency, recycling, and conservation programs as part of an integrated water management effort that achieves GHG emission reductions within the water sector. California's water community is continuing collaborative efforts to reduce its carbon footprint while improving water supply reliability, drought resilience, and public safety; fostering environmental stewardship; and supporting a stable State economy.

California's 2009 Water Conservation Act (Senate Bill x7-7) specifically addresses urban and agricultural water conservation. The Act's key urban provision established an aggressive statewide goal to reduce per capita water use by 20 percent by 2020. To date, 400 urban water agencies have prepared water management plans, which cover close to 80 percent of California's population.

The State has also set ambitious goals for development of alternative water sources such as recycled water and stormwater. The State Water Resources Control Board (SWRCB) adopted recycled water and stormwater goals through a stakeholder-driven process. Recycled water usage is to be increased above the 2002 usage levels by at least one million acre-feet per year by 2020 and by at least two million acre feet per year by 2030. Stormwater usage is to increase above the 2007 usage levels by at least 500,000 acre-feet per year by 2020 and by at least one million acre-feet per year by 2030. Grant and loan programs have provided over $1.15 billion for recycling and stormwater capture infrastructure, and projects are coming online.

In addition, the State has invested $1.5 billion to support 48 regional collaborative efforts to develop water management plans, diversify regional water portfolios, and increase regional water supply self-reliance to support future growth and development. Governor Brown has also taken action to permanently reduce water use consumption by directing State agencies and departments to reduce their overall water use by ten percent by 2015 and 20 percent by 2020.[85]

85 See Executive Order B-18-12, issued on April 25, 2012.

The ongoing drought in California affects energy management as well as water systems. Reduced snowpack decreases hydroelectricity production, and reduced surface flows create additional demands for groundwater pumping. These relationships highlight the need for closer coordination between water and energy managers. Coordinated water and energy investments can be coordinated to maximize GHG emission reductions, if local and State agencies work together to identify project designs that best serve both purposes.

Maintaining Momentum

The primary mechanisms to reduce water-related energy use are energy efficiency and water conservation strategies. Many water and wastewater agencies are already leading the way through conservation-adjusted business plans, investments in efficient infrastructure, reuse of wastewater, and self-generation of renewable energy; but more work is needed. Achieving industry-wide shifts will require sustained State leadership and new policy and regulatory frameworks that account for water supply, water and energy use, water quality standards with regional flexibility and funding, and effective data collection and analysis. Reducing GHG emissions from the water sector will require close coordination between water agencies and energy agencies. Greater attention will need to be paid to the water-related impacts of land use and development. Most important, the State and local water agencies will need to play a key role in three areas:

- Prioritizing investments in conservation.
- Adopting rate structures and pricing that maximize conservation.
- Promoting less-energy intensive water management, such as a comprehensive groundwater policy.

Additional gains in water conservation, especially use reductions in both agricultural and urban landscape irrigation, are critical not only for meeting GHG emission reduction goals, but also for resilience to more frequent and severe droughts. Many local agencies throughout California have invested in water conservation and water use-efficiency activities. The State should encourage and facilitate local water conservation projects that achieve co-benefits of energy efficiency and greenhouse gas emission reductions.

Establishing a conservation-first policy for water-sector investment and action would help to sustain declining per-capita usage. This policy would be similar to the State's "loading order" policy for energy, which prioritizes investments in energy efficiency ahead of developing new power supplies. The conservation-first policy could be implemented through legislation or joint-agency action. (The State's Energy Action Plan, for example, was jointly approved by the CEC, CPUC, and CAISO).

Pricing policies are another key tool to deter waste, encourage efficiency, and require those who use the most to pay the costs of assuring the water supply. It is important that such policies also protect the ability of low-income households to purchase minimum necessary water supplies. While water rates are set at the local level, the State can use financial and regulatory incentives to promote widespread adoption of strong and equitable price signals to maximize conservation. These incentives could be made available within State grants and loans, or through applicable regulatory relief processes such as water rights applications.

California must also develop policies that thoroughly and accurately reflect the economic, social, and environmental value of water, to ensure the effectiveness of future water management practices, and to evaluate competing water use demands and trade-offs. For example, in the California Water Action Plan, the State proposed a comprehensive groundwater policy to reduce overdraft and energy-intensive pumping from deep underground. This policy will require collaboration between the SWRCB, Department of Water Resources (DWR), Department of Food and Agriculture, and other agencies.

Successfully meeting the water sector goals will also require balancing multiple policy objectives, such as flood protection, sustainable food production, and renewable energy development. Interagency coordination, such as the recent efforts of the SWRCB to develop the Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling (once-through cooling), shows interagency coordination is possible without a drastic overhaul of regulatory responsibilities. Nevertheless, additional challenges posed by the changing climate and economic pressures to successfully achieve mitigation goals across multiple economic sectors must be addressed. Multiple policy objectives must be balanced across a wide spectrum of State water and climate planning documents, such as the AB 32 Scoping Plan, the Safeguarding California Plan, the California Water Plan, the Delta Plan, the Bay Delta Conservation Plan, and the Integrated Regional Water Management Strategic Plan. The California Water Action Plan provides some guidance on the relationship between the priorities established in these water and climate planning documents by establishing priorities for the next five years.

State agency collaboration and policy alignment requires a foundation of information sharing and feedback. Both agency staff and executives will need to devote more time to inter-agency dialogue to ensure that policy differences are resolved with a full understanding of the consequences of decisions taken. In addition, achieving efficient and aligned policies across agencies may require alterations to existing agency authorities and decision-making procedures.

Key Recommended Actions for the Water Sector

Funding

- DWR and SWRCB to give priority to funding integrated management plans that include robust existing or proposed water and energy conservation and efficiency and measures that achieve GHG emission reductions. Conservation programs should include numeric targets.

Technology

- CEC to implement new water-related energy conservation measures and efficiency standards.
- CPUC to complete water-energy nexus rulemaking by 2016 and to continue implementation of joint water-energy utility efficiency programs and partnerships
- SWRCB and CPUC to incent resource-recovering wastewater treatment projects by 2015.
- SWRCB and RWQCB by 2016 to implement green infrastructure permits to treat and capture urban runoff for local use.

Administration

- As directed by the California Water Action Plan, the DWR, the SWRCB, CPUC, CEC, CDFA, and ARB to guide adoption of GHG emission-reducing policies for water sector investments and action by 2015. Conservation measures and regulations to reduce GHG emissions and maintain water supply reliability during drought periods will be a centerpiece of this administration action.
- As directed by the California Water Action Plan, DWR, SWRCB, CPUC in consultation with the CDFA, to identify and incent implementation of rate structures that accurately reflect the economic, social, and environmental value of water in California while maintaining affordability for basic services.
- As directed by the California Water Action Plan, the SWRCB to develop a comprehensive groundwater management strategy, and the DWR and CDFA to provide technical and financial assistance to exceed SBx7-7 targets.
- SWRCB and RWQCBs by 2016 to modify State and regional water board policies and permits to achieve conservation, water recycling, stormwater reuse, and wastewater-to-energy goals.

Education

- As directed by the California Water Action Plan, DWR, SWRCB, CPUC, CEC, and CAISO to promote water-energy conservation outreach and education.

5. Waste Management[86]

The Waste Management Sector covers all aspects of solid waste and materials management, including the recycling, reuse, and remanufacturing of recovered material; composting and anaerobic/aerobic digestion; municipal solid waste (MSW) thermal operations (waste-to-energy); biomass management (combustion, composting, chip and grind); and landfilling. This sector also includes market development programs, such as the State's environmentally preferable and recycled-content product purchasing program. The primary source of GHG emissions from this sector is the direct emission of methane from the decomposition of organic material in landfills. However, recycling, reuse, and reduction of waste materials will reduce upstream GHG emissions associated with the production and transport of products. Although many of these upstream GHG emissions happen outside of California, California's waste policies can help reduce both local and global GHG emissions and create jobs within the State.

California has a robust waste management system in place, with established programs that reduce air emissions through activities such as gas collection systems from landfills and stringent recycling mandates. California adopted landmark legislation in 1989 (Assembly Bill (AB) 939) that required cities and counties to reduce the amount of waste going to landfills by 50 percent in 2000 and has surpassed this mandate to achieve 66 percent in 2012. This action has resulted in diverting nearly 60 million tons per year of material from landfills to reuse, recycling, composting, and other beneficial uses.[87] These reductions could not have been achieved without the waste industry, local jurisdictions, affected business, and the public working diligently and cooperatively to meet the goal of AB 939. In doing so, we achieved a co-benefit of substantial GHG emission reductions due to the energy savings associated with the use of recovered materials in place of new raw materials.

However, California still disposes about 30 million tons of solid waste in landfills each year. To address this and recognize the role waste management can play in GHG emission reductions, the legislature adopted AB 341 (Chesbro, Chapter 476, Statutes of 2011) in 2011. This legislation set a clear mandate to achieve more significant waste reductions by 2020, setting a goal that 75 percent of the solid waste generated be reduced, recycled, or composted by 2020. It is estimated that achieving the AB 341 waste reduction goal will result in a yearly GHG reduction of about 20 to 30 $MMTCO_2e$.[88]

The initial Scoping Plan identified several activities that would continue to move California forward in enhancing this integrated system for addressing waste-related issues and further reduce GHG emissions from this sector. These activities include landfill methane emission reductions, reduction in waste generation, and shifting waste to more beneficial uses. In 2009, ARB adopted the Landfill Methane Control Measure to further reduce methane emissions from landfills. And, in 2012, CalRecycle adopted the Mandatory Commercial Recycling regulation to further increase recycling programs throughout the State.

ARB approved two resolutions to work with CalRecycle and other stakeholders to characterize emission reduction opportunities for different options for handling solid waste, including recycling, remanufacturing of recovered materials, composting and anaerobic digestion, waste-to-energy, landfilling, and the treatment of biomass. In addition, ARB is to develop a comprehensive approach for the most appropriate treatment of the Waste Sector under the Cap-and-Trade Program, based upon the analysis of emission reduction opportunities.

86 ARB and CalRecycle have prepared six technical papers: Recycling, Reuse, and Remanufacturing; Composting and Anaerobic Digestion; Biomass Conversion; Municipal Solid Waste Thermal Technologies; Landfilling of Waste; and State Procurement which are the basis for the information summarized here. The technical papers are available at *www.arb.ca.gov/cc/waste/waste.htm*.

87 This also includes the use of green material as alternative daily cover at landfills and some materials sent to transformation facilities.

88 Most of the estimated emissions benefits will be outside of California, since the majority of the recyclable commodities are currently reprocessed outside the State.

Meeting the AB 341 75 percent recycling goal is the best path forward to maximizing GHG emission reductions from the Waste Management Sector and putting California on the path for even greater GHG emission reductions in the future. In the future, net zero GHG emissions are achievable in a mid-term time frame. By 2050, direct GHG emissions from waste sector activities could be reduced by 25 percent, creating a net negative GHG footprint for the waste sector.

To achieve these goals, California must take greater ownership and responsibility for the waste generated within its borders. Shipping of waste, even recyclable products, to other states or nations is not a viable, long-term, environmentally appropriate waste management practice for California. Furthermore, exporting waste denies California the economic opportunity of significant job growth that would result if these materials were processed and remanufactured in California. While California cannot control exports, implementing the principle of owning our own waste will allow California to develop new, state-of-the-art waste management facilities/system which can be emulated by other states and nations.

Maintaining Momentum

California will need to maximize recycling, composting, and anaerobic digestion (instead of landfilling) and expand current waste management infrastructure to accommodate the increases in recycling and remanufacturing of waste material that is expected. This would mean constructing more composting and anaerobic digestion facilities that can use organics from the waste stream, as well as building more remanufacturing facilities for recyclable commodities such as fibers and resins.

Financing and permitting infrastructure development will be critical elements to achieving the Waste Management Sector goal. Financing, funding, and incentive mechanisms will be needed to support the development of the in-state infrastructure. Mechanisms to be considered will include Cap-and-Trade Investment Plan; loan, grant, and payment programs; Low Carbon Fuel Standard pathways; Public Utility Commission programs (e.g. biogas from anaerobic digestion and Renewable Market Adjusting Tariff); and offset protocols. Actions will also be needed to address permitting challenges and streamlining the multi-agency review of new and expanded infrastructure.

As increasing amounts of materials are diverted and recovered from the landfills, the markets for the recycled, reused, and remanufactured materials must grow. The State can take a leadership role in market development by having public agencies increase procurement of products with low-waste or no-waste attributes. In addition, greater producer responsibility for end-of-life product management, along with product design changes that minimize impacts on human health and the environment at every stage, will be increasingly important.

The State will need to explore opportunities for additional methane control at new and existing landfills either through amendments to the Landfill Methane Regulation and/or moving landfills into Cap-and-Trade or prohibiting/phasing out landfilling of organic materials.

The comprehensive nature of the waste sector has important ramifications for other focus areas. For example, efforts to divert green waste or biomass from the waste stream complements goals within the energy sector to further develop biomass resources for renewable electricity generation. Expanding agricultural waste diversion through composting and anaerobic digestion may affect policies within the agricultural focus area. Efforts to expand urban-based waste recycling and reuse programs may have implications for the transportation, fuels, and land use focus area.

Enhanced collaboration with State and local agencies is necessary, as California's waste-related issues are diverse and interconnected. Determining the best use of recycling alternatives, examining ways to increase the use of collected wastes and expanding their potential markets, providing funds to build needed infrastructure, and undertaking additional research are all important steps to reach the State's 2050 GHG emission goals.

In summary, to achieve the vision for the waste management sector, certain overarching actions are recommended. Actions to identify opportunities to further expand and maximize various waste management alternatives with California's own borders will need to be pursued. This could include the implementation of regulatory or statutory actions to phase out organic materials at landfills; including landfills in the Cap-and-Trade Program; and implementation of "best management" practices. Financial incentives to build adequate in-state infrastructure and incentivize activities to accomplish GHG and waste reduction goals are critical. Collaboration with other agencies, districts, and jurisdictions to streamline the permitting process and address conflicting requirements, including cross media issues, will permit a sustainable waste management system to grow in California. Additional research will also be needed to better characterize emissions for various materials and processes, and identify the best waste management alternatives.

Key Recommended Actions for the Waste Sector

- ARB and CalRecycle will lead the development of program(s) to eliminate disposal of organic materials at landfills. Options to be evaluated will include: legislation, direct regulation, and inclusion of landfills in the Cap-and-Trade Program. If legislation requiring businesses that generate organic waste to arrange for recycling services is not enacted in 2014, then ARB, in concert with CalRecycle, will initiate regulatory action(s) to prohibit/phase out landfilling of organic materials with the goal of requiring initial compliance actions in 2016.
- ARB and CalRecycle will identify and execute financing/funding/incentive mechanisms for in-State infrastructure development to support the Waste Management Sector goals. Mechanisms to be considered will include the Cap-and-Trade Investment Plan; loan, grant, and payment programs; LCFS pathways; CPUC proceedings (e.g. biogas from anaerobic digestion and Renewable Market Adjusting Tariff); and offset protocols.
- ARB will lead a process of identifying and recommending actions to address cross-California agency and federal permitting and siting challenges associated with composting and anaerobic digestion. As the first step, ARB convened a working group in 2013 made up of representatives from CalRecycle, SWRCB, and local air districts to identify challenges and potential solutions. A working group report will be released in mid-2014.
- ARB will explore and identify opportunities for additional methane control at new and existing landfills, and increase the utilization of captured methane for waste already in place as a fuel source for stationary and mobile applications. If determined appropriate, amend the Landfill Methane Regulation and/or move landfills into the Cap-and-Trade Program (2016/17).
- ARB and CalRecycle will develop new emission reduction factors to estimate GHG emission reduction potential for various recycling and remanufacturing strategies. To the extent data are available, these factors will include upstream and downstream emissions impacts.
- CalRecycle and the Department of General Services will need to take the lead in improving the State procurement of recycled-content materials through the State Agency Buy Recycled Campaign reform. Recommended improvements need to be identified by 2014, along with a plan for implementing the identified improvements.

6. Natural and Working Lands (Formerly Referred to as Forest Sector)

Three-quarters of California's landmass comprises biologically diverse landscapes such as forests, woodlands, shrublands, grasslands and wetlands. In this section's discussion, working lands includes rangelands but not agricultural croplands which are addressed in the Agriculture Sector. The initial Scoping Plan included a measure on sustainable forests and also identified additional strategies such as urban forestry and fuels management. This Scoping Plan update recognizes the key role that forests and all natural and working lands must play in meeting California's GHG emission reduction goals.

Natural and working lands act as both a source of GHG emissions and a carbon sink that removes CO_2 from the atmosphere. For example, vegetation growth and associated carbon sequestration in response to favorable growing conditions in one year can be followed by reduced growth or mortality during extended periods of drought. Emissions from wildfire, pest, and disease, are all natural ecosystem processes that can fluctuate from year to year and greatly influence the relationship between source and sink. However, when sustainably managed, the potential for natural and working lands to reduce GHG emissions and sequester carbon is significant and will be critical to reaching California's long-term climate goals.

Efforts to reduce GHG emissions and enhance carbon sequestration on natural and working lands also have significant economic, social, and environmental co-benefits, and can aid progress on efforts to prepare for climate change risks. A few key co benefits include protection of water supply and water quality, air quality, species habitat, recreation, jobs, wood and related products, flood protection, nutrient cycling and soil productivity, reduced heat-island effect, and reduced energy use. However, to ensure resilience, carbon management of these lands must be integrated with a broader suite of resource management objectives for those lands.

The initial Scoping Plan included a Sustainable Forest Target. The goal of this target was to maintain net carbon sequestration on forest lands. This was to be achieved using the mechanisms provided by the Forest Practice Rules, timberland conversion regulations, fire safety requirements, forest improvement assistance programs, and the California Environmental Quality Act (CEQA), which requires avoidance or mitigation of impacts affecting forest site productivity or forest carbon losses to conversion. The initial Scoping Plan also identified other opportunities to realize additional GHG emission reductions and increase sequestration, including the following:

- Preventing the conversion of forestlands through publicly and privately funded land acquisitions.
- Maintaining and enhancing forest stocks on timberlands through forest management practices subject to the Forest Practice Act.
- Planting trees on lands that were historically covered with native forests.
- Establishing forest areas where the preceding vegetation was not forest.
- Planting trees in urban areas.
- Using urban forest wood waste for bioenergy.
- Reducing vegetative fuels that could feed wildfires and using this waste for bioenergy.

The Board of Forestry and Fire Protection (BoF) has been evaluating the adequacy of existing forest regulations and programs for achieving GHG emission reductions and ensuring carbon sequestration on forest lands. In 2010, amendments to CEQA guidelines led to the requirement that timber harvest proponents subject to State regulations must analyze GHG emissions when applying for CAL FIRE permits.

The initial Scoping Plan recognized the need for continued research to improve estimates of ecosystem carbon stocks and GHG flux associated with stock change on forests and other natural lands. In 2011, ARB contracted with researchers from UC Berkeley to develop a new

methodology for assessing carbon stock changes for all California's lands except agricultural and urban areas. The researchers have developed a new emissions assessment approach based on field measurements (Forest Inventory and Analysis data) and satellite remote sensing data and methods. The methodology includes an emissions assessment of forests, woodlands, grasslands, shrublands, and wetlands.[89]

Healthy forests and lands returning to forest are an important source of carbon sequestration. The UC Berkeley research is showing, however, that loss of forests and other natural lands through fire, natural ecosystem succession and conversion of forests and woodlands to other uses represent significant CO_2 release, potentially significantly greater than previously estimated and may outpace carbon sequestration, possibly by substantial amounts. This information underscores the importance of managing our forests and other natural and working lands to maximize the net benefits—increasing sequestration while reducing conversion and carbon stock losses, and maximizing associated co-benefits.

Application of the new research methodology will enable the monitoring of changes on the land over time and periodic quantification of the GHG flux associated with changes in ecosystem carbon stocks. As source data improves and methods are refined, ARB's GHG inventory for forests and other lands will be updated. This new inventory information can help identify the steps needed to reverse adverse trends and inform efforts to manage natural and working lands for net climate benefits.

The methodology developed by UC Berkeley does not include tree-covered urban areas. However, CAL FIRE, in conjunction with the U.S. Forest Service and researchers at UC Davis, is also developing GHG inventory data for urban forests and is continuing to refine and update those data over time. Improvements to ongoing GHG reporting systems will include refinements to methods and incorporation of additional relevant data sets (such as information on vegetation, forest stand treatments, and other activities) that are collected by CAL FIRE and other agencies.

On September 11, 2012, Governor Brown signed Assembly Bill 1492 (AB 1492; Blumenfield, Chapter 289, Statutes of 2012), with the first major changes in forest sector legislation in ten years. Among other things, AB 1492 set into motion a fee on certain types of lumber and wood products in California that now help fund forest management programs related to timberlands. One of the provisions of this new law is the requirement for the State to evaluate ecological performance measures, which are likely to include an evaluation of practices that may directly or indirectly affect GHG emissions.

Maintaining Momentum

While ongoing efforts are being made to reduce GHG emissions and increase carbon sequestration in California's forests, additional work is necessary, and incorporating other land types into our planning will become increasingly important as we move beyond 2020. With appropriate investments and sound science-based policy, natural and working lands in California can provide a tremendous opportunity to meet the State's climate goals. Over time, efforts in the Natural and Working Lands Sector will achieve many other important public and environmental benefits, such as protection of water supply and quality, air quality, and species habitat, as well as providing recreational opportunities and jobs.

Timing is critical for actions in this sector. Activities to enhance carbon storage on natural and working lands, such as reforestation or restoration, will require time to fully realize carbon benefits. For example, planting trees today will maximize their sequestration capacity in 20 to 50 years. In addition, trees in urban environments, or "urban forests," provide significant shading

89 Battles, J., Gonzalez, P., Robards, T., Collins, B., Saah, D., Jan 2014, California Forest and Rangeland Greenhouse Gas Inventory Development, Final Report, California Air Resources Board Agreement 10-778; *www.arb.ca.gov/cc/inventory/sectors/forest/forest.htm*

and other cooling benefits. As the trees mature they reduce urban temperatures and energy needs. Near-term investments in activities such as planting trees will help us reach our 2020 limit, but will also play a greater role in reaching our mid-term and longer-term 2050 targets especially if action is taken in the near-term.

Some actions to reduce emissions and enhance carbon storage in the long-term may result in temporary, short-term reductions in carbon sequestration. For instance, actions taken to address forest health concerns or to reduce wildfire risks may result in temporary reductions in carbon stock, but they are necessary to maintain healthy forests that are more efficient at GHG sequestration and more resilient to future climate conditions. It's important to manage our forests to maximize net climate benefits, increasing sequestration while reducing losses due to fire or other processes, while also considering the broader range of environmental services that forests and other natural lands provide.

There may also be additional benefits beyond carbon that can only be realized if actions are taken early enough. For instance, in some cases restoring tidal wetland can offer flood protection that is able to keep pace with sea level rise through the growth of root mass over time, but such naturally growing flood protection enhancements are only possible if restoration activities are initiated early.

Through implementation of GHG policies, actions, and strategic investments identified below, efforts to enhance, protect, and conserve natural and working lands in California can result in important climate benefits, as well as a more resilient California that is better prepared for climate risks such as more frequent and severe wildfires, changing water availability, and stressors on species and natural communities.

Research and Emission Inventory Updates

Inventory development and improvement are critical for informing carbon management activities in California. Recently developed tools will enable ARB to generate geospatially explicit estimates of ecosystem carbon stocks and GHG flux associated with stock change across a variety of land categories. Though additional work is needed, these tools, along with regularly updated input datasets will allow tracking of changes over time and provide a new method to update the GHG inventory.

The sources and methods for quantifying ecosystem carbon and GHG flux in this sector are complex. Additional work is needed to evaluate the data provided by the UC Berkeley research, to incorporate additional new data, and to identify further research needed to expand use of these tools. Continued refinements will advance carbon quantification, attribution of GHG flux by disturbance process, and reduce uncertainty, all of which will help inform effective carbon management activities. There is also a need to prioritize and conduct additional research on outcomes of specific practices to maximize carbon uptake on natural and working lands in California.

Integrating Biological Systems

Natural and working landscapes in California are composed of widely varied, vibrant, and often interconnected biological systems. Moving forward, it is important to begin looking at these lands in a more holistic and integrated way to ensure that we maximize opportunities to achieve biological carbon benefits across the range of California's natural lands, while also ensuring the health and resiliency of these lands to provide ongoing ecosystem services.

Forest Planning and Actions

California forests must be managed to ensure that they provide net carbon storage even in the face of increased threats from wildfire, pests, disease, and conversion pressures. Quantitative planning targets must be set to increase net forest carbon storage in California in the near-term, mid-term, and by 2050, while ensuring forest resilience, health, and continued ecosystem

services. Forest carbon inventory and assessments should be continually maintained and refined to support this effort, and appropriate measures, funding, and incentives must also be established.

Specific actions to meet these planning targets for increasing carbon storage in California forests will be laid out in a "Forest Carbon Plan" (Plan). The Plan will be developed by a joint inter-agency workgroup and will necessitate engaging our federal partners with respect to federal lands in the State. The Plan should also include input from expert resources and stakeholders such as academia, non-governmental organizations, working forest owners, and local planning groups, to inform policy decisions. Additionally, the Plan should work synergistically with other State planning policies where GHG emission reduction strategies and co-benefits intertwine such as in the Water Action Plan, State Wildlife Adaptation Plan, and Safeguarding California. A resource economics study may be necessary to support the development of the Forest Carbon Plan; funding for such a study would be needed.

The Forest Carbon Plan will, at a minimum, set mid-term and long-term planning targets; identify actions to meet those targets; and provide recommendations on funding those actions. Development of the Plan should include a review of Forest Practice Regulations and recommendations for best management practices and potential additional regulatory measures or amendments needed to minimize GHG emissions and enhance carbon storage associated with silvicultural treatments. For example, a requirement for Sustained Yield Plans to demonstrate that activities not only maintain the current level of carbon sequestration, but actually increase carbon sequestration over the 100-year planning horizon.

Funding recommendations in the Plan should include but not be limited to the following:

- Recommendations regarding the development and implementation of market-based mechanisms applicable to large forest land owners for the purpose of ensuring that forests in California provide net carbon storage.
- Recommendations regarding the development and implementation of a competitive grant program.
- Recommendations regarding types of climate investments that might be supported by varying levels of funding support from Cap-and-Trade auction revenues or other sources.
- Recommendations regarding the process for dedicating a portion of Yield Tax Revenue to fund forest climate investments.
- Recommendations pertaining to property tax restructuring or other financial incentives to attract more interest in active forest management by nonindustrial timberland owners.

Another forest action is to incentivize the sustainable use of biomass obtained from forest management practices to produce energy. This strategy diverts raw materials from being burned in open piles, and reduces criteria and GHG pollutant emissions. Open burn piles create particulate emissions, which can exacerbate health problems and interfere with attaining State and federal ambient air quality standards. In addition, open burning contains black carbon, which is a short-lived climate pollutant (SLCP). As discussed in Chapter II, SLCPs have a shorter lifetime in the atmosphere and have a higher pound-for-pound warming potential than CO_2, and as such, during these shorter lifetimes they are very potent. Because SLCPs are removed from the atmosphere rather quickly, reducing their emissions results in immediate climate and air quality benefits. Cross-sector coordination is needed between the energy, waste, water, natural and working lands, and agriculture focus groups to develop recommendations for addressing economic, infrastructure, and regulatory hurdles regarding the input of bioenergy into the electricity grid from both small-scale and utility-scale biomass energy facilities.

Development of a carbon life cycle analysis for wood products could also be considered. When utilizing wood products for construction, manufacturing, and sale of goods in California, the location of the initial raw wood should be considered along with an analysis of the associated

carbon emissions from the processing and transport of wood products through the various steps of the supply chain. Guidelines could be established that would identify and incentivize wood products that reduce carbon emissions–taking into account GHG emissions from transportation to the mill, from the mill to the production facility, and finally to the retailer. For example, wood harvested in California and transported and utilized locally for construction and manufacturing would have a lower carbon impact than wood that has been harvested and manufactured outside the State, shipped from overseas, or processed and reintroduced within California as a finished wood product.

Rangelands and Wetlands Planning and Actions

In the absence of comprehensive California rangeland and wetland carbon data, these lands should be protected from conversion pressures and degradation that could result in significant carbon emissions. In addition, restoration and improved management practices to increase carbon storage should be incentivized. This is true particularly where such enhancement, protection, and conservation action provide other important climate benefits, such as improving watershed conditions and flood protection, and providing habitat and connectivity for climate-stressed species.

Land Use Planning to Enhance, Protect, and Conserve Lands in California

As described under the Agricultural Sector, an integrated and coordinated approach to local land use planning that considers all land types is important in meeting the State's GHG reduction goals. Urban, natural and working lands, and agricultural croplands within and across jurisdictions must all be considered to create interconnected land areas and ecosystems. Local and regional land use planning actions and policies need to more fully integrate and emphasize land conservation and avoided conversion of croplands, forests, rangelands, and wetlands—as well as expansion and promotion of urban forestry, urban agriculture, and green infrastructure.

Urban Forests

Expansion and support is needed for urban forest programs, particularly in environmental justice communities. Urban forests can significantly reduce the disproportionate environmental impacts on California's environmental justice communities through increased green infrastructure investments that reduce GHG emissions. These investments benefit communities and result in environmental benefits such as reduced storm water runoff and clean air; health benefits from motivating active transportation and reducing urban heat island effects; and economic benefits such as reduced energy demand through cooling and increased land values. Utilizing local groups, such as the Local Conservation Corps, to implement urban forest and urban greening projects in these areas can provide dual benefits by also providing experience, training, and opportunity for at-risk youth.

Funding Needs

Funding is critical to address the needs in this sector, yet it is far below historic levels and in some cases does not exist. Outcomes of actions on natural and working lands often occur on a decadal scale. Action within the next ten years is critical so long-term benefits can be fully realized in the 2050 time frame. Funding sources must be identified, particularly where funds from existing sources can be leveraged effectively.

Funding across the sector is needed for further inventory improvements, research on effective GHG reduction and sequestration practices, and direct on-the-ground activities known to reduce GHG emissions and increase sequestration.

To further define and describe these needs, a natural and working lands climate investment working group will be convened to produce a report that outlines funding needs and opportunities for the Natural and Working Lands Sector as a whole. The GHG inventory, Forest Carbon Plan, local land use planning efforts, and other statewide efforts should be considered in development of the report.

To the extent feasible, the report should include strategic prioritization guidelines for investments in forests, rangeland, or wetlands. As different governmental entities and stakeholders actively manage forest, rangelands, and wetlands, separate prioritization guidelines should be developed for each land type and for the sector as a whole, if possible.

Key Recommended Actions for Natural and Working Lands

- The California Natural Resources Agency (CNRA) and CalEPA will convene an inter-agency forest climate workgroup to prepare and publish a "Forest Carbon Plan" in 2016. The Forest Carbon Plan will:
  - Set quantitative near-term, mid-term, and long-term planning targets to ensure an increase in net forest carbon storage in California commensurate with the State's long-term GHG reduction goals, and in light of recent research that suggest that forests in California may be a source of GHG emissions rather than a carbon sink.
  - Identify near-term and long-term actions necessary to meet quantitative planning targets while ensuring forest resilience and health, ecosystem services, conservation of the forest land base, and continued economic opportunities.
  - Evaluate GHG emission and carbon sequestration trends for different forest land ownership types and consider sector sub-targets for each type.
  - Develop specific recommendations regarding approaches for funding actions to ensure that forests in California provide net long-term carbon storage.
- In 2016, through AB 1504, CAL FIRE and BOF will evaluate methods to develop a life cycle analysis to track carbon in wood products; this work should be coordinated with ARB's forest inventory and support the Forest Carbon Plan.
- The Bioenergy Interagency Working Group will continue to work with stakeholders and relevant agencies to:
  - Strengthen, refine, and implement actions contained in its Bioenergy Action Plan related to use of forest biomass.
  - Evaluate the potential biomass energy generation capacity.
  - Develop methods to quantify biomass life-cycle GHG flux.
- In 2015, OPR, CNRA, CalEPA, CDFA, California Department of Fish and Wildlife (CDFW), CAL FIRE, and ARB will convene an inter-agency workgroup to engage local and regional land use planning agencies in establishing a coordinated local land use program. The program will set planning targets that identify, prioritize, and incentivize land conservation; increase urban forestry canopy cover; bolster development of green infrastructure; and limit the conversion of both agricultural croplands and natural and working lands.
- In 2015, CNRA, CalEPA, CDFA, CDFW, CAL FIRE and ARB will convene a natural and working lands climate investment working group to draft a report outlining funding needs, opportunities, and priorities for the Natural and Working Lands Sector.
- Expand urban forestry and green infrastructure programs and investments, particularly in California's environmental justice communities.
- Continue to analyze the UC Berkeley research methodology and data to develop GHG inventory updates, incorporate more recent data into the newly developed tools for carbon quantification, and invest in and expand monitoring and research to reduce uncertainty in carbon quantification and attribution of GHG flux by disturbance process.

7. Short-Lived Climate Pollutants

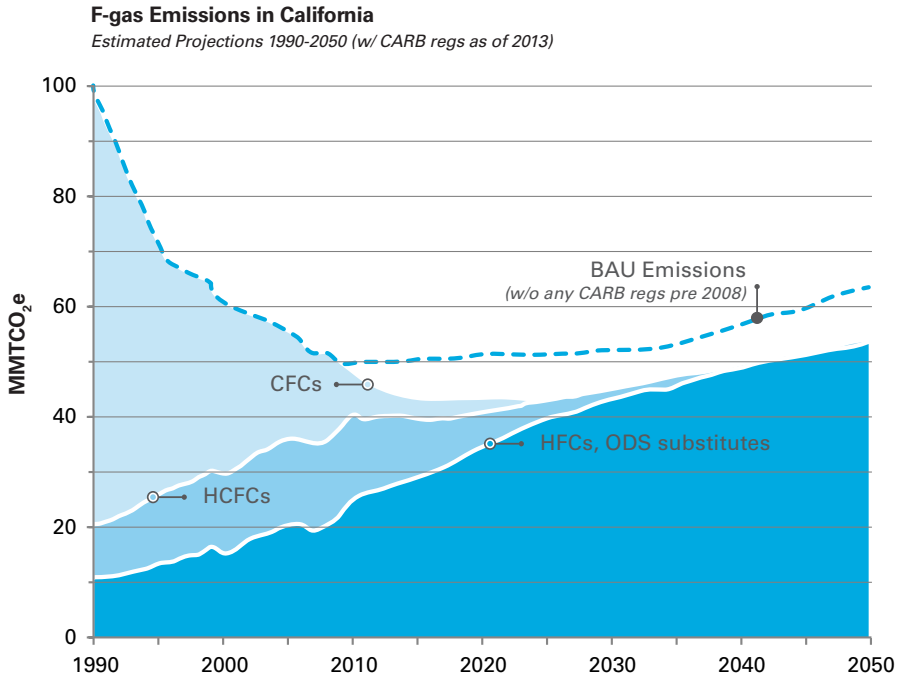
Mitigation of short-lived climate pollutants (SLCPs)—which include black carbon, methane, tropospheric ozone, and some hydrofluorocarbons (HFCs)—produces immediate climate benefits and is an important complement to efforts to reduce emissions of CO_2. Many short-lived climate pollutants are already regulated by ARB, either as part of the air quality and toxics program or under the Scoping Plan. For example, black carbon levels in California will be reduced by 95 percent from the late 1960s to 2020, primarily due to diesel controls and burning restrictions. Peak urban ozone levels have also been reduced by more than 75 percent since the 1960s; however, substantial further reductions are needed to comply with federal requirements to meet the National Ambient Air Quality Standard by 2032. ARB is mitigating methane and HFCs from various sources through the implementation of control measures identified in the initial Scoping Plan and will develop a more aggressive short-lived climate pollutant strategy by 2015 that will include an inventory of sources and emissions, the identification of additional research needs, and a plan for developing necessary control measures. ARB will consult with external experts in the development of this strategy.

Several recent analyses of atmospheric measurements suggest that actual methane emissions may be 1.3 to 1.7 times higher than estimated in ARB's emission inventory. California and federal agencies, universities, and national laboratories have put into place a comprehensive set of research studies to determine the sources of these higher-than-expected methane emissions, and whether additional controls are technologically feasible and cost-effective. In March 2014, the Obama Administration released the Climate Action Plan - Strategy to Reduce Methane Emissions[90] identifying actions to improve methane emission estimates and develop methane emission control measures. The Strategy identifies key agencies that will be responsible for evaluating and implementing methane reduction strategies for various sources including landfills, agriculture operations, coal mines, and oil and gas production. Strategies that address methane emissions in this Update are identified in the preceding sector discussions on energy, agriculture, and waste.

Short-lived climate pollutants have a subcategory of compounds that are considered to have an even higher significance on climate change on a per-ton emission basis than other SLCPs. These compounds are called high global warming potential (GWP) gases. High-GWP gases are those that, on a per-ton basis, contribute to global warming at a level many times greater than carbon dioxide (GWPs of 150 or higher). These gases are manufactured, have no natural sources, and have been in use for decades, primarily in refrigerators, air conditioners, and foam insulation. A majority of the emissions are comprised of hydrofluorocarbons (HFCs), with a smaller percentage from perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). Although emissions of high-GWP gases are only three percent of today's statewide GHG inventory, they are the fastest-growing GHG source in California as HFCs are replacing ozone-depleting substances (ODSs) in response to the Montreal Protocol mandates. Significant efforts will be needed to control these emissions as the ODSs are phased out. The ODSs are primarily chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), and all the fluorine-containing gases are collectively known as F-gases. Figure 7 shows California's F-gas emission trends from 1990 to 2050.

90 *www.whitehouse.gov/sites/default/files/strategy_to_reduce_methane_emissions_2014-03-28_final.pdf*

Figure 7: Fluorinated gas (F-gas) Emissions in California (1990–2050)



Note: The blue dashed line represents business-as-usual F-gas emissions if no CARB regulations had been adopted to reduce high-GWP emissions. The dark blue area represents business-as-usual (BAU) emissions, including reduction measures adopted as of December 2013.

Due to the phase-out of ODSs, total F-gas emissions have been reduced by 57 percent since 1990. However, HFCs continue to increase as they replace the ODSs that are banned by the Montreal Protocol. Even with the current regulations that are in place, HFC emissions are expected to increase by about 40 percent (from 18 to 25 $MMTCO_2e$) between 2012 and 2020. With no additional control measures, HFC emissions in California are expected to more than double by 2050, to 43 $MMTCO_2e$ annually, accounting for approximately half of California's long-term GHG emission target.

While high-GWP gases are not a discrete sector of California's economy, the Scoping Plan addressed them as a sector to organize and track emissions, sources, and emission reduction strategies. The focus of the Scoping Plan measures was primarily on HFC emission reduction programs. These measures focused on two central themes to achieve five $MMTCO_2e$ of GHG emission reductions by 2020: (1) use of lower-GWP alternatives for certain consumer products and new motor vehicle air conditioning systems, and (2) avoiding releases of currently used high-GWP gases, using gas recovery options, such as those for electrical transmission and particle accelerators, and leak tightness specifications.

Implementation of the Scoping Plan measures has reduced emissions from a variety of sources. The biggest reductions of high-GWP gases are expected to come from ARB's Refrigerant Management Program, which requires facilities with refrigeration systems to inspect and repair leaks, maintain service records, and in some cases, report refrigerant use. Significant reductions are also expected to come from a motor vehicle air-conditioning (AC) credit program for vehicle models 2017 and beyond. This measure is part of the Low Emission Vehicle (LEV III) regulation that has been aligned with a new federal Clean Cars program.

In spite of ARB efforts, significant obstacles remain for further reductions of HFCs, due to the diverse nature of sources. Substantial progress has been made in recent years in the development of low-GWP alternatives in the refrigeration and foam industries that can achieve significant reductions in the high-GWP sector. Low-GWP refrigerants and insulating foam are currently under evaluation to better understand their technical feasibility and cost-effectiveness in various applications. Based on further analysis, ARB may develop programs to require low-GWP insulating foam materials and refrigeration systems that use either low-GWP alternatives or significantly reduced amounts of HFCs.

California's efforts can help support a national or international phase-down of HFC production and consumption. On June 8, 2013, the United States and China entered into a preliminary agreement to phase down the production and consumption of HFCs between the two countries. For the first time, the United States and China will work together and with other countries to use the expertise and institutions of the Montreal Protocol to phase down the consumption and production of HFCs, among other forms of multilateral cooperation.

Maintaining Momentum

There are several potential approaches to further reduce high-GWP F-gases. These include:

High-GWP F-gas Phasedown

California to work with the U.S. EPA to establish national standards in alignment with the European Union (EU) proposed F-gas phasedown of HFC production and import to just 21 percent (based on CO_2-equivalents) of baseline annual usage (years 2008 – 2011) by the year 2030. Some sector-specific prohibitions are included within the proposed EU phasedown, including a ban on refrigerants with a GWP greater than 2,500 used in new equipment.

Low-GWP Requirements

Low-GWP substitutes for ODSs and HFCs are becoming increasingly feasible and cost-effective. As such, it will be vital to require that low-GWP compounds be used for commercial refrigeration and air conditioning, residential appliances and air conditioning, insulating foam, motor vehicle air conditioning, transport refrigeration, aerosol propellants, metered dose inhalers, solvents, fire suppressants, sulfur hexafluoride uses, and structural pesticide fumigants if California is to meet its mid-term GHG goals and long-term GHG emission reduction goal of 80 percent below 1990 levels by 2050.

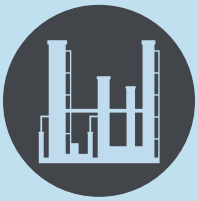
ODS Recovery and Destruction

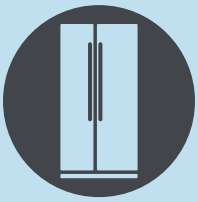
The Montreal Protocol has reduced ODS emissions significantly (by almost 60 percent) by reducing the production and consumption of ODSs. However, it appears that end-of-life emissions from legacy equipment are still significant. Due to higher demand and therefore higher value of recovered ODSs, there is currently less incentive for ODS destruction. More than 80 percent reduction in ODS emissions (approximately 20 $MMTCO_2e$) can be obtained by 2030 by incentivizing recovery and destruction of ODSs at the end-of-life. This can be done by a combination of strategies, including adjustments to current ODS destruction protocols, implementing a mitigation fee, and/or using cap-and-trade revenue to help pay for higher costs.

High-GWP Fee

An upstream mitigation fee on sales of high-GWP gases would incentivize a faster transition to low-GWP substitutes, and could further incentivize improved refrigerant recovery practices. The fee would also be applied to sales or import of equipment pre-charged with high-GWP gases. The mitigation fee would complement rather than replace downstream high-GWP regulations currently in effect or being developed. As sources comply with regulatory measures, affected entities would reduce their emissions and therefore the fees they would need to pay. A high-GWP fee would address high-GWP gases in a consistent manner, on a carbon dioxide equivalent basis, and serve to change behavior, induce new low-GWP alternative products, and provide revenue that can be used to mitigate GHG emissions.

Key Recommended Actions for Short-Lived Climate Pollutants





- Develop a comprehensive strategy for mitigation of short-lived climate pollutants by 2015.
- Continue diesel controls that will reduce black carbon emissions by 95 percent from the late 1960s to 2020.
- Reduce emissions of smog-forming pollutants by about 90 percent below 2010 levels by 2032 to meet the National Ambient Air Quality Standard for ozone.
- Create a collaborative agreement with the U.S. EPA to establish national standards in alignment with the European Union (EU) proposed F-gas phasedown of HFC production and importation to just 21 percent (by CO_2-equivalents) of baseline annual usage (years 2008-2011) by the year 2030.
- Require low-GWP gases where feasible and cost-effective.
- Incentivize recovery and destruction of ODSs at the end-of-life by a combination of strategies, including adjustments to current ODS destruction protocols, and/or implementing a mitigation fee.
- Set an upstream mitigation fee on sales of high-GWP gases and sales or import of equipment pre-charged with high-GWP gases.

8. Green Buildings

Buildings represent the second largest source of statewide GHG emissions, when accounting for electricity, natural gas, and water consumption. However, there are additional GHG emissions related to buildings that have not yet been fully accounted for as part of the Statewide GHG emission inventory. For example, additional GHG emissions could be accounted for under a lifecycle emissions analysis approach such as estimating emissions resulting from the mining, harvesting, processing, and transportation of materials used to construct new buildings, as well as products consumed over the life of a building. The siting and integration of buildings into communities may also affect transportation patterns and infrastructure needs and result in GHG benefits. Green buildings are designed, constructed, operated, and maintained to maximize energy efficiency, conserve water, and minimize waste. They also are strategically located to encourage people to walk, bike, or take public transit rather than drive cars.

Green buildings offer a comprehensive approach to support California's climate change goals across multiple sectors, including energy, water, waste, and transportation while protecting the environment and public health. Green buildings utilize an integrated process to improve the design and construction of new buildings, as well as to retrofit, maintain, and operate existing buildings. By supporting current initiatives and expanding the long-term focus toward zero carbon buildings, green buildings represent a fundamental shift toward a cross-sector and integrated climate policy framework. In the last five years, California has solidified its commitment to green building; leading the way with State buildings, improving building standards, continuing to raise the bar with voluntary programs at the local level, and greening existing buildings.

Leading the Way with State Buildings

Governor Brown took a leadership role by signing Executive Order B-18-12 in April 2012. The Executive Order directs State agencies and departments to take immediate action for state government buildings to serve as models for green buildings. New and renovated State buildings shall achieve Leadership in Energy and Environmental Design for New Construction (LEED-NC) "Silver" certification or higher. All existing State buildings over 50,000 square feet shall complete LEED for Existing Buildings: Operations and Maintenance (LEED-EB: O&M) certification by 2015. In addition, the Order provides that 50 percent of new State facilities beginning design after 2020 shall be zero net energy (ZNE) buildings, and all new State buildings and major renovations starting design in 2025 shall be ZNE buildings. Already, over 100 State buildings have been able to achieve LEED certification. Nearly half of those certifications are for LEED-NC, 35 percent are for LEED-EB: O&M, and about 20 percent are certified to the LEED for Commercial Interiors (LEED-CI) rating system.

In addition, by the end of 2014, there will be 46 megawatts of on-site solar photovoltaic systems at State facilities, plus about 33 megawatts at University of California campuses, and 11.3 megawatts at California State University campuses.

California Green Building Standards

Reducing GHG emissions from construction is being accomplished through continuous updates to the California Green Building Standards (CALGreen) Code. Originally adopted in 2008, the CALGreen Code included all voluntary standards that went beyond the basic building code requirements and introduced new standards for reducing water use, provisions for reducing and recycling construction and demolition waste, criteria for site development to locate buildings near public transit, and measures for improving indoor air quality to protect the health of building occupants. In 2010, the CALGreen Code became mandatory on a statewide basis. The 2010 code, as amended, included provisions for additions and alterations for non-residential buildings, but it still only applied to new construction for low-rise residential buildings. For the 2013 code, effective January 2014, the scope of the CALGreen Code was expanded to all residential

buildings, including high-rise residential, as well as to additions or alterations with increases in conditioned space. In addition to mandatory standards, the CALGreen Code still includes voluntary standards, also known as Tiers, that offer model building code language available for local adoption.

Voluntary Programs at the Local Level

Local governments are helping to reduce GHG emissions as they adopt green building standards that include targets to exceed minimum State building standards for new construction. Over 100 local governments have adopted "beyond code" green building standards. Twenty of those cities adopted building standards to exceed the Building Energy Efficiency Standards by 15 or 30 percent; IOUs supported the adoption of these local "reach" energy standards through technical analysis and funding, as overseen by the CPUC. About 50 cities and counties have standards exceeding the minimum CALGreen Code Tiers. Over 60 local governments have mandated all new construction to achieve third-party green building certification, such as the GreenPoint Rated program and the LEED rating system. Similarly, school districts are pursuing high performance standards for greening public schools. About 40 school districts have mandated minimum Collaborative for High Performance Schools (CHPS) certification for all new construction and major modernization. Since 2008, nearly 200 schools in California have been recognized as CHPS schools.

The State's higher education systems are also leaders in designing and constructing green buildings on their campuses. For example, the University of California system has taken a proactive role in reducing GHG emissions in its buildings and in 2013; President Janet Napolitano declared an initiative for the University of California to achieve carbon-neutrality in its operations by 2025.[91] As of 2011, the California State University system had 36 buildings that were LEED certified with an additional ten buildings expected to qualify for some level of LEED certification.[92] Finally, California's Community Colleges have made remarkable progress toward conserving energy and making their campuses more energy efficient.[93]

Greening Existing Buildings

While building standards for new construction, additions, and alterations are useful to reduce the impacts of climate change, major renovations and sustainable operation of existing buildings offer the greatest potential to reduce building-related GHG emissions. Over 500 buildings have been certified to the LEED-EB: O&M rating system, which certifies that a building's operations follow rigorous green building standards and practices. To maintain momentum for greening existing buildings, progressive programs that accelerate the uptake of proven strategies are needed to reduce not only energy impacts, but also water, waste, and transportation impacts of the existing building stock. To this end, California must begin to develop a process to implement a portfolio of green building requirements to reduce GHG emissions at time of sale or using other trigger mechanisms.

Maintaining Momentum

Zero Net Carbon Buildings

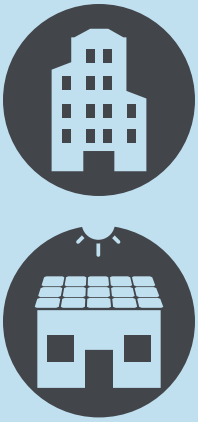
Zero net carbon buildings will be key as we continue to pursue an integrated approach to reduce new and existing building-related impacts that combine climate and air quality programs. To this end, the State will be developing new emission reduction programs for State buildings, schools, homes, and commercial buildings. It will be essential to expand upon the Energy Sector zero net energy building goals and establish goals to achieve zero net carbon buildings. Achieving these goals would result in zero net carbon emissions over the course of a year from all GHG emission

91 *http://sustainability.universityofcalifornia.edu/documents/carbon-neutrality2025.pdf*.
92 *www.calstate.edu/pa/documents/CSU_Sustainability_Report_2011.pdf*
93 *http://extranet.cccco.edu/Portals/1/CFFP/Sustainability/BOG_Energy_Sustainability_Policy_FINAL.pdf*

sources associated, directly and indirectly, with the use and occupancy of buildings. Zero net carbon buildings could utilize high-performance design solutions, generate renewable energy and heating on-site or locally, and employ other techniques to eliminate or offset GHG emissions from all GHG impacts (i.e., energy, water, waste, and transportation) associated with a building. Zero net carbon buildings are the next generation of buildings and could contribute significantly to achieving our long-term GHG emission goals.

The key actions summarized below would support the State's efforts to realize the 2020 emission reduction limit while helping to drive California toward developing and implementing additional strategies to achieve emission reductions from green buildings.

Key Recommended Actions for Green Buildings



Develop a comprehensive GHG emission reduction program for new construction, existing building retrofits, and operation and maintenance of certified green buildings. Program development to be completed by end of 2017 and incorporate the following principles:

- Achieve Executive Order goals for State buildings.
- Build on California's existing zero net energy building goals and activities by 2015.
- Continue research activities to better quantify GHG emission reduction potential of certified green buildings by 2016.
- Strengthen the next two triennial editions (2016 and 2019) of the Green Building Standards Code with mandatory provisions that reduce GHG emissions by 2017 and 2020 respectively.
- Build on AB 758 Action Plan implementation activities, and explore opportunities to implement a portfolio of green building retrofit requirements at time-of-sale or other trigger mechanism by 2017.
- Explore methodologies to quickly but accurately quantify direct and indirect GHG emissions from new and existing buildings by 2017.
- By 2017, establish target dates and pathways toward transitioning to zero net carbon buildings that expand upon and complement ZNE goals.
- By 2018, implement a mechanism to track progress toward achieving statewide green building goals.

9. Cap-and-Trade Regulation

The Scoping Plan recommended the development of a California Cap-and-Trade Program that links with other Western Climate Initiative partner programs to create a regional market system. On January 1, 2013, ARB launched the second-largest GHG Cap-and-Trade Program in the world. The Cap-and-Trade Regulation ensures progress toward the near-term 2020 statewide limit, while providing businesses the greatest flexibility to reduce emissions at the lowest possible cost.

The Cap-and-Trade Program is a vital component in achieving both California's near-and long-term GHG emissions targets. California's Cap-and-Trade Regulation is purposely designed to leverage the power of the market in pursuit of an environmental goal. It opens the door for major investment in emission-reducing technologies and sends a clear economic signal that these investments will be rewarded. The Cap-and-Trade Regulation establishes a hard and declining cap on approximately 85 percent of total statewide GHG emissions. Under the Cap-and-Trade Regulation, ARB issues allowances equal to the total amount of allowable emissions over a given compliance period and distributes these to regulated entities. One allowance equals one metric tonne of greenhouse gases. Each regulated entity must hold allowances or other compliance instruments equal to its emissions.

The Cap-and-Trade Regulation gives companies the flexibility to trade allowances with others or take steps to cost-effectively reduce emissions at their own facilities. Companies that emit more have to turn in more allowances or other compliance instruments. Companies that can cut their GHG emissions have to turn in fewer allowances. But as the cap declines, aggregate emissions must be reduced. Companies can meet a limited portion of their compliance requirement by surrendering offset credits, which are rigorously verified emission reductions that occur from projects outside the scope of the Cap-and-Trade Regulation. The offset program was included in the Cap-and-Trade Regulation because it is an important cost-containment mechanism. The Cap-and-Trade Regulation currently recognizes offset protocols for four project areas: forestry, urban forestry, manure digesters, and the destruction of ozone-depleting substances. ARB recently adopted a compliance offset protocol for the capture and destruction of fugitive mine methane, and is developing a protocol to reduce GHG emissions from rice cultivation. ARB will continue to evaluate additional offset protocols with an emphasis on in-state opportunities.

With just the envisioned six compliance offset protocols, it is clear there will not be enough offsets to meet the 2013–2020 maximum offset demand if every entity chose to use the maximum number of allowable offsets. It should be noted that the Cap-and-Trade Program is designed so that offsets will play a larger role in cost containment in the later years of the program. As ARB continues to work to identify additional compliance offset protocols, there will be challenges, particularly for in-state offset protocols. California has a history of identifying and regulating emissions when it is feasible and cost-effective. Under AB 32, offsets must be additional to any regulatory requirement and beyond business-as-usual. California's focus on regulations limits opportunities for California offsets. This preference for regulatory solutions—which are mandatory under a regulation as opposed to voluntary under an offset protocol—ensures maximum emission reductions. However, it limits opportunities for offsets both in- and out-of State.

The Cap-and-Trade Regulation is being implemented in two stages. Electric generating utilities, electricity importers, and large industrial facilities became subject to the program beginning in 2013, and fuel distributors are brought under the cap in 2015.

The Cap-and-Trade Regulation is different from most of the other measures in the Scoping Plan. The regulation sets a hard cap, instead of an emission limit, so the emission reductions from the program vary as our estimates of "business as usual" emissions in the future are updated. In addition, the Cap-and-Trade Program works in concert with many of the direct regulatory measures—providing an additional economic incentive to reduce emissions. Actions taken to comply with direct regulations reduce an entity's compliance obligation under the Cap-and-Trade Regulation. So, for example, increased deployment of renewable electricity sources reduces a utility's compliance obligation under the Cap-and-Trade Regulation. Finally, the Cap-and-Trade

Regulation provides assurance that California's 2020 limit will be met because the regulation sets a firm limit on 85 percent of California's GHG emissions.

Under the Cap-and-Trade Regulation, a portion of the allowances required for compliance are auctioned by the State. The first auction of emission allowances occurred in November 2012. To date, ARB has held five successful auctions.

The State's portion of the proceeds from these auctions is to be used to fund projects to reduce GHG emissions. A three-year investment plan was submitted to the Legislature in May 2013, identifying the State's GHG emission reduction goals and priority programs for investment of the action proceeds. More discussion of auction proceeds and other investments is included in Chapter V.

Because the Cap-and-Trade Program applies only to California entities, ARB designed the regulation to minimize emissions leakage. ARB continues to conduct ongoing leakage assessment studies that are based on an evaluation of industry emissions and trade exposure.

ARB is considering several amendments to improve the Cap-and-Trade Regulation in 2014. In particular, ARB proposes to provide additional transition assistance in the form of free allowances to industrial producers while the new leakage studies are being conducted. In addition, ARB is proposing mechanisms to keep allowance prices within an acceptable range by allowing a limited number of future allowances to be used for compliance should prices get too high. The continuation of the Cap-and-Trade Program will enhance the effectiveness of the new cost containment mechanism proposal.

California linked its program with the Canadian Province of Québec in January 2014. California and Québec have worked together to harmonize their regulations and coordinate on a joint auction platform and tracking system. ARB provided a report on the status of linkage implementation to the governor and CalEPA in November 2013.

As part of the Cap-and-Trade Regulation, the Board also approved an Adaptive Management Plan[94] to track unintended consequences of the Cap-and-Trade Regulation. The Plan requires ARB to develop systems to track and respond to: (1) potential adverse localized air quality impacts that might be caused by the Cap-and-Trade Regulation, and (2) potential adverse impacts that might be caused by the Compliance Offset Protocol U.S. Forest Projects (Protocol). ARB is working with the local air districts to determine the most effective path forward for gathering and evaluating permit data, GHG data, and other information needed for tracking potential localized impacts. As part of this effort, ARB has amended the Regulation for the Mandatory Reporting of Greenhouse Gas Emissions to collect information on GHG emission increases and decreases from covered entities. ARB has contracted with the University of California, Davis, and is working with forestry experts from around the country to develop an approach to understand potential forest impacts resulting from implementation of the Protocol under Cap-and-Trade.

Maintaining Momentum

The Cap-and-Trade Program will continue to be a vital component in achieving California's longer-term climate change goals. As the cap continues to decline, the Cap-and-Trade Program incentivizes emission reductions associated with the production of energy and goods and encourages consumers to reduce emissions. Sending the market a signal that the Cap-and-Trade Program will continue in the long-term is critical to fully realizing the benefits of the program. Continuing the program and establishing an emission cap beyond 2020 will also reduce the costs of the program as California industry and households make long-term capital and investment decisions. A clear path forward will lead to a lower-carbon California.

94 The 2011 Adaptive Management Plan for the Cap-and-Trade Regulation is available at *www.arb.ca.gov/cc/capandtrade/adaptive_management/plan.pdf*.

As the Cap-and-Trade Program continues to help achieve our long-term climate goals, it will be increasingly important to bolster the offset program. As noted above, there are real challenges to identifying in-state offset protocols, but ARB is committed to pursuing those that are workable. Part of the strategy to ensure sufficient offsets are available is to continue to consider international sector-based offset programs. The Cap-and-Trade Regulation already includes a placeholder for potential international sector-based offsets from programs designed to Reduce Emissions from Deforestation and Forest Degradation (REDD) through a future rulemaking. To that end, the REDD Offset Working Group, an ad hoc technical expert working group, labored for two years to develop technical and policy recommendations that were provided for consideration in final form to ARB, Acre (Brazil), and Chiapas (Mexico) in July 2013.[95]

Carbon capture and sequestration (CCS) is another option to reduce emissions under both the Cap-and-Trade Program and the Low Carbon Fuel Standard (LCFS). Successful development and deployment of CCS in California would provide in-State GHG emission reductions, lower an entity's compliance obligation under Cap-and-Trade, and potentially lower an entity's carbon intensity under LCFS.

B. Progress to Date

The initial Scoping Plan laid out an ambitious plan for reducing GHG emissions from a combination of direct regulatory measures, incentives, and market-based approaches. The Cap-and-Trade Program establishes an overall limit on GHG emissions from most of the California economy—the "capped sectors." Within the capped sectors, some of the reductionvvs are being accomplished through direct regulations, such as improved building and appliance efficiency standards, the LCFS, and the 33 percent RPS. Whatever additional reductions are needed to bring emissions within the cap is accomplished through price incentives posed by emissions allowance prices. Together, direct regulation and price incentives assure that emissions are brought down cost-effectively to the level of the overall cap. Reductions in the remainder of the economy—the "uncapped sector"—are being accomplished through specific measures, such as those for high-GWP gases and fugitive emissions from industrial sources.

Over the last five years, ARB has worked with other State and local agencies to implement the climate change programs outlined in the Scoping Plan and to ensure their smooth implementation. The State's progress on measures included in the Scoping Plan and other complementary activities have put California on the path to achieve the statewide GHG emissions limit of 1990 levels by 2020, and to achieve the maximum technologically feasible and cost-effective reductions over the long-term. Today, many of the State's GHG emission reduction measures and initiatives set forth in the initial Plan have been adopted and are in the early stages of implementation. Full implementation of all adopted measures by 2020 will not only allow us to reach our near term GHG goals but will also provide numerous additional public health and environmental benefits.

We measure progress toward the 2020 statewide limit in two ways:

- **Evaluating the expected emission reductions from ongoing regulations and programs:** ARB and other State agencies are implementing numerous programs to reduce GHG emissions. The California Greenhouse Gas Report Card is an annual report that summarizes state agency activity to reduce greenhouse gases.[96] To assess whether California will meet the 2020 limit, it is necessary to estimate the expected emission reductions from these measures in 2020 based on the regulatory requirements.

95 REDD Offset Working Group. 2013. California, Acre and Chiapas – Partnering to Reduce Emissions from Tropical Deforestation: Recommendations to Conserve Tropical Rainforests, Protect Local Communities and Reduce State-Wide Greenhouse Gas Emissions. Available at *http://greentechleadership.org/documents/2013/07/row-final-recommendations-2.pdf*.

96 The State Agency Greenhouse Gas Reduction Report Card is available at : *www.climatechange.ca.gov/climate_action_team/reports/2013_CalEPA_Report_Card.pdf*.

- **Evaluating emission trends:** Each year, ARB updates the statewide GHG emission inventory. This information provides a retrospective look at emissions and is based on actual data, either reported directly to ARB or to other regulatory agencies. The emission inventory is useful for evaluating progress in sectors that are affected by many different programs. For example, the electricity sector is affected by the Renewable Energy Standard, energy efficiency programs implemented by utilities, appliance efficiency standards, building codes, and numerous other programs. One way to assess progress in this sector is to retrospectively examine whether actual emission trends are consistent with our expectations.

ARB used both of these methods to evaluate progress toward the 2020 statewide limit in this Update. As the Scoping Plan is in the early stages of implementation, this evaluation will be ongoing.

1. Key Accomplishments

California has undertaken a number of notable groundbreaking climate change initiatives. These include the first in the nation economy-wide Cap-and-Trade Program, the Low Carbon Fuel Standard, a 33 percent Renewable Portfolio Standard, and an Advanced Clean Cars program that has been adopted at the federal level. ARB has also worked closely with our local and regional partners to implement the Sustainable Communities and Climate Protection Act of 2008 (Senate Bill 375). Strategies developed under this program integrate land use, housing, and transportation planning to reduce regional passenger vehicle GHG emissions.

In addition to these efforts, additional actions include Building and Appliance Energy Efficiency Standards, the California Solar Initiative (i.e., Solar Hot Water Heaters and Million Solar Roofs), Water Efficiency, Mandatory Commercial Recycling, and High-Speed Rail.

2. GHG Emissions Trends

In 2006, Assembly Bill 1803 mandated that ARB prepare, maintain, and update California's statewide GHG emission inventory. The GHG emission inventory serves as the foundation for tracking the State's emission trends and progress toward California's GHG emission reduction goals. The GHG inventory provides estimates of the amount of GHGs emitted to the atmosphere by human activities within California. The inventory includes estimates for carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs), which are often referred to as the "six Kyoto gases," plus nitrogen trifluoride (NF_3). The emission estimates of the seven gases are typically expressed in terms of million tonnes of carbon dioxide equivalents ($MMTCO_2e$). The emissions of the non-carbon dioxide gases are converted in CO_2e units based on their global warming potential relative to that of carbon dioxide.

The California statewide GHG emission inventory is structured and aligned with the Guidelines for National Greenhouse Gas Inventories developed by the IPCC (2006). Emission estimates rely primarily on state, regional, or national data sources. The inventory also incorporates methodology and data from the Inventory of U.S. Greenhouse Gas Emissions and Sinks, published by the U.S. EPA.[97] Starting in 2008, facility-level data from ARB's Mandatory GHG Reporting Program have been used to compile statewide emissions from electricity generation facilities, refineries, cement plants, and lime and nitric acid production facilities.

ARB regularly publishes updated versions of California statewide GHG emission inventory on its Greenhouse Gas Emission Inventory website.[98] A technical support document detailing the data sources and methods used to develop the inventory is also available for download from the same website. The current inventory compiles statewide anthropogenic GHG emissions from 2000 through 2012, using consistent sets of data and methods to allow for the detection of trends over time (Figures 8a and 8b). ARB updated the GHG emission inventory in this Update to be based on GWPs in the IPCC's Fourth Assessment Report.

97 *www.epa.gov/climatechange/ghgemissions/usinventoryreport.html*)
98 *www.arb.ca.gov/cc/inventory/inventory.htm*.

Figure 8a: California Total and Per Capita GHG Emissions (2000-2012)

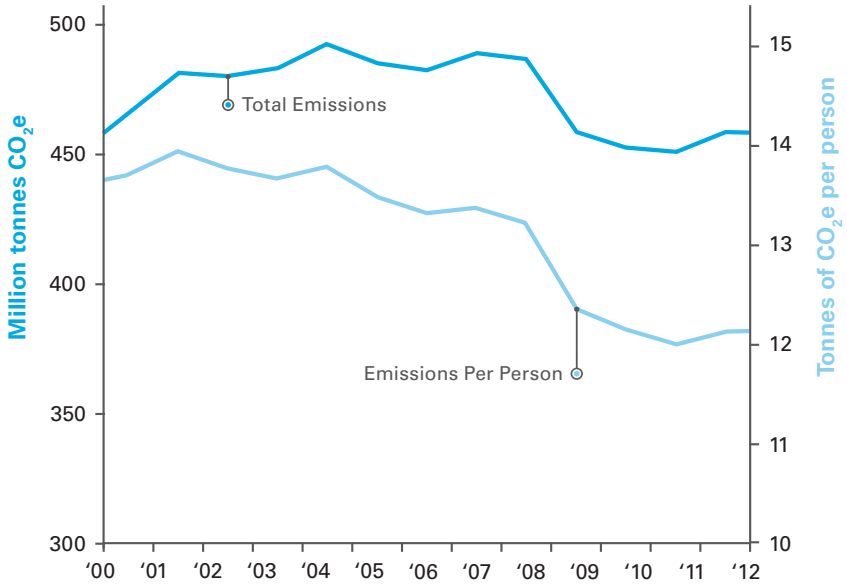
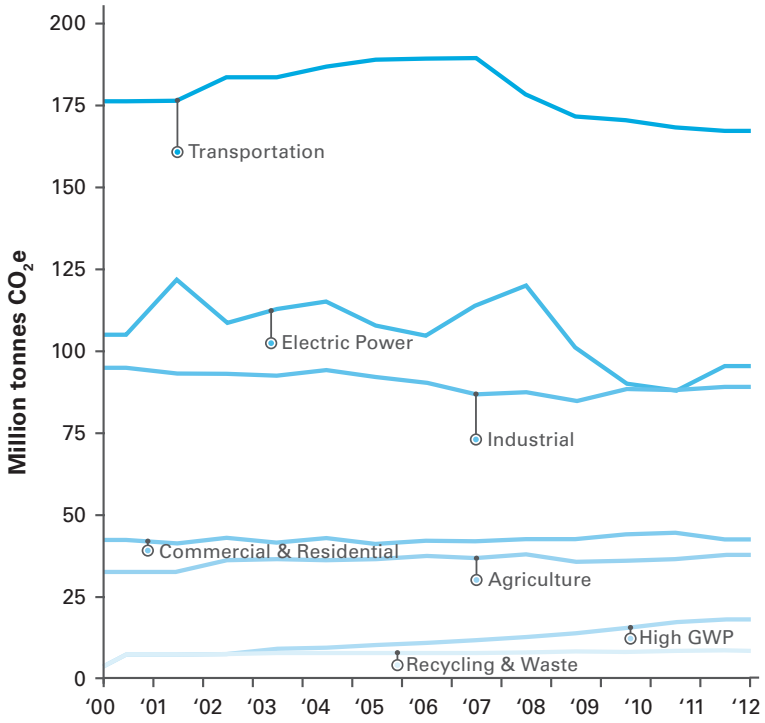


Figure 8b: California Sectoral GHG Emissions (2000-2012)



Over the last decade, the total statewide GHG emissions decreased from 466 $MMTCO_2e$ in 2000 to 459 $MMTCO_2e$ in 2012—a decrease of 1.7 percent. The emissions in 2012 increased for the first time in the five-year period since 2007. This increase was driven largely by the increased natural gas-generation of in-state electricity due to the closure of the San Onofre Nuclear Generating Station (SONGS) as well as dry hydrological conditions in 2012 (drought) causing a drop in the in-state hydropower generation. California's population grew by 11.3 percent between 2000 and 2012. As a result, California's per capita GHG emissions have decreased by 11.6 percent. The recent recession had a major impact on GHG emissions between 2008 and 2009, when emissions

decreased by almost six percent. Other changes reflect ongoing early implementation of Scoping Plan measures, energy efficiency actions, renewable power requirements, and hydrology (rain and snow fall). In 2012, emissions from the transportation sector continued to decrease while emissions from the electric power sector increased from the previous year. Emissions from all other sectors remained relatively constant since 2000.

A summary of the trends in emissions observed for each of the major sectors of the statewide GHG inventory is provided below.

Transportation Sector: The transportation sector remained the largest source of GHG emissions in 2012, constituting more than 36 percent of California's GHG emission inventory. Emissions decreased by five percent between 2000 and 2012. Emissions from on-road vehicles constituted over 92 percent of the transportation sector. These emissions have declined each year since 2007, with the greatest decrease occurring at the time of the recession. In the summer of 2008, fuel prices reached a historic maximum, followed by a dramatic decrease in the consumption of gasoline and diesel fuel. Total transportation fuel consumption declined in 2008, and even with modest increases in 2009 and 2010, on-road emissions continued to decrease, remaining below pre-recession levels as the economy improved.

Electric Power: Greenhouse gas emissions from electricity generation have decreased by 9 percent from 2000 to 2012, in spite of the shutdown of the San Onofre Nuclear Generating Station (SONGS) and low hydro-power generation due to the drought, both of which caused an increase in emissions for 2012. California produces almost 70 percent of its electricity within the State and imports the rest. Emissions from in-state electricity generation decreased by more than 13 percent between 2000 and 2012. During that period, electricity consumption grew from 265.8 terawatt-hours (TWh) in 2000 to 282.1 TWh in 2012, with a peak of 288.0 TWh in 2008.

Over the last twelve years, on average, hydropower provided 13 percent of California's electric power generation. The amount of hydropower produced is dependent on rainfall and was highest in the two wettest years, 2006 and 2011. Hydropower production, as well as other non-emitting sources of energy, affects the GHG intensity of electricity generation (the amount of CO_2e emitted per megawatt-hour [MWh] generated). The GHG intensity of California electricity peaked in 2001 and reached a low point in 2011, a particularly wet year. Both the GHG intensity of in-state generation and that of electricity imports have been reduced since 2008, with in-state intensity showing a slight increase in 2012 due to the double impacts of the SONGS shutdown and the low hydro-power output caused by the drought.

Industrial Sector: Industrial emission sources include refineries, oil and gas extraction, cement plants, and other stationary sources that consume fuel. Emissions from the industrial sector have declined overall, decreasing by six percent between 2000 and 2012. Associated with the recession, a decline of three percent was observed in 2009. However, emissions grew by four percent from 2009 to 2010. Emissions from cement plants, made up of fuel combustion and clinker process emissions, peaked in 2005, with a decrease beginning in 2006 and continuing through 2010. Between 2005 and 2010, cement plant emissions declined 44 percent, reflecting a large decrease in demand due to the crisis in housing and construction, as well as the closure of three cement plants in the State over the period. Cement production has begun to recover, showing a 24 percent increase in emissions in 2012 from its 2010 low.

Commercial and Residential Sectors: Emissions from the commercial and residential sectors are driven by the combustion of natural gas and other fuels for household use and heating and for providing energy for commercial businesses. Emissions remain flat over the past twelve years between 2000 and 2012.

Emissions from residential fuel combustion showed a decline of five percent over the last twelve years, with its lowest point of 28.1 million tonnes occurring in 2012. At the same time, the number of housing units grew steadily, from 12.2 million units in 2000 to slightly over

13.7 million in 2012, resulting in a sharp decline in the fuel consumption per housing unit. The commercial sector emissions increased 16 percent between 2000 and 2012, but at the same time commercial use of floor space has increased slightly faster, resulting in slightly reduced emissions per unit of floor space.

Agricultural Sector: Agricultural emissions represent the sum of emissions from agricultural machinery fuel use, residue burning, soil management and fertilization, enteric fermentation, manure management, and rice cultivation. Emissions (primarily methane emissions from livestock) increased by 16 percent between 2000 and 2012. Agricultural fuel use was the only category that saw a GHG emissions decrease from 2000 to 2012, decreasing by three percent over that period. On the other hand, emissions from manure management increased 29 percent during the same period, reflecting the growth of the number of animals in agriculture in California.

High-GWP Gases: High Global Warming Potential (high-GWP) gases included in the inventory consist primarily of substitutes for ozone-depleting substances. Emissions from this sector increased by 129 percent between 2000 and 2012. This growth is driven by the increasing substitution of these gases to replace ODS gases in refrigeration, air conditioning, aerosols, and other applications over the last decade.

Recycling and Waste: Emissions from the recycling and waste sector consist of methane and nitrous oxide emissions from landfills and from commercial-scale composting, which increased by 16 percent between 2000 and 2012.[99] Emissions from landfills constitute about 94 percent of the total emissions of this sector. In 2000, 37 million tons of solid waste was deposited in California's landfills; deposits grew to 42 million tons by 2005, followed by a steady decline to 29 million in 2012. The decrease in annual landfill deposits has not yet resulted in a landfill emissions trend decline however, since the total waste-in-place not yet decomposed that has accumulated from the landfills' opening continues to drive the increasing amount of landfill gas generated.

3. Emission Reductions to Meet the 2020 Statewide Limit

Assembly Bill 32 required ARB to determine California's 1990 statewide GHG emissions level, which would become California's near-term statewide emissions limit to be achieved by 2020. ARB developed a California statewide GHG emission inventory for years 1990–2004 to support the effort of determining the 1990 level and 2020 emissions limit. In December 2007, the Board approved a total statewide GHG 1990 emissions level and 2020 emissions limit of 427 $MMTCO_2e$, based on the IPCC's Second Assessment Report. As discussed in Chapter II, most national and international climate change organizations are moving to the IPCC's Fourth Assessment Report, which updated the global warming potential of GHGs, especially methane and HFCs. ARB is proposing to update the number for the 2020 limit, weighting the 1990 emissions with 100-year GWPs from the IPCC's Fourth Assessment Report. The new 2020 statewide limit is 431 $MMTCO_2e$—an approximately one percent increase from the 427 $MMTCO_2e$ limit adopted by the Board in 2007. In addition, to assess progress toward the limit in a consistent manner, ARB is using GWPs from the Fourth Assessment Report to update projections of the emission reductions that adopted and anticipated Scoping Plan measures will achieve.

ARB maintains the statewide GHG emission inventory to track California's progress toward the 2020 statewide emissions limit. To determine the amount of GHG emission reductions needed to reduce to 1990 emissions, ARB developed a forecast of 2020 emissions in a business-as-usual scenario (2020 BAU),[100] which is an estimate of the emissions expected to occur in the year 2020 if none of the foreseeable measures included in the Scoping Plan[101] were implemented. ARB

99 See the Recycling and Waste sector discussion earlier in this chapter for a discussion of additional GHG emission reductions associated with upstream activities.

100 *www.arb.ca.gov/cc/inventory/data/forecast.htm*.

101 *www.arb.ca.gov/cc/inventory/data/tables/reductions_from_scoping_plan_measures_2010-10-28.pdf*.

subtracts the estimated reductions from adopted and anticipated measures in 2020 to determine whether the 2020 limit is within reach (Table 5). The Cap-and-Trade Regulation provides a firm cap, ensuring that the 2020 statewide emission limit will not be exceeded. Thus, the estimated emission reductions attributed to the Cap-and-Trade Program depend on the emissions forecast. For example, if the emissions forecast increases, the reductions associated with the Cap-and-Trade Program will increase.

Table 5: Meeting the 2020 Emissions Target

Category	2020 ($MMTCO_2e$)**
AB 32 Baseline 2020 Forecast Emissions (2020 BAU)	509
Expected Reductions from Sector-Based Measures	
Energy	25
Transportation	23
High-GWP	5
Waste	2
Cap-and-Trade Reductions	23*
2020 Limit	431

* Cap-and-Trade emission reductions depend on the emission forecast.
** Based on AR4 GWP values.

C. Next Steps

Since the initial Scoping Plan was released, California has put in place a number of measures that have already led to significant emission reductions, and a transformation to a strong, stable low-carbon economy in California is under way. It is critical that California continues to develop and implement a successful climate policy. Planning must begin now to transition the State toward meeting our longer-term GHG emission reduction goals. Table 6 summarizes the recommended actions the State should take in each of the sectors discussed earlier in this chapter to meet our climate change goals.

Table 6: Summary of Recommended Actions by Sector

All Sectors		
Set mid-term targets to meet a State mid-term GHG emission reduction goal when defined.		
Energy Actions	**Lead Agency**	**Expected Completion Date**
Develop a comprehensive and enforceable GHG emission reduction program for the State's electric and energy utilities.	ARB CEC CPUC CAISO	2016
Develop criteria and rules for flexible demand response resources to participate in wholesale markets and integrate variable renewable resources.	CPUC CAISO	TBD
Expand participation of regional balancing authorities in CAISO Energy Imbalance Market and other methods of balancing authority cooperation.	CAISO	Ongoing
Through AB 758 process, develop a plan to encourage energy assessments and energy use disclosure requirements.	CEC	2016
Enhance energy efficiency and demand-response programs, and develop robust methodologies to monitor and evaluate the effectiveness of these programs.	CEC CPUC CAISO	Methodologies by 2015/ Enhanced program proceedings by 2016
Develop ministerial, low-cost interconnection process for distributed generation.	CPUC CEC CAISO	2015
Assess existing barriers to expanding the installation of CHP systems and propose solutions that help achieve climate goals. A future CHP measure could establish requirements for new or upgraded efficient CHP systems.	ARB CEC CPUC CAISO	2016
Continue development of statewide programs that could require new residential and commercial construction to meet ZNE standards.	ARB CPUC CEC	TBD
Develop cost-effective, on-site reductions for large industrial facilities, consistent with the audit findings under the Energy Efficiency and Co-Benefits Audits for Large Industrial Sources Measure.	ARB	TBD
Develop measures to control fugitive methane and carbon dioxide emissions from oil and gas production, processing, and storage tanks.	ARB	2014
Develop measures to reduce fugitive emissions from natural gas transmission and distribution pipelines and associated facilities (e.g., compressor stations).	ARB CPUC	TBD in the SLCP Plan
Work with the local air districts to evaluate amendments to their existing leak detection and repair rules for industrial facilities to include methane leaks.	ARB	Ongoing
Evaluate the potential for CCS in California to reduce emissions of CO_2 from energy and industrial sources. Working with Division of Oil, Gas and Geothermal Resources, CEC and CPUC, ARB will consider a CCS quantification methodology for use in California	ARB	2017

Transportation Actions	Lead Agency	Expected Completion Date
Propose "Phase 2" heavy-duty truck GHG standard standards.	ARB	2016
Expand upon 2013 ZEV Action plan for medium- and heavy-duty ZEVs.	OPR	2017
Enhance and strengthen the LCFS with more aggressive long-term targets.	ARB	2014
Adopt the necessary regulations and/or policies to further support commercial markets for low-carbon transportation fuels.	ARB CPUC CEC CDFA	2018
Evaluate updating the SB 375 regional targets established in 2010.	ARB	2014
Ensure GHG emission reductions from approved SCS are achieved or exceeded through coordinated planning.	ARB Caltrans SGC HCD Local & Regional	Ongoing
Construct HSR system • Complete all station-area planning. • Complete Caltrain component of HSR. • Complete initial operating segment of HSR. • Run HSR from San Francisco to Los Angeles.	High-Speed Rail Authority	2017 2019 2022 2029
Complete the first phase of the Sustainable Freight Strategy, which will identify and prioritize actions through 2020 to move California towards a sustainable freight system.	ARB	2014
Provide expanded markets for clean passenger transportation, advanced technology trucks and equipment, low-carbon transportation fuels and energy, and related infrastructure.	ARB CEC CPUC CDFA	TBD
Consider lifecycle benefits and impacts for transportation infrastructure projects	Caltrans	TBD
Increase Caltrans and regional transportation agencies' investments in expanded transit and rail services, active transportation, and other VMT reduction strategies in regional transportation plans.	Caltrans & Regional Transportation Agencies	TBD
Support Sustainable Communities Strategies to provide more efficient consumer choices.	SGC	Ongoing
Incorporate into ongoing GHG planning efforts strategies that help achieve significant NO_x reductions by 2032 to meet the national ambient air quality standards for ozone. The 2016 SIPs will outline attainment strategies through 2032.	ARB Caltrans	2016

Agriculture Actions	Lead Agency	Expected Completion Date
Convene an interagency workgroup whose purpose is to: (1) establish agriculture-sector GHG reduction planning targets for the mid-term time frame and 2050; (2) develop a California-specific agricultural GHG tool to estimate GHG emissions and sequestration potential from all on-farm sources; (3) strategies to reduce GHG emissions associated with energy in agricultural water use.	CDFA ARB CEC CPUC	2014
Develop a methane capture standard.	Dairy Digester Workgroup	2016
Evaluate data reported to Long Term Irrigated Lands Programs, to determine if the reported fertilizer data are adequate to establish a robust statewide GHG N_2O inventory for fertilizer used in agriculture.	RWQCB	2017
Develop recommendations for a coordinated local land use program.	OPR CNRA CalEPA CDFA ARB	2015
Implement actions in Bioenergy Action Plan to promote the input of digester biogas into natural gas pipelines and bioenergy onto the electric grid, evaluate the potential biomass energy generation capacity, and develop methods to quantify biomass life-cycle GHG flux.	Bioenergy Interagency Working Group	Ongoing
Water Actions	**Lead Agency**	**Expected Completion Date**
Give priority to funding integrated management plans that include robust existing or proposed water and energy conservation and efficiency, and measures that achieve GHG emission reductions. Conservation programs must include numeric targets.	DWR SWRCB	2014
Implement new water-related energy conservation measures and efficiency standards	CEC	2015
Complete water-energy nexus rulemaking and continue implementation of joint water-energy utility efficiency programs and partnerships.	CPUC	2016
Incent resource-recovering wastewater treatment projects.	SWRCB CPUC	2015
Implement green infrastructure permits to treat and capture urban runoff for local use.	SWRCB RWQCB	2016
Guide adoption of GHG emission-reducing policies for water sector investments and action. Conservation measures and regulations to reduce GHG emissions and maintain water supply reliability during drought periods will be a centerpiece of this administration action.	DWR SWRCB CPUC CDFA ARB	2015
Identify and incent implementation of rate structures that accurately reflect the economic, social, and environmental value of water in California while maintaining affordability for basic services.	DWR SWRCB CPUC CDFA	TBD
Develop a comprehensive groundwater management strategy and provide technical and financial assistance to exceed SBx7-7 targets.	SWRCB DWR CDFA	TBD
Modify State and regional water board policies and permits to achieve conservation, water recycling, stormwater reuse, and wastewater-to-energy goals.	SWRCB RWQCB	2016
Promote water-energy conservation outreach and education.	DWR SWRCB CPUC CEC CAISO	TBD

Waste Management Actions	Lead Agency	Expected Completion Date
Eliminate the disposal of organic materials at landfills.	CalRecycle ARB	2016
Implement financing or incentive mechanisms for in-State infrastructure development to support Waste Sector goals.	CalRecycle ARB	TBD
Develop actions to address cross-California agency and federal permitting and siting challenges associated with composting and anaerobic digestion.	ARB	2014
Identify opportunities for additional methane control at new and existing landfills, and use of captured methane as a fuel source for stationary and mobile applications.	ARB	TBD in the SLCP Plan
Develop new emission reduction factors to estimate GHG emission reduction potential for various recycling and remanufacturing strategies.	ARB CalRecycle	TBD
Identify improvements to the procurement of recycled-content materials through the State Agency Buy Recycled Campaign reform.	CalRecycle DGS	2014
Natural and Working Lands Actions	**Lead Agency**	**Expected Completion Date**
Convene an inter-agency forest climate workgroup to prepare and publish a "Forest Carbon Plan."	CNRA CalEPA	2016
Evaluate methods to develop a life cycle analysis to track carbon in wood products.	CAL FIRE BOF	2016
Implement actions in Bioenergy Action Plans related to use of forest biomass, evaluate the potential biomass energy generation capacity, and develop methods to quantify biomass life-cycle GHG flux.	Bioenergy Interagency Working Group	Ongoing
Develop recommendations for a coordinated local land use program.	OPR CNRA CalEPA CDFA CDFW CAL FIRE ARB	2015
Convene an interagency workgroup to draft a report outlining funding needs, opportunities, and priorities for Natural and Working Lands.	CNRA CalEPA CDFA CDFW CAL FIRE ARB	2015
Expand urban forestry and green infrastructure programs and investments, particularly in California's environmental justice communities.	CAL FIRE	Ongoing

Short-Lived Climate Pollutants Actions	Lead Agency	Expected Completion Date
Develop a comprehensive strategy for mitigation of short-lived climate pollutants, including methane.	ARB	2015
Continue diesel controls that will reduce black carbon emissions by 95 percent from the late 1960s to 2020.	ARB	2020
Reduce emissions of smog-forming pollutants by about 90 percent below 2010 levels by 2032 to meet the National Ambient Air Quality Standard for ozone.	ARB	2032
Create an agreement with U.S. EPA to establish national standards for the proposed F-gas phasedown of HFC production.	ARB	2030
Require low-GWP gases where feasible and cost-effective.	ARB	TBD in the SLCP Plan
Incentivize recovery and destruction of ODS at end of life by a combination of strategies.	ARB	TBD in the SLCP Plan
Set an upstream mitigation fee on sales of high-GWP gases and sales or import of equipment pre-charged with high-GWP gases.	ARB	TBD in the SLCP Plan
Green Building Actions	**Lead Agency**	**Expected Completion Date**
Build on California's existing zero net energy building goals and activities.	CEC CPUC	2015
Continue research activities to better quantify GHG emission reduction potential of certified green buildings.	ARB	2016
Strengthen the next two triennial editions of the Green Building Standards Code with mandatory provisions that reduce GHG emissions.	CBSC	2016 & 2019
Building on AB 758 Action Plan implementation activities, explore opportunities to implement a portfolio of green building retrofit requirements at time-of-sale or other trigger mechanism.	CEC	2017
Explore methodologies to quantify direct and indirect GHG emissions from new and existing buildings.	TBD	2017
Establish target dates and pathways toward transitioning to zero net carbon buildings that expand upon and complement ZNE goals.	ARB CPUC CEC	2017
Implement a mechanism to track progress toward achieving statewide green building goals.	ARB CPUC CEC	2018
Cap-and-Trade Actions	**Lead Agency**	**Expected Completion Date**
Develop a plan for a post-2020 Cap-and-Trade Program, including cost containment, to provide market certainty and address a mid-term emissions target.	ARB	2017

Evaluation Actions	Lead Agency	Expected Completion Date
Develop a plan for an Ex Post Assessment of Realized Cost and Benefits of AB 32.	ARB	2014
Assess the effects of AB 32 programs on disadvantaged communities	ARB	2014 (Phase I)
Develop guidance for agencies administering Cap-and-Trade auction proceeds, including actions to fulfill the requirements for investments to benefit disadvantaged communities.	ARB	2015
Report annually to the Legislature on auction proceeds investment results and benefits to disadvantaged communities.	ARB DOF	Ongoing
Update the three-year Cap-and-Trade Auction Proceeds Investment Plan, identifying funding gaps and new investments needed for GHG emission reductions and other environmental and public health benefits.	ARB	2016

V. Achieving Success

Climate change presents an unprecedented set of challenges for California that cuts across sectors and policy areas. These emerging challenges are increasingly unifying policy planning across government agencies and jurisdictions, allowing us to do more with less – achieving multiple goals more quickly and effectively than if we address separate priorities in isolation.

Successfully delivering on California's climate policies and realizing the full benefits of California's leading approach to climate change requires careful policy planning and implementation, diligent monitoring, and evaluation of policies (Chapter VI). We are integrating climate thinking and sustainability programming into the range of actions we take to grow the economy, protect the environment, and plan for the future. Increasingly, we must coordinate planning to ensure that the way we design and grow our communities for the future allows us to meet all of our goals – including those related to economic growth, equity, climate change and resiliency, air quality, water quality and reliability, mobility, public health, and others. Of course, achieving success requires targeted investment and market support, to launch commercial markets for the cleanest technologies and build the infrastructure we need to support continued economic growth in California that is increasingly free of pollution and consequence for disadvantaged communities or future generations. And it requires active outreach to share our successful approach and expand global action to address climate change.

With strategic investment and coordinated policy-making, California can slash emissions from trucks and trains while at the same time building a world-class goods movement and freight-delivery system. We can modernize our rail and passenger transportation systems to move people in ways that both reduce greenhouse gases and increase mobility options and safety. We can take actions to cut emissions of potent short-lived climate pollutants that will also deliver key public health benefits. And we can align strategies that both support reduction goals and bolster our ability to deal with the impacts of climate change already underway.

The imperative of climate change can push action to advance priorities that affect every aspect of our built and natural environments, and quality of life. Effectively implementing California's climate plan will not just chart the path in the fight against climate change, but also to cleaner air, better health, and lasting, equitable growth.

A. Integrate and Coordinate Planning

California faces many critical, and equally important, planning objectives. In order to most effectively meet each of them, minimize costs, and maximize and accelerate benefits, the State is focused on integrating planning objectives and ensuring that limited investments advanced as many objectives as possible. The strategies we pursue to cut greenhouse gas emissions from our cars, trucks, buses, trains and industries can support ongoing efforts to improve air quality up and down the state, especially in our most heavily impacted communities. Efficiency and conservation programs in the water sector needed to cut emissions will also drive critically

needed efforts to enhance supply and reliability priorities. We can cut emissions from our waste stream while also increasing home-grown sources of low-carbon energy and fuels. And we can manage our natural lands and valuable agricultural resources in ways that both achieve climate goals and enhance their long-term sustainability.

The nexus between air quality and climate is a key example. The South Coast and San Joaquin Valley Air Quality Management Districts, together home to more than half of the State's population, must reduce emissions of smog-forming pollutants by about 90 percent below 2010 levels by 2032 to meet the National Ambient Air Quality Standards. Many of the technologies and strategies to reduce smog-forming pollution or GHG emissions are the same. Advancing progress on climate change should advance progress on air quality, and vice versa. By effectively integrating our planning to do so, as California has done through its Vision modeling exercise and Sustainable Freight Plan (among other activities), we can accelerate progress to meet both air quality and climate change objectives.

Amid dire drought, the availability, reliability, and quality of water are taking center stage. Water efficiency, conservation, and storage are connected to energy efficiency and supply, food supply, land use and housing, and economic growth of our agricultural and other sectors. The phase-out of once-through cooling in the State's power plants links energy supply with water availability, quality, and habitat. As we respond to the drought, develop an increasingly clean and reliable energy supply system, and build upon California's climate framework, we must ensure that our efforts in one area recognize and reinforce the objectives in the others. To that end, DWR has developed a Climate Action Plan. The State Water Board is developing a Guidance Document on Climate Change. Together with other efforts being led through the Climate Action Team and those identified in this Update, California is increasingly focused on integrating objectives for climate and water policy planning.

Increasingly, technologies and planning objectives are converging across sectors. Electrification in the transportation and building sectors must coincide with decarbonization of electricity supply. New electricity loads from these sectors, as well as increasing levels of renewable generation, will change the operational requirements of the electricity grid, which in turn affects emissions and operations for electric transportation. Changes in the energy sector will affect the water and agricultural sectors due to the significant amount of energy used to move water throughout the State and the important role and evolving role of hydropower in the electricity system. Green and net zero energy buildings create new accounting requirements and interactions between utilities and customers and buildings and the electricity grid. The growing role of bioenergy for transportation fuels, heat production, and electricity generation will impact the agricultural, natural lands, water, and waste management sectors. All of this will have direct or indirect effects on land use that will require integrated planning and a closely coordinated effort with locally driven GHG emission reduction initiatives. State agencies are addressing each of these cross-cutting issues and others through standing, interagency working groups that all keep climate change as an overarching or integral theme.

Integrating planning to achieve multiple objectives inherently requires coordination among planning agencies across sectors, systems, and governmental jurisdictions. Already, climate change is serving as a unifying objective that is bringing unprecedented levels of collaboration among government agencies. California state agencies meet routinely and work very collaboratively as part of the Climate Action Team or other climate-related working groups. ARB is working with Caltrans, the South Coast Air Quality Management District, and many other agencies and stakeholders to develop the Sustainable Freight Strategy. SB 375 has created new relationships and coordinated planning between state and local planning agencies. The Desert Renewable Energy Conservation Plan is a unique collaboration among state and federal agencies. And this Scoping Plan Update is key example of the level of coordination happening among California State agencies to address climate change.

State Plans that Will Assist the State in Meeting Its GHG Goals

- California Climate Adaptation Strategy
- Safeguarding California Plan (Update to 2009 Adaptation Strategy)
- California's Clean Energy Future
- ARB's Vision for Clean Air
- California Agricultural Vision
- DWR Climate Action Plan
- CEC Integrated Energy Policy Report
- California Transportation Plan
- Strategic Fire Plan for California
- Water Action Plan
- Environmental Goals and Policies Report
- Zero Emission Vehicle (ZEV) Action Plan
- Caltrans Interregional Blueprint
- Climate Research Plan
- Vision California
- State Implementation Plan
- CDFW Vision for Confronting Climate Change in California
- Extreme Heat Adaptation Guidance Document
- AB 341 75% Plan (in development)

California's state agencies are collaborating to achieve the State's climate change goals and broader environmental protection goals, in concert with achieving their own individual agency's goals. It will be necessary to maintain and strengthen this collaborative effort, and to draw upon the assistance of regional and local governments and private institutions, to achieve the State's near-term and longer-term emission reduction goals and improve its ability to adapt to potential climate change impacts.

The Governor's Office provides leadership to set priorities and to ensure a coordinated effort is taken among the numerous State agencies and departments in pursuing GHG emission reductions. To this end, Governor Brown has overseen the development of the Zero Emission Vehicle Plan and Bioenergy Action Plan, and has set distributed generation and combined heat and power goals for the State in his California Clean Jobs plan. The Governor's Office of Planning and Research (OPR) has hosted several stakeholder conferences and participated in research efforts on issues including climate change adaptation risks and strategies, zero emission vehicles and infrastructure planning, strategies to increase renewable and distributed energy integration, GHG emission assessments in CEQA, and streamlining criteria. OPR is also providing outreach and technical assistance to regional and local government transportation and land use planning agencies.

Climate change, like many issues, crosses economic sectors, policy areas, and governmental jurisdictions. Recognizing this, the State has established interagency workgroups to provide coordinated policies and strategies in various key areas where GHG emission reductions are needed to meet California's 2020 limit. For example, the Water-Energy Team of the Climate Action Team (WET-CAT), consisting of over two dozen State agency and academia representatives, is tasked with coordinating efforts on both GHG emission reductions and adaptation actions affecting the portion of the energy sector that supports the storage, transport, and delivery of water in California while ensuring that the State continues to maintain water quality and adequate water supplies. Part of the WET-CAT effort has been to provide recommendations to pertinent agencies on water and energy policies and actions.

This Update is California's plan for future actions to reduce climate-changing emissions. Other State agencies have already developed plans and actions specific to their priorities that will assist California in fulfilling the vision set forth in the Scoping Plan and this Update, and are expected to continue to do so. Some plans are interagency plans, developed in coordination with

numerous State agencies' policies and priorities. Future State agency planning tools must incorporate mechanisms to help the state meet California's GHG emission reduction goals.

Action plans have been developed in concert with adaptation planning and climate research. State environmental goals and objectives should be integrated and framed to align State agency decision-making toward attaining these goals, as proposed in the Governor's Environmental Goals and Policies Report.

B. Transportation, Land Use, and Housing Planning Development

One of the most critical, cross-cutting issues for addressing climate change and other integrated policy priorities is land use and development.

Over the past 60 years, growth in automobile ownership, development of the highway system, and the rise of suburban neighborhoods has dominated the landscape in much of California and the United States. This development pattern has created a dispersed network of cities and towns, which can be difficult to serve efficiently with transportation and other necessary public services. In the same way that past policies have shaped today's built environment, actions taken today will establish the foundation for a more sustainable future.

For the first time, State law (SB 375) requires an integrated approach to planning our transportation system and land use. Metropolitan planning organizations and local governments are collaborating to evaluate alternative future scenarios that could make land use development patterns and supportive transportation systems more sustainable. Regional planning agencies that are responsible for forecasting growth and preparing transportation plans to accommodate that growth are already responding to significant demographic and market shifts that call for changes in the way we plan our housing and transportation

SUCCESS STORY

Local Governments in Action

In 2013, the City of Palo Alto switched to 100 percent renewable energy. To support this, the city authorized solar power purchases totaling 182,500 MWh of solar a year—enough to power the city's 65,000 residents and more.

The City of Tulare in central San Joaquin Valley has implemented extensive building retrofit and residential solar programs, created a 100 percent green-powered wastewater treatment facility by installing a 900 kilowatt (kW) fuel cell system, one MW of solar power, and much more. Through these improvements, Tulare is expected to save more than $13.9 million in energy costs and avoided capital and operation costs.

In 2010, the Metropolitan Transportation Commission awarded $33 million in grants to promote: innovative, breakthrough techniques to reduce GHG emissions; purchase electric vehicles for public agencies and tribes, and to electrify City CarShare; bringing shore power to the Port of Oakland; implementation of bike-detecting traffic signals; and more.

In December 2012, the City of Glendale launched the use of "smart meters" for all 120,000 residents, which will result in considerable electricity savings over the next 15 years through energy efficiency, increased options for time-of-use electricity rates, and real-time user consumption data to encourage conservation.

Sonoma County's Energy Independence Program (SCEIP) is an innovative voluntary financing program that uses the property tax system to fund permanent energy efficiency, water-efficiency, and renewable-energy improvements. Since 2009, SCEIP provided $64 million in funding to more than 1,900 property owners in the county.

infrastructure. Recently adopted regional sustainable community strategies (SCS) are designed to respond to shifts in the way future generations of Californians will live, work, recreate, and travel. As residential development constitutes the largest share of urbanized and land uses, changes in housing development are particularly critical to influencing travel patterns, energy use, and emissions. Location-efficient, affordable transit-oriented development (TOD), for example, has been estimated to yield VMT reductions of 20 to 40 percent over households in non-TOD locations. In large urban regions of California, the demand for more livable cities with smaller dwelling units located close to activity centers and more transportation options are creating momentum for more sustainable community development. As transit ridership is highest among lower-income households, many of whom already reside in transit-rich areas, the preservation and upgrading of affordable housing in these locations is also important.

Traffic congestion and higher gasoline prices are forcing consumers to consider the financial ramifications of longer commutes and continued use of fossil-fueled vehicles. Recent demographic trends predict a shift toward lower vehicles miles traveled both in-state and nationally, along with changing attitudes toward driving automobiles. For example, nationally, young people between 16 and 34 drove 23 percent fewer miles on average in 2009 than they did in 2001.[102] Those born between 1983 and 2000 are more likely to want to live in urban and walkable neighborhoods and are more open to public transportation than older Americans. These trends are expected to continue beyond 2020.

Metropolitan areas are beginning to change and trend toward more dense urban development designed to minimize energy consumption, waste output, air pollution, and water pollution. Business districts are encouraging more infill development that offers a mix of residential space, entertainment, restaurants, shopping, and other amenities within close proximity, which reduces dependence on private vehicles. These trends create opportunities for developers to satisfy changing consumer desires and for land- use planners to establish policies for more sustainable development patterns. It takes decades for changes in land use and transportation policies to result in tangible changes, including GHG emission reductions. The next generation of regional integrated plans is expected to result in climate benefits well beyond the 2035 time horizon.

Integrated regional planning efforts under SB 375 enable communities to understand the differences between alternative development patterns and to make choices accordingly. Recently approved SCSs reflect regional goals for a more sustainable form of community development that brings with it economic, social, and environmental benefits. The implementation of these regional goals through individual action by local governments and the development community will be essential to meeting the State's ongoing climate objectives. The success of efforts to reduce GHG emissions within other economic or resource sectors such as water, energy, and transportation will be greatly improved by a transition to more sustainable land use practices in the years ahead.

Similarly, California must pursue integrated planning in the freight sector, recognizing that passenger vehicles and trucks share the same transportation system.

C. Investments

Investments in financial incentives and direct funding are critical components for successful implementation of GHG emission reduction strategies. These investments combine with California's regulatory and market-based programs to provide an environment where businesses that make smart investments can be rewarded for developing advanced technologies. Targeted, performance-based standards and technology-forcing rules can kick-start markets and drive technologies to higher volumes, lower prices, and ultimately, to become market-winning solutions, rather than compliance approaches. Strategic financial investments and policy support can accelerate market transitions to cleaner technologies.

102 Dutzik, T., and P. Baxandall. 2013. A New Direction: Our Changing Relationship with Driving and the Implication's for America's Future. U.S. PIRG Education Fund and Frontier Group. Spring.

The initial Scoping Plan contained a comprehensive array of strategies to reduce GHG emissions in California and acknowledged the important role that strategic investments and financial incentives play in moving the State toward the 2020 goal. The initial Plan noted that funding, combined with effective regulatory policies, should help to foster an economic environment that promotes California-based investment and the development of new clean energy. Many of the initial Plan's measures relied on incentives and funding to achieve the full benefits, including energy efficiency, forestry management, and local land use planning.

The State has existing, but limited, incentive programs and it is critical to use these resources effectively to leverage private-sector investment and build sustainable, growing markets for clean and efficient technologies. Some examples include: millions of dollars in rebates for Californians that purchase or lease electric or fuel cell cars; millions of dollars for grants to help diesel truck owners buy cleaner trucks; billions of dollars in assistance to help improve the energy efficiency of homes and businesses; and the potential use of Cap-and-Trade revenue to promote growing clean energy markets.

There are many existing funding programs that work in tandem at the Federal, State, and local levels to achieve GHG emissions reductions and help foster the transition to a clean energy economy. For example, since 2008, the CEC has administered the Alternative and Renewable Fuel and Vehicle Technology Program, authorized under AB 118 (Núñez, Chapter 750, Statutes of 2007) to fund alternative and renewable fuels and advanced transportation technologies and help meet California's climate change goals. The program invests $100 million annually to develop and deploy advanced technology fuels, build fueling infrastructure, purchase clean vehicles, and provide the workforce training that is needed to operate and maintain these new technologies. In addition, ARB administers the Air Quality Improvement Program (AQIP) which is also authorized under AB 118 and continues to provide incentives for zero-emission passenger vehicles, zero-emission and hybrid trucks, and advanced technology demonstrations. These AB 118 programs are critical to meeting California's long-term air quality and climate change goals and have recently been reauthorized through 2023[103] providing about $1 billion in public investments over the next decade to reduce GHG, criteria, and toxic emissions.

Table 7 highlights some of the existing federal, State, and regional incentive programs.

103 Assembly Bill 8, (Perea, Chapter 401, Statutes of 2013).

Table 7: Existing Regional, State, and Federal Incentive Programs

Regional Programs
• Clean truck and bus grants/incentives from local air districts • Urban greening and sustainable development grants from metropolitan planning organizations and local governments • Utility rebates/incentives for energy efficiency and renewable energy • Transit assistance from local governments and transit operators • Water efficiency and wastewater diversion projects via local air, water and sanitation agencies
State Programs
• ARB incentives for clean cars and buses, fuel infrastructure, equipment electrification, and RD&D of sustainable freight technology • CEC incentives, via the Electric Program Investment Charge (EPIC) Program and AB 118, for alternative and renewable energy, alternative fuel technology, energy efficiency, waste-to-energy, and applied research and development for innovative energy technology • CPUC and CSD* energy efficiency, weatherization, and solar projects • Climate dividends for electricity ratepayers • Energy efficiency projects for schools and clean energy jobs via Proposition 39 • SGC/DOT/HCD** grants for sustainable community planning and development • CalRecycle incentives for waste reduction, recycling, and composting, including infrastructure • CAL FIRE/CDFW support for natural resource protection • HCD Transit Oriented Development Housing Program (TOD) • CDFA funding for RD&D of environmentally sound fertilizing materials
Federal Programs
• U.S. EPA incentives reducing mobile source emissions, encouraging smart growth and increasing multi-modal transportation options • U.S. DOE funding for energy efficiency, renewable energy, alternative fuels and vehicles, and alternative fuel infrastructure • U.S. DOT incentives for increased transit opportunities, cleaner fuels, congestion reduction, and multi-modal transportation options • U.S. Department of Housing and Urban Development (HUD) funding for residential energy efficiency and affordable infill development • U.S. Department of Agriculture (USDA) support for rural electricity and bioenergy programs

* (CSD) Community Services & Development, **(HCD) Housing and Community Development;

While the funding resources shown above represent existing programs, the initial Scoping Plan focused on potential State proceeds from the auction of allowances under the Cap-and-Trade regulation. The initial Plan also identified a number of possible investments, including funding energy efficiency and renewable resource development, providing incentives to local government, delivering rebates to consumers, and funding research, development, and deployment.

In 2013, the Brown Administration developed an Investment Plan to guide the investment of State proceeds from Cap-and-Trade auctions—expected to be one of the largest State sources of funding for climate mitigation programs. The Investment Plan was developed to meet the requirements of AB 1532, SB 535, and SB 1018, which provide a framework for how the auction proceeds will be administered, including requirements to spend a percentage of the proceeds within disadvantaged communities and to benefit disadvantaged communities. The Administration's first three-year Investment Plan, which continues through the 2015–16 fiscal year, contained the following investment principles to guide the expenditure of auction proceeds:

- Emphasize investments in existing programs in sectors which have the greatest GHG emissions—transportation, energy, waste, and natural resources—with investments commensurate with relative emissions.
- Maximize economic, environmental, and public health benefits to the State.
- Foster job creation, through promotion of in-state GHG emission reductions carried out by California workers and businesses.

- Complement efforts to improve air quality.
- Direct investments toward the communities and households disproportionately burdened by multiple sources of pollution.
- Provide additional opportunities to businesses, public agencies, nonprofits, and other community institutions to participate in and benefit from statewide efforts to reduce GHG emissions.
- Lessen the impacts and effects of climate change on the State's communities, economy, and environment.

ARB will outline multi-year auction proceeds investment strategies every three years as part of the required updates to the Cap-and-Trade Auction Proceeds Investment Plan.

Building upon the results of the public process and multi-agency effort for the first three-year Investment Plan, the Governor's proposed January budget for fiscal year 2014-2015 (Proposed Budget) presented auction proceeds investments in existing State programs that support California's ongoing effort to reduce GHG emissions and promote a more energy-efficient California. The Proposed Budget included a balanced portfolio of $850 million in initial investments for GHG emission reductions and benefits to disadvantaged communities, as directed by SB 535 (De León, Statutes of 2012), in the transportation, energy, waste, and natural resources sectors.

An important element of auction proceeds investment will be identifying and funding projects that meet or exceed the requirements in SB 535, which states that at least 25 percent of funding provide benefits to disadvantaged communities and at least ten percent of funding be allocated to projects located in disadvantaged communities. Over the last year, the Administration has received comments with varying interpretations of how an investment can benefit disadvantaged communities. To ensure consistent implementation of SB 535, ARB will develop guidance for administering agencies, including what qualifies as a benefit to disadvantaged communities. ARB will solicit public input on this guidance and the SB 535 specific elements. Informed by the public process, ARB will also work with implementing agencies to define how those benefits can be quantified, tracked, and reported. Table 8 provides a preliminary timeline for the SB 535 implementation process.

Table 8: Proposed SB 535 Implementation Process

Activities	Preliminary Timeframe
• Develop preliminary guidance, including what it means for an investment to benefit a disadvantaged community • Solicit public input on SB 535 implementation	Summer 2014 to Winter 2015
• Quantify and report on benefits to disadvantaged communities • Revise SB 535 guidance as needed and as new investments are made	Each year

Continued investment in existing programs with established success in reducing GHG emissions will help maintain the 2020 limit. However, extensive additional innovative strategies and funding sources are needed in sustainable community planning and development, clean transportation, clean energy, energy efficiency, water efficiency, agriculture, natural resources, and waste diversion to achieve deeper emissions reductions.

For the near-term, funding is needed to fill information gaps and analyze the trade-offs associated with different policy choices and technologies. These strategic investments can be made now to demonstrate and identify projects with long-term environmental and economic benefits for California. For example, investment in research to develop improved fertilizer management practices has the potential to result in larger-scale strategies that can reduce GHG emissions while maintaining or enhancing crop yields.

On the transportation side, as part of 2013-14 State Budget, Governor Brown charged the California State Transportation Agency with identifying California transportation needs and long-term funding sources. Per this direction, in April 2013, the California State Transportation Agency formed the California Transportation Infrastructure Priorities Workgroup (CTIP) to help set priorities for transportation spending and explore long-term funding options to support California's infrastructure needs. In February 2014, the CTIP released a visioning document for the next ten years of California's transportation infrastructure that recognized the need to continue to seek consensus and implementation on viable long-term, dedicated, funding such as increased local revenue, mileage-based user fees, toll facilities and lanes, and others.

The availability of dedicated and long-lasting funding sources, such as those identified by the CTIP, helps provide certainty and additional partnership opportunities at the State, regional, and local levels for further investing in projects that have the potential to reduce millions of metric tons of GHGs, such as sustainable communities, transit infrastructure, energy conservation, renewable energy, and natural resources projects.

Funding available to support AB 32, whether from short or long-term sources, should be primarily focused on programs that (1) reduce GHGs or short-lived climate pollutants, (2) are consistent with state climate strategies, and (3) provide co-benefits such as job creation and better air quality. As an example, investments in urban forestry projects administered by Local Conservation Corps are identified in the Investment Plan and can provide economic and educational co-benefits combined with long-term carbon sequestration and GHG emission reductions. Table 9 describes the types of funding that support the purposes of AB 32 and provide valuable co-benefits.

Table 9: Funding of Specific Areas to Support AB 32

- Expansion of established programs:
  - affordable transit-oriented development (TOD) and infill housing development that cut VMT
  - local, regional, and state funding programs supporting transit, infrastructure, active transportation (walking/biking), land-use changes, and other projects that place a priority on reducing VMT and GHG emissions and are identified in the Sustainable Community Strategies or Regional Transportation Plans
  - rebates and grants for zero and near-zero emission vehicles, trucks, and buses
  - funding for goods movement and other mobile source advanced technology demonstration/deployment projects
  - residential energy efficiency financing mechanisms
  - weatherization and building energy efficiency upgrades
  - residential solar retrofits
  - incentives for small-scale energy storage systems and smart-grid technology to support zero-net energy buildings
  - water efficiency/conservation
  - industrial and agricultural operational energy efficiency
  - diesel pump replacement and electrification
  - Recycling Market Development Zones loans
  - organic waste reduction, recycling, and increased composting to turn waste into a resource
- Infrastructure investments that are integrated with sustainable community plans, maximize transit trips, and cut VMT
- Partnerships with local programs, such as the California Green Business Program, which promote and improve environmental practices within businesses to reduce GHG emissions
- Rail modernization efforts that grow transit ridership, improve mobility across the State, and reduce GHG emissions
- Wide-scale implementation of sustainable freight transport strategies and other mobile source strategies
- Research, development, and deployment for projects that have the potential to further reduce or sequester GHG emissions, such as low-emission distributed generation, advanced energy storage, renewable/low carbon fuels, and carbon capture, utilization, and sequestration
- Low carbon bioenergy, including developments in second-generation biofuels
- Urban forestry, forest, and biomass energy projects that result in a net increase in carbon stocks
- Agricultural and rangeland efforts to reduce or minimize GHG emissions through fertilizer and amendment strategies, soil management practices, and land conservation and management aligning with SB 375 and AB 32 goals
- Water conservation and efficiency
- Wetlands, rangelands, and other land use efforts to minimize GHG emissions or increase net sequestration
- Commercialization of low-/lower-GWP gas alternatives for existing high -GWP gases

Looking forward, the State will need to make targeted, priority investments with the limited funding available. California will need to continue coordinating and utilizing funding sources such as the Greenhouse Gas Reduction Fund[104] (auction proceeds), the Alternative and Renewable Fuel and Vehicle Technology Program (AB 118), Electric Program Investment Charge (EPIC) Program, and the Proposition 39: Clean Energy Job Creation Fund to expand investments in California's clean economy and further reductions in both GHG emissions and short-lived climate pollutants. For example, the State can use auction proceeds to provide rebates that encourage consumers to purchase zero- and near-zero emission vehicles. This effort can be coordinated with CEC AB 118 investments for the installation of charging infrastructure to help meet the objectives of AB 32 and move the State to the widespread adoption of zero-emission vehicles needed to achieve ongoing climate and air quality goals.

D. Expanding Climate Actions

California's achieved success of reducing emissions while supporting economic growth and improving quality of life creates another leading policy regime in California that others necessarily want to follow.

Engaging with other governments is critical to expanding action to address global climate change and maximizing benefits to California. Fostering broad action on the global scale is critical to minimize the impacts of climate change on California, reach sectors that California policy has a hard time affecting, and scale markets for clean technologies, including California products. California and other leading national and subnational jurisdictions are working to expand action to reduce emissions and combat climate change and share best practices in order to maximize the efficiency and benefits of doing so.

Successful climate action does not start or end with government, however. It depends on how we interact with our built and natural environments. It depends on how businesses create value and interact with customers. Ultimately, it depends on the choices we each make. A critical element of California's strategy to achieve climate policy success is remaining flexible, facilitating local and private sector leadership, and providing a greater array of choices for consumers that include cleaner technologies and lower carbon lifestyles.

1. Support Sustainable Choices by Households and Businesses

The choices that we make—where we live, how we travel, what we purchase—have significant impacts on energy use and GHG emissions. Individuals and businesses play critical roles in addressing climate change. According to a recent Lawrence Berkeley National Laboratory (LBNL) study,[105] changes in behavior can result in 8 to 17 percent energy savings. Moving forward, it will be essential to expand the range of options Californians have to live sustainable, healthy lives.

Through policies implemented under AB 32, California is offering consumers more choices. This is materializing in just about every area of our lives that is touched by the way we use energy and is illustrated by the examples below:

- **Cars and trucks:** We have an expanding array of choices in the cars and trucks that we drive. There is now a wide, and growing, range of efficient and zero emission vehicles in showrooms.
- **Alternatives to driving:** Those who want an alternative to driving or vehicle ownership are finding more alternatives, as local governments design their communities to accommodate more walking, biking, and public transportation and businesses pioneer new mobility models.
- **Fuels:** Drivers can now pick from fossil or bio-based gasoline and diesel, ethanol, electricity, natural gas, renewable natural gas, or hydrogen.

104 AB 1532 (Pérez, Chapter 807), SB 535 (De León, Chapter 830), and SB 1018 (Senate Budget Committee, Chapter 39) established the GHG Reduction Fund to receive Cap-and-Trade auction proceeds.

105 Wei, M., J. H. Nelson, M. Ting, and C. Yang. 2012. California's Carbon Challenge: Scenarios for Achieving 80% Emissions Reduction in 2050. Lawrence Berkeley National Laboratory.

- **Energy in the home:** Homes and appliances are more energy efficient, delivering more comfort for less cost. Consumers have more control over how and when they use energy, how much it costs, and where it comes from. New home buyers can pick among an array of energy options, including various levels of efficiency and solar.
- **Business productivity:** Businesses are improving productivity and delivering more value with lower energy use and emissions. They have more options for cutting their energy costs and getting products to market quickly and efficiently. And they are leading on distributed generation deployment and clean energy investment.

Always, California's climate policies and programs need to leverage and enable its citizens and businesses to innovate and further reduce GHG emissions.

2. Enable Local and Regional Leadership

California's local and regional governments are critical partners in meeting the State's GHG goals. They have broad influence and, in some cases, sole authority over activities that contribute to GHGs and air pollutants, including industrial permitting, land use and transportation planning, zoning and urban growth decisions, implementation of building codes and other standards, and control of municipal operations.

Local and regional governments are uniquely positioned to collaborate to affect GHG emission reductions on a larger scale. As cities and counties fall into a larger regional framework, they are working together to create synergistic relationships for reductions through land use and transportation networks, as well as within specific sectors, such as energy.

Local air pollution control and air quality management districts (districts) have a key role to play in reducing regional and local sources of GHG emissions. Because many actions to reduce air pollutants also reduce GHG emissions, many districts are actively integrating climate protection into air quality programs. Districts also support local climate protection programs, by providing technical assistance and data, quantification tools, and even funding. In addition, districts can be key players in regional cross-media collaborations to mitigate and adapt to climate change. The California Air Pollution Control Officers' Association, and its 34 local air district members, prepared a detailed discussion of local and regional efforts to mitigate climate change; this document is included as Appendix D.

Since the approval of the Scoping Plan, local and regional governments throughout California have increasingly pursued efforts to reduce GHG emissions across sectors. The passage of SB 375 has accelerated regions toward the development of more integrated, sustainable regional transportation plans that, if implemented, could reduce passenger vehicle emissions and bring about substantial co-benefits. So far, each of the major metropolitan planning organizations (MPOs) that have adopted SCSs has demonstrated that it could meet its region's emission reduction targets under SB 375.

Local governments have initiated efforts to reduce GHG emissions beyond those required by the State. Local governments are improving their municipal operations by upgrading their vehicle fleets, retrofitting government buildings and streetlights, purchasing greener products, implementing waste-reduction policies, and more. In addition, they are adopting more sustainable codes, standards, and general plan improvements to reduce their community's emissions. For instance, localities are implementing landscaping ordinances to reduce water use, streamlining permitting for small-scale renewable energy systems, requiring commercial buildings to be retrofit on resale, and updating General Plans to improve transportation mobility options and land use decisions. Regions throughout California are also supporting innovative programs and technologies—supporting the accelerated adoption of advanced vehicle technologies and programs, creating innovative financing options for residents to retrofit their homes, and pursuing their own alternative energy sources. To maximize success in reducing

GHG emissions and promoting sustainability within communities, local governments are creating integrated planning processes and are developing innovative regional collaborations that extend beyond government agencies to include utilities, universities, labor, and leadership from business and community groups.

While the Scoping Plan encouraged local governments to adopt GHG emission reduction goals consistent with those of statewide targets, many local governments had already initiated their own locally driven climate action efforts. By late 2011, 27 percent of California's cities and counties—representing 50 percent of the state's population—were signatories to the U.S. Conference of Mayors Climate Protection Agreement or the Sierra Club's "Cool Counties" program.[106] By September 2013, 76 California local governments had joined the International Council for Local Environmental Initiatives' Climate Protection Campaign—representing 57 percent of the State's population.[107] Today, locally driven climate actions continue to increase among local governments. According to a recent survey, roughly 70 percent of California jurisdictions have either completed policies or programs to reduce GHG emissions or are in the process of adopting them.[108] While many local governments have become leaders in sustainability, there remains significant opportunity for many local governments to take meaningful action.

A number of tools and resources have been developed to assist local climate action planning. These include:

- The local Government Operations Protocol, which provides a standard GHG emission inventory methodology for municipal operations.
- The U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions.
- Climate action plan templates and monitoring and tracking tools developed through the Statewide Energy Efficiency Collaborative in coordination with ARB and OPR.

Many of these tools can be found on the *CoolCalifornia.org* website, which also houses climate action tools and resources for businesses, schools, and individuals.

106 Bedsworth, L. W., and E. Hanak. 2013. "Climate policy at the local level: Insights from California." Global Environmental Change 23: 664–677.
107 ICLEI Local Governments for Sustainability membership status as of September 2013.
108 Office of Planning and Research. 2012. Annual Planning Survey Results 2012. *www.opr.ca.gov/docs/2012_APSR.pdf*.

SUCCESS STORY

COOLCALIFORNIA
CITY CHALLENGE

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CoolCalifornia City Challenge

To engage communities in reaching the State's climate goals, the Air Resources Board sponsored a pilot project, the CoolCalifornia Challenge. Conducted by the University of California, Berkeley, the Challenge was a yearlong competition between California cities to reduce the carbon footprints of residents and build more vibrant and sustainable communities. Using lessons from successful community-based social marketing programs that motivate individuals to take climate action through peer-to-peer capacity building and leadership, the Challenge inspired over 225 metric tons of greenhouse gas emission reductions by over 2,600 participants in its eight participating cities, equivalent to taking 95 California homes off the electrical grid for one year.

To enable local and regional leadership to further reduce GHG emissions beyond State programs and policies, California must always provide a supportive framework to advance community-wide, voluntary efforts. In addition to reducing emissions across sectors, many of these activities also can bring benefits to households and businesses, create more sustainable lifestyles, and help our communities thrive.

Community-wide Emissions Reduction Target

Recognizing the important role local governments play in the successful implementation of AB 32, the initial Scoping Plan called for local governments to set municipal and community-wide GHG reduction targets of 15 percent below then-current levels by 2020, to coincide with the statewide limit. As California continues to build its climate policy framework, there is a need for local government climate action planning to adopt mid-term and long-term reduction targets that are consistent with scientific assessments and the statewide goal of reducing emissions 80 percent below 1990 levels by 2050. Local government reduction targets should chart a reduction trajectory that is consistent with, or exceeds, the trajectory created by statewide goals. Improved accounting and centralized reporting of local efforts, including emissions inventories, policy programs, and achieved emission reductions, would allow California to further incorporate, and better recognize, local efforts in its climate planning and policies.

Local Government Financing Mechanisms and Incentives

The development of long-term revenue streams and creative local financing mechanisms and incentives can accelerate emission reductions. For instance, local financial incentives can spur retrofits of the existing building stock, net-zero energy or carbon projects, and other voluntary GHG emission reductions. The expansion of PACE financing programs, the creation of incentive opportunities under various policies and planning efforts, and the formation of new mechanisms are all options that should be explored to continue progress toward reducing emissions across our communities.

3. Coordinate with Subnational, Federal, and International Partners

California has established itself as a national and international leader in addressing and combatting climate change. The release of the initial Scoping Plan strengthened the State's commitment to address climate change, but California is not alone. Reducing the risks of climate change requires effective action among all the world's major GHG emitters. Recognizing the interconnected and multi-jurisdictional nature of climate change, California has established a wide range of partnerships, both within and beyond its borders, to promote its own best practices and learn from others while further leveraging the State's leadership in climate protection.

California's efforts on clean energy and climate policy have been successful in leveraging action at the interstate, federal, and international levels. Through collective efforts such as the Western Climate Initiative (WCI) and other alliances of states, California is taking action to expand emission reduction programs and build resiliency against climate change impacts. At the federal level, many of California's policies and programs have served as models for action. California has developed climate solutions with key federal agencies, including the U.S. Department of Energy (U.S. DOE), U.S. EPA, U.S. Department of Transportation (U.S. DOT), and others. Internationally, California is engaged in consultation and collaboration with both national and subnational jurisdictions to share best practices, build capacity, and pioneer new policy tools. These activities are assisting in implementing and strengthening a variety of climate programs around the world.

Efforts in all of these areas are consistent with the State's long-standing leadership in environmental protection and leadership. Coordinating and promoting climate action at the interstate, federal, and international levels is necessary to adequately address climate change, expand clean energy and economic development, and enhance the competitiveness of the State's businesses, workers, and economy.

Interstate Partnerships

California has a long history of working with other states on environmental protection. Continuing this practice and recognizing the value in broad collaborative action to reduce GHG emissions, the State has reached beyond its borders to enlist its neighbors in joint climate-change efforts and promote interstate action.

With the adoption of the initial Scoping Plan, California became the first state in the nation to formally approve a comprehensive GHG emission reduction plan that involves every sector of the economy. Today, several states and cities are following suit and achieving real emission reductions and gaining valuable policy experience as they take action on climate change.

Through participation in interstate initiatives and partnerships with other states, California continues to promote its own best practices and learn from others while finding solutions to reduce GHG emissions, develop clean energy sources, and achieve other environmental and economic goals. Specific examples of these ongoing efforts include:

- Coordination with the WCI on Cap-and-Trade.
- Ongoing consultation with the Regional Greenhouse Gas Initiative, a forum for leadership and information sharing and a common voice on issues faced by the region.
- An agreement with the Pacific Coast Collaborative partners (California, Oregon, Washington and British Columbia) to develop coordinated approaches to reduce GHG emissions, including setting mid-term climate targets, pricing carbon, developing Low Carbon Fuel Standards, and developing an alternative fuels plan for the heavy-duty sector.

Federal Collaborations

In June 2013, President Obama approved the nation's first Climate Action Plan that lays out a series of executive actions to reduce carbon pollution, prepare the nation for the impacts of climate change, and lead international efforts to address global climate change.

California has worked closely with key federal agencies to ensure that the federal approach is consistent with California's stringent standards, as well as the programs in other states that have been leaders in climate protection. Examples of successful collaboration between California and the federal government include the following:

- ARB worked with U.S. EPA and NHTSA to harmonize federal light-duty vehicle standards with California's existing standards through 2016.
- ARB worked with U.S. EPA and NHTSA to develop the first-ever federal GHG standards for medium- and heavy-duty vehicles.
- ARB and U.S. EPA routinely coordinate on advanced transportation and fuels, including the relationship between the federal Renewable Fuels Standard and California's LCFS.
- ARB and the U.S. Department of State routinely coordinate on common issues between California's climate programs and the negotiations under way at the United Nations Framework Convention on Climate Change.
- In January 2012, Governor Brown signed a memorandum of understanding (MOU) with U.S. Department of Interior Secretary Ken Salazar to expand a state and federal partnership that has paved the way for more than a dozen utility-scale solar energy projects and more than 130 renewable power projects in California.

Currently, California is engaging with U.S. EPA and others in the development of national GHG emission standards for power plants under the federal Clean Air Act. As U.S. EPA moves forward to set standards, California is well positioned to respond based on our pioneering actions on climate and air quality.

California is committed to working with the federal government as it implements the President's Climate Action Plan. This commitment includes ensuring that actions the State has already taken to cut emissions will be reflected in subsequent federal actions.

International Engagement

As one of the largest economies in the world and a leader on addressing climate change, California is committed to working at the international level to reduce global GHG emissions. As part of this effort, California has engaged in consultation and collaboration with both national and subnational jurisdictions to share best practices, build capacity, and pioneer new policy tools. These activities are successfully assisting in implementing and strengthening a variety of climate programs around the world, in turn supporting the ability of both developing and developed countries to make more meaningful climate commitments under both the United Nations Framework Convention on Climate Change and bilateral agreements.

California also engages in multi-lateral forums that help develop the policy foundation and technical infrastructure for GHG regulations in multiple jurisdictions. Recognizing that many efforts were under way around the world to use market forces to motivate GHG emission reductions, California worked with other governments to establish the International Carbon Action Partnership (ICAP) in 2007. The ICAP provides a forum for sharing experiences and knowledge among jurisdictions that have already implemented or are actively pursuing market-based GHG programs.[109]

Similarly, and recognizing the need to address the substantial GHG emissions caused by deforestation and degradation of tropical forests, California worked with a group of subnational governments to form the Governors' Climate and Forests Task Force (GCF) in 2008.[110] The GCF is currently comprised of 22 different subnational jurisdictions, including states and provinces from Brazil, Indonesia, Mexico, Nigeria, Peru, Spain, and the U.S. that are contemplating low-emissions development policies and programs, such as REDD. These include addressing forest-related emissions and sharing experiences on how such programs could potentially interact with carbon markets, including California's Cap-and-Trade Program. Ongoing engagement between California and its GCF partners, including with more advanced jurisdictional programs, such as Acre (Brazil), and emerging programs in Chiapas (Mexico) and elsewhere, as well as ongoing discussions with other stakeholders, will provide lessons on how such programs could fit within California's Cap-and-Trade Program. Furthermore, REDD is a key topic within the United Nations Framework Convention on Climate Change and between national and subnational jurisdictions, including through collaboration between California and the U.S. Department of State. Continued evaluation of REDD and other sector-based offset programs further demonstrates California's ongoing climate leadership and could result in partnering on other mutually beneficial climate and low emissions development initiatives, particularly those in Mexico.

In April 2013, Governor Brown led a delegation of California government and business leaders to Beijing and several Chinese provinces. California signed Memorandums of Understanding (MOUs) pledging direct cooperation in developing clean technology, pollution reduction, and climate mitigation policies and markets with the Beijing Environmental Protection Bureau, the Ministry of Environmental Protection, and Guangdong Province. In June 2013, California and Shenzhen, China, signed an MOU to work together to share policy design and early experiences from their climate trading programs. In July 2013, California and Australia signed an MOU to guide collaboration between the agencies in addressing the global issue of climate change.

More recently, Governor Brown signed the first agreement of its kind between a subnational entity and China's National Development and Reform Commission to expand bilateral cooperation on climate change. The Memorandum of Understanding is intended to boost

109 International Carbon Action Partnership Website: *http://icapcarbonaction.com/*.
110 Governors' Climate and Forests Task Force Website: *www.gcftaskforce.org/*.

bilateral cooperation on climate, clean energy, and development, and sharing of low-carbon programs and policies. In his 2014 State of the State address, the Governor announced his intention to work with Mexico on climate change.

As California continues to engage at all these levels and share its experiences, policy programs, and leading approach to climate change, we will also seek new partners to expand global action to address climate change, minimize its impacts, and deliver benefits to our State.

VI. Evaluations

Continuing to effectively build upon California's climate framework and ensuring successful implementation of the State's policies requires periodic monitoring and program evaluation, so that programs can be built upon, adapted, and enhanced – as appropriate – to continue driving down emissions well into the future. California will continue to evaluate the economic, environmental, and public health impacts of its set of climate policies to inform its ongoing activities to reduce emissions. Importantly, the State is committed to ensuring an equitable distribution of benefits from its climate programs, and will continue monitoring impacts in environmental justice communities and target programs and investments where appropriate to enhance benefits in disadvantaged communities.

This chapter discusses the economic, public health, and environmental justice evaluations that will be conducted as the Scoping Plan continues to be implemented. It also discusses the environmental analysis that was prepared of this Update.

A. Economic Analysis

In California, the implementation of Scoping Plan measures is under way but still in the early stages, presenting challenges in the ongoing assessment of the economic impacts of AB 32. While comprehensive in regulatory scope and scale as indicated below, the net impact of AB 32, even after full implementation, is estimated to be small in relation to the $2 trillion California economy,[111] making it difficult to isolate its economic impact. In addition, the global recession and California's subsequent recovery complicate the evaluation of the economic impact of the suite of regulatory measures that are being implemented under AB 32. This challenging economic landscape requires careful analysis of the costs and benefits of AB 32 on industries and individuals in California. The assessment can inform the design and refinement of cost-effective actions California can take toward its long-term climate goals.

As California emerges from the recession, the overall impact of AB 32 remains unclear, and many questions remain unanswered. How has AB 32 impacted economic growth? Has AB 32 spurred innovation and economy-wide growth? How have the impacts of Scoping Plan measures been distributed among businesses and Californians? These questions and others are critical in the accurate assessment of the economic impacts of AB 32 and are the driving force in a multi-pronged approach to the analysis of the economic costs and benefits of AB 32.

Prior to the implementation of regulatory measures under AB 32, the anticipated micro- and macroeconomic costs of the suite of regulatory measures were estimated. Now California turns to the next stage of analysis that consists of estimating the aggregate costs of measures already implemented and analyzing their distributional impacts across businesses and individuals in California and beyond.`

111 Center for Continuing Study of the California Economy. *www.ccsce.com/PDF/Numbers-July-2013-CA-Economy-Rankings-2012.pdf*.

Moving forward, the assessment of the economic impact of AB 32 is divided into two phases: (1) the continued estimation of regulatory costs as measures are implemented, and (2) an ex post analysis of the macro- and microeconomic impacts of AB 32. As California prepares for a retrospective ex post analysis in subsequent Scoping Plans, the State continues to assess whether the economic costs of the implementation of AB 32 are in line with ex ante estimates of costs. In the first phase of the assessment, State agencies are monitoring the costs of AB 32 regulatory measures. In the second phase of the assessment, State agencies will collaborate with external economic experts, researchers, and stakeholders in the design, development, and implementation of rigorous micro- and macroeconomic assessments of the ex post economic impact of AB 32.

The following sections outline the assessments of economic impacts that occurred prior to the implementation of AB 32, the assessments that will occur once AB 32 measures are more fully implemented, and the assessments of economic impacts that are currently under way.

Ex Ante Assessment of Potential Costs and Benefits

Section 38561 of AB 32 requires State agencies to evaluate the total potential costs, as well as the total potential economic and non-economic benefits of the Scoping Plan using the best available economic models and emission estimation techniques.[112] Pursuant to AB 32, ARB conducted two full-scale analyses, as part of the 2008 Scoping Plan and 2010 Updated Economic Analysis of the Scoping Plan, to assess the potential economic impacts of the portfolio of Scoping Plan measures on the California economy. In addition, four external general equilibrium analyses have been conducted.

The two internal and four external macroeconomic analyses estimated the overall potential impact of AB 32 on California gross state product to range from an increase of 1.0 percent to a decline of 2.2 percent in 2020.[113] The models and modeling approaches underlying the

112 The AB 32 text is available at *www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf*.

113 The six analyses include analyses conducted by ARB, David Roland-Holst, the Electric Power Research Institute, and Charles River Associates. These analyses can be accessed at: ARB. 2008. Climate Change Scoping Plan. *www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf*;

SUCCESS STORY

California Local Governments

Local governments are in many ways the "boots on the ground" for meeting California's climate change goals, beginning with their local planning efforts. Municipalities use a number of frameworks to outline their goals and implementation strategies for reducing greenhouse gases. According to 2012 OPR's Annual Planning Survey, about 90 local governments have adopted policies and/or programs to address climate change, often in the form of Climate Action Plans. Moreover, over 270 local governments reported they were making progress towards adopting climate change policies. As of October, 2013, 135 California mayors have voluntarily signed the U.S. Conference of Mayors Climate Protection Agreement, which strives to meet or beat the Kyoto Protocol reduction targets.

six analyses vary in terms of structure and inputs, yet they yield a generally similar conclusion on the economy-wide impact of AB 32.[114] The analyses also identified the impacts of AB 32 on certain industrial sectors in California. These results led to program modifications—most notably the inclusion of output-based allocation for industrial entities in the Cap-and-Trade Program.

In addition to identifying the impact of AB 32 when all implemented measures achieve expected emission reductions, in the 2010 Updated Economic Analysis of California's Climate Change Scoping Plan ARB estimated the economic impact of reaching the near-term emission limit in 2020 should measures not provide anticipated GHG emission reductions.[115] Within the five sensitivity cases developed in the analysis, the overall costs of reaching the near-term emission limit in 2020 were minimized when all measures, as currently being implemented, achieve their anticipated GHG emission reductions. Scenarios in which AB 32 measures related to energy efficiency, transportation, and renewable energy fall short of expected emission reductions result in an increase in the overall cost of AB 32, as additional, less cost-effective emission reductions are required from the remaining measures to meet the 2020 emission limit. This sensitivity analysis highlights the need to monitor the GHG emission reductions and costs of individual measures to identify the overall costs of the suite of AB 32 regulatory measures.

While robust analyses have estimated the potential, or ex ante, economic impacts of AB 32 prior to implementation, more data and analysis is necessary to determine the realized, or ex post, impacts of the regulatory measures on California's industries, businesses, and consumers. In addition, the range of potential economic impacts identified in the six macroeconomic analyses highlights the challenge in parsing the effects of AB 32 from other macroeconomic conditions in the California economy. The recent economic recession and recovery, as well as the presence of overlapping local, State, and federal regulations present challenges in the identification of a "business as usual" baseline against which to evaluate the impacts of AB 32.

The macroeconomic ex ante analyses provide important information; however, the models used in these assessments are often highly aggregated and lack specific detail about individual industries or technologies. Greater detail is important for assessing the potential economic impact of individual regulatory measures that is required under the Administrative Procedure Act (APA). Section 11346.2 of the APA requires as part of the Initial Statement of Reasons (ISOR) an assessment of the benefits and costs of any proposed or amended regulation.[116] For regulatory measures adopted under AB 32, assessments of the costs and benefits have been included as part of the regulatory package. These assessments require gathering sector-specific information regarding the engineering and economic costs of regulatory compliance on businesses and estimating the indirect and induced impacts of these costs, as well as the corresponding expected environmental benefit. While the scale, scope, and assumptions used in these assessments are regulation-specific, these industry-level calculations provide additional data outlining the projected costs and benefits of AB 32.[117]

ARB. 2010. Updated Economic Analysis of California's Climate Change Scoping Plan. *www.arb.ca.gov/cc/scopingplan/economics-sp/updated-analysis/updated_sp_analysis.pdf*; Roland-Holst, David. 2008. Economic Analysis of California Climate Policy Initiatives Using the Berkeley Energy and Resources (BEAR) Model (Appendix G-III). *www.arb.ca.gov/cc/scopingplan/document/appendices_volume1.pdf*; Roland-Holst, David. 2010. Climate Action for Sustained Growth: Analysis of ARB's Scoping Plan. *www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/042110/rolandholst.pdf*; Electric Power Research Institute. 2007. An Updated Macroeconomic Analysis of Recent California Climate Action Team Strategies. *www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000000001015510*; Charles River Associates. 2010. Analysis of the California ARB's Scoping Plan and Related Policy Insights. *http://crai.com/uploadedFiles/analysis-of-ab32-scoping-plan.pdf*.

114 The internal ARB and external analyses differ, most notably, in assumptions related to emissions leakage, the rate of technological change, input substitution, costs of VMT, and economic growth in the "Business as Usual" scenario.

115 Table 12 outlines the sensitivity cases considered in the analysis and is available at: *www.arb.ca.gov/cc/scopingplan/economics-sp/updated-analysis/updated_sp_analysis.pdf*

116 The APA text is available at *www.leginfo.ca.gov/cgi-bin/displaycode?section=gov&group=11001-12000&file=11346-11348*.

117 Regulatory documents are available through ARB's Climate Change Programs at *www.arb.ca.gov/cc/cc.htm*.

Ex Post Assessment of Realized Costs and Benefits

In the years since the analyses of potential economic impacts were conducted, California has moved from the assessment of projected impacts to the implementation of measures outlined in the Scoping Plan and planning the ex post estimation of realized costs and benefits. California has two objectives in the assessment of the ex post economic impacts of AB 32: (1) estimating the overall costs and benefits of the suite of AB 32 measures on the California economy, and (2) identifying the distribution of impacts on industry, small businesses, households, environmental justice communities, and the public sector. California agencies are currently designing a work plan to guide this two-prong approach, including the time line, data requirements, and appropriate methodology for the objective. The work plan will be developed and made publicly available in 2014.

The overall economic impact of AB 32 on the California economy is dependent in large part on the performance of specific measures, including the Renewables Portfolio Standard (RPS), Advanced Clean Cars, Low Carbon Fuel Standard (LCFS), high global warming potential gas measures, and the Cap-and-Trade Program. The costs and benefits of these measures will be fully realized only after the measures reach full stringency. Thus, while the ex post work plan is under development, the full ex post analysis will be conducted in the coming years. As economic impacts may not be immediately realized upon implementation, delaying the assessment also allows for the analysis of lagged economic indicators such as structural changes in employment and production, including the global competiveness of California businesses.

Economic Advisors

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In pursuit of guidance, ARB has engaged a group of Economic Advisors to assist in the development of the work plan to achieve the first objective and estimate the ex post economic impact of AB 32. The Advisors are helping to identify the metrics and methodologies that are best suited to identify the overall costs and benefits of AB 32. More details on macroeconomic modeling of the overall impact of AB 32 and ex post analysis will be included in future updates to the Scoping Plan.

During the implementation of AB 32, California has been collecting data toward the second objective of the ex post assessment—identifying the distributional impacts of AB 32. Through mandatory requirements and voluntary reporting, facility-level data are being collected, and California is beginning the process to analyze, both internally and externally though contracted researchers, how putting a price on carbon changes the behavior and economic health of California businesses and individuals. The data will be used to inform microeconomic models estimating the direct and indirect costs of AB 32, including expenditures on energy, capital, and labor. This analysis will allow the impacts of AB 32 to be quantified over a variety of time horizons, geographic regions, industrial sectors, and income groups, and will provide flexibility in the interactions of regulatory policies. Further, California will continue to track technological developments and the various pathways that industries use to comply with environmental regulations in order to better understand program costs.

The ex post assessment of economic impacts will also inform the design of California's long-term climate change regulatory portfolio. Estimating the economic impact of the current suite of AB 32 measures will provide guidance in establishing long-term emission targets. Assessing the costs and environmental benefit of each regulatory measure over time can lead to modifications

of specific measures as well as the mix of programs within AB 32. This will ensure that the interaction of regulatory measures achieves the goals of AB 32. Thus, the ex post assessment can inform the scope, scale, and stringency of measures in the climate change mitigation portfolio to achieve California's long-term emission targets.

Ongoing Economic Assessment

In addition to the longer-term objectives of the ex post assessment, there are analyses under way to estimate the facility-level regulatory costs and benefits of AB 32 on specific sectors, to inform near-term regulatory modifications. Currently, two analyses are under way at ARB to assess the ability of industrial entities in the Cap-and-Trade Program to maintain competitiveness while incorporating the carbon price into their production processes. In each analysis, external researchers are reevaluating the leakage classification, a measure of the energy intensity and trade exposure of an industrial sector, of California producers using facility-level data on energy consumption, trade flows, and market transfers.[118] The results of the leakage analyses will be used to inform the level of transition assistance needed to minimize leakage in the industrial sector in the third compliance period of the Cap-and-Trade Program. Results are expected by 2016.

External research has also informed the longer-term design of measures under AB 32— most notably the Cap-and-Trade Program and the LCFS—to identify the link between program design and the California economy. For example, the Market Simulation Group (MSG) was established under contract to inform ARB on issues pertaining to market rules and efficiency. It has provided input in assessing program costs, as well as the supply and demand for allowances in the Cap-and-Trade Program.[119] In addition, ARB co-sponsored a symposium in 2012 that brought together economic researchers and regulators to identify the metrics required for the effective analysis of the Cap-and-Trade Regulation.[120] Academic researchers are also providing input to ARB on the design of the LCFS and the near-term cost of compliance.[121] Discussions between regulators and expert economists has spawned ongoing research that is helping to inform the work plan for the ex post analysis of AB 32.

California agencies have also actively engaged the general public and stakeholders to ensure that the economic costs of AB 32 measures are not overly burdensome to specific sectors or income groups. ARB has conducted workshops on the economic costs of LCFS and the Cap-and-Trade Program and solicited comments on internal white papers discussing potential options for cost containment.[122] Gaining insight into the economic market conditions faced by stakeholders allows for the more accurate modeling of economic impacts under AB 32 and provides a measure of some of the compliance costs faced by covered entities.

Along with the collection of data and the active engagement of researchers and stakeholders, ARB is also monitoring the impact of AB 32 on the supply and demand of energy in California. Partnering with the Federal Energy Regulatory Commission (FERC) and CAISO, ARB is monitoring energy and fuel markets to identify the impact of AB 32 on energy markets and the wholesale energy costs faced by industrial, commercial, and residential consumers.[123] These analyses will assist ARB in identifying areas in which to improve the design and stringency of Scoping Plan measures in order to achieve AB 32 emissions goals with minimal economic impact.

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118 Stephen Hamilton of Cal Poly San Luis Obispo and a team of researchers from UC Berkeley are conducting an analysis on the food processing sector, while Meredith Fowlie of UC Berkeley and a team of researchers from Stanford, Resources for the Future, and Clark University are conducting an analysis that covers all remaining industrial sectors. The results of these analyses will be publically available on the ARB website upon completion.

119 The draft analysis is available at *http://ei.haas.berkeley.edu/pdf/Forecasting%20CA%20Cap%20and%20Trade.pdf*.

120 More information is available at *www.bren.ucsb.edu/events/AB32.htm*.

121 The analysis of the LCFS and compliance costs is available at *www.des.ucdavis.edu/faculty/Lin/California_LCFS.pdf*.

122 The LCFS white paper is available at *www.arb.ca.gov/fuels/lcfs/regamend13/20130522ccp_conceptpaper.pdf*; the Cap-and-Trade Program white paper is available at *www.arb.ca.gov/cc/capandtrade/meetings/062513/arb-cost-containment-paper.pdf*.

123 More information is available at *www.caiso.com/Documents/2013SecondQuarterReport-MarketIssues_Performance-Aug2013.pdf* and *www.ferc.gov/EventCalendar/Files/20121220111740-A-4-Presentation.pdf*.

Achieving Near-Term and Long-Term Goals

The Cap-and-Trade allowance price can be used as a proxy for the cost of some GHG emission reductions (those that remain after reductions from the other AB 32 regulatory measures have occurred). By projecting the allowance price through 2020, models estimate the overall cost of a portion of the emissions abatement required under AB 32. Recent analyses suggest that the allowance price in 2020 will likely be near the price floor at the time, around $17 per metric ton.[124]These analyses highlight the uncertainty inherent in the projection of future market conditions, as well as the critical need to identify a "Business as Usual" emissions baseline. While there is much uncertainty in these analyses, the projected allowance prices are lower than the allowance price projected by ARB in the 2010 Updated Economic Analysis to the Scoping Plan.[125] ARB estimated that the 2020 emissions limit could be met with an allowance price of $21 per metric ton and an associated 0.1 to 0.2 percent change in Gross State Product relative to the forecasted 2020 "Business as Usual" baseline.

The similarity of the external estimates of the 2020 allowance price and the projected allowance price in the 2010 Updated Economic Analysis to the Scoping Plan may offer evidence that the assessment of the projected economic impacts of AB 32 is reasonable and that California can reach the near-term 2020 emissions limit without sacrificing economic stability.

The assessment of economic impacts will continue as California develops a climate mitigation portfolio to achieve its long-term climate change mitigation goals. The assessment of the overall economic impacts of the current suite of AB 32 measures will inform the design of the long-term regulatory portfolio as well as the analysis of its impact. However, extending the time horizon of the assessment of economic impacts will present new challenges. Regulatory and climate uncertainty, as well as the performance and costs of existing AB 32 measures, will need to be incorporated in the estimation of potential economic impacts of the long-term climate change mitigation portfolio.

Isolating the specific macroeconomic effects of AB 32 from other economic volatility will continue to present a significant challenge as California looks to the future and achieving long-term climate goals. Long-term economic shifts will need to be incorporated into the assessment of economic impacts. For example, household energy demand and vehicle miles traveled will be influenced by demographic changes in the California population, changes in land use, and the built environment. These issues are the direct focus of regional planning agencies and sustainable community legislation and will require the inclusion of policy interaction and jurisdictional overlap in the long-run modeling of policies affecting energy demand.

Challenges will also arise in estimating the long-term effects of AB 32 across sectors, jurisdictions, and natural resources. The promulgation of climate change mitigation and adaption policies worldwide has highlighted the importance of understanding the far-reaching impacts, both in terms of costs and co-benefits, of climate change and climate change regulations. In 2011, ARB acknowledged the importance of analyzing the impact of the Cap-and-Trade Regulation on localized air quality impacts, special status species, sensitive habitats, and federally protected wetlands in the Adaptive Management Plan. Measuring the long-term impacts of AB 32 will require new methodologies to parse the impacts of individual climate mitigation polices across sectors, jurisdictions, and natural resources. Accounting for the co-benefits and the economic costs of AB 32 will allow California to maximize emission reduction towards long-term climate change mitigation targets while also maximizing the benefits, through improved air quality and natural resources for all Californians.

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124 In $US 2013 (the price floor is currently at $11.34 and rises five percent plus inflation each year). See, for example, the MSG report linking in footnote 105.

125 The projected allowance price of $21/ton ($US 2007) corresponds to -0.2 percent change in gross state product in 2020. Available at *www.arb.ca.gov/cc/scopingplan/economics-sp/updated-analysis/updated_sp_analysis.pdf*.

ARB will continue to consult with external experts to develop new analytical tools and methods to incorporate these issues in the assessment of economy-wide and distributional impacts of California's long-term climate change mitigation portfolio.

B. Climate Change and Public Health Assessment

Climate change has been identified as the greatest health threat of the twenty-first century.[126] As described in Chapter II, in California, climate change is expected to increase temperatures, change precipitation patterns, increase the frequency and severity of extreme weather events, and increase wildfires and sea level rise—all of which could have significant impacts on the health of California's residents.

Efforts to reduce GHGs minimize the impacts that climate change will have on human health. In addition to combatting climate change and its subsequent health impacts, many of these efforts have additional direct and indirect public health impacts. It is challenging to assess the magnitude of health impacts that result specifically from AB 32 mitigation measures. However, assessing the directionality of the relationship between many mitigation actions and health based on current empirical literature indicates that overall, the State's climate control program has many health co-benefits, particularly for chronic diseases. In the instances in which mitigation measures may be at odds with positive health outcomes, California must ensure that positive health outcomes are maximized as we address climate change. Local governments, and in particular local public health departments, are important partners in this work.

Assessing the Health Impacts of AB 32 Implementation

As with economic impacts, efforts to fully quantify the health impacts due to Scoping Plan measures remain challenging and are complicated by many factors. Communities and individuals are influenced by a multitude of factors, including socioeconomic conditions, occupational and environmental exposures, the natural and built environments, and personal choices. The influence of all these factors impairs the ability to assign causation between a discrete set of policies, such as the State's climate program, and quantified health impacts. In addition, the long time scale over which certain health impacts may appear—particularly for chronic diseases—complicate attribution to specific actions. Efforts to quantify health impacts by modeling the reduction of co-pollutants to estimate health impacts associated with reductions of GHG measures are difficult because they rely on assumptions about what would have happened if those measures had not been implemented. Assessing the magnitude of health impacts that result specifically from AB 32 mitigation measures remains challenging; however, the directionality of the relationship between many mitigation actions and health can be evaluated using current empirical literature. Efforts are now under way to develop health co-benefit modeling tools to be used in conjunction with regional transportation demand models used by California's Metropolitan Transportation Organizations to help quantify health co-benefits of active transport in future Sustainable Community Strategies (Table 10). For instance, the Strategic Growth Council has convened a Technical Advisory Committee to provide recommendations on the development and use of a health module as part of the Urban Footprint model—a scenario development and modeling tool designed to inform planners on the impacts of development decisions. In addition, CDPH has advanced a model—the Integrated Transport and Health Impact Modeling tool (ITHIM)—that quantifies the health impacts of active transportation and low carbon driving scenarios. The ITHIM model is currently being evaluated by MPOs for use in their regional planning processes.

126 Costello, A., et al. 2009. "Managing the health effects of climate change." The Lancet 373: May 16, 2009. *www.ucl.ac.uk/global-health/project-pages/lancet1/ucl-lancet-climate-change.pdf*.

Table 10: Current Models Designed to Quantify Health Co-Benefits of Sustainable Community Strategies

Model	Timeline
Urban Footprint	SGC Advisory Committee recommendations anticipated Spring 2015
Integrated Transport and Health Impact Modeling Tool (ITHIM model)	Under evaluation by MPOs

Health Impacts of Unmitigated Climate Change

Left unchecked, climate change will affect health in a number of ways. Increasing temperatures from climate change will increase the severity and frequency of heat waves. As California saw in the 2006 heat wave, which resulted in over 650 excess deaths, over 16,000 excess emergency department visits and almost 1,200 excess hospitalizations,[127, 128] extreme heat events create a significant risk of adverse health effects and heat-related mortality. Older adults with chronic health problems, and agriculture, construction, and other outdoors workers are particularly at high risk for adverse effects of extreme heat. Increasing temperatures may exacerbate air pollution in California; in particular, ozone and fine particulate matter.[129] In addition to increasing air pollutants directly, higher temperatures will also likely increase and intensify wildfires in the State, exacerbating poor regional air quality.[130] An increase in air pollution can increase the number of cases of exacerbation of asthma, allergies, and cardiovascular and respiratory diseases, as well as incidents of cancer, neurological and reproductive disorders, and premature death.[131] These impacts are especially felt among our most vulnerable populations, including children, elderly, people with cardiovascular or respiratory diseases, low-income communities, and people without access to health insurance.[132] Changes in climate can also affect the prevalence and geographic location of food-, mosquito-, and vector-borne diseases. While hard to predict, it is possible for infectious diseases like West Nile Virus and Lyme disease to become more prevalent in California as the climate changes.[133] Extreme weather events can lead to both physical and mental health problems.[134] In addition, climate change is associated with higher pollen levels, which contribute to allergies and asthma attacks.[135] Additional climate change impacts, including changes in precipitation patterns, can threaten the quality and supply of water, endanger agriculture production, and lead to many other health-impacting consequences.

The impacts of climate change will not affect everyone the same way. Climate change is expected to more seriously affect the health and well-being of the communities in our society that are the least able to prepare for, cope with, and recover from its impacts. For instance, low-income communities and communities of color are expected to be hit harder by extreme heat, extreme weather events, and worsened air pollution; and are more sensitive to the economic stresses associated with climate change, like increased prices for basic needs and threat of job loss in the agricultural and tourism sectors.[136] If this "climate gap" is not addressed, climate change will exacerbate many of the health and social disparities among California residents. Fortunately,

127 Hoshiko, S., P. English, D. Smith, and R. Trent. 2010. "A simple method for estimating excess mortality due to heat waves, as applied to the 2006 California heat wave." Int J Public Health 55(2): 133–7.
128 Knowlton, K., M. Rotkin-Ellman, G. King, et al. 2009. "The 2006 California heat wave: Impacts on hospitalizations and emergency department visits." Environ Health Perspect 117(1): 61–7.
129 Drechsler, D. M. 2009. Climate Change and Public Health in California.
130 Ibid.
131 CARB. ARB Fact Sheet: Air Pollution and Health. *www.arb.ca.gov/research/health/fs/fs1/fs1.htm*.
132 Shonkoff, S., R. Morello-Frosch, M. Pastor, and J. Sadd. 2009. Environmental health and equity impacts from climate change and mitigation policies in California: A review of the literature. California Climate Change Center. *www.energy.ca.gov/2009publications/CEC-500-2009-038/CEC-500-2009-038-D.PDF*.
133 Drechsler, D. M., N. Motallebi, M. Kleeman, D. Cayan, K. Hayhoe, L. S. Kalkstein, N. Miller, S. Sheridan, J. Jin, and R. A. VanCuren. 2005. Public health-related impacts of climate change in California.
134 CDC. 2013. CDC's Climate Change and Health Program: *www.cdc.gov/nceh/information/climate_and_health.htm*.
135 Ibid.
136 Ibid.

many of the actions that reduce GHG emissions also improve the health and well-being of these vulnerable communities, providing an opportunity to address many of our current environmental and health disparities.

Health Impacts of AB 32 Mitigation Measures

Climate change mitigation efforts not only help combat the direct adverse health impacts of climate change, many of the strategies laid out in the Scoping Plan have additional health co-benefits—many of which can improve existing health disparities. In addition, these climate strategies have implications for chronic disease—which accounts for the vast majority of ill health in California. Chronic disease and injury account for 80 percent of deaths in California, and affect the lives of millions of Californians. Chronic disease is also the key driver of health inequities, lost workforce productivity, and rising health care costs.[137]

The strategies California has employed to reduce GHG emissions from the transportation sector include cleaner and more fuel-efficient vehicles and land use strategies that reduce vehicle miles traveled and promote active transport (bicycling and walking—alone and in combination with public transit.) Putting cleaner and more fuel-efficient vehicles and heavy-duty trucks on the road is reducing GHGs and criteria air pollutants and toxics, including NO_x (which forms ozone and $PM_{2.5}$) and directly emitted $PM_{2.5}$ (which includes toxic diesel PM). Since statewide monitoring efforts began in 2000, $PM_{2.5}$ levels have decreased by an average of four percent each year.[138] Strategies that will help us achieve our 2050 climate goals, including zero emission vehicles and increased electrification of goods movement, will further reduce air pollutants and bring health co-benefits throughout the State. These improvements will particularly benefit many low-income communities of color, who are disproportionately exposed to traffic-related air pollutants.[139]

The impact that our built environment—including land use decisions, transportation systems, and our buildings—has on human health and well-being has long been recognized.[140] Statewide efforts to reduce GHG emissions through integrated land use and transportation planning will fundamentally change our communities, bringing with it public health benefits. The Sustainable Community Strategies (SCSs) adopted by Metropolitan Planning Organizations are planning for communities in a way that reduces travel demand per person, provides greater mobility options, increases access to employment and services, and creates more vibrant surroundings. Reducing vehicle travel will reduce GHG emissions and improve regional air quality. For instance, Southern California's 2012–2035 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) is expected to result in a 24 percent reduction in total pollution-related health incidences, saving over $1.5 billion per year in total costs.[141] In an effort to improve mobility options for California residents, the RTP/SCSs are also increasing opportunities for residents to use bicycling and walking as travel alternatives. Active transportation increases physical fitness and improves mental health.[142, 143] The health benefits of physical activity are extensive and well documented: physical activity—even in modest amounts—has been linked with a decreased risk of cardiorespiratory diseases, type 2 diabetes, breast and colon cancer, depression, cognitive

137 CDPH. 2013. The Burden of Chronic Disease and Injury. *www.cdph.ca.gov/programs/Documents/BurdenReportOnline%2004-04-13.pdf*.

138 ARB staff analysis.

139 Shonkoff, S., R. Morello-Frosch, M. Pastor, and J. Sadd. 2009. Environmental health and equity impacts from climate change and mitigation policies in California: A review of the literature. California Climate Change Center. *www.energy.ca.gov/2009publications/CEC-500-2009-038/CEC-500-2009-038-D.PDF*.

140 U.S. EPA. 2013. Our Built and Natural Environments. A Technical Review of the Interactions Among Land Use, Transportation, and Environmental Quality. Second Edition, *www.epa.gov/smartgrowth/pdf/b-and-n/b-and-n-EPA-231K13001.pdf*.

141 SCAG. 2012–2035 RTP/SCS; American Lung Association Analysis: *www.lung.org/associations/states/california/assets/pdfs/advocacy/smart-growth/smart-growth-analysis.pdf*.

142 Atkinson, M., and L. Weigand. 2008. A Review of Literature: The Mental Health Benefits of Walking and Bicycling. *www.pdx.edu/ibpi/sites/www.pdx.edu.ibpi/files/Mental%20Health%20Benefits%20White%20Paper.pdf*.

143 Ewing, R., T. Schmid, et al. 2008. "Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity." Urban Ecology 567–582.

decline, all-cause mortality, and improved musculoskeletal health.[144] These regional plans are not just providing more travel options, they also have implications for other health-related factors, like improved access to health services and employment opportunities and safer, more cohesive neighborhoods. The SCS plans created by regions are key mechanisms for improving factors that have indirect but broad implications for the health and well-being of California's communities.

Climate change strategies that also reduce urban heat islands improve public health and help build climate change resiliency. Increasing urban tree canopy and green space combats climate change directly through sequestration of GHGs and indirectly by reducing ambient air temperatures[145] and reducing the energy needed to heat and cool buildings.[146] The cooling effects of urban trees reduce urban heat islands and can lessen the severity of extreme heat events. Additional health-related benefits of urban trees include reduced air pollutants,[147] reduced noise from traffic,[148] and other psychological and social benefits that help decrease stress and aggressive behavior.[149, 150, 151] Cool roofs and cool pavements also combat climate change while cooling our communities.[152]

Strategies to build more energy-efficient, green buildings—if done right—also can have public health benefits. Improving indoor air quality through source reduction and strategies such as high-efficiency air filtration can greatly improve indoor air quality and occupant health. The State's green building code (CALGreen) includes both required and voluntary measures that improve public health. A number of these measures help assure healthful indoor air quality, such as those addressing chemical emissions from composite wood products, carpets, resilient flooring materials, paints, adhesives, sealants, and insulation, as well as those addressing ventilation. ARB has been active in improving building indoor air quality by sponsoring and conducting research, regulating indoor air cleaners and consumer products, and helping to develop green building standards and guidelines that both reduce GHG emissions and protect indoor air quality.

Reducing the use of nitrogen fertilizers can reduce GHG emissions and improve water quality. Many Californians live in agricultural areas that have water nitrogen levels well above national health-based standards.[153] Central Valley residents in areas with contaminated drinking water must also spend far more than average to purchase safe water, reducing the ability to spend on other health-protective necessities such as food and housing.[154]

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144 PAGAC. 2008. Physical Activity Guidelines Advisory Committee Report, 2008. U.S. Department of Health and Human Services.

145 Trees can lower outdoor air temperatures by as much as 9°F (5°C) through evapotranspiration: EPA. 1992. Cooling our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing. U.S. Environmental Protection Agency, Office of Policy Analysis, Climate Change Division. p. 32.

146 Akbari, H., D. Kurn, S. Bretz, and J. Hanford. 1997. "Peak power and cooling energy savings of shade trees." Energy and Buildings 25:139–148. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 5)

147 Nowak, D. J., D. E. Crane, and J. C. Stevens. 2006. "Air pollution removal by urban trees and shrubs in the United States." Urban Forestry and Urban Greening. 4(2006):115–123. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 6)

148 Nowak, D. J., and J. F. Dwyer. 2007. Understanding the Benefits and Costs of Urban Forest Ecosystems. In: Kuser, J. E. Handbook of Urban and Community Forestry in the Northeast. New York: Kluwer Academic/Plenum Publishers. 25–46. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 9)

149 Wolf, K. 1998. Urban Nature Benefits: Psycho-Social Dimensions of People and Plants. Center for Urban Horticulture, College of Forest Resources, University of Washington, Fact Sheet #1. Seattle, Washington. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 9)

150 Laverne, R. J., and K. Winson-Geideman. 2003. "The Influence of Trees and Landscaping on Rental Rates at Office Buildings." Journal of Arboriculture 29(5): 281–290. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 9)

151 Kuo, Francis E., and W.C. Sullivan. 2001. "Environment and Crime in the Inner City: Does Vegetation Reduce Crime?" Environment and Behavior 33(3): 343–367. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 9)

152 U.S. EPA. No date. Reducing Urban Heat Islands: Compendium of Strategies — Cool Roofs.

153 UC Davis. 2011. Addressing Nitrate in California's Drinking Water. *http://groundwaternitrate.ucdavis.edu*.

154 Pacific Institute. 2001. The Human Costs of Nitrate-contaminated Drinking Water in the San Joaquin Valley. *www.pacinst.org/wp-content/uploads/2013/02/nitrate_contamination3.pdf*.

Ongoing Evaluation

As California looks beyond 2020, there will be many opportunities to address long-standing air quality and public health issues through the implementation of sustainable community strategies, the expanded deployment of zero and near-zero emission vehicles in the light- and heavy-duty sectors, and the more efficient use of electricity and natural gas. But we must be mindful of how current and future strategies are implemented, so that they maximize the health benefits while minimizing unintended negative health impacts. For instance, pursuing more compact, transit-oriented development will help reduce GHG emissions and regional air pollutants; however, without appropriate preventative measures, it may have the potential to displace current residents who are disproportionately from low-income and minority communities, as well as to increase near-roadway exposure for some individuals. Additional efforts are needed to prevent any adverse health impacts that may be exacerbated by future land use and transportation decisions. ARB is pursuing research to help improve health impacts from near-roadway exposure.

While the Cap-and-Trade Regulation is designed to reduce GHG emissions, co-benefits such as reductions in criteria and toxic air pollutants, are expected to follow. However, concerns have been raised that these reductions in criteria and toxic air pollutants may not occur in some areas, or that the Cap and Trade Program may exacerbate some localized air pollution impacts. To address these concerns, ARB is working with CAPCOA to design elements of a Cap-and-Trade adaptive management process to identify and respond to concerns about the potential for localized emission increases due to the Cap-and-Trade Regulation. The effort will involve a transparent process to collect, review, and evaluate data to determine if any potential adverse localized air quality impacts might have occurred as a result of implementing Cap-and Trade. If a potential impact is identified through this process, ARB is committed to developing appropriate responses through a public process, including consideration and approval by the Board as necessary.

Despite the difficulties in quantifying the health impacts that result from AB 32 implementation, additional action can be taken to better understand the relationship between climate control measures and health impacts. Several efforts undertaken by the California Department of Public Health will aid in this endeavor, including the development of land use/transportation health impact assessment tools and the development of health community data and indicators to facilitate monitoring and tracking of progress. Additional effort will be needed to advance the development and adoption of tools to evaluate the health benefits of land use and transportation planning, as well as to better educate policymakers, local officials, and the public of these impacts. Moving forward, ARB will continue to monitor and track statewide air pollution levels and community pollutant levels to ensure that our policies and programs continue to improve air quality for all Californians. In addition, ARB will continue to ensure that efforts to reduce GHG emissions through the building sector continue to simultaneously improve indoor air quality and occupant health and safety. Continued research and analysis is needed on the short- and long-term health co-benefits of climate strategies to help communities maximize the positive impacts of local actions.

Federal air quality requirements could be an important driver in influencing how and when California achieves mid-term climate targets. The South Coast and San Joaquin Valley Air Quality Management Districts, together home to more than half of the State's population, must reduce emissions of smog-forming pollutants by about 90 percent below 2010 levels by 2032 to meet the National Ambient Air Quality Standards. Since many of the technologies to reduce smog-forming pollution are the same as those to reduce GHG emissions, and recognizing that it is imperative to integrate planning to meet multiple objectives, complying with federal air quality standards will likely accelerate climate action in California.

In addition, ARB will continue to evaluate ways to monitor the public health of disadvantaged communities. As with economic impacts, communities and individuals are subjected to a multitude of factors that affect their health; consequently, teasing out the impacts of one discrete set of policies, such as the climate program, is very challenging.

C. Environmental Justice and Disadvantaged Communities

State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. ARB is committed to considering environmental justice in every program and process.

In 2001, ARB adopted Policies and Actions for Environmental Justice (Policies) to provide a framework for incorporating environmental justice into its programs. The Policies apply to all communities in California, but recognize that environmental justice issues have been raised mostly in the context of low-income and minority communities. These Policies are intended to promote the fair treatment of all Californians and cover the full spectrum of ARB activities. The Policies recognize the need to engage community members as ARB develops and implements its programs. ARB is committed to work closely with all stakeholders, environmental and public health organizations, industry, business owners, other State and local agencies, and all other interested parties, to successfully implement these Policies.

Climate change will present additional challenges to those that environmental justice communities are already facing. Climate change has both direct and indirect impacts on health. These health effects disproportionately impact vulnerable individuals—the young, elderly, and people with chronic illness—and people in environmental justice communities.

Climate change will affect human health, infrastructure, and transportation systems, as well as energy, food, and water supplies. Environmental justice communities may face greater challenges to adapting to climate change due to limited resources. To the extent feasible, the State should work to identify and address any adverse effects of the State's climate programs, policies, and activities on environmental justice communities. In addition, the State must ensure that its climate programs, policies and actions also result in benefits to environmental justice communities.

Potential Impacts and Benefits to Environmental Justice Communities

The implementation of air pollution control programs in California at the federal, State, and local levels targeting GHGs, criteria pollutants, and air toxics will together result in a reduction of air pollution throughout the State. These statewide emission reductions are intended to improve the health of all of California's residents. Specifically, the implementation of the Scoping Plan will result in significant GHG emission reductions in California, accompanied by criteria and toxic pollutant emission reductions at the State and local level. ARB will work to ensure that implementation of the Scoping Plan and all of its programs do not adversely affect environmental justice communities. ARB will continue to work closely with the local air districts to monitor air pollution to ensure that emission reductions at the State, local, and regional levels are occurring as intended, and that environmental justice communities are also sharing in the benefits of cleaner air.

In addition, as part of a focused effort, ARB will continue to work with CAPCOA to design elements of a Cap-and-Trade adaptive management process to identify and respond to concerns about the potential for localized emission increases due to the Cap-and-Trade Regulation. The effort will involve a transparent process to collect, review, and evaluate data to determine if any potential adverse localized air quality impacts might have occurred as result of implementing Cap-and-Trade. If a potential impact is identified through the process, ARB is committed to developing appropriate responses through a public process, including consideration and approval by the Board as necessary.

Environmental justice communities will also benefit directly from the expenditure of Cap-and-Trade auction proceeds. SB 535 requires CalEPA to identify disadvantaged communities based on geographic, socioeconomic, public health, and environmental hazard criteria for purposes of

expending Cap-and-Trade auction proceeds. SB 535 also requires that at least 25 percent of Cap-and-Trade auction proceeds be allocated to projects that benefit these communities, and at least ten percent of the proceeds be allocated to projects located in the communities.

To the extent feasible, all State, regional, and local government agencies with a role in implementing AB 32 should employ available data sources to help target resources, programs, incentives, and enforcement efforts to ensure that residents of EJ communities receive benefits from climate-related efforts and to guard against worsening conditions or creating new environmental justice problems.

Assessing the Effects of AB 32 Climate Change Programs in Environmental Justice Communities

ARB, in coordination with CalEPA and the Office of Environmental Health Hazard Assessment (OEHHA), is working on developing a method to assess the effects of California's climate change mitigation efforts on environmental justice communities. AB 32 requires that, to a feasible extent, ARB must ensure that activities undertaken to address climate change do not disproportionately impact disadvantaged communities and that those communities also benefit from statewide efforts to reduce GHG emissions.

The Environmental Justice Advisory Committee, formed pursuant to AB 32, has expressed significant interest in the development of metrics for tracking, assessing, and quantifying the potential impacts and benefits of the State's climate programs, policies, and actions on California's economy, environment, and public health, particularly with respect to environmental justice communities.

Tools such as CalEnviroScreen (released by CalEPA and OEHHA) have been developed to evaluate multiple indicators of environmental and socioeconomic vulnerability in disadvantaged communities. These tools do not show the impacts of any single program, but are intended to evaluate a community's vulnerability to pollution's adverse effects.

In contrast, the effort discussed here attempts to focus on the impacts of AB 32 programs that reduce GHGs and other climate change pollutants. Any effort to track the effects of AB 32 will require, at a minimum, the identification of indicators that could be tied to the programs of interest and a method for assessing those indicators. An effective and meaningful evaluation of AB 32 programs must rely on indicators expected to fluctuate with government, community, and industry actions to implement climate change mitigation programs.

Project Concept

ARB staff, in coordination with CalEPA, OEHHA and other agencies, is undertaking an effort to assess the effects (benefits and potential impacts) of AB 32 programs on disadvantaged communities. The key objective is to develop a quantitative mechanism to gauge the effectiveness of AB 32 programs with respect to disadvantaged communities. Specifically, to help address the question "Is the implementation of AB 32 programs fulfilling the statutory responsibility to provide benefits and avoid disproportionate harmful impacts to the extent feasible in those communities?"

ARB is developing a multi-phase approach, beginning with identifying sources of existing available and accessible data. This first phase would look at changes in emissions of multiple air pollutants at individual facilities and include a visual tool to support ready public access to those data. ARB will rely on a process of extracting and reviewing criteria and toxics emissions information, developed by and in concert with the local air districts, in order to understand localized impacts. The next phase would expand in scope to encompass entire disadvantaged communities (per SB 535), reflecting emissions from both facilities and mobile sources in

each area. In a later phase, we would include relevant emission reduction and economic data from projects funded through the investment of Cap-and-Trade auction proceeds to benefit disadvantaged communities. Table 11 below describes the phases of the proposed approach. The Scoping Plan Economic Advisors, other State agencies (like OEHHA), and local air districts may aid ARB by supplementing these data and analyses, which would provide an expanded view.

Existing data sources include the following:

- California Electronic Greenhouse Gas Reporting Tool (Cal e-GGRT)
  - Cal e-GGRT is California's Mandatory Greenhouse Gas Emissions Reporting Program that provides quality assured and third-party verified emissions data from sources that contribute the most to Statewide GHG emissions.
- California Emission Inventory Development and Reporting System (CEIDARS)
  - CEIDARS data are the result of facility reports to air districts that are passed to ARB. CEIDARS provides facility criteria and toxic emissions data.
- EMissions FACtors for emissions from California's on-road vehicles (EMFAC)
  - EMFAC is California's model for estimating GHG, criteria and toxic emissions from on-road vehicles operating in California.
- Off-Road Motor Vehicles and Equipment
  - Category-specific methods and inventory models are being developed for specific regulatory support projects to replace the OFFROAD model. The following ARB website lists the categories that have been or are being updated with new methods and data: *www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles*.

The goal is to provide an evaluation of the effects of AB 32 programs, considering multiple variables, including greenhouse gases, criteria pollutants, and toxic air contaminants. This assessment would not only meet the goals of the Cap-and-Trade Adaptive Management Plan but would also include impacts not otherwise attributed to Cap-and Trade. The results of this assessment would provide an evaluation of the effects of all AB 32 programs on disadvantaged communities. Data collected could provide information needed for ARB to plan and implement investment, regulatory, or policy responses to any identified adverse localized impacts on specific disadvantaged communities.

Staff intends to present this effort as part of the Cap-and-Trade Adaptive Management Plan public workshops scheduled for mid-2014. Additionally, staff anticipates that with the Cap-and-Trade Adaptive Management Plan, an update on the progress of this effort will be presented to the Board before the end of 2014.

Table 11: Project Phases for Assessing the Effects of AB 32 Programs on Disadvantaged Communities

Phase	Description
Phase 1 Collect and Make Available Facility Data	The focus will be on facilities that are required to report consistent with ARB's Mandatory Reporting Regulation. We will compile several years of climate, criteria pollutant, and air toxics emissions data for these facilities. We will also make this information available for review and analysis by the public, including communities, academics, and government.
Phase 2 Evaluate Facility Emissions Data	Analyze the information collected in Phase 1. We intend to utilize the data evaluation process developed for the Cap-and-Trade Adaptive Management Plan and annually provide a summary of findings for public review.
Phase 3 Collect and Make Available Community Data	The focus will be on disadvantaged communities as defined by CalEPA under SB 535. We will integrate "community-level" mobile source emission data and investment data from Cap-and-Trade auction proceeds. In this phase, we will also quantify trends and provide data biennially for public review and analysis.
Phase 4 Evaluate Community Data	Conduct a detailed analysis of the information collected in Phase 3. We will summarize our findings and biennially release results for public review.
Phase 5 Respond to Evaluations in Scoping Plan	Respond to Phase 4 results and discuss project progress in the next Update to the Climate Change Scoping Plan.

Outreach and Community Capacity Building

As climate policy and programs are developed and implemented, community capacity building through education and outreach efforts—as well as integration of community members into the decision making process—are critical components of helping to ensure that the needs of these communities are known and addressed. Additional effort is needed in communities that are geographically, linguistically, and/or economically isolated. Collaboration with trusted sources of information, such as community-based organizations, regional climate collaboratives, and culturally appropriate messaging techniques, are recommended.

Environmental Justice Advisory Committee

To ensure environmental justice needs and concerns are integrated into the State's climate programs, ARB reconvened the Environmental Justice Advisory Committee (Committee) to advise the Board on the Update. On March 21, 2013, the Board appointed members based on nominations received from environmental justice organizations and community groups.

Environmental Justice Advisory Committee		
Martha Dina Argüello	Physicians for Social Responsibility	Los Angeles
Nicole Capretz *(Served on EJAC until August 2013)*	Environmental Health Coalition	San Diego
Gisele Fong	End Oil	Los Angeles
Tom Frantz	Association of Irritated Residents	Central Valley
Kevin Hamilton	Clinica Sierra Vista	Central Valley
Rey León	Valley LEAP	Central Valley
Penny Newman *(Appointed to EJAC but unable to serve)*	Center for Community Action and Environmental Justice	Inland Empire
Luis Olmedo	Comite Civico Del Valley	Imperial Valley
Susan Riggs *(Served on EJAC until March 2014)*	San Diego Housing Federation	San Diego
Kemba Shakur	Urban Releaf	Bay Area
Mari Rose Taruc	Asian Pacific Environmental Network	Bay Area
Monica Wilson	Global Alliance for Incinerator Alternatives	Bay Area
Ryan Briscoe Young *(Served on EJAC until April 2014)*	The Greenlining Institute	Statewide

The Committee met four times from June 2013 to April 2014 to discuss the Update. The Committee focused their discussions on each Scoping Plan sector and developed comprehensive recommendations that ARB considered in drafting this Update. The Committee's "Final Recommendations on the Proposed AB 32 Scoping Plan" provided recommendations for each Scoping Plan sector and overarching environmental justice policy. The final recommendations included the need for monitoring and assessing potential impacts of the State's climate programs; a call for a 2030 target of, at a minimum, 40 percent reduction from 1990 levels and a 2040 target of, at a minimum, 60 percent reduction from 1990 levels; a call for California to reduce its energy use and transition to 100 percent renewable energy; financial support for transportation in disadvantaged communities; and amendments to the Cap-and-Trade Regulation that would exclude direct allocation and offset credits. The Committee's final recommendations can be found in Appendix E.

D. Environmental Analysis

ARB prepared an environmental analysis (EA) of the Scoping Plan Update pursuant to its regulatory program certified by the Secretary of the Natural Resources Agency (14 CCR 15251(d); 17 CCR 60000–60008). The draft EA is included as Appendix F. In accordance with Public Resources Code section 21080.5 of CEQA, public agencies with certified regulatory programs are exempt from certain CEQA requirements, including but not limited to those preparing environmental impact reports, negative declarations, and initial studies (14 CCR 15250). The resource areas from the CEQA Guidelines Environmental Checklist are being used as a framework for assessing the potential for significant impacts (17 CCR 60005(b)).

A draft EA was released for a 45-day public review on March 15, 2014. ARB summarized and responded in writing to all comments submitted on the EA in a supplemental response document for the Board to consider for approval along with the Update.

VII. Conclusions

California is forging a path forward in the fight against climate change. By expanding on existing policies and developing new ones, we are steadily bending the arc of economic growth in our state in a cleaner, more sustainable direction. And while climate change demands it, the steps we are taking to cut emissions are the very actions we should be taking anyway to build for the future in California.

Sustainability and climate action have increasingly become part of the DNA of who we are and how we, as Californians, see ourselves. It is now as inconceivable to pump unlimited amounts of carbon pollution into the atmosphere as it was once to spew mercury, lead, sulfur dioxide, or arsenic into the air.

Day by day, in steady steps of visible progress, we are seeing the emergence of a clean energy future. Solar panels are commonplace, whether on roofs, commercial warehouses, or in shiny ground-based arrays across the State. Thousands of wind turbines have become part of the California clean energy panorama, their blades describing slow graceful arcs as they generate more than 4,000 megawatts of pollution-free energy.

Electric vehicles are a common sight on our streets and highways, and each day brings more charging stations to parking structures and shopping malls. Biofuel is available at retail outlets. Even big-rigs are getting a climate makeover as trailer skirts, low-rolling resistance tires, and aggressively aerodynamic cabs mean less wind resistance, lower fuel costs, and fewer emissions.

These efforts aren't just cutting greenhouse gases. They are cleaning our air; helping to better preserve water, and agricultural lands, and other critical natural resources; powering the growth of new long-term economic drivers in the state; and helping to pull together and better align public policy priorities across programmatic silos.

As California takes these steps, public support for action also continues to grow. Recent polls show that 79 percent of Californians believe global warming is happening, and a majority want to see more action by the State; 73 percent say corporations and industry need to do more; 70 percent feel they, themselves, should be doing more to address the issue.

This public consensus aligns with the dictates of science, which tell us unequivocally that we must continue on the path we are on, and even accelerate our efforts in the coming years.

That is exactly what this Update does. It builds on California's framework for climate action with a range of strategies that will keep pushing our state toward a cleaner, more sustainable future. It is a continuation of what we have already begun. Now is the time to make it a reality.

California Environmental Protection Agency

Air Resources Board

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EXHIBIT B

ACTION

Agenda Item #6

October 15, 2015

Subject: **Proposed Fall 2015 Affordable Housing and Sustainable Communities Program Notice of Funding Availability**

Quarter: 3rd Quarter 2015

Reporting Period: July, 2015-October, 2015

Staff Lead: Affordable Housing and Sustainable Communities Program Staff

Recommended Action:

Approve issuance of the Fall 2015 Notice of Funding Availability (Fall 2015 NOFA) for the Affordable Housing and Sustainable Communities (AHSC) Program of approximately $30 million.

Summary:

At the June 2015 Council Meeting, in light of the high quality of applications and substantial effort to prepare and review the 2014-2015 AHSC applications, many members of the public and the Council indicated a desire to award a small amount of the 2015-2016 AHSC funds to projects that applied for funding in Round 1, but could not receive an award due to limited funds and the "jurisdictional cap" in the AHSC Program Guidelines. This cap limits funding for one geographic location to $15 million.

Accordingly, AHSC program staff recommends that the Council approve issuance of a new Fall 2015 NOFA that authorizes awarding approximately $30 million of Fiscal Year (FY) 2015-2016 AHSC Program funds to the highest scoring eligible project applications received in Round 1, that either were not awarded any grant funds, or only received an award for partial funding, at the June 2015 Council Meeting. Because statute requires the Council to award all AHSC funds pursuant to guidelines, for additional funding awards at this time the Council must apply the existing AHSC Program Guidelines. However, the remaining FY 2015-2016 AHSC Program funds will be awarded by the Council in 2016 after revision of the AHSC Program Guidelines.

Background:

SB 862, Statutes of 2014, established the Affordable Housing and Sustainable Communities (AHSC) Program, which is administered by the Strategic Growth Council (SGC, or Council). The AHSC Program furthers the purposes of AB 32 (Chapter 488, Statues 2006) and SB 375 (Chapter 728, Statutes, 2008) by investing in projects that reduce GHG emissions by supporting more compact, infill development patterns, encouraging active transportation and transit usage, and protecting agricultural land from sprawl development. Funding for the AHSC Program is provided from the Greenhouse Gas Reduction Fund (GGRF), an account established to receive Cap-and-Trade auction proceeds and is awarded by the Council. In Fiscal Year (FY) 2014-2015, approximately $130 million was available from the GGRF for the first funding cycle of the AHSC Program. After adopting AHSC Program Guidelines on January 20, 2015, the Council issued a Notice of Funding Availability dated January 30, 2015 (January NOFA) and awarded those funds, referred to as Round 1 funds, at the Council Meeting on June 30, 2015.

SB 862 apportioned 20 percent of GGRF annual proceeds to the AHSC Program beginning in FY 2015-2016.

Proposed Fall 2015 NOFA

The proposed draft Fall 2015 NOFA is attached to this Report. The draft NOFA provides detail on projects eligible to apply for this round of funding, loan and grant amounts, application scoring and recommendations, and application procedures and deadlines. Key Council considerations are noted below.

Eligibility

AHSC program staff recommends that the only projects eligible for funds pursuant to the proposed NOFA are projects that

1. Applied in Round 1 and was invited to submit a Full Application, and

2. Received a Final Score greater than 60%, but were not awarded any funds, or only received an award for partial funding, at the June 2015 Council Meeting.

This score cut-off will ensure that only the highest quality applications submitted in response to the prior NOFA are eligible for the limited amount of AHSC Program funds offered at this time, and will also allow for a competitive award of funds.

The projects that are eligible for funding pursuant to the Fall 2015 NOFA are listed in Attachment A. These include three projects that received partial funding from the Council at the June 2015 meeting. For these projects, the "Unfunded Amount" of the request for funding is listed. Four projects are eligible that received high scores, but were not selected for funding because of the "jurisdictional cap" of $15 million for one geographic location in the AHSC Program Guidelines. To ensure competition and account for the possibility that projects withdraw or requested funding amounts are reduced, staff recommends that all projects that scored over 60% are eligible for funding pursuant to this NOFA. Using 60% as the minimum qualifying score, three additional projects are eligible to apply for funding under this NOFA.

Application Requirements

In order to apply for the Fall 2015 funds, a Statement of Continued Interest (Statement) will be submitted to the Department of Housing and Community Development (HCD) by eligible applicants. This Statement will establish whether funding for the project is still requested, if the amount requested has been reduced, and if there are any substantial changes to the scope of the project. **If there are substantial changes to the scope of a project, it is not eligible to receive an award of funds pursuant to the Fall 2015 NOFA.** This condition is required because if the scope has substantially changed, the GHG emission reductions and other project benefits used to score the applications may be substantially different, and resulting in a Final Score that may no longer be applicable.

Application Scoring for Fall 2015 NOFA

It is not the intent of AHSC program staff to re-score applications for the Fall NOFA round. However, if the only change to an application is a reduced funding request because other funds

were obtained, two scoring criteria will be affected: the GHG reduction score (Total GHG reductions per AHSC funds requested), and the Capital Leverage score. The Round 1 score may then be modified using the methodology in the AHSC Program Guidelines and updated information provided by the Fall 2015 applicant. The Final Fall 2015 NOFA will describe details how AHSC program staff will address potential changes in Final Score.

AHSC Fall 2015 Award Recommendations

At a subsequent Council meeting, AHSC program staff will provide recommendations to the Council for awarding approximately $30 million to eligible projects. However, the Council retains the right to determine the appropriate amount to award, which projects to select, and whether to award more or less than $30 million to eligible projects.

As noted previously, four projects but were not selected for funding because of the "jurisdictional cap" for one geographic location. This $15 million limit applies separately to each round of funding granted pursuant to a separate NOFA, so it does not prevent awarding additional funds to these projects pursuant to this NOFA. However, the limit of $15 million to each geographic location again applies for this NOFA, and could impact which of the eligible projects are awarded funds.

As previously noted, the current AHSC Program Guidelines must be applied in recommending and selecting projects to receive funds pursuant to this NOFA. In addition to the $15 million jurisdictional cap, criteria in the Guidelines include awarding a minimum of 30% of funds to Integrated Connectivity Project (ICP) Areas and awarding a minimum of 40% of funds to Transit Oriented Development (TOD) Project Areas. These criteria may restrict the ability of the Council to fund some of the projects eligible to apply under this NOFA.

While the Guidelines also provide some authority for the Council to make adjustments in the award of funds, until the responses to the NOFA are received – indicating whether projects still request funding and if any funding requests are reduced, and staff determines whether any project scores should be revised – it is not possible to determine all the options available to the Council regarding selection of projects for new awards. This will be addressed at a subsequent meeting when the Council considers award recommendations pursuant to the Fall 2015 NOFA.

EXHIBIT C

Daly City Planning Commission
Agenda Report

333 - 90th Street ◆Daly City ◆ California ◆ 94015 ◆ 650-991-8033

Meeting Date: November 4, 2015

Application: Use Permit UPR-7-14-9291 and Design Review DR-7-14-9292

Project Planner: Tendai Mtunga, Associate Planner

Project Location: 4619 Brunswick Street (APN 003-210-160)

Project Description: Construction of a five-story mixed-use apartment building comprised of 206 senior affordable apartments and 6,451 square feet of ground floor office/commercial space

Applicant: Alexis Gevorgian, AMG and Associates
16633 Ventura Boulevard, Suite 1014
Encino, CA 91436

Property Owners: The Church of Jesus Christ of Latter-Day Saints
50 East North Temple Street, 12th Floor
Salt Lake City , Utah 84150

Environmental Assessment: The project was reviewed pursuant to Section 21155.2 of the Public Resources Code (PRC), and a Sustainable Communities Environmental Assessment (SCEA) as specified under the California Environmental Quality Act (CEQA) streamlining provisions offered under SB375 for Transit Priority Projects.

Applicable Daly City Municipal Code Sections: Chapter 17.20 – C-2 Heavy Commercial District
Chapter 17.34 – Off-Street Parking and Loading
Chapter 17.44 – Use Permits
Chapter 17.45 – Design Review
Chapter 17.52 – Density Bonus

Site Information

Property Sizes	Existing Use	Proposed Use	General Plan Designation	Current Zoning
1.15 acres	Vacant parcel	Senior apartment building	Commercial Mixed Use (CMU)	C-2 Heavy Commercial

Area Information

Land Use	**Zoning**
North: Retail/office use	C-1: Light Commercial
South: Public assembly and multifamily	C-2: Heavy Commercial and R-3 Multifamily Residential
West: Retail/office/auto detailing facility	C-2 Heavy Commercial
East: Vacant land and parochial school	C-2: Heavy Commercial and R-1 Single-Family Residential

Background

The applicant, Alexis Gevorgian, requests approval to construct a five-story mixed-use apartment building on a vacant parcel located on the north side of Brunswick Street, across from Chelsea Court (see Attachment A – Location Map). Because the project proposal involves a 100 percent affordable housing development, the applicant is requesting regulatory concessions related to the maximum building height and reduced usable open space.

In consideration of the concession requests, the Affordable Housing Council Committee reviewed the project on two occasions. A preliminary meeting was held to direct the applicant as to whether a General Plan amendment application was required for the project. At that time, the project consisted of 227 units in roughly the same building configuration (five stories over a two-level parking garage). Because the project provided an insufficient amount of retail/office space to qualify it as a "mixed–use development," as mandated by the General Plan, the Committee directed the applicant to either apply for a General Plan amendment to the Residential Very High Density (R-VHD) designation or amend the project to include a retail/office component.

A second meeting was held to discuss the applicant's request for regulatory concessions based on a revised project consisting of 206 apartments and an 11,100 square foot retail/office component at the street-level. Although the Committee expressed support for the revised project, the Committee directed the applicant to reduce the retail/office space and provide an increase to the square feet devoted to the resident amenity area at the street level. As an outcome of the second committee meeting, the project's street-level floor plan has been revised to include a 4,804 square foot resident amenity area, an increase from the 2,120 square feet initially reviewed by the committee.

Due to a shift from retail square feet to amenity square feet, a regulatory concession initially sought by the applicant related to required parking is no longer necessary as the project meets the Zoning Ordinance parking requirement without it.

Project Overview

The proposed building would be comprised of 206 affordable senior apartments, 6,451 square feet of street-level retail/office space, 4,804 square foot resident amenity area, and a 2,719 square foot leasing office (see Attachment B – Project Plans). Construction would include one five-story mixed-use building with a two-story (partially underground) parking garage. The mixed-use building would be 132,880 square feet (exclusive of the parking garage) on a 1.15 acre site, representing a 2.6 floor area ratio (FAR).

A total of 59 off-street parking spaces are proposed, all which would be located in the two-level (partially underground) parking garage beneath the building. Each parking level would have a separate entrance from Brunswick Street. The lower level ("Level 1"), which would be accessed by the most westerly garage entry, would provide 32 parking spaces. The upper level garage ("Level 2"), which would be accessed via a driveway entry along the northeastern property line, would provide 27 spaces. For the convenience of building residents, the applicant is providing two electric car charging stations on each garage parking level.

Pedestrian access from the apartments to the garage would be provided by three separate stair towers. In addition, the applicant is proposing three elevators which will service all floors and both parking levels. Within the upper garage level is the building's trash receiving and storage area which would be designed in accordance with Allied Waste requirements for solid waste and recyclable materials. This refuse receiving area is connected vertically to the apartments above by two dedicated garbage chutes which would be located within specifically designated trash rooms on each floor.

Pedestrian access to the apartments from the sidewalk would be through the main entry lobby directly adjacent to the office and directly accessible off the sidewalk at Brunswick Street. Security will be designed into the project so controlled access can be maintained for the safety of residents. This office and lobby area will also serve as a primary mail and parcel receiving area for the project. Directly above the second story parking garage, the applicant is proposing a retail/office use accessible from the ground floor elevator lobby adjacent to the leasing office.

To the southeast of this proposed retail/office space would be the project's leasing office and amenity area. As designed, the proposed leasing office would be approximately 2,700 square feet and directly accessed off of the main elevator tower lobby. The primary utilization of this space would be to transact lease agreements, address resident occupancy issues, and maintain records within secure, lockable storage rooms. This office would be provided with natural lighting through windows that would look out onto Brunswick Street.

In terms of open space, the proposed building would provide two separate exterior courtyards, one at the easterly portion over the third floor commercial space and a second, more linear space at the westerly portion of the site. These areas would provide professionally designed exterior amenities accessed from within the building. Both will be provided with bench seating adjacent to landscape planter areas and have ornamental tree plantings appropriate to the scale of the space. The easterly exterior patio would provide a covered trellis and bench seating area.

Also, directly adjacent to both the proposed retail/office space and leasing office, the project will have approximately 4,800 square feet of amenity area. The area is planned to have a great room for resident meetings and socialization that may include some of the following: a kitchen (non-commercial grade) for resident's use, a business office space, media room with designated sound and video system and theatre-style seating, a possible game room and smaller, individual spaces for contemplation and discovery. This area would also include restrooms and be designed with commercial grade interior finishes on all surfaces, for example, tile flooring, specialty lighting and commercial loom grade carpeting or carpet tiles. Within this amenity area will be dedicated a minimum of 1,500 square feet designed for a Senior Community Center. Also within this area there will be a Community Wellness Center for educating and promoting wellness.

In association with constructing the apartment building, the applicant would complete improvements in the public right-of-way, including undergrounding utilities, installing a new sidewalk, and installing street trees with decorative tree grates similar to those approve for the 6800 Mission Street mixed-use building or those found in front of the Peninsula Del Rey apartment building on Pierce Street.

Request for Regulatory Concessions

As indicated in the plans, each of the 206 apartments would consist of a 438 square foot studio (open floorplan with no bedrooms). All apartments within the building would be income-restricted and age-restricted for occupancy by persons 62 years of age or older. Due to the affordable nature of the project, the applicant is requesting regulatory concessions related to the maximum building height and reduced usable open space (see Attachment C – Request for Regulatory Concessions).

The two requested concessions are as follows:

1. A concession for a building height deviation from the 36-foot maximum height specified in the C-2 Heavy Commercial zoning district to a height variation of 50 feet in some locations to 75 feet in others.

2. A concession for reduced usable open space to that which is currently proposed, i.e., 3,808 square feet of outdoor open space, i.e., "upper courtyard," 4,804 square feet of interior "amenity area," and 82 private balconies providing 50 square feet of open space each (4,100 square feet total), for a total of 12,712 square feet of open space. The Zoning Ordinance requires that 150 square feet of usable open be provided for each dwelling unit, or 30,900 square feet in the case of the proposed 206-unit project.

In consideration of the concessions request, Chapter 17.52 – Density Bonus of the Daly City Municipal Code authorizes the City Council to grant the requested concessions unless the concession is either: a) not required in order to provide for affordable housing costs, as defined in Section 50052.3 of the Health and Safety Code, or for rents for the targeted units to be set as specified in Section 65915(c) of the Government Code; or b) would have a specific adverse impact, as defined in Government Code Section 65589.5(d)(2), upon public health and safety or the physical environment or on any real property that is listed in the California Register of Historical Resources and there is no feasible method to satisfactorily mitigate or avoid the specific adverse impact without rendering the development unaffordable to low- and moderate-income households.

Use Permit

The applicant is required to obtain a use permit pursuant to Daly City Municipal Code (DCMC) Chapter 17.20.010C, mixed-use developments in the C-2 Heavy Commercial zoning district require use permit approval to allow residential in the building at the proposed density of 179 units per acre. Accordingly, staff has evaluated the project pursuant to the Title 17 (Zoning) and offers the following analysis:

Parking and Circulation

The project supplies the number of parking spaces required by the Zoning Ordinance through the provision of 59 spaces. The following table presents a summary of the Zoning Ordinance parking requirement and parking provision within the proposed building:

Use	Square Footage / Units	Requirement Factor	Total Regular Parking Requirement	Senior affordability reduction	Total Parking Required
Commercial	6,451 square feet	1 space per 300 square feet	22		22 spaces
Residential	206 studio apartments	1 space per unit	206	171 spaces (75 percent)	51.5 spaces
Total			228 spaces		73.5 spaces
			After Mixed-Use Parking Reduction (20 percent)		**59 spaces**

Without parking reductions for affordability, the project would require 228 parking spaces. However, pursuant to the Zoning Ordinance parking regulations, multifamily developments designed and intended for the exclusive occupancy of low income elderly persons are permitted a 75 percent parking reduction and mixed-use buildings are permitted a 20 percent reduction. This provision reduces the required parking by 171 spaces, resulting in the total parking requirement of 59 spaces, which equates to the number of spaces proposed.

As described in the *Discussion* section of this staff report, all of the project parking spaces are proposed in the two-level (partially underground) parking garage, each level having a separate entrance from Brunswick Street. Although either parking level could provide parking for the retail/office component of the project, the lower garage entrance would be more visible to patrons of this space. Staff is recommending a Condition of Approval that, should the applicant choose to install an electronic gate at either level, that the gate not restrict access to 18 spaces during business hours. The purpose for this restriction is to ensure that patrons to the retail/office portions of the building are provided off-street parking.

Building Height

The maximum allowed in the C-1 Light Commercial zone is 36 feet. The building height calculation is taken from an average of the building mid-point, at each of the four building elevations. Pursuant to the Zoning Ordinance, the maximum building height envelope is then tapered at 45-degree angle from the 36th foot, allowing for buildings that are taller than 36 feet, so long as they are recessed toward the site interior.

As proposed, the average building height of the proposed mixed-use building would vary between 50 feet in some locations to 75 feet in others, exceeding the maximum building height by as many as 39 feet (see Attachment D – Photosimulations). For this reason, the applicant has requested a development concession for the project related to height. Staff estimates that a strict

adherence to the mandated building height would result in the removal of the proposed third, fourth, and fifth floors of the building, which provide 126 units, resulting in the project only providing 80 units total.

Because the project would provide 100 percent of the total number of units to low-income households, the City must provide at least one concession to allow for the construction of a low-income project. The applicant has requested that the City grant two concessions, one being the building height deviation from the maximum permissible 36 feet height. In compliance with State law, staff is recommending that the Planning Commission and City Council grant the building height concession.

Development Intensity

The General Plan Future Land Use Map designates the project site as C-MU Commercial Mixed-Use, which anticipates residential intensification along and adjacent to the Mission Street Corridor. As described in the General Plan Land Use Element, the floor area ratio (FAR) for land uses within the corridor typically ranges between 1.0 and 6.0. The proposed building with 132,880 square feet on a 1.15-acre development site represents a 2.6 FAR, well within the 6.0 FAR anticipated by the General Plan.

The project's proposed density is 179 dwelling units per acre (179 du/ac). As the General Plan establishes no maximum residential density for properties with the Commercial Mixed-Use designation, the maximum allowable density is largely driven by building height, which was discussed in the previous section. Should the City Council ultimately grant a regulatory concession related to building height, the allowance would also permit the proposed density.

In consideration of the proposed density, the Planning Commission should be aware that, as a matter of comparison, the proposed age-restriction studio apartments would be significantly smaller than many two- and three-bedroom apartments currently in the marketplace, many of which exceed 1,000 square feet. Due largely to their limited size and lack of a bedroom, it is very likely that the proposed studio apartments would be occupied solely by one- and possibly two-person households. For this reason, although the density appears extremely high, the building's *population* density would approximate that of a project that was half as dense, but provided two or three times the number of bedrooms.

Open Space

The Zoning Ordinance requires that 150 square feet of usable open space be provided for each dwelling unit, or 30,900 square feet in the case of the proposed 206-unit project. The applicant has currently proposed 12,712 square feet of open space in the following format: 3,808 square feet of outdoor open space, i.e., "upper courtyard," 4,804 square feet of interior "amenity area," and 82 private balconies providing 50 square feet of open space each (4,100 square feet total). The proposed open space provision is 18,188 square feet less than that required.

Because the project would provide 100 percent of the total number of units to low-income households, the City must provide at least one concession to allow for the construction of a low-income project. The applicant has requested that the City grant two concessions, one being the 18,188 square foot open space provision deviation. As indicated previously, the City's

Affordable Housing Council Committee directed the applicant to reduce the retail/office space and provide an increase to the square feet devoted to the resident amenity area at the street level. The project's street-level floor plan has therefore been revised to include a 4,804 square foot resident amenity area, an increase from the 2,120 square feet initially reviewed by the Committee.

In compliance with State law and based on the applicant's compliance with the Committee's direction, staff is recommending that the Planning Commission and City Council grant the open space concession. With the intent of off-setting the *amount* of open space provided, staff has recommended Conditions of Approval related to the quality and scope of services that would be provided to building residents. Examples of these services would include health screenings, social events, recreational activities, and educational opportunities. Resident services programming would be focused on wellness, empowerment, and quality of life.

Design Review

The applicant has proposed contemporary exterior architecture for the building, which will be visually prominent from the Top of the Hill and adjacent residential neighborhoods. The proposed façades contain a number of key architectural features, the most prominent of which would be the northern stair tower monolith along Brunswick Street. This feature would be clad in stucco, painted a visually prominent blue with an orange complementary accent band inset at the parapet line, and receive vertical windows, purposely off set from each other to add design interest.

As a means to break up the massing of what is a very large and linear structure, the project architect has developed vertical architectural elements to provide visual articulation along the building's exterior walls. These elements, which mimic large bay windows, would be stepped back from one another both vertically at the parapet and horizontally along the plane of the exterior walls. The elevation inset, which would be stucco, would be painted off-white, while the vertical elements would receive smooth siding panels and painted in a brown/mustard color to provide contrast and visual relief with the off-white inset. Staff believes the two finishes, i.e., stucco and smooth siding, would provide sufficient visual interest and articulation, while also creating distinct and attractive shadow lines at material interfaces.

The proposed rooflines also add design interest primarily at the top of the building wall above the building pedestrian entry, where the parapet for the off-white stucco and brown/mustard panels terminates at the easterly end of the building into deep parapet overhang. This parapet overhang, as engineered, would also offset the bold orange band at the top of the blue lobby monolith.

Windows for the individual units are proposed to be commercial-grade vinyl, similar to the windows in the nearby 88 Hillside building. They would be double-paned, insulated, and, where appropriate, provided with acoustical film. Windows at the commercial components and along the entry lobby will be commercial-grade aluminum storefront windows.

Staff is satisfied with the building architecture and recommends no Conditions of Approval other than the plans submitted for building permit reflect potential sign locations for retail/office tenants, that all building signs remain at the street level, and that signs be incorporated to guide

retail/office patrons to appropriate parking level, i.e., unencumbered by a gate during retail/office hours.

Zoning Ordinance and General Plan Consistency

The site is zoned C-2 Heavy-Commercial with a General Plan Land Use designation of Commercial – Mixed Use (C-MU). This C-2 zoning and C-MU land use designation allow residential and retail/office uses in the same building, subject to use permit and design approval.

As discussed in the preceding use permit analysis, the floor area ratio (FAR) for land uses within the C-MU designation typically ranges between 1.0 and 6.0. The proposed building with 132,880 square feet on a 1.15-acre development site represents a 2.6 FAR, well within the 6.0 FAR anticipated by the General Plan. Additionally, the property is identified in the General Plan Housing Element as a potential housing site and was communicated in the list of sites the City used to satisfy its portion of the Regional Housing Need Allocation (RHNA). The Housing Element indicates the site having the capability for at least 58 units and 206 are proposed. Due to the proposed density exceeding 30 dwelling units per acre and the deed restricted affordability associated with the proposal, all of the units would qualify as meeting the City's affordable housing obligation under the RHNA for the 2014 – 2022 Planning Period.

Aside from the Housing Element, the General Plan encourages infill housing in existing neighborhoods on underutilized sites, where residential development represents the highest and best use, and where public infrastructure exists to support the intensity of the proposed development. The subject site is situated adjacent to existing apartments, an assembly use, retail/office/service uses, and a parochial school. Residential development is the highest and best use for the subject property given its size and shape, and these adjacent uses.

Utility Providers

The subject property is located within a fully urbanized area with all public services likely capable of serving the development. However, as a Condition of Approval, the City has required that the applicant develop water and sewer studies to identify where upgrades to existing utilities may be required. Any upgrades in the system deemed necessary will be the applicant's responsibility.

Utility	***Provider***
Water, Sanitary Sewers, Storm Drains	City of Daly City
Gas & Electric	PG&E
Telephone	AT&T
Cable Television	Astound! Cable Services
Fire/Police Protection	North County Fire Authority/City Daly City

Fiscal Analysis and Impacts

The construction of 206 senior affordable apartments will add an incremental demand for City services. Prior to project completion, the project applicant will be required to pay building permit, plan check, and AB 1600 fees to the City.

Environmental Assessment

After completing an initial study for the project, staff has determined that adoption of a Sustainable Communities Environmental Assessment (SCEA) and Mitigation Monitoring and Reporting Program (MMRP) for the project is appropriate pursuant to Section 21155.2 of the Public Resources Code (PRC), as specified under the California Environmental Quality Act (CEQA) streamlining provisions offered under SB375 for Transit Priority Projects. The Draft SCEA and MMRP identify a number of mitigation measures applicable to the subject project, including the following:

1. Prior to the issuance of building permits the project applicant shall pay fair share fees for the implementation of improvements at the Hillside Boulevard / Brunswick Street intersection. The project adds 32 trips to the intersection during the A.M. peak hour. The total volume through the intersection under Cumulative Plus Project condition is 1,553 trips during that time period. Thus, the proposed project's fair share is 2.1 percent of the improvement cost.

2. The proposed project would replace a 320 foot section of wastewater pipe to accommodate the proposed project.

3. A geotechnical investigation would be performed to evaluate potential impacts from liquefaction, lateral spreading, landslides, and expansive soils.

A copy of the Draft SCEA and MMRP are provided as Attachments E and F, respectively.

Findings

Staff finds that, as conditioned, the approval of Use Permit UPR-7-14-9291 and Design Review DR-7-14-9292 would be in compliance with Title 17 (Zoning) of the Daly City Municipal Code. Approval of the proposed project will not be detrimental to the health, safety, morals, comfort and general welfare of persons residing in or working in the neighborhood, or be injurious or detrimental to the property and improvements in the neighborhood or the general welfare of the City. These findings are based on the following facts:

1. In accordance with Title 17 of the Daly City Municipal Code, as well as applicable State zoning enabling legislation, the Planning Commission will conduct a public hearing on November 4, 2015; notice of said hearing was published in a newspaper of general circulation on October 23, 2015, posting and first class mailing to property owners within 300 feet;

2. After completing an initial study for the project, staff has determined that adoption of a Sustainable Communities Environmental Assessment (SCEA) for the project is appropriate pursuant to Section 21155.2 of the Public Resources Code (PRC) and a SCEA as specified under the California Environmental Quality Act (CEQA) streamlining provisions offered under SB375 for Transit Priority Projects. Furthermore, a Mitigation Monitoring Plan and Reporting Program prepared for the proposed project would be implemented for the project at the time of construction;

3. The proposed mixed-use building is consistent with the General Plan. The Land Use Element designates the project site as C-MU Commercial Mixed-Use, which anticipates residential intensification within the Mission Street corridor.

4. As described in the General Plan Land Use Element, the floor area ratio (FAR) for land uses within the Mission Street corridor typically ranges between 1.0 and 6.0. The proposed building with 132,880 square feet on a 1.15-acre development site represents a 2.6 FAR, well within the 6.0 FAR anticipated by the General Plan.

5. The property is identified in the General Plan Housing Element as a potential housing site and was communicated in the list of sites the City used to satisfy its portion of the Regional Housing Need Allocation (RHNA). The Housing Element indicates the site having the capability for at least 58 units and 206 are proposed.

6. The project's proposed density is 179 dwelling units per acre (179 du/ac). Although the General Plan establishes no maximum residential density for properties with the Commercial Mixed-Use designation, the proposed density is supported by the General Plan Housing Element, which indicates that he City should provide regulatory incentives for developers to construct higher-density mixed-use development at locations within close proximity to public transit. The Daly City BART Station is apprxomiaely one-half mile from the site and a SamTrans bus route runs along Mission Street, in close proximity to the proposed building;

7. The proposed mixed-use building complies with applicable provisions of the Title 17 (Zoning) of The Daly City Municipal Code, include Chapter 17.20 – C-2 Heavy Commercial District, Chapter 17.34 – Off-Street Parking and Loading, Chapter 17.44 – Use Permits, Chapter 17.45 – Design Review, and Chapter 17.52 – Density Bonus;

8. The proposed mixed-use building complies with the Zoning Ordinance parking requirement. The proposed number of parking spaces conforms with the number of spaces required by the City's Zoning Ordinance for a multifamily development designed and intended for the exclusive occupancy of low income elderly persons and mixed-use buildings. This required number of parking spaces equates to the 59 spaces proposed;

9. The proposed mixed-use building is requesting via a concession to deviate from the 36 feet maximum height permitted by the zoning ordinance in the C2 zoning district to a height variation of 50 feet in some locations to 75 feet in others. Strict adherence to the mandated building height would result in the removal of the proposed third, fourth, and fifth floors of the building, which provide 126 units, resulting in the project only providing 80 units total;

10. The Zoning Ordinance requires that 150 square feet of usable open be for each dwelling unit, or 30,900 square feet in the case of the proposed 206-unit project. The applicant is requesting a concession to reduce usable open space to that which is currently proposed, i.e., 12,712 square feet. To off-set the amount of open space provided, the applicant would be required to enhance the quality and scope of services that would be provided to building residents, e.g., health screenings, social events, recreational activities, and educational opportunities.

11. The proposed mixed-use building merits use permit approval, as the building would be compatible with existing adjacent uses, adequate utility and infrastructural capacity exists within close proximity to serve the site, and the provision of parking is substantial and, as designed, would not have a detrimental impact to the adjacent neighborhood;

12. General site considerations, including site layout, open space and topography, orientation and location of buildings, vehicular access, circulation and parking, setbacks, heights, walls, fences, public safety and similar elements have been designed to provide a desirable environment.

13. General architectural considerations have been incorporated in order to ensure the compatibility of this development with its design concept and the character of on-site signage. These considerations include, but are not limited to, the character, scale and quality of the design, the architectural relationship with the site and other buildings, building materials, and colors;

14. General landscape considerations of Chapter 17.41, Landscaping, will be provided to ensure visual relief, to complement buildings and structures and to provide an attractive environment for the enjoyment of the public; and

15. The available on-site parking spaces would provide ample parking spaces for the apartment residents and the retail/office spaces within the building, and the proposed mixed-use building would not conflict with the adjacent uses;

16. The project will minimize the risk to existing public improvements and adjacent private property by providing controlled stormwater runoff from the site to City facilities in full compliance with Order R-2 NPDES Permit No. CAS612008 and Order No. 2010-0014-DWQ, NPDES No. CAS000002, the statewide National Pollutant Discharge Elimination System (NPDES) General Construction Activity Storm Water Permit.

Conditions of Approval

Staff recommends the Planning Commission forward a recommendation of approval to the City Council for Use Permit UPR-7-14-9291 and Design Review DR-7-14-9292, subject to the following conditions and Daly City General Conditions of Approval. Minor deviations from the conditions of approval may be approved by the Planning Division. Significant deviations will require review and approval by the Planning Commission and City Council.

A . DEPARTMENT OF ECONOMIC AND COMMUNITY DEVELOPMENT

General

1. The applicant shall file a Declaration of Acceptance of the Conditions of Approval with the City Clerk within thirty (30) days of City Council approval. Until said declaration is filed, the approvals of Use Permit UPR-7-14-9291 and Design Review DR-7-14-9292 shall not be valid for any purpose.

2. The project shall be valid only in conjunction with detailed plans submitted with this project. Any modifications required, due to the Conditions of Approval, and minor changes to the plan, must be reviewed and approved by the Planning Division prior to the change. Major site or architectural modifications shall be treated as an amendment and shall be subject to review by the Planning Commission and City Council.

3. The approvals granted herein shall be valid for a period of one year. If building permits have not been issued within this timeframe, the applicant shall apply for a time extension.

4. The applicant shall comply with all requirements and conditions outlined in the project's Mitigation Monitoring and Reporting Program during construction prior to Final Certificate of Occupancy when applicable.

5. Prior to the issuance of a building permit, the applicant shall enter into a density bonus agreement with the City. The agreement shall outline the conditions under which the concessions granted by Use Permit UPR-7-14-9291 and Design Review DR-7-14-9292 would remain valid, including, but not limited to, adherence to the Affordable Housing Agreement outlined in these Conditions of Approval. The density bonus agreement will run with the land, be binding upon successors in interest, and be recorded with the county recorder.

6. The applicant shall supply, contract for, or provide in some other form acceptable to the Planning Division, a vehicular transportation service for residents who do not drive. Prior to building permit issuance, the applicant shall provide a service plan for the transportation service that identifies the day and hours of operation, the method by which residents may request the transportation service, and passenger capacity of the vehicle to be used in the service. The Planning Division shall review and approved the service plan and the plan shall be in perpetual effect for the life of the project.

<u>Site Design</u>

7. Should the applicant choose to install an electronic gate at either level, that the gate shall not restrict access to 18 parking allocated to retail/office spaces during business hours.

8. The design of any retaining walls which may be necessary to build the project shall be reviewed and approved by the Planning Division. Walls highly visible from off-site locations shall incorporate high quality materials and finishes, and shall receive a color approved by the Planning Division.

9. The applicant shall fully improve and landscape the public right-of-way. This shall include installing decorative landscaped planters behind the sidewalk, installing decorative pedestrian-oriented street-lights, and providing street trees with decorative tree grates along the entirety of the Brunswick Street fronting the project.

10. Landscape planters shall have an integral appearance, constructed from concrete, and receive a veneer and decorative cap to match the veneer proposed on the subject building.

11. Street trees shall be installed twenty feet on center, sized as 15-gallon minimum, receive triple staking at installation, and receive establishment irrigation. The tree staking and establishment irrigation shall be identified in building plans submitted for a building permit.

12. Backflow preventers shall be concealed and/or screened from public view to the satisfaction of the Daly City Community and Economic Development Director prior to issuance of building permit.

Building Design

13. The applicant shall, prior to building permit submittal, provide a sign program for Planning Division review and approval. The final building elevation design shall consider sign placement and plans submitted for building permit approval shall reflect such placement. The program reflect potential sign locations for retail/office tenants, restrict all building signs to street level, incorporated into the project to guide retail/office patrons to appropriate parking level, i.e., unencumbered by a gate during retail/office hours. Illuminated wall signs shall incorporate halo-illumination.

14. All residential windows shall be aluminum or commercial-grade vinyl. All street-level windows shall be aluminum;

15. All canopies, metal trim elements, and/or residential balcony materials shall be wood or other material with a demonstrated ability to withstand the local climate. Wood shall receive weatherproof treatment. Any metal materials shall be galvanized;

16. All rooftop mechanical equipment shall be screened from the view of all adjacent public rights-of-way by screen walls, painting, and similar treatments acceptable to the Planning Division. The Planning Division may require screenwalls for equipment located within 20 feet of the rooftop parapet wall.

Landscaping

17. The applicant shall submit a detailed landscape plan at the time of building permit submittal communicating all amenities in open space areas and the post-graded landscape treatments of all hillsides.

18. The project landscaping exceeds the 1,000 square feet of landscaped area is subject to the Daly City Landscaping Ordinance. The landscaping plans shall be required to meet all applicable requirements including water efficient irrigation and will incorporate Bay Area Friendly species that are drought tolerant. Irrigation systems will incorporate water efficiency measures and shall show the details on the building permit plans. No building permit may be issued until this condition is met.

19. The applicant shall provide establishment, and where necessary, long-term irrigation to all trees, shrubs, and groundcover.

20. The applicant shall triple-stake all trees and this staking shall be subject to initial inspection by the City. Trees shall remain triple-stake through the establishment period.

21. The planted trees shall be 24-inch box.

Affordability

22. Prior to the issuance of a building permit, the applicant shall enter into an Affordable Housing Agreement with the City, expressing all of the following:

    a. the levels of affordability and maximum rents for the project;

    b. interior finish qualities and amenities of each unit at initial construction;

    c. the method used for marketing the units and selecting residents at initial lease-up, which will include a lottery to select initial tenants;

    d. the method used for maintaining a waitlist and selecting residents upon vacancy of any given unit;

    e. the method used for annual income verification and certification of residents;
    the terms of a contract with a qualified resident service provider and plan to offer services and activities for all residents at no additional charge. The provider, service logic model and scope of services shall be approved by the City.

    f. the annual reporting requirements to the City to demonstrate compliance with the affordability and resident services requirements, and an annual fee for the City's compliance monitoring;

    g. emergency response plan for resident medical conditions; and

    h. continual on-site property management.

23. The Agreement shall be recorded against the property prior to building permit issuance. The Agreement shall be in effect in perpetuity and the Agreement shall so stipulate. Failure to abide to the Agreement may result in code enforcement action by the City or revocation of the use permit.

Stormwater Treatment

24. The applicant shall develop and submit a stormwater management plan that illustrates full compliance with Section C.3 of Order R-2-2009-0074 NPDES Permit No. CAS612008. The project must comply with Order No. 2010-0014-DWQ, NPDES No. CAS000002, the statewide National Pollutant Discharge Elimination System (NPDES) General Construction Activity Storm Water Permit.

25. The applicant shall receive approval of the stormwater management plan from a third-party reviewer appointed by the City prior to building permit submittal. The applicant shall pay the entire cost of the third-party reviewer, beginning with a $10,000 deposit from which the Planning Division may draw to pay for the costs from the third-party review and associated inspections.

26. All stormwater treatment facilities shall be inspected during construction to ensure eventual compliance with the stormwater management plan. The applicant shall pay the entire cost of these inspections.

27. The applicant shall enter into a Maintenance Agreement with the City to ensure long-term maintenance and servicing by the Property Owner of stormwater site design and treatment control measures according the approved Maintenance Plan.

28. The applicant shall arrange and pay for final inspection of installed treatment measure by municipality's Special Inspector within 45 days of installation or project construction completion, whichever comes first.

29. Additional stormwater information and updated forms may be required during the building permit review stage when more details of the construction drawings are known. Information and/or designs that may be required if there are any changes that impact the forms submitted for the subdivision application. No building permit may be issued until acceptable storm water requirements are met.

30. The applicant shall receive approval of the stormwater management plan from a third-party reviewer appointed by the City prior to building permit submittal. The applicant shall pay the entire cost of the third-party reviewer.

<u>Site Maintenance</u>

31. The site shall be maintained in a safe, sanitary, and litter free condition at all times.

32. The proposed development shall provide on-site property management at all times.

33. No outside storage shall be allowed, except in the approved trash enclosure area.

34. Doors to the trash enclosure area shall be kept closed except when necessary to dispose of trash or to store material to be recycled.

35. All sidewalks, walkways, driveways, parking lot facilities, and easements within and adjacent to the property, including weeds. The requirement shall not apply to adjacent State-owned highway.

36. Garbage storage areas are to be kept sanitary and free of litter and debris.

37. The applicant shall submit a parking management plan to City prior to final building inspection and shall manage the building consistent with the plan. The plan shall identify 18 parking spaces for access by retail/commercial and on-site management employees.

38. The buildings and site shall remain clean and clear of all graffiti, debris, and other visual nuisances at all times. The building and site shall be periodically cleaned, as needed, to prevent discoloration and debris accumulation.

39. The applicant shall provide evidence that they have contracted with Allied Waste to have the provider remove the bins for refuse collection and have the bins returned to the designated waste collection area upon being emptied prior to Certificate of Occupancy

B. BUILDING DIVISION

40. The applicant shall comply with the following Building Accessibility Regulations: Privately funded multistory apartment or condominium dwelling, at least 10 percent shall comply with Housing Accessibility 1102A.3.

41. The applicant shall comply with the following CalGreen Regulations:
Building - Designated Parking (CGBSC 1.106.5.2)
Provide designated parking for any combination of low-emitting, fuel-efficient and carpool/vanpool vehicles.

42. The applicant shall comply with the Building - Municipal Code Title 15
City of Daly City Amendment to California Code of Regulation requiring that the Applicant and design team shall check for amendments to the California Code of Regulations that may affect the design of the building.

43. The applicant shall comply with the following Building - Sound Transmission Control
Allowable Interior Noise Level Wall, partitions and floor ceiling assemblies separating dwelling units must be designed to comply with air-borne sound, structure-born sound per CBC 1207.

44. Applicant shall install protected window opening for the exterior fire rated wall. Maximum protected window opening shall be limited to 15 percent per CBC Table 705.8.

45. Architectural roof projections at the north and west side of the building shall be limited to 24 inches measured from the face of the building.

46. The applicant shall maintain all vertical and horizontal clearances for structures required by Pacific Gas and Electric Company (PGE) located on the adjacent overhead utilities to the east of the subject parcel. Evidence of PGE review the proposed duplex shall be supplied to the City at the time of building permit application submittal.

47. Upon submittal for building permit, the applicant shall provide an acoustical analysis report that shows topographical relationships of noise sources and dwelling sites, identification of noise sources and their characteristics, predicted noise spectra, and levels at the exterior of the proposed dwelling structure considering present and future land usage, basis for the prediction, noise attenuation measures to be applied, and an analysis

of the noise insulation effectiveness of the proposed construction showing that the prescribed interior noise level requirements are met.

48. Construction hours will be limited to 8:00 a.m. to 5:00 p.m., Mondays through Fridays and construction on weekends and holidays shall be prohibited.

C. ENGINEERING DIVISION

49. Plans submitted for building or grading permit shall show all existing and proposed utilities, on-site and in the street, including water, sanitary sewer, and storm drain mains.

50. The project's electrical transformer shall not be installed within the public rights-of-way.

51. The applicant shall be financially responsible for all project-related storm drainage improvements on- and off-site, as required and approved by the City Engineer in accordance with City Standards.

52. Depending on the extent of trench-work in Castle Street, Second Avenue, or Third Avenue, resurfacing all or a portion of the street may be required.

53. The applicant shall replace the City sidewalk fronting the subject parcel.

54. An encroachment permit is required prior to any work or underground utilities installation within the public right-of way.

55. Following new utility installation, the applicant shall replace areas of street pavement, sidewalk, curb, and gutter damaged by construction. Such repair shall be per City standard specifications.

56. All roof drainage shall be directed toward the curb gutter through pipes underneath the City sidewalk. There shall be no storm water sheet flow over the sidewalk.

57. All street trees shall be maintained by the building owner in perpetuity, with irrigation tied to and maintained by the private building.

58. Street lights shall be installed as per plans approved by the City Engineer. All lighting shall be designed to minimize glare onto adjacent properties.

59. The applicant shall pay a fair share contribution to the cost of improving the Hillside Boulevard / Brunswick Street intersection. The project adds 32 trips to the intersection during the a.m. peak hour.

D. DEPARTMENT OF WATER AND WASTEWATER RESOURCES

60. All costs associated with any sewer system improvements required by the City as a result of this project shall be borne by the applicant.

61. The applicant shall contract with the City's consultant, Brown and Caldwell, to analyze the current water system and design any water system improvements required to supply

the project to meet its fire flow and domestic needs. All costs associated shall be borne by the applicant.

62. A sewer capacity study is required for the project and Brown and Caldwell shall be contracted through the City's Engineering Department to conduct capacity study to determine if the current system is capable of transporting the flow from the project to the District's treatment plant and if any improvements to the system are necessary, all costs associated with the study shall be borne by the applicant.

63. All engineering costs associated with any improvements required by the City as a result of this project shall be borne by the applicant.

E. FIRE DEPARTMENT

64. The applicant shall install Fire Sprinklers as required per 2013 CFC, per NFPA 13 and 13R.

65. The project shall comply with fire flows per 2013 CFC Appendix B for buildings with fire sprinklers.

66. The project shall comply with hydrant requirements as per fire code.

67. The project shall comply with hydrant location and spacing per 2013 CFC Appendix C.

68. The project shall comply with Fire Apparatus Access per 2013 CFC Chapter 5 Fire Service Features, 501.4 for Fire Apparatus Access Roads and Water supply.

69. The project shall provide fire hydrant to comply with 2013 CFC Chapter 5 section 507.5.1.1

70. The project shall comply with 2013 CFC Appendix D. for fire apparatus access requirements.

71. The project shall comply with 2013 CFC Chapter 9 section 905 Standpipes.

72. The project shall comply with 2013 CFC Chapter 9 section 907 Fire Alarm and Detections systems.

<u>Recommendations</u>

Staff recommends that the Planning Commission forward to the City Council the following recommendations:

1. Adopt the Findings as outlined herein;
2. Adopt the Sustainable Communities Environmental Assessment and associated Mitigation Monitoring Plan and Reporting Program;
3. Approve Use Permit UPR-7-14-9291 and Design Review DR-7-14-9292, subject to the Conditions of Approved outlined herein.

Staff is available to provide any additional information desired by the Planning Commissioners.

Respectfully submitted,

Tendai Mtunga
Associate Planner

Tatum Mothershead
Interim Director of Economic and Community Development

Attachments

Attachment A – Location Map
Attachment B – Project Plans
Attachment C – Request for Regulatory Concessions
Attachment D – Photosimulations
Attachment E – Draft Sustainable Communities Environmental Assessment
Attachment F – Draft Mitigation Monitoring and Reporting Program

EXHIBIT D

State of California
AIR RESOURCES BOARD

EXECUTIVE ORDER G-14-028

Association of Bay Area Governments' (ABAG) and
Metropolitan Transportation Commission's (MTC)
Sustainable Communities Strategy (SCS)
ARB Acceptance of GHG Quantification Determination

WHEREAS, the Sustainable Communities and Climate Protection Act of 2008 ((Chap. 728, Stats. 2008) Senate Bill 375, or SB 375, as amended) requires each California Metropolitan Planning Organization (MPO), as part of its Regional Transportation Plan (RTP) planning process, to develop a Sustainable Communities Strategy (SCS) or an Alternative Planning Strategy (APS) that meets regional greenhouse gas (GHG) emission reduction targets (targets) set by the Air Resources Board (ARB or Board);

WHEREAS, SB 375 also recognizes ARB's target-setting responsibility as a recurring process, requiring ARB to update the targets every eight years and permitting target updates every four years;

WHEREAS, on September 23, 2010, the Board set targets for the ABAG/MTC region of 7 percent per capita reduction from 2005 by 2020, and 15 percent per capita reduction from 2005 by 2035;

WHEREAS, in March 2013, ABAG/MTC published a draft Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS), known as Plan Bay Area, for 2040 that stated it would achieve the region's GHG targets with a 10 percent per capita reduction from 2005 by 2020 and a 16 percent per capita reduction from 2005 by 2035;

WHEREAS, ARB staff performed a technical evaluation of the SCS in the draft Plan Bay Area based on ARB's technical methodology for evaluating an SCS (published in July 2011);

WHEREAS, ARB staff's evaluation showed that ABAG/MTC used technical methodologies that would accurately quantify GHG reductions from the SCS in the draft Plan Bay Area;

WHEREAS, ARB staff evaluated key performance indicators that support ABAG/MTC's determination that the SCS in the draft Plan Bay Area would achieve the region's GHG targets;

WHEREAS, ARB staff's evaluation showed that ABAG/MTC's SCS in the draft Plan Bay Area, if implemented, would meet the GHG targets that the Board established for the region for 2020 and 2035;

WHEREAS, ARB staff presented an informational item on ABAG/MTC's SCS to the Board at its June 27, 2013 public meeting;

WHEREAS, during the public discussion of this item at its June 2013 meeting, the Board acknowledged that several of Plan Bay Area's Climate Policy Initiatives will provide useful data for future analysis;

WHEREAS, in response to comments from the public, stakeholders, ABAG Executive Board members, and MTC Commissioners, ABAG/MTC staff made minor modifications to the draft Plan Bay Area which did not significantly change the GHG emission reduction results;

WHEREAS, these proposed changes were presented at public meetings held by ABAG/MTC on June 14, 2013 and July 12, 2013;

WHEREAS, the ABAG Executive Board and MTC Commissioners adopted the final Plan Bay Area as revised at its public meeting on July 18, 2013;

WHEREAS, ABAG/MTC submitted the final Plan Bay Area containing the final SCS to ARB on January 6, 2014 and provided the final data table on February 18, 2014 in support of its GHG quantification determination of a 10 percent per capita reduction by 2020 and a 16 percent per capita reduction by 2035, as required by California Government Code section 65080(b)(2)(J)(ii);

WHEREAS, ARB staff reviewed both the draft SCS and subsequent modifications to the SCS contained in the adopted 2013-2040 Plan Bay Area;

WHEREAS, the modifications adopted by the ABAG Executive Board and MTC Commissioners as part of the final Plan Bay Area are minor, and do not change the underlying technical land use and transportation assumptions of the SCS or its GHG quantification methodology, and does not significantly change the GHG reduction results demonstrated by the draft SCS for 2020 and 2035;

WHEREAS, ARB staff's technical review of ABAG/MTC's GHG reduction quantification is contained in Attachment A, "Technical Evaluation of Greenhouse Gas Emissions Reduction Quantification for the Association of Bay Area Governments' and Metropolitan Transportation Commission's SB 375 Sustainable Communities Strategy" dated April 2014;

WHEREAS, section 65080(b)(2)(J)(ii) of the California Government Code calls for ARB to accept or reject the MPO's determination that the strategy submitted would, if implemented, achieve the GHG emission reduction targets established by the Board;

WHEREAS, the California Health and Safety Code sections 39515 and 39516 delegate to the Board's Executive Officer the authority to act on behalf of the Board in this manner;

NOW, THEREFORE, BE IT RESOLVED that pursuant to section 65080(b)(2)(J)(ii) of the California Government Code, the Executive Officer hereby accepts ABAG/MTC 's quantification of GHG emissions reductions from the final SCS adopted by the ABAG Executive Board and MTC Commissioners on July 18, 2013, and the MPO's determination that the SCS would, if implemented, achieve the 2020 and 2035 GHG emission reduction targets established by ARB.

NOW, THEREFORE, IT IS ORDERED that ARB staff is directed to forward this executive order to the ABAG Executive Board, the MTC Commission, and the ABAG and MTC Executive Directors.

Executed at Sacramento, California, this 10th day of April 2014.

Richard W. Corey
Executive Officer

Attachment A:
"Technical Evaluation of Greenhouse Gas Emissions Reduction Quantification for the Association of Bay Area Governments' and Metropolitan Transportation Commission's SB 375 Sustainable Communities Strategy" April 2014

EXHIBIT E

TECHNICAL EVALUATION OF THE GREENHOUSE GAS EMISSIONS REDUCTION QUANTIFICATION FOR THE ASSOCIATION OF BAY AREA GOVERNMENTS' AND METROPOLITAN TRANSPORTATION COMMISSION'S SB 375 SUSTAINABLE COMMUNITIES STRATEGY

April 2014

California Environmental Protection Agency

Air Resources Board

Electronic copies of this document can be found on ARB's website at
http://www.arb.ca.gov/cc/sb375/sb375.htm

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Sustainable Communities and Climate Protection Act of 2008 (SB 375) calls for the California Air Resources Board (ARB or Board) to accept or reject the determination of each metropolitan planning organization (MPO), that its Sustainable Communities Strategy (SCS) would, if implemented, achieve the greenhouse gas (GHG) emission reduction targets (targets) for 2020 and 2035, set by the Board in 2010. These regional targets were defined by the Board as a percent reduction in per capita GHG emissions from passenger vehicles from a base year of 2005.

On July 18, 2013, the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC) adopted a regional transportation plan (RTP) known as Plan Bay Area, which includes the region's first Sustainable Communities Strategy (SCS).

This technical report supports ARB's action on ABAG/MTC's SCS. It describes both the method used to review ABAG/MTC's SCS GHG quantification and the results of the technical evaluation.

The results of ARB staff's technical review were presented to the Board at a public meeting on June 27, 2013, and were based on review of ABAG/MTC's draft Plan Bay Area, published in March 2013. The RTP/SCS that was adopted in July 2013 and published in December 2013 contains minor modifications. However, these modifications do not affect the plan's ability to achieve the per capita GHG emission reduction targets, if the plan is implemented.

This report documents ARB staff's technical review of the draft plan, together with its subsequent review of the adopted Plan Bay Area, as modified. This review affirms that ABAG/MTC's adopted SCS demonstrates that, if implemented, the region will achieve a 10 percent per capita GHG emissions reduction in 2020, and a 16 percent reduction in 2035. These reductions meet the targets established for ABAG/MTC of 7 percent and 15 percent per capita GHG emissions reductions from 2005 for the years 2020 and 2035, respectively.

I. LAND USE AND TRANSPORTATION PLANNING IN THE SAN FRANCISCO BAY AREA

With a population of over seven million people, the San Francisco Bay Area (Bay Area) encompasses nine counties and 101 cities and towns. Known as much for its beautiful parks, open spaces, vineyards and other agricultural lands, as for its urban and suburban areas, the Bay Area represents about one fifth of the State's population, and about one fourth of the State's economy, as of 2011.

Several regional agencies cooperated in the preparation of the Bay Area's Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS), known as Plan Bay Area. While the legal responsibility for the SCS falls to the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC), the cooperation of several other agencies, including the Bay Area Air Quality Management District (BAAQMD), the Bay Conservation and Development Commission (BCDC), the county Congestion Management Agencies, local governments, local transit agencies, and local community agencies was vital to the creation of Plan Bay Area. With this extensive coordination, ABAG and MTC included well over one hundred self-governing public agencies that implement air quality and climate programs, protect and enhance the bay, build and operate transportation systems, keep traffic levels manageable, and control local land use decisions in the region.

Plan Bay Area is part of a larger initiative in the region. One Bay Area, a joint initiative of the four main regional government agencies (ABAG, MTC, BAAQMD, and BCDC), combines a variety of programs and projects with the overarching goal of protecting the environment, economy, and public health. Specifically, the One Bay Area initiatives are: Plan Bay Area, the Climate Initiatives Program, the Bay Area Prosperity Plan, a set of energy management programs, the Clean Air Plan, and the San Francisco Bay Plan. One Bay Area has been a coordinated effort since April 2010.

A. Association of Bay Area Governments

ABAG is a voluntary association formed in 1961 by elected officials from the region's cities, towns, and counties. All nine counties and 101 cities and towns within the Bay Area have chosen to be members of ABAG. For the SCS, ABAG is tasked with providing the regional forecasts on population, jobs, and housing; allocating to the nine counties in the region, the housing targets by jurisdiction and income level that the California Housing and Community Development Department (HCD) determines as the Regional Housing Needs Assessment (RHNA); and gathering and considering the available information on resource areas and farmland in the region. These efforts all support ABAG's broader task, which is to develop the region's preferred growth pattern. This was accomplished with the *Jobs-Housing Connection Strategy*, released and adopted in May 2012.

Serving as the comprehensive regional planning agency and Council of Governments in the Bay Area, ABAG is also responsible for administering the region's Priority

Development Areas (PDA) and Priority Conservation Areas (PCA) through the FOCUS Initiative created jointly in 2008 by ABAG and MTC. Other ABAG planning projects include such efforts as the Bay Trail Project, the San Francisco Estuary Partnership, the Hazardous Waste Green Business Program, and the Earthquake and Hazards Program.

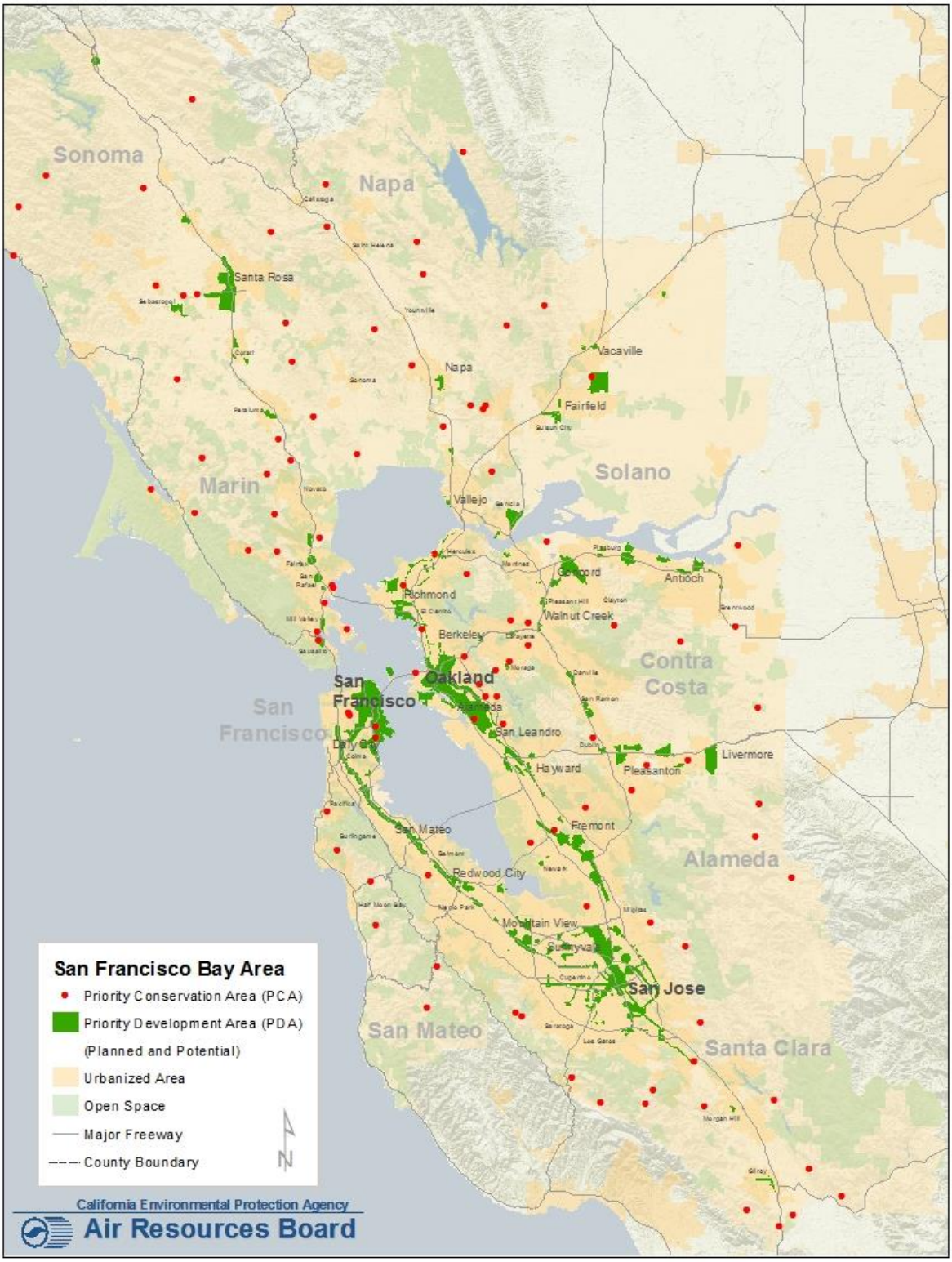
B. Metropolitan Transportation Commission

MTC was created by the State Legislature in 1970 to plan, coordinate, and provide the funding for transportation projects in the Bay Area. MTC is designated by the State as a regional transportation planning area, and by the federal government as the region's metropolitan planning organization (MPO), responsible for updating the regional transportation plan every four years. MTC is tasked with identifying the transportation network to serve the region's transportation needs, and ensuring that the RTP complies with the federal Clean Air Act (42 U.S.C. Sec. 7506), the latter of which is accomplished by coordinating with BAAQMD. In addition, both MTC and ABAG must create an integrated land use and transportation plan showing how the region could meet, if possible, the GHG targets.

1. Planning Area

The regional planning area for which ABAG and MTC are responsible is shown in Figure 1. The diverse geography of the region includes urban, suburban, and rural communities, productive agricultural lands, the Pacific Ocean coastline, and the mountains and valleys of the Pacific Coast Range.

Figure 1. ABAG and MTC Regional Planning Area



The three largest cities in the region, San Jose, San Francisco, and Oakland, currently accommodate about 30 percent of the region's total population of about 7.1 million people, and about 33 percent of the region's total jobs. The counties within which these cities reside, Santa Clara, San Francisco, and Alameda, are among the most populous counties in the Bay Area. The Peninsula region, starting in San Mateo County south of San Francisco and including a portion of northwestern Santa Clara County, consists largely of cities and suburban communities closer to the bay and rural areas nearer the coast. The South Bay includes the majority of Santa Clara County, is urban and suburban in much of its western portion, mountainous and rural in the eastern half, and is known for its high-technology industry in the "Silicon Valley." The East Bay, a highly urbanized portion of the Bay Area, consists of Contra Costa and Alameda counties, and includes the Port of Oakland, the Bay Area's largest port. The North Bay counties, Marin, Sonoma, Napa, and Solano, are generally more rural than the rest of the Bay Area, and are known for their vineyards and other working lands, as well as the natural beauty of their open spaces.

2. Regional Transportation Network

The existing transportation network serving the Bay Area is multimodal, with the great variety of transportation options arising from the region's diverse geography. That Bay Area residents value and rely upon this variety of transportation options is especially evident by observing commuters' mode share data for the San Francisco metropolitan statistical area, which is shown in *The Transport Politic*'s summary of the 2009 American Community Survey to be 14.6 percent for transit. While the Bay Area has nearly 20,000 miles of local streets and roads, 1,400 miles of highway, and eight toll bridges, there are also some-9,000 miles of bus routes, 470 miles of rail transit, five ferry operators, and just over 1,000 miles of bikeways in the Regional Bikeway Network.

Twenty-eight different highways, freeways, and expressways connect the region's local streets and roads between cities and towns in the region. Major thoroughfares include Interstate 80, which has some of the most congested travel in the region, US. Highway 101, which runs from the North Bay counties through the South Bay counties, and State Route 1, which winds along the mostly rural Pacific coast line as a two-lane highway. This highway system includes general purpose lanes, freeway-to-freeway connector lanes, auxiliary lanes, and managed lanes, including 474 lane miles of high occupancy vehicle (HOV) lanes and 14 miles of high occupancy toll (HOT) lanes, referred to locally as express lanes. During non-peak periods, these HOV and HOT lanes become general purpose lanes, resulting in a total of 4,667 lane miles of general purpose and auxiliary lanes during non-peak periods. Due to the central locations of the San Francisco and San Pablo Bays, the region also has eight toll bridges, seven

of which are state-owned and administered, operated, and maintained by the Bay Area Toll Authority, directed by MTC.

There are six rail systems that serve the Bay Area. Bay Area Rapid Transit (BART) currently runs on 104 miles of track, with 44 stations from the communities of Pittsburg and Richmond in the north to Fremont and Millbrae in the south. Caltrain carries passengers between San Francisco and Gilroy, with more than 30 stops available. The Altamont Commuter Express (ACE) operates between San Jose and Livermore in the Bay Area, and continues into the San Joaquin Valley to Stockton. Muni, run by one of the oldest public transit agencies in the U.S., provides a mix of light rail, bus, streetcar, trolley, and cable car service throughout San Francisco. Santa Clara Valley Transportation Authority provides over 25 miles of light rail service (and serves over 300 square miles of urban area with bus service throughout Santa Clara County), as well as partnering with some neighboring county transit providers to bring bus and rail service beyond Santa Clara County borders. Amtrak's Capitol Corridor trains connect the Bay Area to neighboring regions, with 170 miles of track from San Jose to Sacramento, and beyond to Auburn.

In addition to rail systems in the Bay Area, there are several other transit options for residents, visitors, and commuters from outside of the region. The Clipper® card is a fare card that can be used on most of the region's larger transit systems, and will ultimately be available for use on the approximately 20 different transit operators providing bus service throughout the region. Many of these bus systems provide connections to BART, Amtrak, other transit options, and the region's three international airports. Almost all Bay Area buses can accommodate bicycles, providing part of the solution to the "first and last mile" issue of getting people from their homes to transit stops, and from transit stops to jobsites. Bicycles are also allowed on the region's commuter ferries that operate between Vallejo, Oakland, Marin, Angel Island, San Francisco, and South San Francisco. A regional bicycle system, including the Bay Trail's 330 miles ringing the San Francisco and San Pablo Bays, and about 670 more miles of bicycle corridors, provide a means for commuters and for others who access the network for recreation and health. This regional network is envisioned to ultimately contain 2,140 miles of contiguous on-street bicycle facilities and inter-county regional paved trails to connect every incorporated town and city, and to provide access to transit systems, major activity centers, and central business districts of the region.

There are additional transit options in the region such as dial-a-ride, paratransit, employer-sponsored buses by some of the region's large employers, and interregional rail and bus services through Amtrak, the Capitol Corridor Joint Powers Authority, San Benito County Transit, Greyhound, and Megabus.

C. Policies, Laws, and Initiatives Influencing the Regional Planning Area

The Bay Area has a long history of sustainable planning, largely stemming from a region-wide value of the landscapes that characterize the region. A number of policies, initiatives, plans, and programs pre-date and form the foundation of Plan Bay Area. The development of Plan Bay Area integrated this framework into the vision and goals of the plan, relying on regional partnerships. A brief summary of the major planning initiatives, laws, and local plans that influenced that process (in addition to SB 375), and the final plan, follows.

Transportation for Livable Communities

In 1996, MTC adopted the region's first smart growth policy, the Transportation/Land Use Connection Policy. That policy established a program, termed Transportation for Livable Communities (TLC), to fund planning and capital improvements. As one of the regional tools for promoting smart growth, the TLC program allocates grants to cities, counties, and transit agencies in adherence with TLC goals. Those goals include supporting community-based transportation projects that improve downtown areas, commercial cores, neighborhoods, and transit corridors, enhancing the amenities and ambiance in such places, and making them areas where people want to live, work, and visit. In order to support the region's framework for development and conservation, as detailed below, TLC only funds projects and planning efforts located within PDAs, thus directly linking TLC to the FOCUS program. In addition to streetscape projects in high impact areas with multimodal access, TLC funds non-transportation infrastructure improvements, such as sewer upgrades, transportation demand management projects, and density incentives. Aside from funding projects, the TLC program also led to the development of streetscape design guidelines, aimed at addressing all modes of transportation. MTC evaluates project proposals based on how well they address the design guidance.

MTC Resolution 3434

In 2005, the MTC Board passed its Transit-Oriented Development Policy, entitled Resolution 3434. The policy is intended to ensure that transportation agencies, local jurisdictions, and members of the public and the private sector work together to create development patterns that are more supportive of transit by focusing on corridor and station area planning. Specifically, the resolution discusses regional transit expansion, the cost effectiveness of regional investments in new transit expansions, the Bay Area's housing shortage, the creation of new communities, and preservation of regional open space.

Focusing Our Vision (FOCUS)

Similar to the Blueprint programs of other California MPOs, the Bay Area region developed the FOCUS program in 2008 to foster smart growth and livable communities. The program is meant to provide a conservation and development strategy that

encompasses the unique nature of the region. FOCUS capitalizes on cooperation between four regional agencies to maintain and implement smart growth efforts. Spearheaded by the State-established Joint Policy Committee, which is made up of members from ABAG, MTC, BAAQMD, and BCDC, FOCUS utilizes the Joint Policy Committee as the regional planning forum. Technical assistance services are available to local jurisdictions on a competitive basis through the FOCUS program to advance transit-oriented development in PDAs. The Bay Area's Smart Growth Vision, as expressed in the Smart Growth Preamble and Policies and the Smart Growth Strategy/Regional Livability Footprint Project serves as the foundation for the development of regional smart growth policies. Through FOCUS, local governments identified a network of PDAs and PCAs, which are the central framework for the Bay Area's transportation and land use investment strategy.

Projections 2009

Biannually, ABAG publishes long-term population, housing, and employment forecasts for the nine-county region. For the first time in its 2009 forecast, entitled Projections 2009, ABAG included land use, environmental, and transportation metrics to assess the impacts of growth. These performance targets included congestion, carbon dioxide and particulate matter emissions, vehicle miles traveled, land consumption, and affordability and access. ABAG tested these potential impacts through two alternative land use scenarios. The Projections 2009 process incorporated extensive public input through 40 public workshops. The addition of performance targets, scenario alternatives, and public input on the forecasting side of regional planning helped to inform the Plan Bay Area process.

Transportation 2035: Change in Motion

In 2009, the region developed its last regional transportation plan, Transportation 2035: Change in Motion. Previous RTPs had already begun to integrate sustainability into the RTP process, but the 2009 RTP made climate change mitigation a priority as the region laid out its plans for the future transportation system. The 2009 RTP was built on a framework of performance metrics in order to assess the plan's effectiveness in meeting the goals of equity, economy, and the environment. Plan Bay Area followed that same framework and also analyzes the plan with performance targets tailored to the plan's goals and vision, which, pursuant to SB 375, must include greenhouse gas emission reduction targets.

One Bay Area Grants

The One Bay Area Grant Program (OBAG), initiated in May 2012, establishes program commitments and policies for investing about $320 million over a four year period to better integrate the region's federal transportation program with the goals of SB 375. Transportation categories such as Transportation for Livable Communities, bicycle and pedestrian improvements, local streets and roads preservation, and planning activities

are eligible for OBAG funding, along with specific funding opportunities for Safe Routes to Schools and PCAs. In order to be eligible for the funds, local jurisdictions must:

- Accept housing allocations through the Regional Housing Need Allocation (RHNA) process and produce housing using transportation dollars as incentives.
- Adopt a Complete Streets Policy Resolution in addition to meeting MTC's complete streets policy.

II. ABAG AND MTC'S SUSTAINABLE COMMUNITIES STRATEGY

Development of ABAG/MTC's Plan Bay Area began in 2010, with the evaluation and eventual selection of performance targets for use in assessing and comparing alternative strategies with a consistent set of metrics. Early in the process, ABAG/MTC collected the necessary data on current and future regional population, housing, and employment for use in developing forecasts. The base year for Plan Bay Area is 2010 and the horizon year is 2040. This chapter summarizes the key land use and transportation assumptions, GHG emission reduction performance results, and plan development features of ABAG/MTC's adopted RTP/SCS.

A. Land Use

Development of Plan Bay Area's land use approach was initiated by evaluating a variety of land use scenarios that distributed the forecasted growth to specific locations. These scenarios sought to address the needs and aspirations of each Bay Area jurisdiction, as identified in locally adopted general plans and zoning ordinances, while meeting performance targets approved by the regional agencies to guide and measure the region's future growth. The performance targets will be discussed further in Section D. In the development of the preferred land use scenario, the plan sought to achieve four objectives:

- Create a network of complete communities where transit, jobs, schools, services and recreation are located near homes
- Increase the accessibility, affordability, and diversity of housing in order to attract the businesses and talented workforce needed for a robust future economy
- Create jobs in order to maintain and expand a prosperous and equitable regional economy by building on the existing concentration of knowledge-based and technology industries in the region
- Protect the region's unique natural environment of agricultural, natural resource, and open space lands that contribute to residents' quality of life

After a public process and scenario modeling efforts, the preferred land use scenario was selected out of five alternatives. The preferred scenario focuses growth in locally nominated PDAs while preserving land in the PCAs, resulting in the accommodation of

all of the region's growth within five percent of the region's land. By pairing this development pattern with the transportation investments and policies, the region's land use and transportation planning processes were explicitly integrated for the first time.

PDAs are existing neighborhoods chosen by local jurisdictions as appropriate places to concentrate future growth. The region has identified nearly 200 PDAs. These neighborhoods must be served by at least one transit stop or station, be supported by local plans to provide a wider range of housing options, and include amenities and services to meet the day-to-day needs of residents in a pedestrian-friendly environment. Once a community is established as a PDA, the local jurisdiction assigns the PDA one of five Place Type categorizations. Those Place Type categorizations—regional center, city center, suburban center, transit town center, or rural center—guide the character, scale, and density of future growth. In addition to accommodating growth, PDAs help move the region away from a piecemeal approach to development.

It is important to distinguish between the ABAG/MTC-developed term "PDA" and the related concept of Transit Priority Projects (TPP) first defined in SB 375. TPPs, in addition to other provisions, are projects within one-half mile of a major transit stop or high-quality transit corridor included in a regional transportation plan. The difference between these two terms is largely in the geographic nature of the PDA and the project-level specificity of TPPs. In other words, PDAs define a geographic area with some guidelines and streetscapes, while TPPs define the criteria of projects within a geographic area in relation to transit availability for the purposes of CEQA streamlining. In Plan Bay Area, TPPs cover a larger portion of the region and are more tightly focused on transit accessibility than the PDA concept. Figure 2 shows PDAs, TPPs, and areas of overlap within the Bay Area.

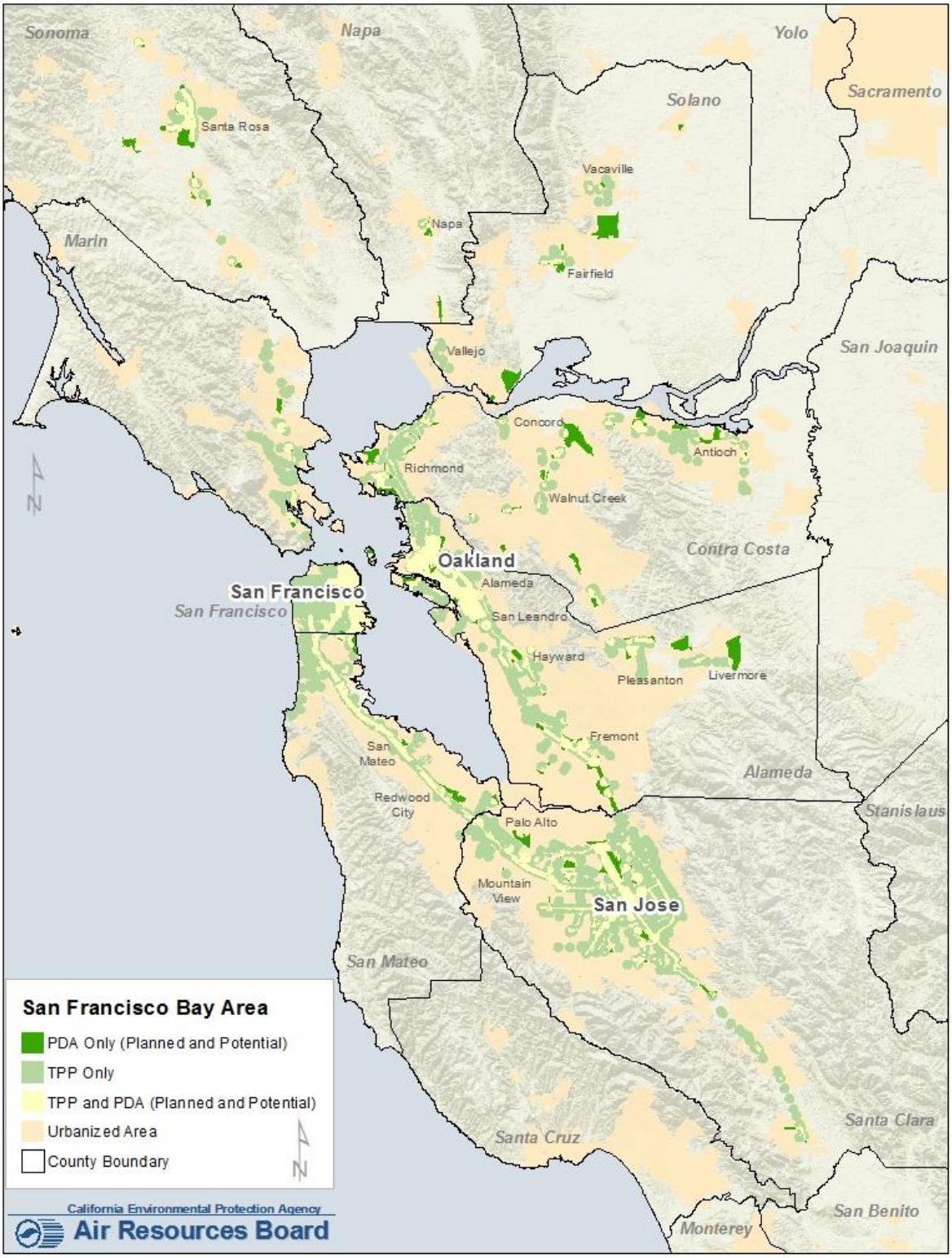
Priority Development Areas

- Locally-supported infill areas within existing communities
- Near existing or planned fixed transit or comparable bus service
- Where there is local commitment to develop more housing, amenities, services

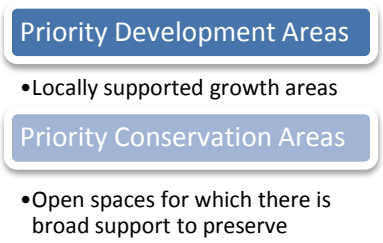
Transit Priority Projects

- Within ½ mile of major transit stop or high-quality transit corridor included in an RTP
- At least 50% residential use
- Minimum net density of 20 units per acre
- At least a 0.75 floor-area ratio for the commercial portion of the project

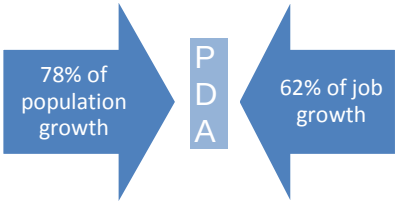
Figure 2. Priority Development Areas and Transit Priority Projects in the Bay Area



To complement the Priority Development concept, PCAs are regionally significant open spaces for which there exists a broad consensus for long-term protection, but which also face development pressure in the near term. PCAs play a central role in ensuring that Plan Bay Area incorporates the protection of farmland and resource areas. For many North Bay communities, PCAs are meant to help preserve the character and the economy of those communities.



The framework of PCAs and PDAs allows the plan to meet all of the region's growth in a manner consistent with the region's land use goals and market demands. In addition to meeting the California Housing Element law's requirement (Chapter 3, Article 10.6 of the California Government Code) that each jurisdiction plan for housing at all income levels, Plan Bay Area allocates all of that growth within existing urban growth boundaries or urban limit lines. For example, the plan results in a shift in the share of multi-family and single family housing units in the region. Of the region's new housing, about 70 percent of those new units are forecast to be developed as multi-family housing and about 30 percent as single-family housing. PDAs are planned to accept 78 percent of the region's population growth and 62 percent of the job growth. The cities that are anticipated to experience the greatest increase in the number of new housing units are San Jose, San Francisco, Oakland, Sunnyvale, and Concord, all of which are cities with multiple PDAs. The top five cities in terms of absolute job growth are San Francisco, San Jose, Oakland, Santa Clara, and Fremont, in descending order.



The One Bay Area Grant program will support the PDA and PCA framework.

B. Transportation

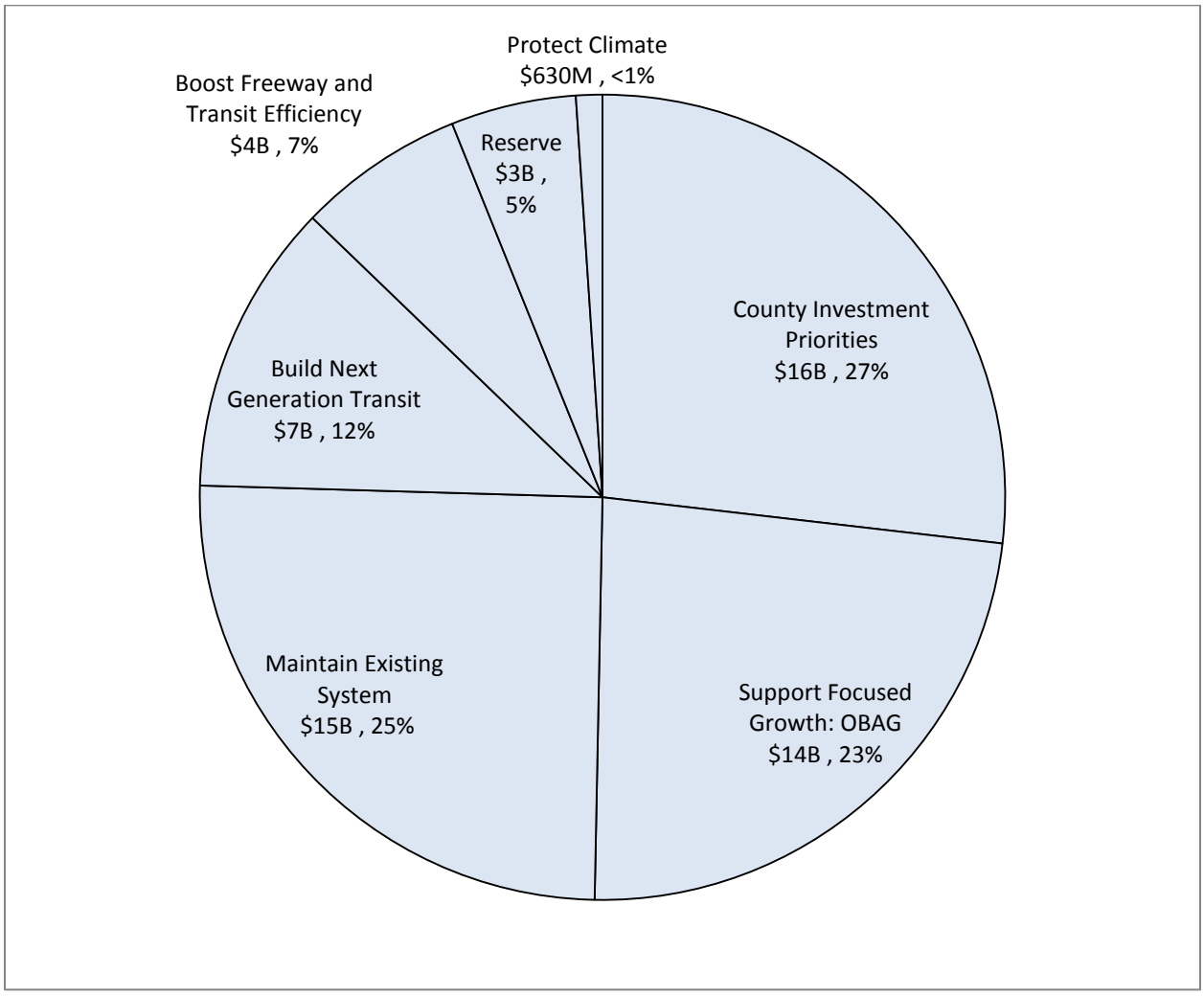
Plan Bay Area structures its transportation investment plan to support the region's long-term land use strategy. To support growth in existing Bay Area communities, the plan continues to support a "fix it first" emphasis, by investing the majority of funds to maintain and boost efficiency of the region's existing transit and roadway system. This was also an emphasis in the 2009 regional transportation plan. The plan also continues to support focused growth in the PDAs, with strategic investments in major new transit projects and with its new One Bay Area Grant program.

Transportation investments in the plan total $292 billion over a 28-year period. Of the total, about 80 percent, or $232 billion, were previously committed for specific projects through existing sales tax measure expenditure plans or State Transportation Improvement Program (STIP) funds. The remaining 20 percent, or $60 billion,

are discretionary funds used to support six transportation strategies:1) maintain the existing transportation system; 2) support focused growth; 3) build next-generation transit; 4) boost freeway and transit efficiency; 5) county investment priorities; and 6) climate initiatives.

The chart below summarizes the discretionary revenue investment levels assumed in the plan, by transportation strategy:

Figure 3. Plan Bay Area Transportation Strategy Investment Summary Discretionary Funds (Total $60 Billion)



Below is a summary of key projects and programs funded under each investment strategy. More detail on Plan Bay Area funded projects and programs is available in the Plan Bay Area Online Project Database (http://rtp.mtc.ca.gov/2040/).

Maintaining the Existing Transportation System

Approximately 87 percent of total plan funding goes toward sustaining the region's existing system. This includes investments in operating and maintaining the transit system, local streets and roads, bridges, and highways. For example, approximately $13 billion in discretionary funds are slated for transit operating and capital needs, $800 million for enhancing the region's current lifeline transit operating program, and another $10 billion in OBAG discretionary funds are dedicated to maintaining the region's existing pavement condition on local streets and roads. The relatively large percentage of discretionary funding and committed revenues directed towards maintenance of the existing transportation system are identified as necessary because the age of the Bay Area's transportation system (among the oldest in the state) requires more funding to maintain, renovate, and replace, and includes more rail services, which require more capital funding than other modes.

Support Focused Growth

To encourage more development near high-quality transit and to reward jurisdictions that produce housing and jobs, Plan Bay Area includes $14.6 billion in discretionary funds for targeted transportation investments in PDAs and support for PCAs. These monies will be administered through the region's One Bay Area Grant (OBAG) program. The OBAG program allows communities flexibility to invest in transportation infrastructure to support infill development, bicycle and pedestrian improvements, local street repair, planning, Safe Routes to Schools, and PCAs. OBAG is a locally administered funding program, guided by county-specific PDA Investment and Growth Strategies, developed by congestion management agencies. To be eligible for OBAG funding, jurisdictions must adopt complete streets policies, and planning and zoning policies that meet the requirements from the Regional Housing Need Allocation (RHNA) process.

Build Next-Generation Transit

Plan Bay Area also identifies significant future transit investments, including improvements to the region's core transit systems, ten new bus rapid transit projects in San Francisco, Oakland, and the South Bay region, rail extensions that support and rely on high levels of future housing and employment growth, and an early investment strategy for high-speed rail in the Peninsula corridor. This category adds $7 billion or 12 percent of total discretionary plan funds to existing investment commitments for transit.

Boost Freeway and Transit Efficiency

The plan also invests an additional $4 billion or 7 percent of discretionary plan funds into boosting the efficiency of the region's existing highway and transit networks. These dollars help support the Freeway Performance Initiative and the Transit Performance Initiative. Both programs aim to use low-cost technology upgrades to improve the

speed and reliability of roadways and transit service. Technology investments include: ramp metering, traffic cameras, changeable message signs, traffic signal coordination, transit signal priority, and incident and emergency management. In addition, investments are also made to support implementation of San Francisco's congestion pricing projects, as well as construction of the Regional Express Lane network in Solano, Contra Costa, and Alameda counties.

County Investment Priorities

More than a quarter of the plan's discretionary funds, or $16 billion, is used to fund key local transportation priorities, identified in county transportation plans prepared by the region's congestion management agencies. These projects complement a number of the regional discretionary investment strategies described above, helping to maintain the existing roadway and transit systems, as well as helping to fund county complete street programs, which deliver substantial bicycle and pedestrian improvements to the region.

Climate Initiatives

Plan Bay Area invests $630 million in the following eight climate initiative programs to support further reduction of greenhouse gas emissions in the region: a clean vehicles feebate program, vehicle buyback and plug-in electric vehicle purchase incentives, construction of a regional electric vehicle charger network, smart-driving education campaign, expansion of car-sharing services, vanpool incentives, a commuter benefit ordinance, and climate initiative innovative grants. Each program is described further in the next section.

C. Climate Initiatives

Below is a summary of the climate initiative programs identified in Plan Bay Area.

Clean Vehicles Feebate Program

Plan Bay Area invests $25 million to establish a regional feebate program. The program is intended to be revenue neutral and incentivize the purchase of more fuel-efficient vehicles by charging a one-time point of purchase fee to consumers purchasing less GHG efficient vehicles, and using the fee to provide rebates to those purchasing more GHG efficient vehicles.

Vehicle Buy-Back/Purchase Incentive Program for Plug-In Electric Vehicles

The new regional vehicle buyback program is intended to accelerate fleet turnover in the region toward more advanced and efficient plug-in hybrid electric or battery electric vehicles (PHEVs or BEVs), by inducing demand among consumers who might otherwise either delay car purchasing, or buy a new or used conventional vehicle. To do this, the program will offer consumers willing to trade in older, less efficient

vehicles, cash incentives toward the purchase of a new PHEV or BEV. The less efficient cars will be retired from service. Cash incentive amounts are expected to vary with the fuel economy of the vehicle being traded in, as well as the vehicle type being purchased. Plan Bay Area sets a total of $120 million aside for this voluntary incentive program.

Regional Electric Vehicle Charger Network

The objective of the new regional charger program is to establish a regional public network of electric vehicle supply equipment (EVSE) for PHEVs, allowing drivers to increase use of a vehicle's all-electric range. Miles traveled using electricity exclusively will yield larger GHG benefits than using these vehicles in the gasoline-powered mode. To achieve this, the program helps overcome some of the cost barriers to EVSE installation, by providing financial assistance to interested employers, retailers, parking management companies, and others, for EVSE installation at workplaces, commuter hubs, and other destinations. Plan Bay Area allocates $80 million to install more EV chargers in the Bay Area.

Smart Driving Strategy

The smart driving strategy program will be a public education campaign for the region's motorists to encourage driving styles and vehicle maintenance that save fuel and reduce vehicle emissions. The program will also provide rebates for in-vehicle, real-time fuel efficiency gauges. Plan Bay Area provides $160 million for the program and targets emission reductions from the existing stock of vehicles not likely to be retired and replaced by a zero emission vehicle in the near future.

Car Sharing

Plan Bay Area invests $13 million to expand car sharing services in the region, with the goals of ensuring that vehicles are available at high-demand locations, and expanding services in the region's suburban communities. Car sharing services allow people to rent cars by the hour, resulting, according to some studies, in reduced vehicle ownership and vehicle travel.

Vanpool Incentives

The plan invests $6 million to enhance the region's existing vanpool program, by reducing the cost of van rentals thereby encouraging greater participation. Vanpools help to remove personal cars from commutes that are not well served by transit, and help reduce overall emissions.

Commuter Benefit Ordinance

The Bay Area Air Quality Management District and MTC will work jointly to adopt a regional commuter benefit ordinance as a means to reduce GHG emissions.

The ordinance would help reduce emissions by requiring employers with 50 or more full-time Bay Area employees to offer incentives for their employees to use a mode other than driving alone while commuting to and from work.

Climate Initiatives Innovative Grants

In its previous RTP, Transportation 2035, MTC invested $33 million in a Climate Initiatives Innovative Grant program to reduce GHG emissions from the transportation sector and included efforts such as Safe Routes to Schools, transportation demand management, and other creative ideas. Given that many of the pilot projects funded in that program show promise in continuing to reduce GHG emissions from the transportation sector, Plan Bay Area has set aside $226 million to expand on this program and the successful strategies it has identified.

D. GHG and Other Outcomes

Building on the Bay Area's history of regional partnership to meet sustainability goals, the plan projects a 10 percent regional reduction of per capita GHG emissions from 2005 levels in the year 2020, and a 16 percent reduction in the year 2035. It does so while also meeting the requirement to accommodate the housing needs of the region's projected population growth. The decline in per capita GHG emissions results from efforts to increase the efficiency of the existing transportation system, to meet the housing demands for the region's changing demographics through transit-oriented development, and to pursue climate initiatives.

ABAG/MTC has appropriately not included in its greenhouse gas emissions reduction figures any GHG emissions reductions from the ARB-adopted technology and fuel programs, such as the Low Carbon Fuel Standard or the Advanced Clean Cars program. This is because the regional targets adopted by ARB in 2010 do not include reductions from these statewide technology and fuel programs, but rather focus on reductions from strategies implemented at the regional and local levels.

In addition to meeting the ARB-established targets for GHGs and the SB 375 planning regulations for housing, Plan Bay Area is meant to help the region achieve a number of other goals. Plan Bay Area also lays out voluntary performance targets for a number of different metrics of significance to the region's residents. These voluntary performance targets address particulate air pollution, active transport, housing, open space and agricultural land, social equity, economic vitality, transportation system effectiveness, and safety.

Plan Bay Area outlines 13 voluntary performance targets in addition to the two statutorily required targets for GHGs and housing. On seven of these voluntary performance targets, the plan either exceeds, achieves, or moves in the right direction. For example, one performance target aims to reduce exposure to fine particulate matter, and another looks at reducing coarse particulate emissions. The plan exceeds the fine particulate matter performance target, which will help the Bay Area maintain its

federal attainment status for this pollutant. The plan makes progress towards the coarse particulate matter performance target, though the region is still not in attainment for this pollutant. Plan Bay Area addresses another public health-related target with an increase in average daily time walking or biking per person for transportation.

The plan loses ground against some of the voluntary transportation system and access performance targets. For instance, the share of household income needed to cover transportation and housing costs rises to 69 percent from 56 percent for low-income and lower-middle income residents during the planning period. Also, the distressed state highway lane-miles will increase to 44 percent of the regional highway system by 2040. Lastly, the share of transit assets past their useful life is projected to increase to 24 percent of all transit assets.

Plan Bay Area considered social equity in the plan evaluation, through the voluntary performance targets, but also through the completion of an equity analysis. The equity analysis evaluated the projected outcomes of the plan for communities of concern. Based on public input, ABAG/MTC define communities of concern as neighborhoods with high concentrations of four or more of the following factors: minority persons, low-income individuals, persons who are Limited English Proficient, seniors age 75 and over, persons with disabilities, households without cars, single-parent households, and renters paying more than 50 percent of household income on rent.

ABAG/MTC used five equity performance measures to conduct its equity analysis. The results of the equity analysis show that, relative to a 2010 baseline, neither the communities of concern, nor the region as a whole show improvement for each of the equity performance measures. The equity analysis highlights key challenges in the areas of housing displacement due to rising land values, increased travel times for communities of concern, and health and safety concerns due to increased vehicle traffic within communities of concern. The plan responds with an increased emphasis on funding to support the provision of affordable housing, requirements for the adoption of local housing elements in order to receive strategic funding, and conditions that PDA Investment and Growth Strategies examine housing policy issues.

E. Public Outreach Process

ABAG/MTC developed Plan Bay Area with extensive input from the region's diverse stakeholders through a collaborative approach. Starting in 2008, ABAG/MTC created a regional initiative, FOCUS, which linked local community development goals with the regional planning process through voluntary efforts. With FOCUS as a foundation, ABAG/MTC launched an effort in February 2011 to bring together stakeholders for the development of Plan Bay Area. Specifically, business groups, environmental organizations, equity organizations, and community-based organizations all voiced their input in the process through public workshops, telephone surveys, online surveys, focus group meetings, and workgroup meetings. Local governments were also involved throughout the process. In addition, the BAAQMD, the BCDC, and three dozen of the region's transportation partners, provided the more regional perspective. Based on their

contributions, as well as multiple rounds of local and partner agency input and review ABAG/MTC released the draft Plan Bay Area in March 2013. The public was invited to provide comments on the draft Plan Bay Area from March 22, 2013 until May 16, 2013.

Public engagement at this stage took the form of three rounds of public workshops throughout the planning process. In total, twelve public workshops took place across the region with over 1,250 residents in attendance. In addition, three telephone polls gathered input from hundreds of the region's residents. ABAG/MTC provided a number of online options for participation, namely, the One Bay Area website, which received over 250,000 hits, and a virtual public workshop, which garnered 1,300 participants. The draft Environmental Impact Report (DEIR) also offered an opportunity for the public to provide input into Plan Bay Area, with formal commenting open during the 45-day comment period from April 2, 2013 until May 16, 2013. Public comments received on the DEIR and the draft Plan Bay Area addressed a variety of issues, but many stakeholders focused on how the Bay Area could better incorporate housing affordability, robust transit options, anti-displacement measures, and jobs/housing balance. Over 550 comment letters were submitted on the DEIR and draft Plan Bay Area by implementing agencies, various stakeholder organizations, and individuals.

F. Plan Implementation

Plan Bay Area outlines the vision and goals for planning the region's growth in the coming twenty-eight years and provides steps and strategies to support plan implementation. These strategies address challenges in transportation financing, affordable housing, governance, climate adaptation, natural disasters, and economic analysis. Because of their land use authority, local governments will also play an essential role in implementing Plan Bay Area.

ABAG/MTC aims to meet these challenges through advocacy, implementation of best practices, public education campaigns, grant programs, and partnerships. For example, Plan Bay Area highlights an existing partnership between MTC, ABAG, BCDC, Caltrans, National Oceanic Atmospheric Administration's Coastal Service Center, and Bay Area communities to increase preparedness and resilience to sea level rise while protecting vital ecosystem and community services. These partners are compiling a comprehensive inventory of potentially vulnerable transportation assets along a section of the Alameda County shoreline and will relate the vulnerability of these assets to the rest of the region's transportation network.

In the plan's advocacy issues platform, five out of six issues relate to the financial tools necessary to fund the housing, infrastructure, and transportation goals in Plan Bay Area. This suggests that successful implementation of Plan Bay Area will require serious attention to transportation finances from all levels of government. For example, the Plan Bay Area advocacy issues platform outlines the necessity of strongly supporting legislative changes to lower the voter threshold for local and regional transportation tax measures from two-thirds to 55 percent. The current voter approval threshold for local self-help taxes is described as missed opportunities for local taxes to

support the cost of the region's future transportation needs. Another strategy outlined as necessary to support plan implementation includes ABAG/MTC urging the passage of State legislation to create a permanent revenue source for transportation in a manner consistent with the region's "fix it first" policy. Such legislation, Plan Bay Area describes, would be essential to maintaining the existing local and state transportation network.

Local governments will be critical to the success of Plan Bay Area at reducing GHG emissions from passenger vehicle activity. Many of the region's local governments are voluntarily adopting GHG emission reduction strategies, primarily through their local climate action planning efforts and general plan update processes. Over thirty local governments in the region have thus far adopted climate action plans and many have updated or amended their general plans to incorporate sustainable communities planning into the circulation, land use, housing, and other elements.

III. ARB STAFF REVIEW

The Sustainable Communities and Climate Protection Act of 2008 calls for ARB's "acceptance or rejection of the MPO's determination that the Sustainable Communities Strategy would, if implemented, achieve the greenhouse gas emission reduction targets" in 2020 and 2035. ABAG/MTC's quantification of GHG emissions reductions in the SCS is central to its determination that the SCS would meet the targets ARB established in September 2010.

As required by Government Code section 65080(b)(2)(J)(i), ABAG/MTC submitted a quantification methodology to ARB on December 1, 2010. For the technical foundation of the RTP/SCS GHG quantification, the methodology identifies MTC's travel modeling system, growth and land use forecast, and transportation project assumptions. Using this methodology, ABAG/MTC estimated that Plan Bay Area would achieve a 10 percent per capita reduction in GHG emissions from passenger vehicles by 2020, and a 16 percent per capita reduction by 2035.

ARB staff prepared the following analyses based on the draft Plan Bay Area and GHG quantification, released in March 2013, then reviewed changes made for the final Plan Bay Area, released in December 2013, that affect the GHG quantification. Staff's analyses show that if implemented, ABAG/MTC's SCS would meet the targets set by the Board for 2020 and 2035. ABAG/MTC followed advanced modeling practices using an activity-based model and used reasonable model inputs and assumptions. In addition, plan performance indicators are supportive of estimated GHG reductions.

A. Application of ARB Staff Review Methodology

ARB staff's review of ABAG/MTC's SCS focused on the technical aspects of regional modeling that underlie the quantification of GHG reductions. The review is structured to examine ABAG/MTC's modeling tools, model inputs, application of the model, and modeling results, following the general method described in ARB's July 2011 document entitled "Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies Pursuant to SB 375." To address the unique characteristics of the region and its modeling system, ARB staff tailored and expanded the general methodology to be applicable for ABAG/MTC's SCS.

ARB staff evaluated how ABAG/MTC's models operate and perform in estimating travel demand, land use impacts, and future growth, and how well they provide for quantification of GHG emissions reductions associated with the SCS. ARB staff also evaluated the climate policy initiatives that MTC developed as part of Plan Bay Area. In evaluating whether ABAG/MTC's GHG quantification is reasonable for some of the region's chosen strategies, ARB staff examined issues such as:

- How the growth forecast reflected the economic recession
- The basis for allocating land use changes
- How well MTC's activity-based model replicated observed results

- How MTC applied off-model tools in estimating the benefits of climate policy initiatives
- MTC's model sensitivity to changes in key land use and transportation variables as compared with the empirical literature

To help answer these and other questions, ARB staff used publicly available information in Plan Bay Area, accompanying documentation including technical appendices, and the model calibration and validation reports. ABAG/MTC also provided additional clarifying information, and a data table, as shown in Appendix A.

In order to assess the technical soundness and general accuracy of ABAG/MTC's GHG emission reduction quantification, four central components of ABAG/MTC's GHG analysis were evaluated, including: modeling tools, data inputs and assumptions for the modeling tools, model sensitivity analyses, and performance indicators.

Data Inputs and Assumptions for Modeling Tools

ARB staff evaluated ABAG/MTC's key model inputs including the underlying data sources and assumptions to confirm that they represented current and reliable data for use in the model. This involved using publicly available, authoritative sources of information, such as national and statewide survey data on socioeconomic and travel factors. A subset of the most relevant model inputs for GHG quantification includes: 1) regional socioeconomic characteristics, 2) the region's transportation network, 3) travel inputs, and 4) cost assumptions. The documentation of region-specific forecasting processes and approaches, especially where applicable to the evaluation of the region's land use forecast assumptions, were also evaluated.

Modeling Tools

ARB staff reviewed MTC's travel demand model (TDM) to assess how well the modeled outputs estimated based on socioeconomic, land use, and travel data inputs and assumptions used to model the SCS replicates observed results. In addition, ARB staff evaluated MTC's off-model documentation and results to gauge whether MTC used appropriate methodologies to quantify the expected reduction in GHG emissions from some of the strategies in the SCS. ARB staff also considered MTC's modeling practices in light of the California Transportation Commission's (CTC) "2010 California Regional Transportation Plan Guidelines," the Federal Highway Administration's (FHWA) "Model Validation and Reasonableness Checking Manual," and other key modeling guidance and reference documents.

Regional Performance Indicators

Performance indicators help to explain changes in VMT and related GHG emissions that are expected to occur, whether through changes in travel modes, vehicle trip distances, or some other means. ABAG/MTC developed several performance

indicators to evaluate the effect of implementing Plan Bay Area. ARB staff conducted a qualitative evaluation to determine if increases or decreases in these individual indicators are directionally consistent with ABAG/MTC's modeled GHG emissions reductions. In particular, the following performance indicators were evaluated: residential and employment density, housing types, housing units in PDAs, passenger VMT, mode share, and change in average trip length.

B. Data Inputs and Assumptions for Modeling Tools

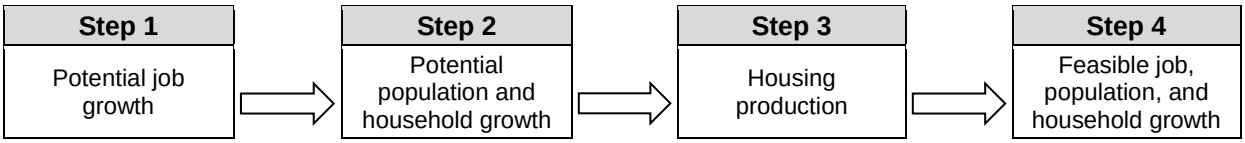
Plan Bay Area is based on a number of significant inputs and assumptions, which influence many of the strategies relevant to GHG emissions reductions. These inputs and assumptions provide the foundation for ABAG/MTC's modeling approach, and are used by MTC's travel model to project changes in the land use and transportation systems. Inputs and assumptions include land use attributes, socioeconomic and transportation network characteristics, and auto operating costs. ARB staff evaluated the appropriateness of the data on which these inputs and assumptions are based.

1. Demographics and the Regional Growth Forecast

ABAG/MTC forecasts growth of the region's population and economy to inform assumptions about how many people will live in the region by 2035, how many households they will form, the number and types of available jobs those people will have, and where they will live. ABAG/MTC attempts to project growth and future land use distribution to guide investments and policies of the nine county region.

ABAG/MTC's growth forecast is based on employment, population, and housing assumptions throughout the year 2040. ABAG/MTC first estimates the potential for job growth for the Bay Area as a share of the U.S. Bureau of Labor Statistics' national growth projections. This estimation is meant to reflect the difference between national and regional labor force participation in 2010 among various economic sectors, such as the professional services and retail sectors. ABAG/MTC determined the population, number of households, and household income levels using their analysis of the initial job growth forecast, labor force participation rates, and the number of persons per household. ABAG/MTC then derived labor force, total population and total households. The third step calculates the regional housing production. This estimation is based on past housing production levels, projected household income, and new policies and programs to support housing production in the Priority Development Areas (PDAs). Since future housing production limitations may influence the number of workforce households that can be accommodated within the region, job, population, and household forecasts were adjusted during the final step. ABAG/MTC's forecast process is shown in Figure 4.

Figure 4. ABAG/MTC's Process to Develop Demographic Forecast



ABAG/MTC's Growth Forecast

ABAG/MTC's growth forecast was prepared by the Center for Continuing Study of the California Economy (CCSCE). Based on the national employment growth by major industry sectors and the region's share of that growth, the projection assumes that the MPO region remains attractive to a diverse and highly specialized labor force in the future. Regardless, potential constraints to the region's economic competitiveness, such as higher housing costs close to employment centers, funding cuts, and an aging infrastructure throughout the region were considered during the forecast process. Much of the region's recent economic growth has been supported by the development of "greenfield" or undeveloped land. These new development areas accommodated substantial new housing, with expanded infrastructure and services, while many of the older cities face physical, market, and regulatory constraints to large-scale housing production. ABAG/MTC assumes that the region's most concentrated job centers will continue to be located in the major central business districts, downtowns, and transit corridors throughout the Bay Area. However, commuter travel time and travel costs may increase and could result in growing congestion in the larger business centers, highways, and freeways.

ABAG/MTC, however, endeavors to concentrate housing and job growth in the region's core, reversing historical trends of the housing and job dispersal. Encouraging infill development, improving the infrastructure, and creating supportive policies, new investments, and sustainable development patterns are intended to support those endeavors. ABAG/MTC expects strong growth in key industries in technology and related sectors within the MPO's larger cities and industrial centers, such as San Francisco and Silicon Valley.

Based on historical housing production data within the Bay Area, ABAG/MTC estimates an additional 660,000 housing units, or an annual average of approximately 22,000, to be constructed between 2010 and 2040. ABAG/MTC recognizes, to accommodate this amount of new housing units within the major districts, city centers, and downtowns, the share of multi-family housing must increase.

ABAG/MTC's approach to forecasting assumes that job growth is the driving force behind regional population and household growth. ABAG/MTC used a number of state and national data sources, such as the California Department of Finance (DOF) and the U.S. Census Bureau, to develop assumptions about the population profile, the number

of employees per household, the labor force participation rate, the vacancy rate, and other variables. Based on those assumptions, and given the estimated number of new housing units that could be constructed, ABAG/MTC then derived the number of jobs that the region could support. ABAG/MTC's growth projections are summarized in Table 1.

Table 1. ABAG/MTC's Employment, Housing, and Population Projection

Demographics	2010	2020	2035	2040
Employment	3,385,000	3,987,000	4,347,000	4,505,000
Housing Units	2,786,000	2,956,000	3,321,000	3,446,000
Population	7,091,000	7,718,000	8,795,000	9,299,000

The demographic inputs and assumptions ABAG/MTC used in establishing its growth forecast describe a number of key characteristics of the future population living and working in the Bay Area. These data inputs and assumptions were developed through ABAG/MTC's forecast process, described above. External consultants from CCSCE, UC Berkeley, and Strategic Economics validated the final forecast for the Bay Area region. ARB staff focused its review on the employment, housing, and population inputs to the model through the year 2035.

Employment

Employment describes the total number of workers in a region, which in turn, influences travel patterns. Furthermore, employment relates to the number of generated commute trips. Estimating the amount and the reasonable distribution of employment within a geographically constrained region is therefore the key element in ABAG/MTC's growth forecast. ABAG/MTC used a number of recognized and accepted data sources in developing its employment forecasts, including historic employment data from the Employment Development Department (EDD), the U.S. Census Bureau, the American Community Survey (ACS), and the sector forecast model from Caltrans.

To establish employment levels for the 2010 base year, employment was based on total jobs by sector and was also derived from California EDD wage and salary job estimates. Additionally, estimates for self-employed workers were developed from the 1990 and 2000 census and ACS annual estimates. Employment was then distributed throughout the region based on industry sector totals by county, forecasted by Caltrans. ABAG/MTC's job estimations for 2005 and 2010 are compared to EDD data in Table 2 below. With the extensive economic impacts of the recent national recession, the Bay Area experienced a substantial decline in employment, as seen in both ABAG/MTC's and EDD's job estimations in Table 2. According to ABAG/MTC, nearly 3.5 million jobs were available in the region by the end of 2005. During the recession years however, employment growth stagnated. On average, ABAG/MTC's job estimations are 3 percent higher than EDD's.

Table 2. Employment Comparison (number of jobs)

Year	ABAG/MTC	EDD
2005	3,449,640	3,328,900
2010	3,385,000	3,291,500

ABAG/MTC's job growth forecast follows a complex process starting with determining the employment composition by industry sector, followed by distributing it to jurisdictions and PDAs. ABAG/MTC categorized their industry sectors into three major groups: knowledge-sector jobs, population-serving jobs, and all other jobs. According to ABAG/MTC, changing trends in industry and businesses will largely influence the labor force distribution, as summarized in Table 3.

Table 3. Changing Trends in Business Locations Inform ABAG/MTC's Employment Distribution Approach

Business Location Trend	Expected Changes to Employment Distribution
Knowledge based jobs, culture and entertainment activities increasing in regional centers	• More employment downtown San Francisco, downtown Oakland, and downtown San Jose expected due to growth in professional services sector • More international businesses in those downtowns expected, as well as more tourists, artists, and entertainers
Multiple activities and transit at office parks on the rise	• Many office parks are beginning to provide direct transit access, often offer housing, services, and other amenities • More businesses are providing private shuttle services for employees, support mitigating traffic congestion
Medium and small cities' downtown areas and transit corridors expanding services for downtown residents	• Demand for local transit service, housing, and transportation choices expected to increase
New vitality of industrial and agricultural lands	• Changing and diverse mix of businesses has relocated to some industrial area locations • Besides traditional industries and businesses, now food processing, high tech product development, car repair, graphic design, recycling businesses, and others moving in the area

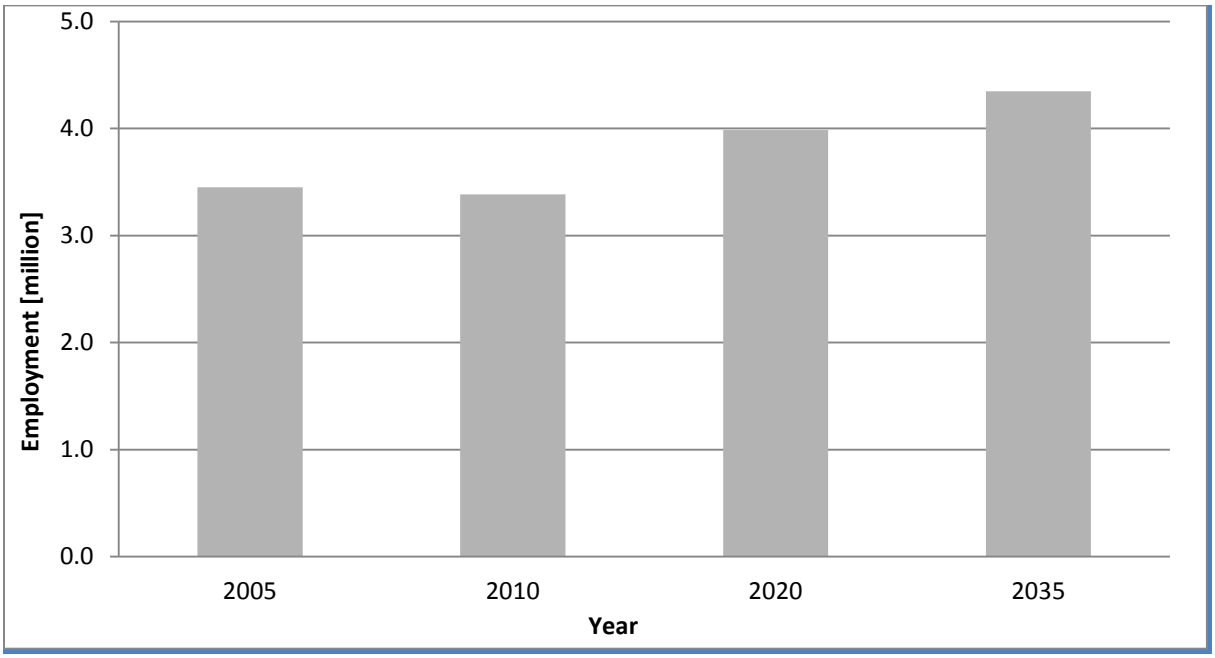
Future employment was distributed using five growth distribution factors:

- Population-serving jobs ratio
- Knowledge-sector jobs index
- Existing employment share for all other jobs
- Local planning assumptions
- Resource areas and farmland

In general, Plan Bay Area encourages job growth in the region's larger cities and PDAs with an existing employment base. PBA supports the distribution of the employment growth as planned for by the local jurisdictional plans.

As Figure 5 illustrates, ABAG/MTC expects employment to grow from approximately 3,385,000 available jobs in 2010, to 3,987,132 by 2020, and up to 4,346,762 by 2035. This change over the 25 year period represents a 28 percent increase. California's other three large MPOs expect a similar percentage job growth throughout 2035.

Figure 5. ABAG/MTC Regional Employment Projection



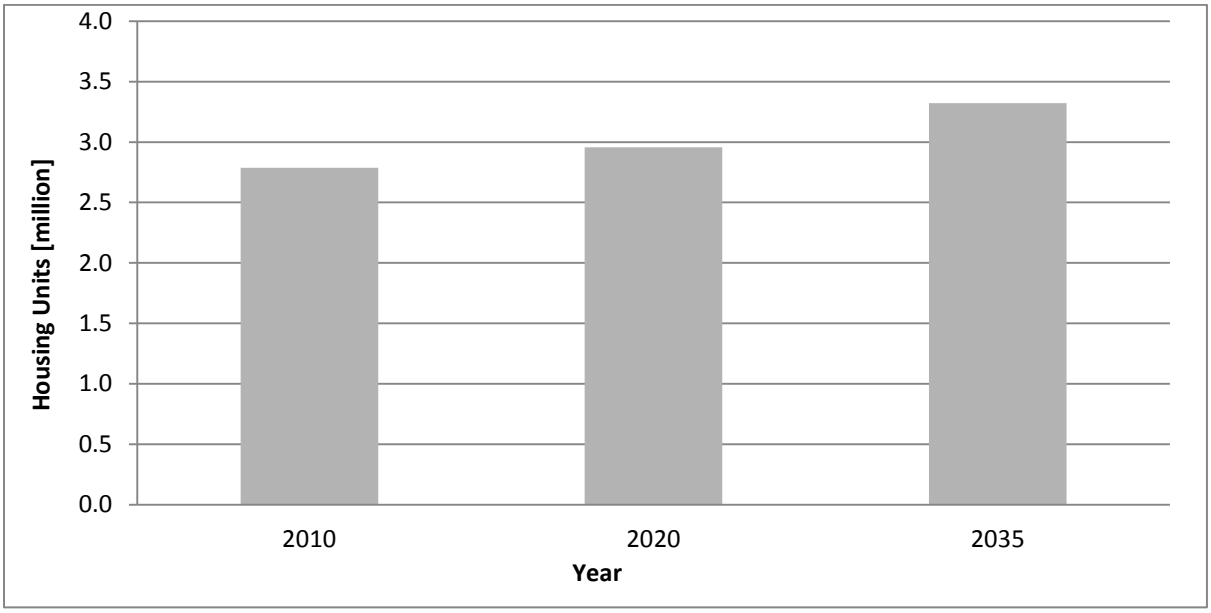
Housing

A household consists of a group of people occupying one housing unit, and can include both family and non-family members. The number of households is an important assumption in travel models because it is a primary input in determining the number of trips that occur in the region.

ABAG/MTC's 2010 household and housing unit calculations are based on 2010 census data. Although census tracts are most often used to analyze residential housing patterns, ABAG/MTC used 2010 block data, which are smaller than tracts. ABAG/MTC's housing growth forecast approach is built on the concept of sustainable development through maximizing the regional transit network, and focusing on infill and new development along the transit network and major corridors. To distribute this future growth, a locally-based assessment was performed, utilizing general plans, specific plans, and zoning ordinances, thus helping to determine the housing development potential for the target years 2020 and 2035.

ABAG/MTC estimated 2,785,948 available housing units in 2010. About 170,000 new housing units are expected by 2020 and approximately 365,000 new units between 2020 and 2035. This converts to growth rates of approximately 17,000 units per year, totaling 2,955,948 units by 2020 and approximately 24,000 units per year by 2035, totaling 3,321,190 units. The vacancy rate is expected to decline during the early forecast years, which would provide additional housing, causing a slower growth rate than in the later years. Over the 25 year period, ABAG/MTC expects housing to grow by 16 percent. This trend is shown in Figure 6.

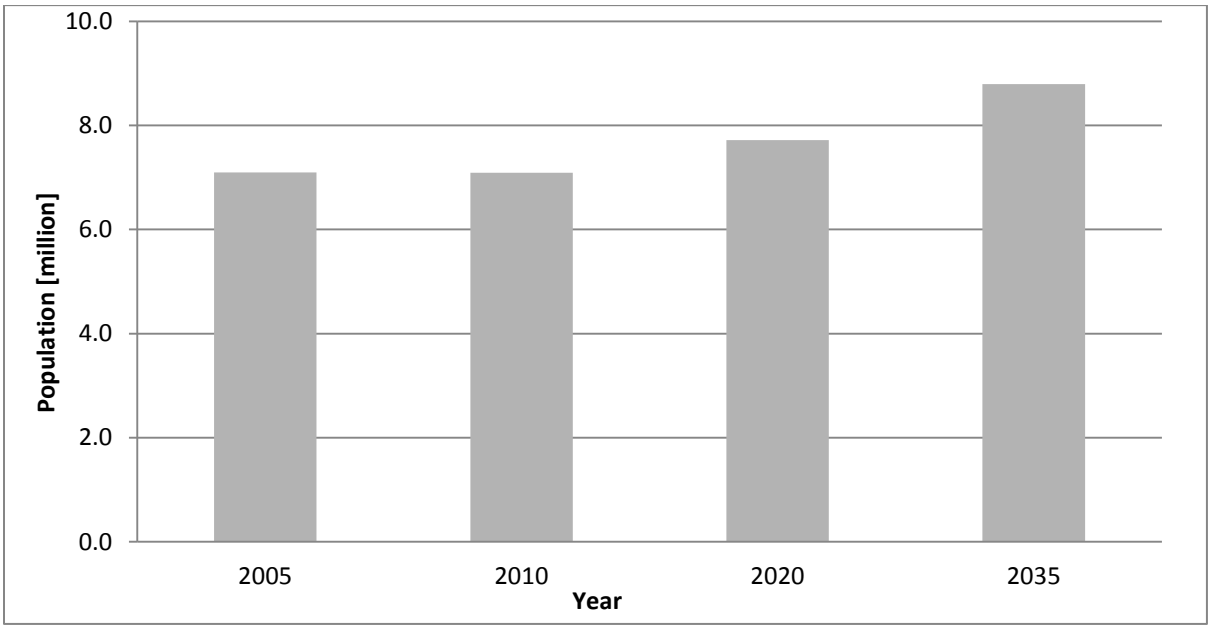
Figure 6. ABAG/MTC Region Housing Projection



Population

Population is a basic component of how present and future demand for transportation is estimated, since regional travel patterns are closely linked to population growth over time. An MPO's population assumptions have a direct effect on their estimates of regional GHG emissions. Figure 7 shows ABAG/MTC's assumed population inputs, which indicate that the region's population will grow by 24 percent between 2010 and 2035, from about 7.1 million in 2010, to 7.7 million by 2020, to just under 8.8 million by 2035.

Figure 7. ABAG/MTC Region Population Projection



ARB staff reviewed the population figures to see that they are in line with publicly-available, authoritative sources of information like those from the U.S. Census Bureau or the California Department of Finance (DOF). Existing housing law (Government Code Section 65584, et. seq.) has been integrated with RTP/SCS planning through SB 375, and requires that population growth projections developed by the council of governments be within 3 percent of those developed by DOF for the same time period. Table 4 shows a comparison between ABAG/MTC's population assumptions and the most recent population projection figures for 2020 and 2035 published by DOF.

Table 4. Population Comparison

Year	ABAG/MTC	DOF	Percent Difference
2010	7,091,000	7,150,739	1%
2020	7,718,000	7,597,338	2%
2035	8,795,000	8,250,335	6%

While ABAG/MTC's population assumptions are within three percent of DOF population projection numbers in the base year and near-term 2020 target period, the agencies' population projection for 2035 is 6 percent greater than DOF's forecast. The result is that the current plan assumes slightly more housing and travel in the region between 2021 and 2035 than would otherwise occur using the DOF forecast.

ARB staff's analysis of ABAG/MTC's population projection methodology shows that ABAG/MTC used the best available information at the time of their forecast development process. The regional agencies considered a variety of data inputs to

estimate the future population, such as the 2010 census, Bureau of Labor Statistics projections, DOF projections, local jurisdiction inputs, expert panel review, and a consultant-provided set of economic assumptions. In April 2013, ABAG/MTC held a public meeting in which a panel of representatives from ABAG, MTC, DOF, and the California Department of Housing and Community Development (HCD) explained the coordination among the agencies in developing population and housing needs forecasts. The difference in timing for each agency's forecast development process was cited as a major source of the difference between the forecast that ABAG/MTC developed and those developed by DOF and HCD. Given that population projections are continuously revisited and refined by ABAG and MTC, it is anticipated that the range of difference in projections for this time period will diminish with subsequent RTP/SCS updates.

2. Future Land Use Development

MPOs develop a long-range land use forecast as part of their transportation plan development process that estimates three major characteristics: how much development will occur in the region, where that development will be located, and at what intensity that development occurs. In this case, "development" means both households and employment, and indirectly population. In the case of ABAG/MTC, the future land use scenario takes the population, housing, and employment (the future growth forecast, discussed in the previous section) and allocates that growth to areas in the region.

This anticipated future growth pattern, or land use forecast, is a critical input to an MPO's SCS. This is because people's travel needs depend, to a large extent, on the location of homes, employment, shopping, recreation, and other destinations. Forecasting of future development patterns is an important step to developing an accurate picture of future travel demand in the region. As such, it becomes the basis from which MPOs begin planning what transportation infrastructure and services (transportation supply) are needed to serve the region's future population.

When reviewing Plan Bay Area, ARB staff's evaluation focused on the process ABAG/MTC used to generate the assumptions about future land use patterns. ARB staff also reviewed the land use forecast to verify that the projected levels of population, housing, and employment were accommodated.

Process to Develop the Land Use Forecast

ABAG/MTC used an outreach process that involved cities, counties, transportation agencies and the public. The process comprised three major steps which are discussed in more detail below:

1) Establish a set of performance metrics
2) Develop "visioning scenarios" (i.e. combinations of land use and transportation investments)

3) Evaluate each scenario against each of the metrics developed in step 1 and select a preferred scenario based on the results obtained in step 3

ABAG and MTC involved the public and stakeholders in each of the three steps summarized above. The following section expands on the steps above.

a) Establish Performance Metrics

The first step was to formulate a set of performance metrics,[1] against which alternative scenarios and the plan was to be evaluated. Performance metrics allowed ABAG/MTC to assess the various alternative strategies in a consistent way.

For performance metrics to be useful, the modeling tools employed by the MPO must be able to forecast the metric, and the metrics selected need to be at least potentially influenced by the investments and policies proposed by the MPO. ABAG/ MTC reviewed nearly 100 candidate performance metrics by examining them against a set of evaluation criteria in a collaborative process. Table 5 lists the performance metrics adopted by ABAG/MTC in January 2011.

Table 5. Performance Metrics Adopted by ABAG and MTC

Goal or Outcome	Performance Metric (by 2040, unless otherwise noted)
Required	
Climate Protection	• Reduce per-capita CO_2 emissions from cars and light-duty trucks by 15 percent in 2035.
Adequate Housing	• House 100 percent of the region's projected growth (from a 2010 baseline year) by income level (very-low, low, moderate, above-moderate) without displacing current low-income residents
Voluntary	

[1] In Plan Bay Area, MTC and ABAG refer to these as "performance targets". Here we use the term "performance metric" to avoid confusion with the term *target* used in other contexts, for example greenhouse gas reduction *targets*.

Healthy and Safe Communities	• Reduce premature deaths from fine particulates (PM2.5) by 10 percent • Reduce coarse particulate emissions (PM10) by 30 percent • Achieve greater particulate emissions reductions in highly impacted areas • Reduce by 50 percent the number of injuries and fatalities from all collisions (including bike and pedestrian) • Increase the average daily time walking or biking per person for transportation by 70 percent (for an average of 15 minutes per person per day)
Open Space and Agricultural Preservation	• Direct all non-agricultural development within the year 2010 urban footprint (existing urban development and urban growth boundaries).
Equitable Access	• Decrease by 10 percentage points (to 56 percent, from 66 percent) the share of low-income and lower-middle income residents' household income consumed by transportation and housing
Economic Vitality	• Increase gross regional product (GRP) by 110 percent — an average annual growth rate of approximately 2 percent (in current dollars).

Transportation System Effectiveness	• Increase non-auto mode share by 10 percentage points (to 26 percent of trips)
	• Decrease automobile vehicle miles traveled per capita by 10 percent
	• Maintain the transportation system in a state of good repair:
	  ○ Increase local road pavement condition index (PCI) to 75 or better of total lane-miles
	  ○ Reduce share of transit assets past their useful life to 0 percent

Source: Final Plan Bay Area, Table 4

The performance metrics in the table above enabled ABAG/MTC to evaluate plan scenarios against consistent and specific criteria. Additionally, in order to meet equity analysis requirements in federal transportation law, ABAG/MTC undertook an equity analysis. This analysis identified communities of concern in the region. Communities of concern are communities with notably high concentrations of socioeconomically disadvantaged or vulnerable populations. ABAG/MTC defined these communities and the equity priorities in these communities, in consultation

with regional stakeholders, public agency staff, and community representatives. From these priorities, the equity performance metrics, shown in Table 6, were developed. These metrics were used to evaluate the equity performance of the plan alternatives.

Table 6. Plan Bay Area Equity Performance Metrics

Equity Issue	Performance Metric
Housing and Transportation Affordability	Percent of income spent on housing and transportation by low-income households
Potential for Displacement	Percent of rent-burdened households in high growth areas
Healthy Communities	Average daily vehicle miles traveled per populated square mile within 1,000 feet of heavily used roadways
Access to Jobs	Average travel time in minutes for commute trips
Equitable Mobility	Average travel time in minutes for non-work based trips

Source: Final Plan Bay Area, Table 5.

b) Scenario Development

ABAG and MTC undertook the development of plan scenarios in two broad phases. In the first phase, ABAG/MTC developed two scenarios as visions of the Bay Area future land use and transportation system and tested those visions using the transportation network from the 2009 adopted plan. In the second phase, ABAG and MTC developed a series of alternatives that depicted a wider range of alternative land use patterns. ABAG/MTC considered general plans adopted by cities and counties, pending updates to those documents, and other local transportation and land use policies and regulations.

In the first phase, two potential land use patterns, or visioning scenarios, were developed by ABAG staff. The first, “Current Regional Plans,” reflected cities’

existing general plans and visions for growth in those plans. The second, the "Initial Vision Scenario," is a hypothetical growth pattern put forward by ABAG staff with input from local governments and county congestion management agencies. Each of these land use patterns was evaluated with the transportation network contained in the previous RTP ("Transportation 2035," adopted in 2009) and evaluated against both the performance and equity metrics described above. The results of this evaluation provided a starting point for initial conversations about where new development should occur, and how new long-term transportation investments might serve this new growth. Table 7, below depicts the relationship between these two initial land use scenarios and the Transportation 2035 network.

Table 7. Visioning Scenarios

<table>
<tr><th>Land Use Patterns</th><th>Transportation Network</th></tr>
<tr><td>Current Regional Plans.

• Generally reflects cities' current general plans for lower amounts of growth
• Growth includes 634,000 new housing units and 1.1 million new jobs.</td><td rowspan="2">Transportation 2035 Plan Network (T-2035)

• Network is the multimodal investment strategy in the existing Transportation 2035 Plan.
• Contains significant funding for operations and maintenance of the existing systems; limited expansions of highway and transit networks.</td></tr>
<tr><td>Initial Vision Scenario

• Growth pattern developed with input from local governments and county congestion management agencies.
• Land uses based on Priority Development Areas and Growth Opportunity Areas.
• Growth includes 902,000 new housing units and 1.2 million new jobs.</td></tr>
</table>

Source: Final Plan Bay Area Table 6

In the second phase, after consultation with stakeholders, ABAG/MTC staff developed a second set of scenarios which depicted a wider range of alternative land use patterns. These five land use patterns, including a revised Initial Vision scenario, were matched with one of two proposed transportation networks: either the Transportation 2035 Network (i.e., the existing long-range plan) or a Core Capacity Transit Network. The choice of network to be used with which land use scenario was made based on which network best supported the scenario's pattern of development. These land use/network combinations were then separately evaluated against the performance metrics, and then against the

five social equity metrics discussed earlier. Table 8 lists the specific land use/travel network pairings.

Table 8. Alternatives to the Visioning Scenarios Developed in Phase 2.

Land Use Patterns	Transportation Networks
Initial Vision Scenario Revised • Concentrates housing and job growth in Priority Development Areas (PDAs)	Transportation 2035 (T-2035) Plan Network • Network is the multimodal investment strategy in the existing Transportation 2035 Plan. • Contains significant funding for operations and maintenance of existing system; limited expansions of highway and transit networks
Core Concentration (Unconstrained) • Concentrates housing and job growth in locations served by frequent transit service, and/or in core Bay Area locations with a 45-minute transit commute area of the downtown areas of San Francisco, Oakland, or San Jose • Scenario is "unconstrained" due to the high levels of population and job growth that were assumed.	Core Capacity Transit Network • Significantly increased transit service frequencies along core transit network. • Keeps T-2035 investment levels for maintenance and bike/pedestrian projects; reduces T-2035 roadway expansion investments. • Requires additional capital and operating funds to pay for major expansion of transit services.
Core Concentration (Constrained) • Similar to unconstrained version above; housing and job growth is distributed to selected PDAs in the inner Bay Area, focusing on major downtowns and areas along the region's core transit network. • Scenario is "constrained" with lower levels of population and job growth than Unconstrained or Initial Vision.	
Focused Growth • Growth is distributed more evenly along transit corridors and job centers, with emphasis on development in PDAs and Growth Opportunity Areas.	
Outward Growth • Distributes greater amounts of growth to inland Bay Area, with some emphasis on focused growth near suburban transit hubs. Scenario is closer to historical trends.	T-2035 Network (See above)

Source: Final Plan Bay Area Table 7.

c) The Preferred Scenario

After evaluating the results of the second phase of scenario development and outreach to regional stakeholders, ABAG/MTC developed the Jobs-Housing Connection Strategy. This land use pattern places 78 percent of residential growth and 62 percent of job growth in PDAs throughout the region.

ABAG/MTC also developed the Preferred Transportation Investment Strategy to identify the investment approach best serving the Jobs-Housing Connection Strategy. The ABAG Executive Board and the MTC Commission adopted the Jobs-Housing Connection Strategy and the Preferred Transportation Investment Strategy in May 2012 as the preferred scenario, which was incorporated into Plan Bay Area. Table 9, below summarizes the characteristics of the preferred scenario.

Table 9. Characteristics of the ABAG\MTC Preferred Scenario

Land Use Pattern	Transportation Network
Jobs-Housing Connection Strategy • Focuses 78 Percent of new housing and 62 percent of new jobs in PDAs • Reduces GHG emissions, limits growth outside of the region's core, and preserves natural resources and open space • Reduces VMT per capita by 10 percent. • Includes sufficient housing to house all of the region's projected growth.	Preferred Transportation Investment Strategy • Devotes 87 percent of funding to operate and maintain existing transportation network. • Directs remaining funding to next-generation transit projects and other high-performing projects, to programs aimed at supporting focused growth and reducing GHG emissions, and to county-level agencies for locally designated priorities.

Source: Final Plan Bay Area Table 8.

3. Transportation Network Inputs and Assumptions

MTC's transportation network used in the trip assignment step of travel demand modeling is comprised of the regional highway network and the transit network. The highway network consists of roadway links classified by facility type. The transit network is used to model the impacts of transit and land use strategies on travel patterns throughout the region. ARB staff reviewed the coding procedures of MTC's highway and transit networks, as well as travel demand model base year link capacity and free-flow speed assumptions. The methodologies MTC used to develop the transportation network and travel demand model input assumptions are consistent with guidelines in the National Cooperative Highway Research Program (NCHRP) Report 716. The NCHRP Report 716 reflects current travel characteristics, and provides guidance on travel demand forecasting procedures and their applications for solving common transportation problems.

Highway Network

Figure 8 shows the base year regional freeway and roadway systems that are included in MTC's highway network. Each roadway link in the highway network is coded with attributes such as number of lanes, link capacity, free-flow speed, facility type, toll class type,[2] user class type, and area type. There are five highway network time periods in MTC's travel demand model: early AM (3 am to 6 am), AM peak (6 am to 10 am), midday (10 am to 3 pm), PM peak (3 pm to 7 pm), and evening (7 pm to 3 am). The regional highway network includes about 18,959 centerline miles for all freeways, arterials, and collectors, of which 4,667 lane miles are on freeways. The model's base year lane miles by type of roadway are summarized in Table 10.

MTC's development of the highway network was compared with the NCHRP Report 716 and found to be consistent with the recommended practice.

[2] Two types of tolls are coded: bridge tolls are the toll charged at the bridges; and value tolls are tolls paid to save time by shifting to use high occupancy toll lanes, known in the Bay Area as express lanes.

Figure 8. 2010 MTC Regional Highway Network

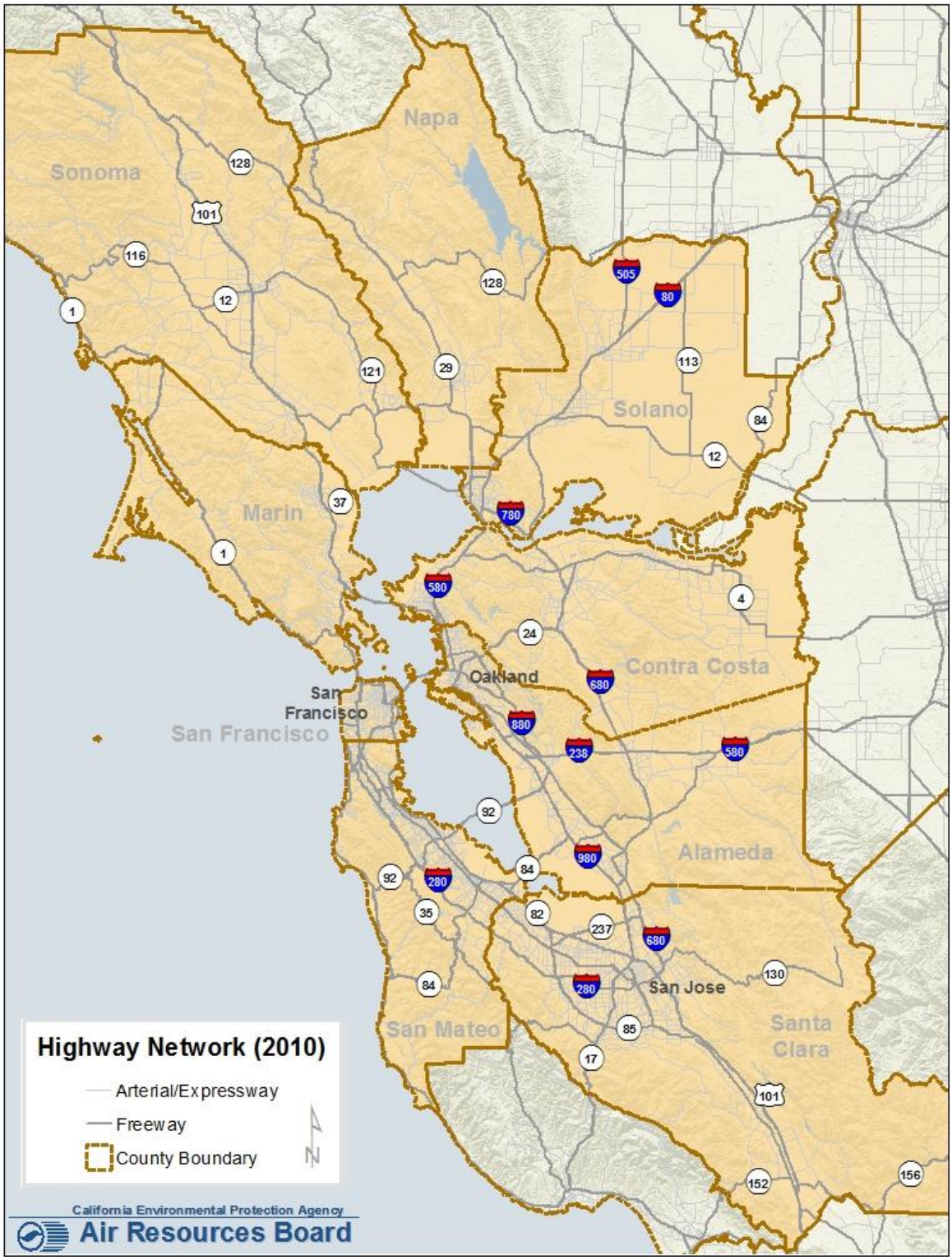


Table 10. Summary of MTC's Highway Network Inventory in 2010

Type of Roadway	Lane Miles (2010)
Freeway including managed lanes and auxiliary lanes	4,667
High occupancy vehicle (HOV) lanes	474
Express lanes	14
Mixed-flow lanes and auxiliary lanes	4,179
Arterial	8,710
Collectors	5,582

Link Capacity and Free-flow Speed

Link capacity is defined as the number of vehicles that can pass a point of roadway at free-flow speed[3] in an hour. One important reason for using link capacity as an input to the travel demand model is to measure congestion impact, which can be estimated as the additional vehicle-hours of delay traveling below free-flow speed. Table 11 summarizes MTC's free-flow speed and link capacity assumptions by facility type.

Table 11. Base Year (2010) Free-flow Speed and Link Capacity Assumptions

Facility Type	Free-flow Speed (mph)	Link Capacity (vehicles/hour/lane)
Freeway-to-freeway connector	40 to 50	1,850 to 2,000
Freeway	55 to 65	2,025 to 2,150
Expressway	40 to 55	1,450 to 1,650
Collector	10 to 35	600 to 950
Freeway ramp	30 to 40	1,450 to 1,550
Major arterial	20 to 40	900 to 1,050

The methodology used to estimate roadway free-flow speeds and link capacities in the MTC region was reviewed and found to be consistent with the practice indicated in the NCHRP Report 716.

[3] Free-flow speed is used to calculate the shortest travel time between two points in the highway network.

Transit Network

The transportation network of the MTC activity-based travel demand model also contains a transit network (Figure 9), which reflects a mix of transit operators of local and express buses, ferries, light rail, heavy rail, and commuter rail. Coded transit line attributes include, but are not limited to runtime, headways by time period, description of the route, and the direction of the route. The base year transit service coverage in the MTC region is summarized in Table 12.

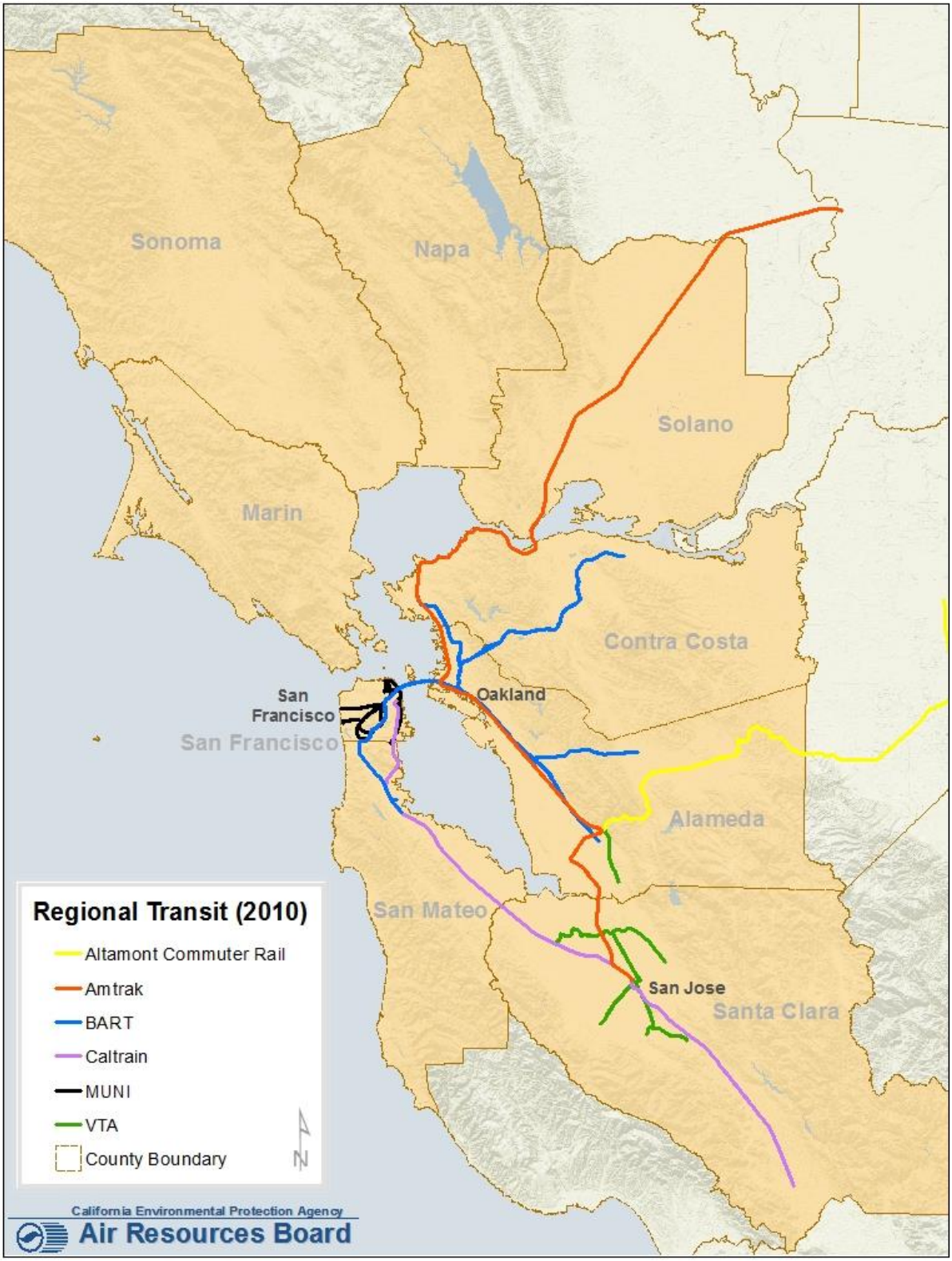
Table 12. MTC Regional Transit System in 2010

Transit System	Seat-miles[4] in 2010
Local and express bus	21,019,000
Light rail	4,057,000
Heavy rail	22,067,000
Commuter rail	7,232,000

ARB staff reviewed the transit attributes coded in the transit network and the procedures MTC followed in developing the transit network. MTC's development of the regional transit network is consistent with the procedures discussed in the NCHRP Report 716 and USDOT's "Model Validation and Reasonableness Checking Manual."

[4] A one-mile segment of a bus with forty seats is forty-seat miles.

Figure 9. 2010 MTC Regional Transit Network



4. Travel Demand Model Inputs and Assumptions

The time and length of trips based on trip destinations can influence the amount of travel within a study region. ARB staff reviewed key model inputs (e.g. number of trips produced per household by purpose) for each step of the travel model, and compared them to those from independent data sources using the methods described in the "Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375." This review allowed ARB to understand the variables used in the model, the assumed values of the variables, and the sources of the model input.

Trip Generation Rates

The trip generation rate is the average number of daily person trips for a given trip purpose or mode of transportation in a planning region. Factors such as automobile ownership, income, household size, density and type of employment, and the availability of public transportation, can influence the amount of travel in a region.

MTC's model included trips on mandatory tours[5], at-work tours, and non-mandatory tours. Table 13 summarizes the daily per person average trip rates by type of tour.

[5] A tour is a unit of analysis that measures the sequence of trips, originating from a single location, such as home or work. This unit of analysis helps to better account for the influence of connections between trips on travel behavior.

Table 13. Trip Generation Rates by Type of Tours

Type of Trip	Total Daily Trips	Average Number of Trips per Person
Trips on mandatory tours[6]	10,159,000	1.4
Trips on at-work tours[7]	1,577,000	0.2
Trips on non-mandatory tours[8]	11,684,000	1.7
Total	23,420,000	3.3

Trip Distance Distribution

Trip distance, estimated using the regional highway and transit networks, was used as an input to quantify travel impedances between zones. The trip distance data by mode of transportation reported by MTC are presented in Table 14. MTC's trip distance for each mode is comparable to those reported in the 2009 National Household Travel Survey (NHTS) except for the mode of auto. The lower auto trip length in the MTC region compared to the national average is attributed to the proximity of transit and/or job centers to residential units so that residents can use transit conveniently and/or drive a shorter distance to work or other activities.

Table 14. Average Trip Distance by Mode

Mode	Average Trip Length (miles)	
	2010 MTC Model	2009 NHTS
Auto	6.9	12.09
Walk	0.9	0.98
Bike	2.4	N/A
Transit	9.1	10.18

Average Daily VMT per Bay Area Resident by County of Residence

Another input to the travel demand model is the average daily VMT reported by each county in the MTC region. Table 15 summarizes these per resident VMT or per worker VMT figures, by county. As expected, most of the trips and distance traveled are for commute purposes; the average daily VMT per worker is higher than the average daily VMT per resident for each county in the MTC region.

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[6] Mandatory tours are primary tours associated with work and school .
[7] Round-trips that are made while at work (e.g. trip to lunch from work, trip for personal errands).
[8] Non-mandatory tours are tours for purposes such as shopping and recreation.

Table 15. Average Daily VMT by County

County	Average Daily VMT per Resident	Average Daily VMT per Worker
San Francisco	7.4	12.6
San Mateo	16.7	29
Santa Clara	15.4	24.6
Alameda	15.4	25.8
Contra Costa	18.8	27.3
Solano	16.4	24.3
Napa	17.6	27.8
Sonoma	18.9	22.6
Marin	18.5	34
All Counties	15.6	23.8

Zonal Data

Zonal data inputs to the travel demand model are comprised of socioeconomic data and transportation and land use characteristics. ABAG developed the aggregated zonal demographic and employment data inputs, which include total households in each of the four income categories (i.e. $0-30K, $30-60K, $60-100K, and $100K+), population in each of the five age categories (i.e. 0-4, 5-19, 20-44, 45-64, and 65+), high school and grade school enrollment, and the number of jobs in each of six employment categories (i.e. agricultural and natural resources, manufacturing, wholesale trade and transportation, retail trade, financial and professional services, health, educational and recreational services, and other). The zonal transportation and land use characteristics are estimated parking cost, auto terminal time, and the land areas devoted to different uses. Each zone is also categorized into one of six area types (i.e. regional core, central business district, urban business, urban, suburban, and rural).

ARB staff reviewed the descriptions of the socioeconomic, transportation, and land use variables included in the zonal data inputs. Zonal data inputs of MTC's travel demand model are consistent with the practice suggested in the "Data Needed for Model" section of the NCHRP 716 report.

5. Cost Inputs and Assumptions

The costs associated with travel represent a significant factor in determining the mode of transportation used for any given trip. ARB staff reviewed the following basic travel cost components used as inputs in MTC's travel model: household time value, bridge tolls, express lane tolls, transit fares, automobile operating costs, parking costs, and

cordon tolls. MTC ran its model for 2010 using DOE's forecast, which was developed using 2009 dollars. Results are shown in Table 16.

Auto Operating Cost

Three main inputs are used in determining the perceived auto operating cost in Travel Model One: average fuel price, average fleet-wide fuel economy, and other non-fuel related operating and maintenance costs. The costs of purchasing and insuring automobiles are not included.

MTC incorporated the approach that California's MPOs adopted at the recommendation of the Regional Targets Advisory Committee to use consistent assumptions for fuel price. The future year forecasts prepared by the U.S. Department of Energy (DOE) were completed in 2010. California's MPOs developed fuel price forecasts by using a weighted average of DOE's low end estimate (weighted 25%) and DOE's high end estimate (weighted 75%) plus a 25 cent surcharge to account for the additional costs for fuel sold in California. These costs are expressed here in year 2009 dollars (consistent with the DOE forecasts). The average fleet-wide fuel economy is taken from ARB's EMFAC motor vehicle emissions model.

Table 16. Auto Operating Cost Breakdown

	2010	2020	2035	2040
Average Fuel Price/gal (in year 2009 dollars)	$3.25	$4.74	$5.24	$5.40
Miles per Gallon	21.35	24.10	30.88	31.26
Non-Fuel Related Operating Cost	$0.08	$0.09	$0.11	$0.12
Perceived Automobile Operating Cost (per mile)	$0.23	$0.28	$0.28	$0.29

Value of Travel Time

In MTC's model, the population's perceived value of time is considered in the structure of the mode choice travel model. As would be anticipated, the value of an individual's time is in direct correlation with household income. For children,

their value of time is calculated as 2/3 that of the adult. The value of time has been held constant between the baseline and future forecast years for the model.

Bridge Tolls

Bridge tolls have been held constant in MTC's model at the level in effect as of July 1, 2012. Tolls are expressed in the model in year 2010 dollars. For the San Francisco – Oakland Bay Bridge and the Golden Gate Bridge, peak-period tolls are $6, and for all other bridges the tolls are $5. Carpool tolls are generally half of the full price tolls and tolls during off-peak periods are reduced. This toll schedule is not changed for future forecast years. The only additional toll included as part of the proposed plan is a $5 toll for passenger vehicles leaving Treasure Island during the morning and evening commute periods.

Express Lane Tolls

The travel model includes the option of paying a toll for the use of an express lane (a high occupancy toll or HOT lane), thus saving time relative to the use of the adjacent toll-free mixed flow lanes. A specific price is assigned for each time of day and vehicle class for each HOT lane segment in the travel model. In real world operating conditions, prices would be optimized so as to minimize congestion and maximize utilization. Prices are held constant over the entire four hour morning and evening commute periods. Congestion is assumed to remain at the same level throughout each peak period for the travel model. The proposed prices (in year 2010 dollars) for HOT lane segments vary from 0.0 cents per mile to 18.9 cents per mile in the 2035 and 2040 scenarios. Prices differ in the 2020 scenario, but were not provided by MTC.

Cordon Tolls

MTC's plan scenario includes a $3.00 toll (in year 2010 dollars), or cordon fee, for vehicles entering the greater downtown San Francisco area during the morning and evening commute hours. This would be similar to the sort of fee charged to vehicles entering London's downtown area during peak commute hours.

Parking Cost

The price of parking is applied at the travel analysis zone (TAZ) level in the model. The price is expressed in hourly rates for both long term (daily) or short term (hourly) parking. For both long and short term parking, the rates for all lots in a TAZ are averaged. For long term parking, the average monthly rate is divided by 22 days per month and 8 hours per day to generate an hourly parking cost. For short term parking, the average hourly rate is used (and is typically higher than the hourly rate for daily parking). The areas where paid parking can generally be found are greater downtown San Francisco, downtown Oakland,

Berkeley, downtown San Jose, and Palo Alto. For future forecast years, it is assumed that the cost of parking will increase following a linear trend.

Transit Fares

For the model, transit fares are assumed to remain constant starting from the 2010 baseline through all future forecast years. However, it is also assumed that travelers pay the full cash fare for each transit service. For example, the full base fare for the San Francisco Municipal Transit Agency (MUNI) in year 2010 dollars is $2.00, the base fare for Alameda/Contra Costa County (AC) Transit is $2.00, and the base fare for Golden Gate Transit's Marin County to San Francisco bus service is $3.65. MTC uses this as a simplified approach consistently throughout all years of the RTP/SCS.

C. Modeling Tools

ABAG/MTC used several models to quantify GHG emissions resulting from implementation of Plan Bay Area (Figure 10). ABAG/MTC uses a land use model and an activity-based travel demand model to calculate changes in land use patterns and travel demand, based on a number of different modeling inputs, such as population, employment, and potential infrastructure investment. Based on these and other inputs, the land use model predicts the location of housing, jobs, and other activities for future years, and the travel demand model produces vehicle activity outputs such as VMT, vehicle hours traveled, number of vehicle trips, and average speed.

MTC estimates GHG emissions reductions from its plan for 2020 and 2035, using the VMT outputs from its travel demand model. VMT outputs are converted to GHG emissions by running ARB's vehicle emissions model, EMFAC 2011. MTC also makes use of off-model calculations to account for GHG emissions reductions from its climate initiative programs. The section below describes the various models ABAG/MTC used to develop and analyze Plan Bay Area, as well as planned model improvements for the next RTP/SCS update.

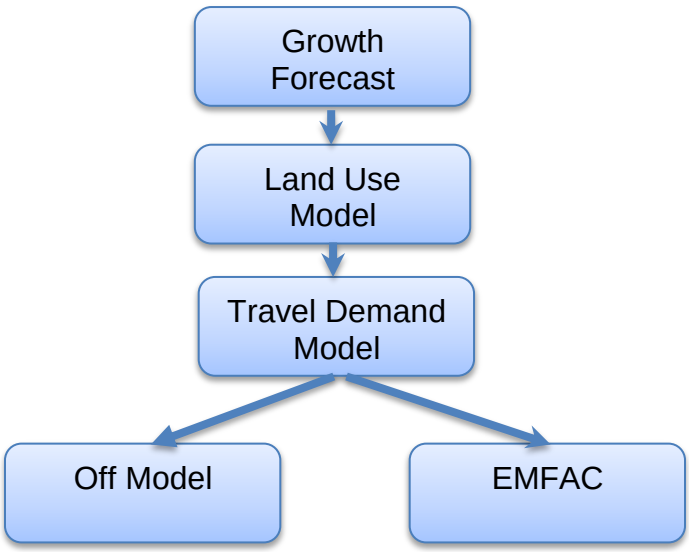


Figure 10. ABAG/MTC's Modeling Tools

1. Land Use Model

The land use model Urban Simulation (UrbanSim) is the first of three modeling tools that ABAG/MTC uses to forecast land use changes in the nine county region. This tool was developed for ABAG by the University of California, Berkeley, to understand the interactions between the transport system and land use changes. MTC incorporated ABAG's updated control total estimates of regional population, households, and employment, as well as planning policies into UrbanSim to forecast land use change in the region.

Input data in UrbanSim are from the U.S. Census Bureau's 2010 Public Use Microdata Sample (PUMS), Employment Development Department (EDD), and local employment and economic surveys. The total number of employees by sector, demographic projections, and the total number of households by income category within the region for base and forecasted years were prepared by ABAG and input into UrbanSim. UrbanSim uses these inputs to simulate the real-world location/employment/development choices and actions of households, businesses and developers through sub-models. Sub-models include economic and demographic transition models, employment and household relocation models, employment and household location choice models, a real estate development model, and a land price model.

The outputs of UrbanSim are: households by income, age, size, and presence of children; employment by industry and land use type; acreage of dwelling units by type; square feet of nonresidential space by type; and real estate prices. UrbanSim is integrated with the MTC travel demand model to improve the interaction between transport system changes and land use changes. Projected land use patterns and spatial distribution of activities from UrbanSim are input to MTC's regional travel demand model at an aggregated transportation analysis zone (TAZ) level for base and forecasted years.

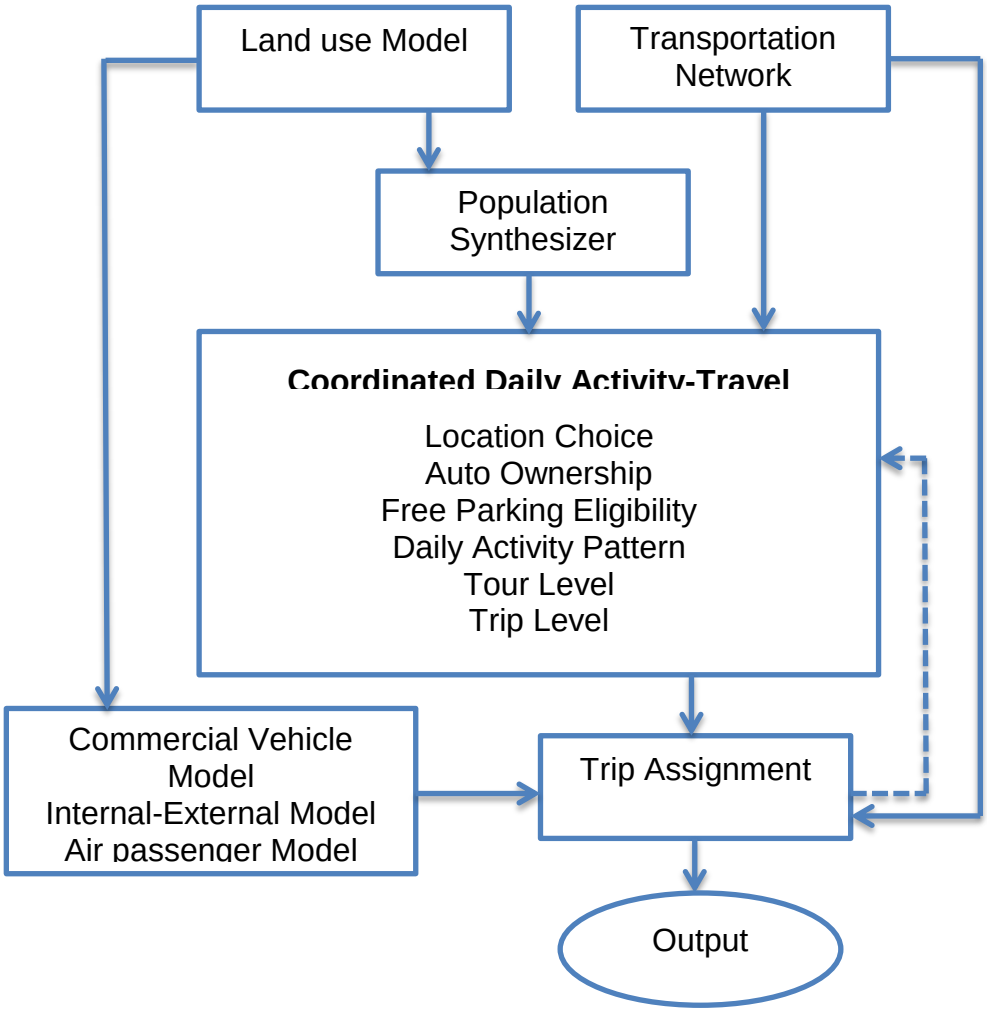
2. Activity-Based Travel Demand Model

The travel demand model MTC used for Plan Bay Area is based on the Coordinated Travel Regional Activity-Based Modeling Platform (CT-RAMP) called Travel Model One. Travel Model One simulates activities of individual person travel choices including intra-household interactions between household members, and households in the region. MTC used Travel Model One to assess the long-term needs of the nine-county San Francisco Bay Area region's transportation system such as roadways, transit planning, and goods movement, as well as to perform federally required air quality conformity and GHG analyses under SB 375.

Key components of the Travel Model One are transferred from San Francisco County Transportation Authority, the Atlanta Regional Commission, and Mid-Ohio Regional Planning Commission models. The nine-county San Francisco Bay Area is divided into 1,454 zones to allocate socioeconomic and land use characteristics. Travel Model One

explicitly models intra-household and joint travel that is critical for realistic modeling of the individual decisions made in the households. Similar to other travel demand model types, it is an aggregation of a number of different sub-models (Figure 11). This section reviews the key components of Travel Model One: population synthesis, location choices, auto ownership, free parking eligibility at work location, daily activity pattern, tours/trips by time of day and mode of travel, and trip assignment. This section also discusses the model validation process MTC performed to establish the credibility of the model's outputs.

Figure 11. MTC's Travel Model One



Population Synthesizer

The population synthesizer is the first step of Travel Model One. It uses household information from the U.S. census and zone levels to estimate a synthetic population[9] for the entire Bay area for the base and forecast years. The synthetic population creates a list of households, with various attributes for each synthesized person, so it is well suited to determine travel behavior. Attributes include the household to which the person belongs, type of person (full-time worker, part-time worker, retired, schoolchild, or university student), and whether it is a high-, medium-, or low-income household. To develop the base year synthetic population, the model first estimates the number of households in each zone with detailed socio-demographic census data. Public Use Micro-data Samples (PUMS)[10] are then matched to zonal level information using control variables such as household size, presence of children in household, number of workers in household, income, age, and number of housing units in household structure. An iterative proportional fitting procedure is used to match the control totals and its distributions.

The population synthesizer creates a synthetic population for the base year and for each forecast year. The key difference between the base and future years is the initial distribution. The control variables for the future year are based on the land use forecasts developed in UrbanSim. Other procedures were followed, similar to base year, to estimate the synthetic population. To validate the population synthesizer, MTC used the year 2000 census data.

The variables MTC used to develop the control totals and the population distributions in the base and future years are reasonable when compared with the 2000 census data. Table 17 shows the percent difference between the synthesized population and the census population. At the zonal level, comparisons among all variables matched within less than two percent difference. ARB staff recommends in the future that MTC also validate the population synthesizer by back-casting to 1990 and compare the results to the observed data to increase the confidence on the estimates. In addition, model documentation should provide key statistics such as the correlation coefficient between the model and census data, average household size by county and average number of workers per household by county. This would help in the understanding of the level of details at which the population synthesizer can reasonably estimate key attributes used in the travel forecasting model.

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[9] The synthetic population represents a close-to-reality human population for use in Travel Model One.

[10] A sample of population and housing unit records from the American Community Survey.

Table 17. Comparison of Travel Model One and 2000 Census Population

Variables	Population Synthesizer	Census (2000)	Percent difference (%)
Total persons	6,672,830	6,764,730	1.4%
Total households	2,466,190	2,466,200	0.0%
Total employed residents	3,389,000	3,394,820	0.2%
Single-family dwelling units (%)	63.1	63.1	0.0%
Multi-family dwelling units (%)	36.9	36.9	0.0%
Households with zero workers (%)	20.1	20.1	0.0%
Households with income $100K+ (%)	27.8	27.8	0.0%

Coordinated Daily Activity-Travel Pattern

Travel Model One simulates the full day activity and travel schedule of each person in the Bay Area in two stages: long term and short term. The long term decision model predicts primary work/school location, auto availability for each household, and availability of free parking for workers, since the choices do not change for months or sometimes for years. Long term decisions are then fed into the short term decision model to capture the complex aspects of travel decisions such as mode, time of travel, frequency, and other individual decision-making processes of travel choices. The daily activity-travel pattern model captures the behavioral aspects and travel decisions at each level. Travel Model One is implemented by replacing and extending a certain portion of a typical four-step model (e.g., trip generation, trip distribution, and mode choice) into several distinct sub-models including a location choice model, an auto ownership model, a free parking eligibility model, a daily activity pattern model, and a tour and trip level model. This section describes and evaluates each sub-model in detail.

- Location Choice Model

  The location choice model predicts the primary destination location for each worker, school-aged child, and college student in the nine-county region. It uses a multinomial logit model[11] structure with constraints on residence location, household, and person characteristics. The model uses employment by categories (retail, agriculture, manufacturing, trade, health service, and other), and enrollment in school and colleges to predict the primary destination location. The location choice model also uses accessibility variables such as level-of-service and trip length to reflect the ease of travel between zones. Some of the parameters for this model were borrowed from the San Francisco County

[11] A special form of regression used to analyze the relationship between predictor variables and a categorical outcome variable.

Transportation Authority (SFCTA) Model. MTC calibrated the model for the year 2000 using the Census for Transportation Planning Package (CTPP) and the Bay Area Travel Survey (BATS 2000).

ARB staff reviewed the variables used in the location choice model and overall, the location choice model predicted destination within the expected range. The location choice model uses household income by employment category, accessibility to various modes, and area type to capture land use characteristics. Area type and location variables played a significant role in explaining location choices in the region. The ease of travel between zones, which is captured using the mode choice logsum variable, influences the location choice.

ARB staff also evaluated average distance between home and work, home and school/college, and county-to-county work/school trips. Table 18 shows a comparison of the average distance between home-to-work and home-to-school/college predicted by the location choice model and the observed data. The distance distributions for school and college trips matched very closely with less than 5 percent difference, whereas the difference between the model and observed data for distance to work was 6.3 percent. MTC attributes this difference to higher-income workers traveling further distances to work than lower-income workers. The comparison of county-to-county worker/student flows from the model and CTPP seems reasonable.

Table 18. Average Distance Between Home and Work/School/College

	Model (miles)	Observed data (miles)	Difference (%)
Average distance to work (one-way)	12.7	11.9	6.3%
Average distance to school, (one-way)	3.7	3.7	0.0%
Average distance to college, (one-way)	7.4	7.1	4.1%

To allow for evaluation of the model's structure and overall performance of the location choice model, ARB staff recommends that MTC provide goodness-of-fit statistics in the model documentation. It is insufficient to check only the average trip lengths for this portion of the evaluation. The frequency distribution of trip lengths should also be checked using coincidence ratios, which were not readily available.

- Auto Ownership Model

The auto ownership model is applied at the household level and reflects five ownership choices: zero car, one car, two cars, three cars, and four or more cars. It utilizes a multinomial logit model structure with variables such as number of workers, household income, age of household members (to indicate driver's license eligibility), residential and employment density, land use mix, parking cost, travel time from residence to work for each worker, and auto and transit accessibility. MTC developed the model using BATS 2000 data and calibrated the model at the county level using year 2000 census data.

ARB staff reviewed the structure and variables used in the auto ownership model. The auto ownership model showed a good fit with a rho-squared[12] value of 0.456. There is a strong relationship between the number of people aged 18-24 in a household and owning at least one auto, in MTC's auto ownership model. The number of vehicles available per household decreased when the density increased. The model followed the recommendations in CTC's 2010 California Regional Transportation Plan Guidelines (RTP Guidelines) that travel demand models should have an auto ownership model, and be sensitive to land use and transit accessibility.

Auto ownership at the county level from Travel Model One was compared with household data. In San Francisco and Alameda County, MTC's model originally showed a systematic deviation from the observed data in the zero vehicle households. To address this issue MTC included a geographic constant to better match the observed distribution. After incorporating the geographic constant this has improved the match between the observed and modeled data, as shown in Table 19. To better estimate the GHG reductions associated with SCS strategies in the future, ARB recommends that the auto ownership model be validated against the Department of Motor Vehicle data.

[12] This indicates how good the model fits the data points. In other words, it indicates the goodness-of-fit of the model.

Table 19. Auto-Ownership Distribution

County	Zero Vehicle HH		One Vehicle HH		Two Vehicle HH		Three plus Vehicle HH	
	Observed (%)	Model (%)	Observed (%)	Model (%)	Observed (%)	Model (%)	Observed (%)	Model (%)
San Francisco	28.4	29.2	42.0	42.0	22.3	21.8	7.4	7.0
San Mateo	6.0	5.5	31.8	32.3	39.9	40.9	22.2	21.3
Santa Clara	5.6	6.3	28.9	28.6	41.0	40.8	24.5	24.4
Alameda	10.8	10.7	34.8	31.7	36.2	37.5	18.2	20.1
Contra Costa	6.5	4.3	30.3	31.9	41.1	43.3	22.2	20.5
Solano	6.6	6.7	28.9	30.9	40.0	39.9	24.5	22.5
Napa	6.2	6.2	32.2	32.8	39.9	40.1	21.7	20.9
Sonoma	5.7	5.7	31.5	30.7	40.2	41.2	22.6	22.3
Marin	5.0	5.6	34.8	36.5	42.3	42.1	18.0	15.7

- Free Parking Model

The free parking model is used by MTC to reflect the cost of driving to work when individuals consider mode choice. It predicts the availability of free parking at work locations where parking charges are otherwise applicable (e.g., San Francisco, Berkeley, Oakland). This model is based on a model from the Mid-Ohio Regional Planning Commission. It utilizes a binary logit model structure with variables such as total employment, household size, income, work location, and number of cars per household. MTC calibrated the model at the county level using the zonal data from ABAG and BATS 2000.

To evaluate the free parking model, ARB staff reviewed the variables used in the model. The predictive capabilities of the free parking model are reasonable. The high income group and household size variables were statistically significant as expected. This model included three sets of geographic constants to capture the geographic distribution of free parking at the workplace. The free parking availability predicted by Travel Model One was compared with the observed data (BATS 2000), as shown in Table 20. The free parking availability matched closely with less than 5 percent difference with observed data.

Table 20. Employees with Free Parking by County

County	Model (%)	Observed (%)	Difference (%)
San Francisco	6.0	5.9	-0.1
Santa Clara	54.4	57.4	3.0
Alameda	45.7	47.7	2.0

- Daily Activity Pattern Model

The daily activity pattern (DAP) model is similar to the trip generation step in a four-step model. The model provides detailed daily travel activity for each person in the synthetic population. This model was transferred from the Atlanta Regional Commission's travel demand model. It uses a multinomial logit model structure and estimates travel activities at a temporal resolution of one hour. The DAP model includes three activity patterns: mandatory (predicts the number of home based work, school, or college activities, and extra stops a person might make for other activities); non-mandatory (personal business, shopping, and social/recreational activities); and home (only in-home activities). This model also predicts the number of tours, frequency, time of departure and arrival, and duration of each tour. An important feature of the DAP model is its linkage across household members. In other words, this model allows two or more people to travel jointly for any travel activity. For example, the model may predict when individuals could carpool for shopping or eating out. After joint tours are determined, the remaining time left for additional activities are updated for each person in the synthetic population.

The DAP model utilizes variables such as person (age, gender, employment status, school/college student), household (auto ownership, income), zonal characteristics (accessibility, density), and level of service by time of day. The DAP was calibrated by MTC using BATS 2000 at the person tour level.

Overall, the modeled tours by person types closely follow the observed data. Auto ownership, demographics, and accessibility variables strongly influence the number and the duration of tours. The signs and coefficients of each variable in the DAP model seem reasonable. Table 21 provides a comparison of modeled and observed shares of tours per day by person type. Both mandatory and non-mandatory modeled tours are within 5 percent of their corresponding observed tours, whereas in-home activities by person type are underestimated by 2 to 19 percent. In the future, ARB staff recommends that MTC devote more resources to model validation of this step, since it is a key component of Travel Model One to predict the travel activities in the region.

Table 21. Tours by Person Type per Day

Person Type	Mandatory		Non-mandatory		Home	
	Observed (%)	Modeled (%)	Observed (%)	Modeled (%)	Observed (%)	Modeled (%)
Full-time worker	81.3	81.6	10.1	10.3	8.6	8.1
Part-time worker	60.1	60.4	27.5	27.8	12.3	11.8
Non-worker	--	--	81.2	81.2	18.8	18.8
Retired	--	--	78.2	78.1	21.8	21.9
University student	70.0	70.2	22.0	22.1	8.0	7.7
Student driving age	76.3	76.6	10.8	10.7	12.9	12.7
Student of non-driving age	74.7	75.4	13.8	14.2	11.5	10.4
Pre-school child	40.6	41.1	36.3	37.0	23.1	21.9

The average tour length for non-mandatory tours was also evaluated. Table 22 shows a comparison of the average distance predicted by the DAP model and the observed data. Average tour length for non-mandatory tours varies between 2 percent and 18 percent, which MTC attributes to poor observed data. In the BATS 2000 survey, the primary destination of a tour was not asked; rather, it was inferred from the pattern of stops. To better evaluate the model structure and overall performance of the DAP model, ARB staff recommends that in the future, goodness-of-fit statistics be provided in the model documentation.

Table 22. Average Tour Length for Non-Mandatory Tours

Average distance	Modeled data (miles)	Observed data (miles)	Difference (%)
Shopping	4.3	4.5	4.4%
Eat out	5.7	6.3	9.5%
Visit	5.3	5.9	10.2%
Maintenance	5.6	5.9	5.1%
Discretionary	5.4	5.9	8.5%
Escort	4.0	3.9	-2.6%
At-work	3.1	3.8	18.4%

- Tour-Level Model

A tour-level model is used to predict the primary mode choice for all tours predicted in the DAP model. It uses a nested logit model structure to forecast the main tour mode, from the tour origin to the primary destination, and back to the origin. Once the daily activity pattern has been estimated for each person, the model schedules the tours that he or she would be expected to take. The tour-level mode choices include drive alone, shared ride (2 persons and 3 or more persons), drive-to-transit, walk-to-transit, bike and walk. The model further splits the auto mode into free or pay, and transit into specific modes (BART, express bus, commuter rail, Light Rail Transit). The model also allows travelers to use walking as a mode for any trip in a tour, and allows travelers to switch between transit and auto modes. This model was transferred from SFCTA and estimated using BATS 1990 data such as zonal characteristics of origin and destination zones, in-vehicle travel time, other travel time, cost, level of service, household auto ownership, number of stops in a tour, initial wait time, and transfer wait time.

Table 23 shows a comparison of modeled and observed mode share for all trip purposes in the year 2000. Overall, the tour-level model results track closely, and are consistent with, the observed data.

Table 23. Comparison of Mode Share for All Trip Purposes in 2000

Mode	Observed data (percent of total)				Model Results (percent of total)			
	Work	School	College	Shop	Work	School	College	Shop
Walk	2.6%	13.4%	7.6%	8.8%	2.6%	13.9%	8.2%	8.0%
Bike	1.6%	1.5%	1.2%	1.2%	1.7%	1.5%	1.3%	1.1%
Drive alone	56.6%	3.6%	33.7%	55.3%	56.3%	3.5%	33.1%	59.6%
Shared ride 2	15.7%	22.1%	16.1%	17.5%	15.7%	21.8%	16.0%	16.9%
Shared ride 3+	9.4%	49.9%	15.7%	13.3%	9.4%	49.6%	14.8%	11.3%
Walk-transit	9.6%	9.2%	22.1%	3.6%	9.9%	9.4%	22.0%	3.0%
Drive-transit	4.4%	0.3%	3.7%	0.2%	4.4%	0.3%	4.6%	0.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

In the estimated nested logit model, the coefficients of key variables used in the model are correctly signed. The coefficient on the walk mode is generally significantly higher than the coefficient on the bike mode, indicating the relative inconvenience associated with the walk mode. This is well captured in this model due to the inclusion of zonal topographic characteristics. The autos per worker constant in the model (autos=0, autos<workers, autos>=workers) was significant. This indicates that there is a higher probability to choose a walk/bike mode in cases where the number of autos is zero or less than the number of workers in households. Various demographic and socioeconomic attributes of both households and individuals play significant roles in the model.

MTC's mode choice model was calibrated and validated using the BATS 1990 data. In the future, to better estimate the GHG reductions associated with SCS strategies, MTC should revisit and recalibrate the mode choice model using the latest household travel survey data. Model documentation should include the model estimation process, estimated parameters, and statistical significance of the estimates.

- Trip-Level Model

In the trip-level model, estimated tours are converted into trips. The trip-level model is applied after all tour-level models and is constrained by tour-level predictions. For example, if a person bikes to work he/she cannot drive a car back home from work. Intermediate stop locations within a tour are predicted based on the constraints of tour origin and the primary destination, as well as trip characteristics such as tour purpose, tour mode, stop purpose, person type, and household characteristics. The trip-level model also predicts the mode for each trip on a given tour. The variables used in the trip-level mode choice component are similar to those in the tour-level mode choice model.

The model structure of both trip-level stop location and mode choice sub-models are consistent with that of the tour-level models, respectively. It is observed that the stop distance on a tour makes a significant contribution in determining the location of each trip on a tour. In the trip-level mode choice model, the coefficients of in-vehicle time and other travel times have correct signs and values are within the reasonable ranges as indicated in the FHWA guidelines. They are generally greater in absolute value than those estimated in the tour mode choice models, indicating higher elasticities with respect to time and cost for each trip mode given the tour mode. The model constants were adjusted to match the tour mode distribution. ARB staff recommends that in the future, the model documentation elaborate on how the model constants were adjusted and which parameters were estimated.

Trip Assignment

The final step in Travel Model One is trip assignment. This step consists of separate highway and transit assignments. The trip assignment step of Travel Model One is performed by converting person-tours to vehicle trips by mode and time period, aggregating those trips with internal-external, commercial, and air passenger trips, and assigning them to the highway and transit networks. Travel Model One runs over five time periods using multi-class user equilibrium assignments to assign vehicle trips on the transportation network for drive alone, shared rides, and all other vehicles. When all trips are assigned to a network, it estimates the total number of trips by mode, and the volume of vehicle traffic in each link. It also predicts the congested travel time in the entire transportation system by considering roadway capacity. MTC estimates effective roadway capacity of each facility by considering facility type and area type. This allows for consideration of priority lanes for shared rides and no-truck routes. Transit assignment is predicted by accounting for the congested travel time from the highway assignment. The times taken to access, egress, and transfer from one transit vehicle to another are weighted twice that of the travel time in the general purpose lane. For the assignment process, MTC used convergence criteria of 0.0005 and estimated the congested speed and volume/capacity ratio for the entire travel network.

Travel Model One uses a capacity constrained assignment function to estimate link volumes and speeds. The root-mean squared error (RMSE)[13] for daily traffic assignment in Travel Model One is 0.30 or 30 percent. MTC's practice in trip assignment is consistent with CTC's *2010 California RTP Guidelines* (RTP Guidelines). Further, Travel Model One has a correlation coefficient of 0.922 between the modeled and the observed volumes, indicating that the model closely follows observed data. Table 24 compares average weekday traffic volumes to observed traffic counts. Overall, Travel Model One underestimated traffic volumes by about 7.2 percent in 2005. MTC attributes this largely due to poor observed data because the Caltrans highway count database has few observed data for these facilities.

[13] RMSE measures average error between observed and modeled traffic volumes on links.

Table 24. Comparison of Estimated and Observed Traffic Counts in 2005

Facility type	Modeled	Observed	Difference (%)	FHWA Guidelines (%)
Freeway	11,157,023	11,921,536	-6.4%	±7
Major Arterials	939,317	1,091,728	-14.0%	±10
Collector and local	33,273	60,213	-44.7%	±20

Table 25 compares the modeled daily transit boardings by mode to the observed data from transit agencies. Generally, the transit boarding predicted by Travel Model One in the year 2005 is within 12 percent difference of the observed data. However, commuter rail ridership in the region is underestimated by 51 percent compared to the observed boarding data. MTC attributes this to artificial competition in the model between the commuter rail and new express bus service, and the extension of BART to the San Francisco airport.

Table 25. Comparison of Estimated and Observed Transit Boardings in 2005

Transit Mode	Modeled	Observed	Difference (%)
Commuter Rail	17,330	35,250	-50.8%
Heavy Rail	341,159	335,860	1.6%
Express	47,593	44,665	6.6%
Ferry	12,836	11,498	11.6%
Light Rail	177,954	168,434	5.7%
Local	1,007,374	933,628	7.9%

Model Validation and Peer Review

Model validation is a critical step in the development of any regional travel demand model. It establishes the credibility of the model to predict future travel behavior. The following analysis references the recommendations and requirements in the RTP Guidelines which MTC followed to enhance the modeling capabilities and validation procedures (see also Appendix A).

In performing model validation, MTC conducted both a base year validation of Travel Model One as well as future year validation, as recommended by the CTC Guidelines. Base year validation is also called static validation and is performed by comparing model results to observed data. For static validation, MTC compared model outputs to observed data as a check on the reasonableness of its modeling results. Future year (or dynamic) validation tests the predictive capabilities of the model by changing the input data for future year forecasts.

As part of the peer review process, MTC hired a consultant to review the model codes and to recommend improvements. Releasing the peer review document would help other MPOs to learn from MTC's experience and incorporate changes into their travel demand models. Further, this would add value to the existing literature on activity-based travel demand models. The RTP Guidelines also recommend that peer reviews be made publicly available as a part of the model documentation.

Current model documentation of Travel Model One needs significant improvements. As indicated in the RTP Guidelines, an MPO should include a goodness-of-fit measure derived from sub-model specification, and should include a comprehensive list of output metrics. To improve the transparency of the Travel Model One, MTC staff should work closely with all stakeholders to define the model needs and applications at the beginning of the process. MTC staff should coordinate with various stakeholders on modeling issues, and work to build consensus on socioeconomic and demographic forecasts. Model documentation should thoroughly describe the procedures used in model development, calibration, and validation. Model documentation is essential for model users and important for informing stakeholders on model processes.

Planned Model Improvements

This section describes the planned modeling improvements at MTC for the next RTP. In order to accurately model detailed travel movements throughout the region, MTC is planning to enhance the TAZ structure. MTC is also planning to improve the sensitivity to active transportation by enhancing the bike and pedestrian network in the model.

MTC is also in the process of developing an enhanced land use model under the UrbanSim model framework. This model is intended to predict economic activity associated with land use as a result of changes in transportation investments and policies. MTC plans to integrate the UrbanSim model with Travel Model One in order to better evaluate the effects of transportation and land use policy changes through interactions between variables and a feedback mechanism.

3. EMFAC Model

ARB's Emission Factor model (EMFAC2011) is a California-specific computer model which calculates weekday emissions of air pollutants from all on-road motor vehicles including passenger cars, trucks, and buses for calendar years 1990 to 2035.
The model estimates exhaust and evaporative hydrocarbons, carbon monoxide, oxides of nitrogen, particulate matter, oxides of sulfur, methane, and CO_2 emissions. It uses vehicle activity provided by regional transportation planning agencies, and emission rates developed from testing of in-use vehicles. The model estimates emissions at the statewide, county, air district, and air basin levels.

The EMFAC2011 modeling package contains three components: EMFAC2011-LDV for light-duty vehicles, EMFAC2011-HD for heavy-duty vehicles, and EMFAC2011-SG for future growth scenarios. EMFAC2011-SG uses the inventory from EMFAC2011-LDV and EMFAC2011-HD modules and scales the emissions based on changes in total VMT, VMT distribution by vehicle class, and speed distribution. To estimate per capita CO_2 emissions, MTC estimated passenger vehicle VMT and speed profiles for the region and applied them to the EMFAC2011-SG model. MTC then divided the estimated CO_2 emissions for passenger vehicles by the year 2005, 2020, and 2035 residential populations to obtain CO_2 emissions per capita.

4. Off-Model Adjustments

MTC used off-model estimates to account for GHG emissions reductions from the plan's climate initiative strategies. Off-model estimates were provided for the following strategies: regional electric vehicle (EV) chargers, vehicle buy-back and plug-in electric vehicle (PEV) purchase incentive, clean vehicle feebates, car sharing, smart driving, a commuter benefit ordinance, and vanpools.

The innovative concepts put forth in these strategies, such as increasing the proportion of clean vehicle miles driven in the region, and encouraging the use of car sharing and alternative modes for commuting are sound, and likely to support reduction in regional GHG emissions. The region's proposed regional EV chargers, vehicle buyback/PEV purchase incentive, and feebate programs will support the goals of California's Advanced Clean Car regulation. Local policies like these are essential for increasing awareness, and play an important role in maintaining consumer demand for advanced vehicle technologies as they are introduced into the market.

MTC developed strategy-specific quantification methods and assumptions for estimating program GHG emissions reductions. The methodologies consider a reasonable range of factors. In many cases, however, these quantification methods rely on assumptions about technology and travel behavior, which is an area with sparse empirical data but of high interest to agencies and communities looking ahead to future GHG emission reduction strategies. As the Bay Area begins to pilot these strategies at a regional-level, ARB staff will work with the region to collect program data that can inform future efforts in this emerging area.

ARB staff's review of MTC's climate initiative GHG emissions calculations is summarized below by strategy.

Regional Electric Vehicle Charger Program

Plan Bay Area's regional charger program aims to expand the region's public network of electric vehicle supply equipment (EVSE) for plug-in hybrid electric vehicles (PHEV). The network will allow electric vehicle drivers to increase their miles traveled in the vehicle's all-electric mode. Miles traveled using electricity

exclusively yield larger GHG benefits than miles traveled in the hybrid's gasoline mode.

To achieve this, the program helps overcome some of the cost barriers to EVSE installation. Financial assistance will be provided to interested employers, retailers, parking management companies, and others, for EVSE installation at workplaces, commuter hubs, and other destinations.

MTC estimates the program will reduce regional GHG emissions by 0.1 percent per capita from the 2005 baseline level by 2020, and 0.3 percent per capita by 2035. MTC estimated GHG emission reduction benefits by calculating the change in emissions with an increase in the all-electric mode miles traveled by PHEVs in the region.

Key assumptions in MTC's charger program analysis include: 1) there is no increase in total VMT or a shift in fleet make-up as a result of EVSE availability; 2) an increase from a baseline of 30 percent of PHEV travel miles as all-electric travel miles to 41 percent due to the regional charger program; and 3) that 20 to 25 percent of all PHEVs would require access to EVSE at any given time to achieve the increased electrification goal of this strategy.

ARB staff reviewed the fleet, VMT, and energy assumptions used in MTC's analysis of this strategy, and the method used to calculate the GHG emissions reductions of increasing all-electric mode miles traveled in the region. MTC's method and baseline assumptions are reasonable.

In the absence of existing data or other research, it is difficult to assess the reasonableness of MTC's assumption on the amount of EVSE stations or access needed to achieve a certain percent increase in all-electric travel miles by PHEV drivers. Data from implementation of this regional program is expected to provide better information for future analyses.

Vehicle Buyback and Plug-In Electric Vehicle Purchase Incentive

The objective of the regional vehicle buyback program is to accelerate fleet turnover in the Bay Area region toward more advanced and efficient plug-in hybrid electric or battery electric vehicles (BEV), by prompting demand among consumers who might otherwise either delay car purchasing, or buy a new or used conventional vehicle. The program will offer consumers who are willing to trade in older, less efficient vehicles, cash incentives toward the purchase of a new PHEV or BEV. Cash incentive amounts are expected to vary with the fuel economy of the vehicle being traded in, as well as the vehicle type being purchased.

MTC estimates the program will reduce regional GHG emissions by 0.5 percent per capita from the 2005 baseline level by 2035. MTC estimated emission reduction benefits by calculating the difference in emissions between a baseline fleet and a cleaner fleet, by decreasing vehicles older than ten years and replacing those vehicles with PEVs assumed to be deployed as part of the program.

While program details are still to be defined, key assumptions in MTC's greenhouse gas analysis include: 1) program implementation beginning in 2020; 2) an additional 47,000 PEVs on Bay Area roads attributable to the program, split 50/50 between PHEVs and BEVs; 3) buyback vehicles are more than ten years old; and 4) incentive levels of $1,000 per PHEV and $2,000 per BEV.

ARB staff reviewed the fleet, VMT, and energy assumptions used in MTC's strategy analysis, and the method used to calculate the GHG emissions reductions of incentivizing drivers of some of the region's older less efficient vehicles to replace them with PHEVs and BEVs. MTC's method and baseline assumptions are reasonable.

MTC assumes that an additional 47,000 PEVs will be attributable to this program. In the absence of existing data or other research, implementation of this regional program will be important to provide better information about the potential impact of buyback incentives on PHEV and BEV vehicle sales and the level of fuel economy improvements that can be achieved with displaced older vehicles.

Clean Vehicles Feebate Program

Feebates use a combination of fees and rebates to influence consumer purchasing behavior. MTC proposes establishing a regional feebate program, starting in 2020, where consumers who purchase vehicles emitting more GHG emissions per mile than a defined standard are assessed a fee at the point of purchase. Fees are used to provide consumers with rebates to purchase vehicles emitting less GHG emissions per mile than the defined standard. A regional clean vehicle feebate program would be the first of its kind in both the state and nation, and would likely require action by the State Legislature. In the near term, MTC plans to engage with ARB and the Bay Area Air Quality Management District (BAAQMD) to initiate its program development process.

While program details are still to be determined, MTC estimates a program like this can provide regional GHG emission reduction benefits of 0.7 percent per capita from its 2005 baseline by 2035. Emissions reductions were calculated by first estimating the improvement in average fuel economy of the region's new vehicle fleet between 2020 and 2035 due to a feebate program. A modified fuel economy was then estimated for the region's entire fleet between 2020 and 2035

and used to calculate a well-to-wheels differential in CO_2 emissions between the modified fleet and the baseline fleet.

Key assumptions in MTC's GHG analysis include: 1) the feebate program is introduced at the regional-level in 2020; 2) there are no increases in fuel economy standards at the state- or national-level after 2025; 3) the Bay Area represents about 20 percent of California's new car market; 4) a $20 per CO_2 grams/mile feebate rate; 5) as a result of the program, average CO_2 emissions for new vehicles sold in the region is reduced 10 grams/mile in 2020 and 2.5 grams/mile in 2035; and 6) the program is revenue neutral with administrative costs covered by MTC.

ARB staff reviewed the fleet, VMT, and energy assumptions used in MTC's strategy analysis, and the method used to calculate the GHG emissions reductions of incentivizing drivers to purchase cleaner vehicles with feebates. MTC's method and baseline assumptions are reasonable.

Data from implementation of this first in the nation regional program is expected to provide more information to support MTC's assumptions related to the expected percent change in average fleet GHG emissions under a feebate program. In its calculation, MTC assumes a selected value from a range of modeled results prepared by Bunch and Greene (2011) for ARB. MTC's approach is reasonable, but may be optimistic in light of California's Advanced Clean Cars (ACC) program, which includes more aggressive standards than were modeled in the Bunch and Greene (2011) study.

Smart Driving

Plan Bay Area's smart driving strategy is a public education campaign for the region's motorists that aims to reduce emissions by teaching techniques that change driving style, and by providing rebates for in-vehicle, real-time fuel efficiency gauges. This program targets emissions reductions from the existing stock of vehicles that will not be turned over for a zero emission vehicle in the near future. Examples of techniques that could be promoted include more regular vehicle maintenance and changes in driving style, like smooth acceleration and deceleration.

MTC estimates its smart driving program will achieve a 1.8 percent per capita GHG emissions reduction from the 2005 baseline in 2020 and a 1.5 percent per capita reduction in 2035. The emissions reductions decrease over time due to a number of factors including: the frontloaded impact of the program at the outset of the campaign when many drivers first adopt smart driving strategies, anticipated reduction in VMT, and increased vehicle fuel efficiency. MTC estimates emission reduction benefits for the program by calculating the number

of people anticipated to adopt the strategies advertised in the public education campaign and applying those estimations to the daily vehicle miles traveled.

Key assumptions in MTC's GHG analysis include: 1) a public education campaign focusing on four specific smart driving techniques -- smooth acceleration and deceleration and staying at or below the speed limit, linking of shopping trips, the use of trip planning applications, and the use of real-time, in-vehicle fuel efficiency meters; 2) based on a 2011 MTC survey, 10 percent of residents will implement the smart driving behaviors; 3) average daily miles traveled per vehicle would be 15.04 in 2020 and 13.8 in 2035;[14] and 4) adoption of one of the smart driving techniques does not interact with the GHG emissions reductions from the adoption of another smart driving technique.

ARB staff reviewed the assumptions regarding the effectiveness of the four smart driving techniques used in MTC's strategy analysis, and the method used to calculate the GHG emissions reductions from its smart driving campaign. In general, smart driving (also known as ecodriving) has been shown to reduce vehicle emissions. Due to the lack of recent, U.S.-based data on the effectiveness of smart driving/ecodriving the robustness of research on assumptions used in MTC's analysis about the efficacy of public education campaigns for smart driving/ecodriving techniques to the American context is lacking. The research that does address ecodriving/smart driving often refers to a variety of related measures and techniques that do not align directly with the public education campaign measures identified in Plan Bay Area. over time, data from implementation of the program is expected to help ARB staff better assess reasonableness of the effects of such a public campaign in future analyses.

Car Sharing

Car sharing is a short-term auto use program in which people rent cars for short periods of time, often by the hour. While reducing negative impacts of privately owned and operated vehicles, such as air pollution or congestion, car sharing provides a flexible transportation alternative to vehicle ownership for people that use a vehicle only occasionally. Fewer GHG emissions as a result of reduced VMT and reduced vehicle ownership are environmental benefits frequently associated with car sharing, as many trips shift from those typically made in a single occupancy vehicle, to walking, bicycling, and taking public transit. Studies

[14] As discussed with MTC and ICF.

show that with a car sharing option, people will choose alternatives to driving for shorter trips, while using the car sharing vehicle for occasional longer trips.

MTC estimates its car sharing program will achieve a 2.6 percent per capita reduction in GHG emissions by 2020 and a 2.6 percent per capita reduction by 2035. MTC estimates emission reduction benefits for the program by summing the estimated reductions in car share member VMT compared to non-car share members, and estimating the increases in car share member fuel efficiency, assuming that car share vehicles are more fuel efficient than the average vehicle.

Key assumptions in MTC's GHG quantification include: 1) there are currently over 60,500 car sharing members in traditional Bay Area car sharing systems; 2) car share members drive an average of seven fewer miles per day than non-car share members; 3) car share members drive approximately 1,200 miles per year in car share vehicles; 4) car share vehicles are more fuel efficient than the average vehicle, using approximately 29 percent less fuel per mile than the non-car sharing community through 2040; 5) the car share population in 2020 is 15 percent of the region's urban area population, and in 2035 it is 15 percent of the urban area population plus 5 percent of the suburban area population; and 6) there will be a constant, major shift in travel mode share to walking, bicycling, and taking public transit.

ARB staff reviewed the fleet, VMT, and energy assumptions used in MTC's strategy analysis, and the method used to calculate the GHG emissions reductions from expanding car share services in the region. MTC's method and baseline assumptions appear reasonable.

MTC's assumptions are based on several research studies that vary in sample size (number of participants), location (Bay Area, United States, Canada), and other survey characteristics. While the individual research results analyze demographics and travel behavior of a defined sample, linking those results and driving assumptions to Bay Area conditions is challenging. Data from implementation of a car sharing program at the regional level is expected to provide more information on the rate of participation in car sharing as a mode of travel, and the potential for behavioral change. This information will be useful for future analysis.

Commuter Benefit Ordinance

MTC and the Bay Area Air Quality Management District (BAAQMD) are now in the process of jointly developing a regional commuter benefit ordinance. This program is expected to require employers with 50 or more full-time Bay Area employees to offer their employees incentives to use a mode other than driving alone while commuting to and from work. With the legislative authority (SB 1339) to implement this region-wide ordinance already in place, this strategy is

projected to decrease VMT by shifting some employees from driving alone to using transit, vanpools, carpools, or active transportation modes.

MTC estimates the ordinance would achieve GHG emissions reductions of 0.1 percent per capita in 2020, and 0.3 percent per capita in 2035, compared to a 2005 baseline. MTC calculated GHG emissions reductions by first estimating the number of businesses with at least 50 employees, then the number of single occupancy vehicle (SOV) commute tours attributable to those businesses, taking only 54 percent of those tours to account for the assumed 46 percent of employers who already offer a commuter benefit program, and using that to calculate the daily number of trips shifted from SOV to transit. This number of trips is then used to calculate the daily reduction in VMT, which is an input to EMFAC2011 used to obtain the amount of CO_2 projected to be reduced.

While several incentive options are available, for the sake of calculating the GHG emission reduction benefits, Plan Bay Area assumes that all employers in the program will provide the lowest cost option to their employees, and estimates the change in commute VMT associated with this option, allowing employees to pay for transit, vanpooling, and/or bicycle expenses using pre-tax income. Other incentive options are also available to employers.

Additional key assumptions in MTC's GHG analysis include: 1) an elasticity of 0.15 (that is, for every one percent reduction in transit cost, there would be a 0.15 percent reduction in the number of single occupancy vehicle commuters on the road), 2) that the pre-tax benefit would result in a 33 percent transit cost reduction, 3) that 46 percent of employers already offer one of the required benefits prior to implementation of the ordinance, and 4) in the interest of simplifying calculations, employees who take advantage of these incentives would all shift from SOV modes to modes that wouldn't result in new vehicle trips.

ARB staff reviewed MTC's assumptions regarding the estimates for VMT reductions and the method used to calculate GHG emissions reductions and finds them generally reasonable. One exception is with respect to the elasticity that MTC chose. While MTC cited a long-term elasticity from Litman's 2004 literature review, they have used a short-term elasticity. In addition, MTC mischaracterized the elasticity as directly relating auto trips with transit fares. According to Litman's paper, only ten to 50 percent of the rise in bus ridership resulting from reduced fares can be substituted for automobile trips. The end result of these two differences with the cited Litman study is that, while MTC's VMT reduction estimates still fall within Litman's cited range, MTC's estimate is closer to the middle of the range, rather than at the low end, as they state in their off-model documentation.

Still, there is a limited amount of research available to draw upon in assessing the reasonableness of MTC's elasticity assumption. Data that could be generated from the implementation of this program is expected to provide better information for future analyses.

Vanpools

Plan Bay Area calls for additional resources to MTC's existing vanpool program, with the goal of increasing vanpool ridership, which is expected to reduce the number of single occupancy vehicles on the road, and therefore, VMT. To achieve this goal, MTC plans to increase the subsidy given to vanpools to $400 per month per van, from the current one-time $500 start-up subsidy, up to $100 per year when a passenger drops out of a vanpool, and free bridge tolls.

MTC estimated that the vanpooling program will reduce regional GHG emissions by 0.3 percent per capita from the 2005 baseline by 2020, and 0.4 percent per capita by 2035. MTC estimated these GHG emissions reductions by calculating the daily VMT expected to be traveled by commuters who would be new participants in vanpools, the number of trips per day eliminated by future vanpool participants who are no longer driving alone or in two- or three-person carpools, and the emissions from the eliminated VMT and trips, using EMFAC 2011.

Key assumptions that MTC's GHG quantification of the vanpool program relies upon are that 1) the vanpool fleet will double from the current 515 vans with over 5,500 daily participants to 1030 vans; 2) the average of 10.8 passengers and the roundtrip distance of 116 miles per van will remain constant over time; and 3) to account for the emissions of the vans themselves, an average of 9.8 passengers will be used in the calculations.

ARB staff reviewed the expected increase in the vanpool fleet and the method used to calculate the GHG emissions reductions from an increase in the vanpool fleet. MTC's method and baseline assumptions are reasonable.

D. Model Sensitivity Analysis

The use of sensitivity analyses is intended to provide an indication on how an MPO travel demand model actually behaves, compared to how it is expected to behave, and whether the model is capable of producing forecasts that could reasonably be expected to result from the data inputs and assumptions used. The analyses usually involve systematically changing one model input variable at a time (e.g. increases in transit frequency, roadway pricing, land uses) to see how sensitive the model outputs, such as VMT, are to changes in the input variable. However, sensitivity analyses are not intended to quantify model inputs or outputs or provide an analysis of actual modeled data. They are simply intended to assess the performance of the model itself.

Travel modelers will typically rate models as being sensitive as long as changes in model outputs result from changes in model inputs. ARB's analysis goes further by asking whether or not the results of the SCS sensitivity analysis demonstrate that the model is showing output changes that are within the range of values published in relevant empirical literature. In those cases where there was a lack of empirical literature with which to corroborate MTC's sensitivity analysis findings, ARB staff would simply indicate that the findings were or were not sensitive, depending upon whether changes in model inputs resulted in changes to model outputs. In those instances where the findings were corroborated by the empirical literature, the findings were referred to as either sensitive directionally, meaning that the direction of change was consistent with findings in the empirical literature, or sensitive in magnitude, meaning that the amount of change predicted was consistent with the literature.

ARB requested that MTC conduct a series of sensitivity analyses for its model using the following variables:

- Combined household income, residential density, and employment density
- Auto operating cost
- Express lane pricing
- Transit service frequency, BART only

MTC's sensitivity analyses were evaluated to understand how its travel demand model outputs changed as the network, land use, or transportation-related inputs changed. Changes in model outputs were compared with expected changes indicated in the empirical literature. In those cases where the range of elasticities[15] was available in the literature, ARB applied them to changes in model inputs that were used in MTC's sensitivity analyses. Results of these sensitivity analyses provided a better understanding of the travel demand model's capacity to effectively capture the GHG emissions impacts of MTC's SCS on key model outputs such as VMT, trips, and mode share.

Following is a summary of the evaluation of the sensitivity analyses that are reported by MTC. We note that neither the sensitivity analyses, nor pertinent findings in the empirical literature, are in all cases definitive. The integration of sustainable community strategies into transportation modeling is still relatively new, resulting in analytical knowledge gaps that experience and new research will overcome over time. Nevertheless, the results of MTC's sensitivity analyses are complete and generally consistent with available empirical literature.

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[15] Elasticity is defined as the percent change in one variable divided by the percent change in another variable.

Based on both MTC's specific sensitivity analyses, and examination of the relevant empirical literature, ARB staff's evaluation shows that MTC's analysis of model output changes are directionally consistent, and that the model is generally sensitive for the variables tested. MTC's analysis reflected changes to model outputs from changes in inputs. For many of the variables, MTC's results were consistent with the empirical literature. In some cases, no comparable empirical studies were available which examined the same inputs and outputs as MTC's analysis. Such a comparison would help ensure that staff's analysis is technically sound. In four instances, MTC's results were slightly outside the lower range of expected impacts based on the literature. These instances are explained in more detail in the following sections, with explanations of factors that may have affected the sensitivity test results.

1. Combined Household Income, Residential Density, and Employment Density

MTC modeled three variables, combined household income, residential density, and employment density, together. As expected, MTC's travel model showed that VMT would increase with increases in household income, and that VMT would decrease with increases in residential density and employment density. MTC staff computed the elasticity for each of these three variables by using the univariate regression coefficient and the sample means.

Household Income Sensitivity Analysis

There is relatively little in the empirical literature that cites the direct effect of income on household VMT. Murakami and Young (1997) report that low income households make 20 percent fewer trips than other households. Since this number counts all trips (including walking and transit), the effect on VMT is even more significant: VMT per household in low income households is about half of that in other households. MTC's sensitivity analysis showed a computed elasticity of 0.166. The model shows that it is sensitive to changes in household income levels; the changes are moving in the right direction (i.e. more income correlates with more VMT), but the degree of change cannot be evaluated since no elasticities specific to income were identified in the empirical literature.

Residential Density Sensitivity Analysis

Most of the studies cited in the empirical literature that relate to residential density focus on overall population density, and is probably the best proxy for residential density. The elasticities for the impacts of population density on VMT cited in the studies range from -0.05 to -0.12 (Boarnet and Handy, 2013). MTC's sensitivity analysis showed an estimated elasticity of -0.063, which indicates that the model is sensitive directionally and in magnitude to changes in residential density; the changes are moving in the right direction (i.e. higher residential densities result in lower VMT), and MTC's estimated elasticity falls within the range of elasticities cited in the empirical literature.

Employment Density

One way to examine the impacts of changes to employment density is with jobs-housing balance data. In other words, researchers consider the impacts to employment density if the number of jobs relative to housing is increased or decreased. Another proxy for employment density is land use mix since, by definition, it presumes the addition of commercial land use (with corresponding employment) in residential areas. MTC's sensitivity analysis showed an estimated elasticity of -0.103. The model shows that it is directionally sensitive to changes in employment density (i.e. greater employment density results in fewer VMT), however, because MTC's sensitivity test was not based on either jobs-housing balance or on land use mix, directly relevant empirical literature could not be identified.

2. Auto Operating Cost

MTC conducted five sensitivity tests to determine the model's responsiveness with respect to changes in auto operating cost. In these tests, auto operating costs were changed to 50, 79, 100 and 300 percent of the 2000 baseline auto operating cost of $0.14 per mile (in 2000 dollars). MTC refers to the operating cost as perceived because of uncertainty about what an individual traveler assumes the cost to be; therefore, MTC assumes every resident in the region behaves as if traveling one mile in their car costs 14 cents. MTC staff assumed that fuel cost has the greatest influence on perceived auto operating cost, therefore test results were compared to the available empirical literature on changes in fuel costs.

When auto operating cost increases, travelers are expected to drive less and/or make shorter distance trips, resulting in VMT decreases. When auto operating cost decreases, VMT is expected to increase. The empirical literature includes elasticities that range from -0.02 to -0.09 (Small and Van Dender, 2007) and -0.15 (Agras and Chapman, 1999) for changes in vehicle travel over the short-run (less than five years) relative to fuel price. The long-run elasticities (greater than five years) from these studies are -0.11 to -0.34 (Small and Van Dender, 2007) and -0.32 (Agras and Chapman, 1999).

Table 26 summarizes the modeled VMT resulting from various auto operating costs. When operating cost was dropped to 79 percent of the base case cost, VMT increased by 10 percent. Conversely, when auto operating cost was increased to 300 percent above the base case, VMT decreased by 22 percent. All the modeled VMT fall within the expected short-run VMT ranges; but the modeled VMT associated with 100 and 300 percent increases in auto operating cost do not fall within the expected long-run VMT ranges, which possibly means that the change of 100 and 300 percent in auto operating cost are outside the applicable range of change in auto operating cost in the existing literature.

Table 26. Auto Operating Cost - Sensitivity Test Results

Test	Auto Operating Cost*	Modeled VMT (thousands)	% Change in VMT from Base Case	Expected Short-Run VMT Range† (thousands)	Expected Long-Run VMT Range§ (thousands)
79 percent decrease from base case cost	$0.03	188,555	10%	174,535 - 192,087	186,686 - 217,739
50 percent decrease from base case cost	$0.07	182,197	6%	173,553 - 184,723	181,286 - 201,047
Base case	$0.14	171,835	0%	--	--
100 percent increase from base case cost	$0.28	155,064	-10%	146,060 - 168,398	113,411 - 152,933
300 percent increase from base case cost	$0.56	133,344	-22%	94,509 - 161,525	0 - 115,129

*In 2000 dollars.

†Calculated based on short-run elasticities of -0.02 to -0.15

§Calculated based on long-run elasticities of -0.11 to -0.34

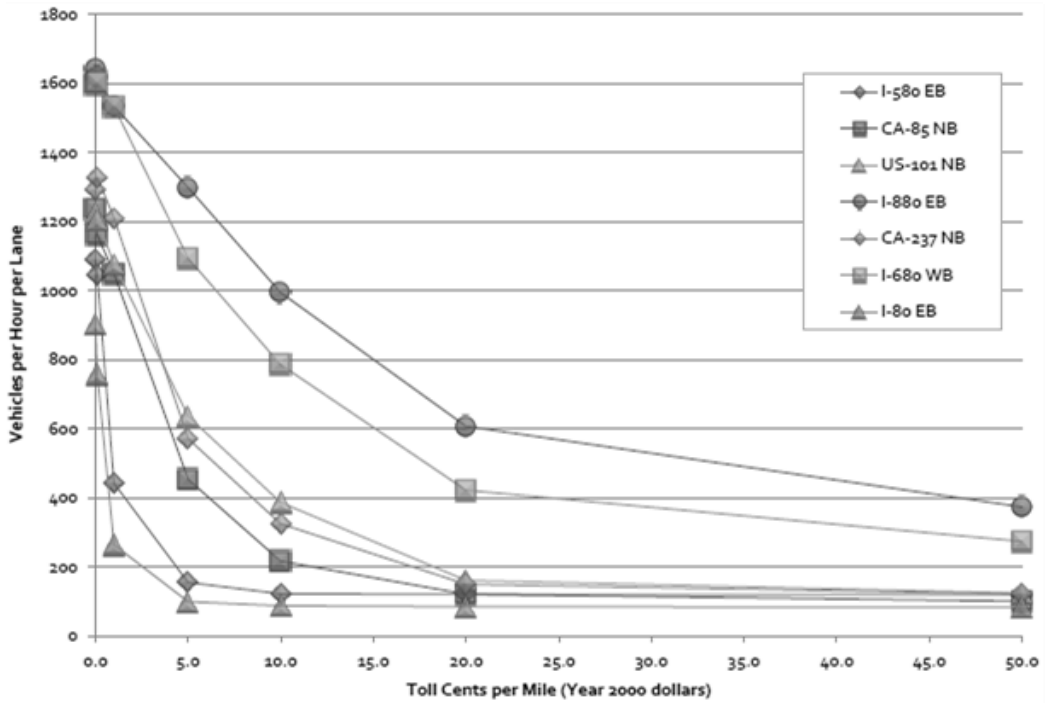
3. Express Lane Pricing

Express lanes, also known as high-occupancy toll (HOT) lanes, are high occupancy vehicle (HOV) lanes that give solo drivers the option of paying a fee to use the lanes, while vehicles with two or three occupants may use them free of charge. The intent of express lanes is to increase the efficiency of underused HOV lanes and ease congestion in the general purpose lanes.

MTC performed seven sensitivity tests varying the charge for the use of express lanes for low-occupancy vehicles (i.e. drive alone and 2-person carpools) to examine the responsiveness of its travel demand model to the change of express lane pricing. In these tests, the year 2035 scenario with an extensive express lane network served as the base case. MTC staff tested the model with the express lane price set at 0, 0.1, 1, 5, 10, 20, and 50 cents per mile.

As the toll price increases, there would be an expected decrease in usage and an increase in speed on the express lanes, and there would be a corresponding increase in usage and decrease in speed on the general purpose lanes. Figure 12 shows one of the three model results of average volume on the express lane during the morning commute peak period, as reported by MTC. The trends in Figure 12 are consistent with expectations – as the toll price increases from 0 to 50 cents per mile, hourly volume on the express lanes decreases.

Figure 12. Average Morning Commute Peak One Hour Express Vehicles per Lane



Source: MTC with Parsons Brinckerhoff, Inc. (2013), *Travel Model Development: Sensitivity Testing*.

It is also expected that the drive alone mode share would increase when the toll price is set between 0 cents per mile and the break-even price, at which the benefit of using the express lane is the same as the cost of the toll price. The reported percent mode share results for drive alone (DA), 2-person carpool (S2), 3-person carpool (S3), walk/bike, and transit with respect the change of toll price are summarized in Table .

Table 27. Percent Mode Share – Sensitivity Test Results

Mode	Toll Price (cents/mile)						
	0	0.1	1	5	10	20	50
DA	49.8%	50.1%	50.1%	49.9%	49.8%	49.7%	49.7%
S2	17.7%	17.9%	17.9%	17.9%	17.9%	17.9%	17.8%
S3	13.2%	12.9%	12.9%	13.0%	13.0%	13.1%	13.3%
Walk/Bike	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%
Transit	6.6%	6.5%	6.5%	6.5%	6.5%	6.6%	6.6%

As expected, when the toll price increases from 0 to 1 cent per mile, the percent mode share of DA increases slightly. When the toll price is higher than 1 cent per mile, the percent mode share of DA or S2 starts to reduce slightly because the benefit of travel time saving is less than the cost of the toll. Because S3 users could access the express lane free of charge, their response to the change in toll price is almost irrelevant. Because the implementation of toll price would directly affect highway traffic but not non-motorized trips, the response of walk/bike and transit is unchanged with changes in toll price.

4. Transit Service Frequency, Bay Area Rapid Transit (BART)

MTC conducted sensitivity tests to determine the model's responsiveness to the BART system's service frequency. MTC used a year 2010 baseline of 15 minute service frequency and ran sensitivity tests of 5, 10, 20, and 25 minute service frequencies for BART (Table). Based on MTC's model runs at 5 and 10 minute frequencies, ridership increased 26.9 percent and 11.5 percent, respectively, from the baseline. At 20 and 25 minute frequencies, ridership decreased 6.53 percent and 12.42 percent, respectively. The elasticities generated from the model range from 0.46 to -0.62 indicating that the model is directionally sensitive to changes in transit service levels (i.e. more transit service results in more transit ridership), but the degree of change is not entirely consistent with the elasticities from the empirical literature. MTC explains this by saying that this sensitivity test only changes BART's frequency but does not include changes made to all the transit feeder systems to BART.

Table 28. MTC's BART Frequency Sensitivity Analysis Results

Frequency (minutes)	5	10	15	20	25
Trains per Hour	12	6	4	3	2.4
Modeled Ridership	437,227	386,318	346,473	323,860	303,441
Modeled Elasticity	0.10	0.46	--	-0.50	-0.62
Percent change in ridership from Baseline	26.19%	11.50%	--	-6.53%	-12.42%
Anticipated Ridership (based on 0.5 elasticity (Handy et al., 2013))	692,946	433,091	--	303,164	277,178
Anticipated Change in Ridership from Baseline	100%	25%	--	-13%	-20%

E. SCS Performance Indicators

ARB staff evaluated changes in a set of key indicators that describe SCS performance. These indicators are examined to determine if they can provide qualitative evidence that the SCS could meet its GHG targets if implemented. ARB staff evaluated the directional consistency of the indicators with MTC's modeled GHG emissions reductions, as well as the general relationships between those indicators and GHG emissions identified in the empirical literature. The indicators include: residential density, housing type mix, housing units in PDAs, passenger VMT, mode share, and average trip length. The assessment relies on key empirical studies for each indicator that illustrate qualitatively that changes can increase or decrease VMT and/or GHG emissions. Below is a summary of the evaluation for the land use and transportation-related performance indicators.

1. Land Use Indicators

To determine the benefits of the development pattern in the RTP/SCS on GHG emissions from passenger vehicles, the evaluation focused on the following performance indicators related to land use: residential density, housing type mix, and housing units in PDAs.

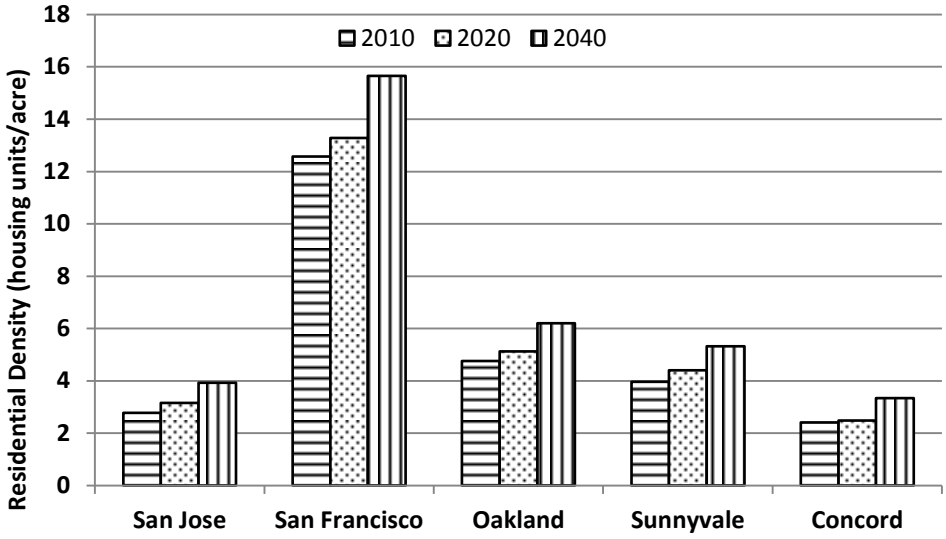
Residential Density

Residential density is a measure of the average number of dwelling units per acre of developed land. Travel characteristics in the region are expected to change as the housing market shifts from single family homes to multi-family housing units. These changes in travel behavior include reductions in average trip length, and could eventually result in decreased regional VMT.

A review of relevant empirical literature reveals that increases in density could reduce VMT. Brownstone and Golob (2009) analyzed National Household Travel Survey (NHTS) data and observed that denser housing development significantly reduces annual vehicle mileage and fuel consumption, which directly results in lower GHG emissions. They also reported that households in areas with 1,000 or more units per square mile drive 1,171 fewer miles and consume 64.7 fewer gallons of fuel than households in less dense areas. Boarnet and Handy (2013) reported that doubling residential density reduces VMT an average of 5 to 12 percent. Litman (2013) reported that a 1 percent increase in population density leads to a 0.2 to 1.45 percent decrease in the demand for car travel.

ABAG/MTC's land use forecast in the final plan projects that between 2010 and 2020 the region's residential density will increase by about 5 percent, and between 2010 and 2040, it will increase by about 19 percent. Figure 13 shows residential density in the five cities in the nine-county region expected to experience the most housing growth between 2010 and 2040. For example, San Jose will have about 130,000 new housing units by 2040. The trend in increased residential density supports the forecasted GHG reductions.

Figure 13. Residential Density in Top Five Cities in Bay Area

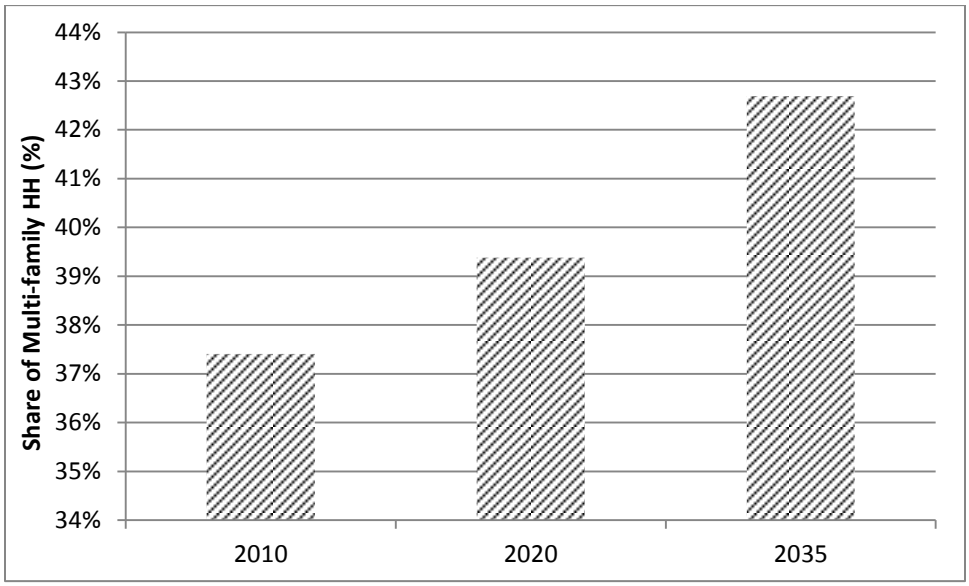


Housing Type Mix

Housing type mix influences what land use patterns can be achieved in a region. The greater the proportion of housing growth that is multi-family development, the more opportunity a region has to accommodate future growth through a more compact land use pattern.

Between 2010 and 2035, Plan Bay Area shows an increase in multi-family households relative to the total number of households from 37 percent to 43 percent (Figure 14) because housing changes occur over the long-term. Projected demographic changes and increased racial and ethnic diversity are anticipated to cause the shift to new multi-family units. By 2040, the region's share of senior citizens will increase to 22 percent from today's 12 percent, and Latinos are expected to emerge as the largest ethnic group. Of the new households in the region since 2010, multi-family households are estimated to grow by about 62 percent by 2020, and 66 percent by 2035. This trend further supports the forecasted GHG emissions reductions.

Figure 14. Share of Multi-Family Housing Units in the Region

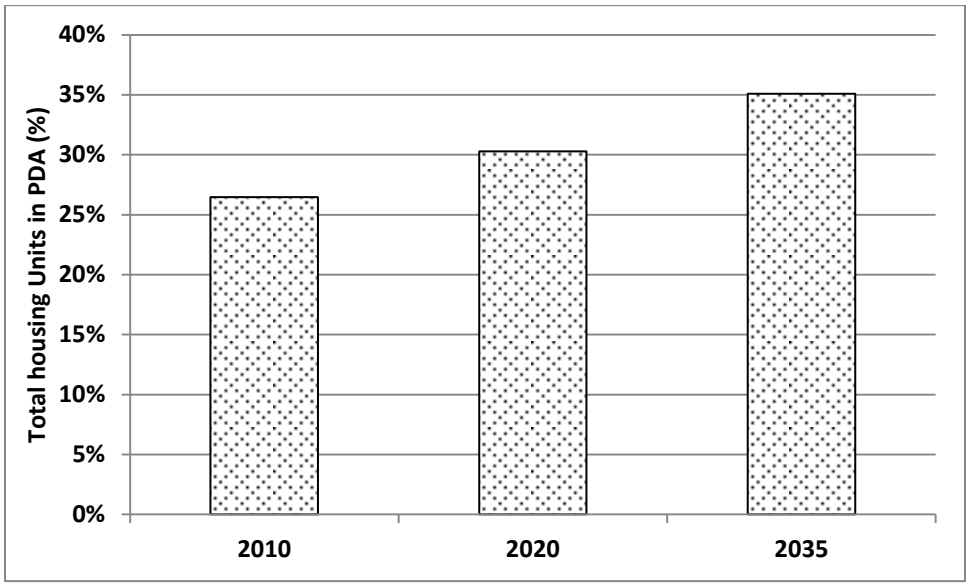


Housing Units in PDAs

In developing the future land use pattern, ABAG/MTC assumed about 78 percent of new housing and 62 percent of employment development would occur within areas close to transit, which are identified as PDAs. Focusing new growth in areas with good access to frequent transit service is a key SCS measure that ABAG/MTC hopes will encourage transit ridership and reduce or eliminate the need for vehicle trips, increase the use of walking or biking, and maximize the benefits of a denser, more compact land use pattern.

Relevant empirical literature provides supporting evidence for the reduction trend ABAG/MTC anticipates in GHG emissions. Proximity of housing and employment to transit is a commonly-used performance measure for evaluating the effectiveness of transit oriented development (TOD). The empirical literature indicates that commuters living within a TOD area use transit two to five times more than do other commuters in the region. Moreover, the literature shows that proximity of housing and employment to transit stations is highly correlated with increased transit ridership. Transit ridership sharply increases as housing and employment increases within a one mile radius of transit stations (Kolko 2011). Other studies show significant VMT reductions for placement of housing and employment closer to rail stations and bus stops (Handy, et.al 2013). In the ABAG/MTC region, the percentage of housing units in PDAs was 26 percent in 2010. ABAG/MTC projects that this will increase to nearly 30 percent in 2020 and nearly 35 percent in 2035 (Figure 15). The anticipated increase in housing units near transit stations/stops provides additional supportive evidence for the reported reduction trend in GHG emissions in the region.

Figure 15. Percentage of Housing Units in PDA



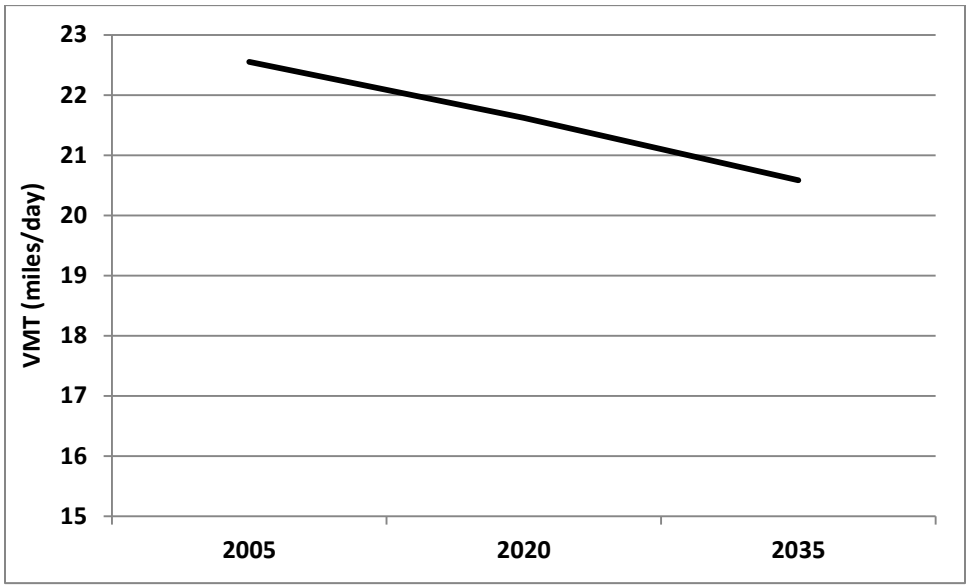
2. Transportation-Related Indicators

ARB staff evaluated three transportation-related performance indicators along with supporting data inputs, assumptions, and sensitivity analyses. These indicators are passenger VMT, mode share, and average trip length.

Passenger Vehicle Miles Traveled

Plan Bay Area, as expected, shows a decline in per capita passenger vehicle VMT over time. VMT per capita decreases by 4.1 percent between 2005 and 2020 and 8.7 percent between 2005 and 2035, as shown in Figure 16. The quantification of GHG emissions from passenger vehicles is a function of both VMT and vehicle speeds. These results are directionally consistent with and supportive of the reported GHG emission reduction trend over time.

Figure 16. Per Capita Passenger VMT Trends

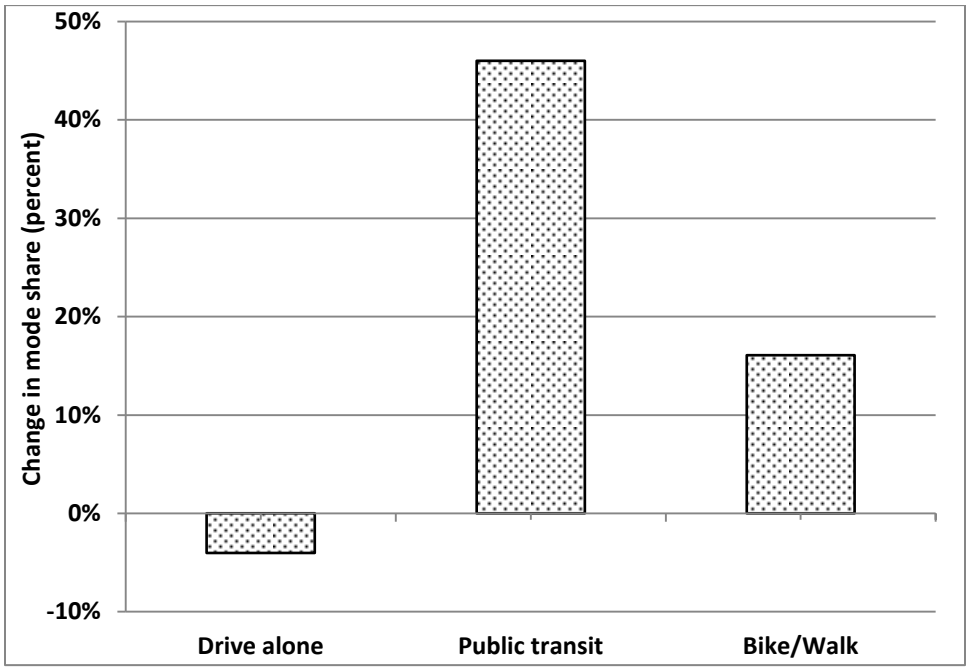


Mode Share

Mode share measures the change over time in the means by which people travel. Shifting trips from vehicle to non-vehicle modes (e.g. bike, walk, working at home) reduce vehicle GHG emissions in a region. While a change in mode shares cannot generally be used to quantify a change in GHG emissions, the empirical literature indicate that GHG emissions per person are likely to decrease as automobile mode share decreases and transit, bike, and walk mode shares increase.

Mode share is included for both commute and non-commute trips, measuring how people travel from home-to-work and back, as well as how they travel for school, shopping, personal business, and all other non-work trip purposes. Figure 17 shows the expected percent change in mode share by 2035 with respect to 2005 for all trips. Since 2005, the drive alone mode share decreases about 4 percent. Bike/walk and transit mode shares increase by 16 percent and 46 percent, respectively. The increase in transit ridership and bike/walk are also due to an increase in density of the population. These results are directionally consistent with and supportive of the reported GHG emission reduction trend over time.

Figure 17. Percent Change in Mode Share by 2035 (all trips)

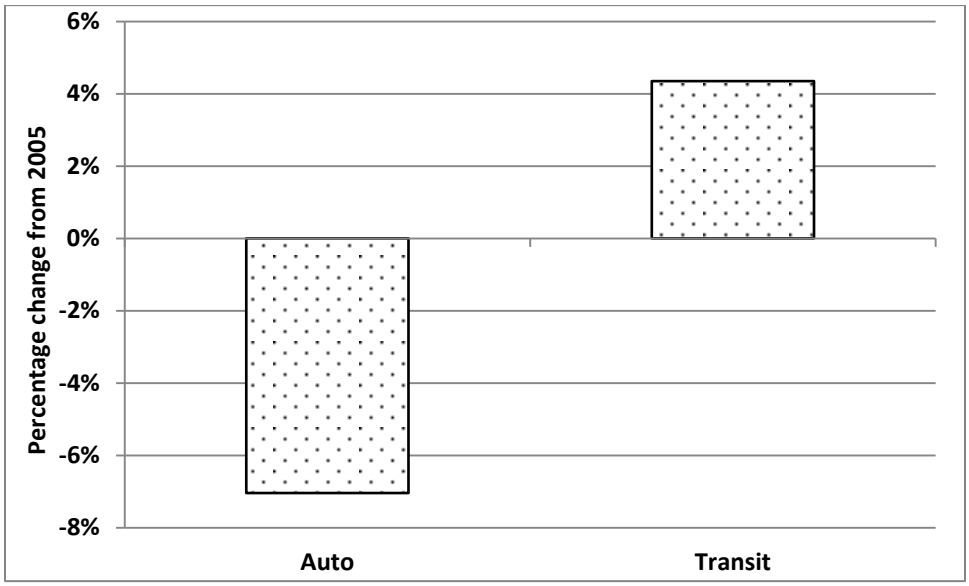


Average Trip Length

Changes in the average trip length by mode can contribute to an overall reduction of GHG emissions in a region. Decreases in average trip length for trips by auto can reduce a region's GHG emissions by decreasing overall miles traveled in a vehicle. An increase in average trip length for trips by transit modes can also contribute to the reduction of GHG emissions.

Figure 18 shows the change in average trip length by mode for all trip purposes as reported by MTC. The data shows that the average automobile trip length decreases by 7 percent, from 7.1 miles in 2005 to 6.6 miles in 2040. During the same time period, average trip length for transit increases 4.3 percent from 9.2 miles in 2005 to 9.6 miles in 2040. These trends are directionally consistent with and supportive of the reported GHG emission reduction trend.

Figure 18. Average trip length by mode by 2040



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APPENDIX A. MTC's Modeling Data Table

This appendix contains MTC's responses to data requests, received February 18, 2014 to supplement staff's evaluation of MTC's quantification of GHG emissions. The requests are consistent with the evaluation methodology.

Modeling Parameters[16]	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)[17]
			(Without Project)[18]	(With Project)		(Without Project)	(With Project)	
DEMOGRAPHIC								
Total population (control) -- excludes institutionalized group quarters population	7,096,469	7,150,741	7,718,418	7,718,420	8,794,967	9,195,569	9,195,546	ARB[19]; PTS[20] 14
Total population (simulated) -- excludes institutionalized group quarters population	7,007,634	7,053,334	7,696,761	7,697,101	8,744,154	8,709,541	9,133,090	ARB; PTS[21] 14
Group quarters population (control) – excludes institutionalized group quarters population	144,597	147,683	93,971	93,956	103,958	110,665	110,627	ARB; PTS 14
Total number of households (control)	2,583,077	2,608,023	2,833,696	2,837,715	3,188,328	3,308,120	3,308,111	ARB; PTS 14
Total number of households (simulated) – includes group quarters	2,720,722	2,732,722	2,894,543	2,925,108	3,285,177	3,281,324	3,411,297	ARB; PTS 14
Persons per household (control) – excludes group quarters	2.69	2.69	2.69	2.69	2.73	2.75	2.75	ARB
Auto ownership per household (simulated)	1.78	1.78	1.79	1.80	n/a	1.78	1.75	ARB

[16] When reporting $ units, indicate what year $s.
[17] If not in RTP/SCS, please indicate other referenced data source (other planning documents, model runs, etc.)
[18] This scenario includes existing plus committed transportation projects/policies for respective calendar years and a no project land use pattern.
[19] Information compiled specifically for ARB
[20] Information can be found in the *Summary of Predicted Traveler Responses* supplementary report
[21] Information can be found in the *Summary of Predicted Traveler Responses* supplementary report

Modeling Parameters	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)
			(Without Project)	(With Project)		(Without Project)	(With Project)	
Total jobs	3,449,640	3,385,281	3,959,089	3,987,130	4,346,745	4,473,934	4,505,232	ARB; p 32
Employed Residents (control)	3,225,106	3,153,267	3,891,142	3,849,814	4,198,398	4,364,374	4,350,068	ARB
Average unemployment rate (%)		10.6	5.1	5.1	5.1	5.1	5.1	Draft Forecast[22] p 6
Average household income (2009$)	$ 107,343	$ 99,426		$ 96,539	$ 93,604		$ 93,261	ARB
LAND USE								
Total agricultural (farmland) acres[23]	---[24]	2,329,000	---	---	---	2,312,038	2,323,087	DEIR, 3.1-50
Total Williamson Act land acres	---	1,252,500	---	---	---	1,247,834	1,251,776	DEIR, 3.1-51
Total open space acres	---	1,015,000	---	---	---	1,013,090	1,012,605	DEIR, 3.1-51/52
Total forest and timberland acres	---	1,233,000	---	---	---	1,230,423	1,231,605	DEIR, 3.1-53
Total acreage available for new development	---	---	---	---	---	---	---	---
Total dwelling units	---	2,785,948	---	2,955,948	3,321,190	---	3,445,950	PBA[25] p 57, ARB
Total agricultural (farmland) acres[26]	---	2,329,000	---	---	---	2,312,038	2,323,087	DEIR, 3.1-50
Total Williamson Act land acres	---	1,252,500	---	---	---	1,247,834	1,251,776	DEIR, 3.1-51

[22] Information can be found in the *Draft Plan Bay Area Forecast of Jobs, Housing, and Population* supplementary report
[23] Agricultural, Williamson Act, open space and forest/timberland includes double counting, so the rows total to more than the Total Acres row.
[24] Not readily available and/or not relevant
[25] Information can be found in the *Plan Bay Area* report
[26] Agricultural, Williamson Act, open space and forest/timberland includes double counting, so the rows total to more than the Total Acres row.

Modeling Parameters	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)
			(Without Project)	(With Project)		(Without Project)	(With Project)	
Regional housing vacancy rate (%)	---	6.4	---	4.0	4.0	---	4.0	Draft Forecast p 6
Households in single family detached and attached dwellings	1,637,119	1,632,549	1,747,902	1,720,196	1,827,195	1,850,263	1,863,707	ARB
Total single family attached housing units	---	---	---	---	---	---	---	---
Total large-lot single family detached housing units	---	---	---	---	---	---	---	---
Total small-lot single family detached housing units	---	---	---	---	---	---	---	---
Households in multi-family dwellings	945,958	975,474	1,065,344	1,117,519	1,361,133	1,349,136	1,444,404	ARB
Total townhouse units	---	---	---	---	---	---	---	---
Total mobile home units	---	---	---	---	---	---	---	---
Total infill housing units	---	---	---	---	---	---	---	---
Share of housing units within ¼ mile of a transit station or stop	---	69%	---	---	---	67%	73%	ARB
Share of housing units within 1/3 mile of a transit station or stop	---	79%	---	---	---	76%	83%	ARB
Share of housing units within ½ mile of a transit station or stop	---	89%	---	---	---	85%	92%	ARB
Share of housing units within 2/3 mile of a transit station or stop	---	93%	---	---	---	89%	95%	ARB
Total housing units within PDAs[27]	---	725,071	---	871,984	1,142,239	---	1,234,635	ARB
New housing units within PDAs	---	---	---	146,916	417,171	---	509,567	ARB
Total employment (employees) within 1/4 mile of transit stations and stops	---	---	---	---	---	---	---	---

[27] For metrics related to Priority Development Area (PDA), use definition of PDA as per MTC's proposed RTP/SCS.

Modeling Parameters	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)
			(Without Project)	(With Project)		(Without Project)	(With Project)	
New employment (employees) within 1/4 mile of transit stations and stops	---	---	---	---	---	---	---	---
Total employment (employees) within 1/2 mile of transit stations and stops	---	---	---	---	---	---	---	---
New employment (employees) within 1/2 mile of transit stations and stops	---	---	---	---	---	---	---	---
Total employment (employees) within PDAs	---	1,478,507	1,848,293	1,830,855	2,062,151	2,167,411	2,164,260	ARB
New employment (employees) within PDAs	---	---	278,385	352,348	583,644	597,503	685,753	ARB
Average residential density - housing units per developed residential acre (Region)	4.2	4.2	4.5	4.4	4.8	5.0	5.0	ARB
TRANSPORTATION SYSTEM								
Freeway general purpose lanes –- mixed flow(lane miles)	---	---	---	---	---	---	---	---
Freeway-to-freeway connector lane miles	---	176	---	---	---	174	173	ARB
Freeway lane miles (including managed lanes and auxiliary lanes)	---	4,667	---	---	---	4,974	5,219	ARB
HOV lane miles	---	474	---	---	---	315	201	ARB
Express lane miles	---	14	---	---	---	410	720	ARB
Freeway auxiliary lanes (lane miles)	---	---	---	---	---	---	---	---
Freeway new ramps or widened ramps (lane miles)	---	---	---	---	---	---	---	---
Arterial (lane miles)	---	8,710	---	---	---	8,767	8,749	ARB; EIR 2.1-27
Minor Arterial (lane miles)	---	---	---	---	---	---	---	---
Collectors (lane miles)	---	5,582	---	---	---	5,548	5,502	ARB; EIR 2.1-27
Locals (lane miles)	---	---	---	---	---	---	---	---
Local and express bus seat miles	22,176,000	21,019,000	21,354,000	23,300,000	23,459,000	21,662,000	23,435,000	ARB

Modeling Parameters	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)
			(Without Project)	(With Project)		(Without Project)	(With Project)	
Light Rail Seat Miles	3,754,000	4,057,000	4,108,000	5,329,000	5,391,000	4,424,000	5,391,000	ARB
Heavy Rail Seat Miles	19,874,000	22,067,000	25,204,000	25,082,000	28,372,000	26,545,000	28,372,000	ARB
Commuter Rail Seat Miles	7,947,252	7,232,000	9,139,000	11,421,000	11,421,000	9,139,000	11,421,000	ARB
Transit total daily vehicle seat miles	56,098,000	56,681,000	62,713,000	68,681,000	72,192,000	64,680,000	72,168,000	ARB
Bicycle and pedestrian (Class I) lane miles	---	---	---	---	---	---	---	---
Bike lane miles (Class II)	---	---	---	---	---	---	---	---
Miles of sidewalk	---	---	---	---	---	---	---	---
ACTIVITY PATTERN SHARE FOR FULL-TIME WORKERS								
Mandatory	82.4%	82.3%	80.5%	80.6%	---	76.7%	76.9%	ARB
Non-mandatory	10.0%	9.9%	10.6%	10.6%	---	12.6%	12.3%	ARB
Home (incl. telecommuting)	7.7%	7.8%	8.8%	8.8%	---	10.7%	10.7%	ARB
TOUR & TRIP DATA								
Number of trips per day	23,593,000	23,420,000	25,500,000	25,412,000	---	28,383,000	29,422,000	ARB
Trips on mandatory tours	10,391,000	10,159,000	11,648,000	11,477,000	---	12,649,000	12,825,000	ARB
Trips on at-work tours	1,661,000	1,577,000	1,878,000	1,847,000	---	1,998,000	1,982,000	ARB
Trips on non-mandatory tours	11,541,000	11,684,000	11,973,000	12,088,000	---	13,737,000	14,616,000	ARB
Average trip distance	6.5	6.3	6.2	6.3	---	6.2	6.1	ARB
Average auto trip length (miles)	7.1	6.9	6.8	6.9	---	6.8	6.6	ARB; PTS 45
Average walk trip length (miles)	0.9	0.9	0.9	0.9	---	0.9	0.9	ARB; PTS 45
Average bike trip length (miles)	2.4	2.4	2.4	2.4	---	2.4	2.4	ARB; PTS 45
Average transit trip length (miles)	9.2	9.1	9.4	9.8	---	9.7	9.6	ARB; PTS 45
Average trip duration (minutes)	16.3	16.1	16.6	16.6	---	17.4	16.8	ARB
Primary tour duration (minutes)	---	---	---	---	---	---	---	---
Secondary tour duration (minutes)	---	---	---	---	---	---	---	---
MODE SHARE FOR ALL TRIPS								
SOV	49.6%	49.5%	49.2%	49.1%	---	48.9%	47.6%	ARB; PTS 50
HOV (2)	19.2%	19.0%	18.0%	18.0%	---	18.1%	18.1%	ARB; PTS 50
HOV (3+)	14.9%	14.9%	13.9%	13.8%	---	14.0%	13.9%	ARB; PTS 50

Modeling Parameters	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)
			(Without Project)	(With Project)		(Without Project)	(With Project)	
Public transit (Local bus)	2.6%	2.5%	2.8%	2.9%	---	2.8%	3.1%	ARB
Public transit (Express Bus)	0.2%	0.2%	0.2%	0.5%	---	0.2%	0.5%	ARB
Public transit (Light Rail/Ferry)	0.7%	0.9%	1.4%	1.6%	---	1.4%	1.6%	ARB
Public transit (Heavy Rail)	1.4%	1.4%	1.7%	1.5%	---	1.8%	1.8%	ARB
Public transit (Commuter Rail)	0.1%	0.1%	0.1%	0.3%	---	0.1%	0.3%	ARB
Non-motorized: Bike	1.1%	1.1%	1.3%	1.3%	---	1.3%	1.3%	ARB; PTS 51
Non-motorized: Walk	10.1%	10.3%	11.3%	11.0%	---	11.4%	11.7%	ARB; PTS 51
PERCENT MODE SHARE (peak period)								
SOV	---	---	---	---	---	---	---	---
HOV/HOT	---	---	---	---	---	---	---	---
Local, express bus, and neighborhood shuttle operation	---	---	---	---	---	---	---	---
Public transit (Express Bus)	---	---	---	---	---	---	---	---
Public transit (BRT)	---	---	---	---	---	---	---	---
Public transit (Rail)	---	---	---	---	---	---	---	---
Non-motorized: Bike	---	---	---	---	---	---	---	---
Non-motorized: Walk	---	---	---	---	---	---	---	---
TRANSIT BOARDINGS BY TECHNOLOGY								
Local bus	---	957,000	1,256,000	1,362,000	1,562,000	1,405,000	1,669,000	ARB; PTS 56
Light rail	---	206,000	357,000	404,000	467,000	393,000	504,000	ARB; PTS 56
Heavy rail (BART)	---	342,000	440,000	407,000	494,000	512,000	539,000	ARB; PTS 56
Commuter rail	---	17,000	27,000	67,000	78,000	32,000	84,000	ARB; PTS 56
All technologies (may not sum due to rounding)	---	1,581,000	2,151,000	2,449,000	2,821,000	2,431,000	3,032,000	ARB; PTS 56
AVERAGE DAILY VEHICLE MILES TRAVELED PER BAY AREA RESIDENT BY COUNTY OF RESIDENCE								
San Francisco	---	7.4	7.3	6.8	---	6.8	6.1	ARB
San Mateo	---	16.7	16.1	15.8	---	15.1	14.8	ARB
Santa Clara	---	15.4	16.1	15.2	---	15.5	14.1	ARB
Alameda	---	15.4	14.7	14.9	---	13.8	13.7	ARB

Modeling Parameters	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)
			(Without Project)	(With Project)		(Without Project)	(With Project)	
Contra Costa	---	18.8	16.6	17.8	---	16.6	16.4	ARB
Solano	---	16.4	16.6	16.7	---	17.0	15.3	ARB
Napa	---	17.6	16.2	16.3	---	16.2	15.2	ARB
Sonoma	---	18.9	17.5	17.4	---	17.7	15.8	ARB
Marin	---	18.5	19.1	19.3	---	18.9	18.4	ARB
All counties	---	15.6	15.0	15.0	---	14.6	13.8	ARB
AVERAGE DAILY VEHICLE MILES TRAVELED PER BAY AREA WORKER BY COUNTY OF WORKPLACE								
San Francisco	---	12.6	---	---	---	10.1	9.8	ARB
San Mateo	---	29.0	---	---	---	25.2	24.1	ARB
Santa Clara	---	24.6	---	---	---	22.0	20.2	ARB
Alameda	---	25.8	---	---	---	23.0	22.7	ARB
Contra Costa	---	27.3	---	---	---	25.6	24.9	ARB
Solano	---	24.3	---	---	---	21.4	21.1	ARB
Napa	---	27.8	---	---	---	27.4	27.3	ARB
Sonoma	---	22.6	---	---	---	21.6	21.0	ARB
Marin	---	34.0	---	---	---	30.9	29.0	ARB
All counties	---	23.8	---	---	---	21.4	20.3	ARB
VEHICLE MILES TRAVELED								
Total 9-county *EMFAC* VMT per typical weekday (all vehicles) (miles)	174,041,000	170,938,000	184,878,000	183,812,000	200,582,000	207,485,000	205,334,000	ARB
Total 9-county EMFAC VMT per typical weekday for passenger vehicles	158,044,000	155,668,000	167,442,000	166,419,000	179,968,000	186,116,000	184,218,000	ARB
Total 9-county *EMFAC* II (Internal) VMT per weekday for passenger vehicles (miles)	138,697,000	---	---	142,423,000	151,437,000	---	---	ARB
Total 9-county *EMFAC* IX/XI VMT per weekday for passenger vehicles (miles)	19,248,000	---	---	24,023,000	28,343,000	---	---	ARB
Total 9-county *EMFAC* XX VMT per weekday for passenger vehicles (miles)	99,000	---	---	162,000	188,000	---	---	ARB

Modeling Parameters	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)
			(Without Project)	(With Project)		(Without Project)	(With Project)	
CONGESTED TRAVEL MEASURES								
Congested weekday *Assigned* VMT on all roadways (miles, V/C ratios >0.75)	21,744,000	18,388,000	21,776,000	20,920,000	26,168,000	33,372,000	27,937,000	ARB
Congested weekday *Assigned* VMT on all freeways (miles, V/C ratios>0.75)	15,869,000	13,217,000	15,132,000	14,647,000	17,918,000	23,107,000	19,084,000	ARB
Assigned VMT at travel speeds slower than 15 mph	---	278,000	501,000	432,000	654,000	1,464,000	728,000	ARB
Assigned VMT at travel speeds between 15 and 30 mph	---	26,258,000	28,220,000	27,310,000	30,526,000	33,785,000	31,399,000	ARB
Assigned VMT at travel speeds between 30 and 45 mph	---	32,446,000	33,538,000	34,935,000	39,342,000	42,152,000	40,683,000	ARB
Assigned VMT at travel speeds between 45 and 60 mph	---	45,564,000	50,694,000	50,010,000	52,958,000	54,279,000	54,458,000	ARB
Assigned VMT at travel speeds faster than 60 mph	---	32,563,000	34,559,000	34,971,000	37,759,000	33,883,000	37,698,000	ARB
Assigned VMT to constant speed links	---	11,937,000	12,820,000	12,748,000	14,019,000	14,496,000	14,431,000	ARB
Total Assigned VMT	---	149,046,000	160,332,000	160,407,000	175,257,000	180,060,000	179,397,000	ARB; PTS 58
CO2 EMISSIONS[28]								
Total SB 375 CO2 emissions per weekday for passenger vehicles (ARB vehicle classes LDA, LDT1, LDT2, and MDV) (tons) (not including policy initiatives)	71,660	70,090	75,390	74,420	80,630	84,210	82,550	ARB; PTS 64

[28] Please provide ARB staff with the EMFAC Input and Output files associated with these outputs.

Modeling Parameters	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)
			(Without Project)	(With Project)		(Without Project)	(With Project)	
Total II (Internal) SB 375 CO2 emissions per weekday for passenger vehicles (tons) (not including policy initiatives)	63,020	---	---	66,530	67,800	---	---	ARB
Total IX / XI trip CO2 emissions per weekday for passenger vehicles (tons) (not including policy initiatives)	8,590	---	---	7,840	12,740	---	---	ARB
Total XX trip CO2 emissions per weekday for passenger vehicles (tons) (not including policy initiatives)	50	---	---	50	90	---	---	ARB
INVESTMENT								
Total plan period investment (YOE$, millions)	---	---	---	---	---	---	$292,000	PBA p 66
Highway and bridge capacity expansion (YOE$, millions)	---	---	---	---	---	---	$11,500	
Other Complete Streets capacity expansion (YOE$, millions)	---	---	---	---	---	---	$3,800	
Transit capacity expansion (YOE$, millions)	---	---	---	---	---	---	$21,000	PBA p 66
Bus transit capacity expansion (YOE$, millions)	---	---	---	---	---	---	**included above*	
Transit - maintain and sustain existing infrastructure (YOE$, millions)	---	---	---	---	---	---	$159,000	PBA p 66
Rail transit- maintain and sustain existing infrastructure (YOE$, millions)	---	---	---	---	---	---	**included above*	
Bike and pedestrian projects (YOE$, millions)	---	---	---	---	---	---	**included with Complete Streets capacity expansion and Complete Streets maintain and sustain existing infrastructure*	

Modeling Parameters	2005 (if available)	2010 (base year)	2020		2035 (Project)	2040		RTP SCS Chapter-Page(s)
			(Without Project)	(With Project)		(Without Project)	(With Project)	
Other(Complete Streets – maintain and sustain existing infrastructure) (YOE$, millions)	---	---	---	---	---	---	$93,800	
TRANSPORTATION USER COSTS AND PRICING								
Perceived vehicle operating costs (2009 cents per mile)		$0.23	$0.28	$0.28	$0.28	$0.29	$0.29	PTS 37
Gasoline price (2009$ per gallon)		$3.25	$4.74	$4.74	$5.24	$5.40	$5.40	PTS 37
Parking price ($ per day)	---	---	---	---	---	---	---	PTS 36
Toll price ($ per trip)	---	---	---	---	---	---	---	PTS 29-35
Congestion price ($ per mile)	---	---	---	---	---	---	---	p 85; PTS 38
Average transit fare per passenger mile ($ per mile)	---	---	---	---	---	---	---	

APPENDIX B. 2010 CTC RTP Guidelines Addressed in MTC's RTP/SCS

This Appendix lists the requirements in the California Transportation Commission's (CTC) Regional Transportation Planning (RTP) Guidelines that are applicable to the MTC regional travel demand model, and which MTC followed. In addition, listed below are the recommended practices from the CTC RTP Guidelines that MTC incorporated into its modeling system.

Requirements

- Each MPO shall model a range of alternative scenarios in the RTP Environmental Impact Report based on the policy goals of the MPO and input from the public.
- MPO models shall be capable of estimating future transportation demand at least 20 years into the future. (Title 23 CFR Part 450.322(a))
- For federal conformity purposes, each MPO shall model criteria pollutants from on-road vehicles as applicable. Emission projections shall be performed using modeling software approved by the EPA. (Title 40 CFR Part 93.111(a))
- Each MPO shall quantify the reduction in greenhouse gas emissions projected to be achieved by the SCS. (California Government Code Section 65080(b)(2)(G))
- The MPO, the state(s), and the public transportation operator(s) shall validate data utilized in preparing other existing modal plans for providing input to the regional transportation plan. In updating the RTP, the MPO shall base the update on the latest available estimates and assumptions for population, land use, travel, employment, congestion, and economic activity. The MPO shall approve RTP contents and supporting analyses produced by a transportation plan update. (Title 23 CFR Part 450.322(e))
- The metropolitan transportation plan shall include the projected transportation demand of persons and goods in the metropolitan planning area over the period of the transportation plan. (Title 23 CFR Part 450.322(f)(1))
- The region shall achieve the requirements of the Transportation Conformity Regulations of Title 40 CFR Part 93.
- Network-based travel models shall be validated against observed counts (peak- and off-peak, if possible) for a base year that is not more than 10 years prior to the date of the conformity determination. Model forecasts shall be analyzed for reasonableness and compared to historical trends and other factors, and the results shall be documented. (Title 40 CFR Part 93.122 (b)(1)(i))

- Land use, population, employment, and other network-based travel model assumptions shall be documented and based on the best available information. (Title 40 CFR Part 93.122 (b)(1)(ii))
- Scenarios of land development and use shall be consistent with the future transportation system alternatives for which emissions are being estimated. The distribution of employment and residences for different transportation options shall be reasonable. (Title 40 CFR Part 93.122(b)(1)(iii))
- A capacity-sensitivity assignment methodology shall be used, and emissions estimates shall be based on methodology which differentiates between peak- and off-peak link volumes and speeds and uses speeds based on final assigned volumes. (Title 40 CFR Part 93.122 (b)(1)(iv))
- Zone-to-zone travel impedance used to distribute trips between origin and destination pairs shall be in reasonable agreement with the travel times that are estimated from final assigned traffic volumes. (Title 40 CFR Part 93.122(b)(1)(v))
- Network-based travel models shall be reasonably sensitive to changes in the time(s), cost(s), and other factors affecting travel choices. (Title 40 CFR Part 93.122 (b)(1)(vi))
- Reasonable methods in accordance with good practice shall be used to estimate traffic speeds and delays in a manner that is sensitive to the estimated volume of travel on each roadway segment represented in the network-based travel model. (Title 40 CFR Part 93.122(b)(2))

Recommendations

- During the development period of more sophisticated/detailed models, there may be a need to augment current models with other methods to achieve reasonable levels of sensitivity. Post-processing should be applied to adjust model outputs where the models lack capability, or are insensitive to a particular policy or factor. The most commonly referred to post-processor is a “D’s” post-processor, but post-processors could be developed for other non-D factors and policies, too.
- The models should address changes in regional demographic patterns.
- Measures of means of travel should include percentage share of all trips (work and non-work) made by all single occupant vehicle, multiple occupant vehicle, or carpool, transit, walking, and bicycling.
- To the extent practical, travel demand models should be calibrated using the most recent observed data including household travel diaries, traffic counts, gas receipts, Highway Performance Monitoring System (HPMS), transit surveys, and passenger counts.
- It is recommended that transportation agencies have an on-going model improvement program to focus on increasing model accuracy and policy

sensitivity. This includes on-going data development and acquisition programs to support model calibration and validation activities.

- Agencies are encouraged to participate in the California Inter-Agency Modeling Forum. This venue provides an excellent opportunity to share ideas and help to ensure agencies are informed of current modeling trends and requirements.
- MPOs should work closely with state and federal agencies to secure additional funds to research and implement the new land use and activity-based modeling methodologies. Additional research and development is required to bring these new modeling approaches into mainstream modeling practice.
- The travel model set should be run to a reasonable convergence towards equilibrium across all model steps.
- A simple freight model should be developed and used.
- Several employment types should be used, along with several trip purposes.
- The models should have sufficient temporal resolution to adequately model peak and off-peak periods.
- Agencies should, at a minimum, have four-step models with full feedback across travel model steps and some sort of land use modeling.
- In addition to the conformity requirements, these regions should also add an auto ownership step and make this step and the mode choice equations for transit, walking and bicycling and the trip generation step sensitive to land use variables and transit accessibility.
- Small Traffic Analysis Zones (TAZ) should be used, to increase sensitivity to infill potential near to rail stations and in Bus Rapid Transit (BRT) corridors. Parking quantity and cost should be represented in the travel model.
- The carpool mode should be included, along with access-to-transit sub modes.
- Feedback loops should be used and take into account the effects of corridor capacity, congestion and bottlenecks on mode choice, induced demand, induced growth, travel speed and emissions.
- Freight models should be implemented in the short term and commodity flows models within a few years.
- Simple Environmental Justice analyses should be done using travel costs or mode choice log sums, as in Group C. Examples of such analyses include the effects of transportation and development scenarios on low-income or transit-dependent households, the combined housing/transportation cost burden on these households, and the jobs/housing fit.

- Household travel surveys should be activity-based and include a tour table. GPS sampling is encouraged or extra emphasis should be placed on accurate geocoding of households, workplace locations, and stops. Regions should take care in the design and data collection procedures of the survey to ensure survey results are appropriate to the type of model being utilized. Coordination with Caltrans' travel survey efforts is encouraged.

APPENDIX C. Changes Made to Draft Plan Bay Area that Could Affect Greenhouse Gas Quantification

This appendix lists key changes that ABAG/MTC made to the Draft Plan Bay Area, in the creation of the Final Plan Bay Area. ARB staff considered these changes in their review of ABAG/MTC's GHG quantification.

- The draft Plan Bay Area indicated that 80 percent of new housing and 66 percent of new jobs would be located in PDAs. The final Plan Bay Area shows 78 percent of new housing and 62 percent of new jobs in PDAs. ABAG/MTC staff reported that, while the overall percentages of new housing and jobs located in areas designated as PDAs were reduced, the actual numbers of new housing and jobs in those same locations are not expected to be reduced; rather, the change reflects a revision in the removal of the PDA designation in certain locations. Therefore, these changes are not expected to affect ABAG/MTC's GHG quantification.

- Several cities requested changes to their PDAs after ABAG/MTC adopted the Jobs-Housing Connection Strategy and after the development of the Plan Bay Area Draft Environmental Impact Report had begun. ABAG and MTC incorporated these changes into the PDA data set. The nature of the requested changes includes reclassifying some PDAs as "Potential PDAs" and others as "Planned PDAs." A "Planned PDA" has a formally adopted plan, as determined by a local jurisdiction. A "Potential PDA" requires more local planning, review and action before it can become a Planned PDA. These changes are not expected to affect ABAG/MTC's GHG quantification.

- Changes were made to discretionary funding, by adding about $2 billion more for building new transit, and about $1 billion more for reserves as a result of assuming about $3 billion over the life of the plan will be available from Cap and Trade funding. As ABAG/MTC has not yet determined the uses of the expected Cap and Trade funding, the effect of this change to Plan Bay Area on ABAG/MTC's GHG quantification is not known. However, ABAG/MTC plans to use these funds for such projects as transit operating and capital rehabilitation or replacement, local street and road rehabilitation, goods movement, and transit-oriented affordable housing.

- Car Sharing per capita CO_2 emissions reductions in 2035 changed from -2.8 percent to -2.6 percent. Smart Driving per capita CO_2 emissions reductions in 2020 changed from -1.9 percent to -1.8 percent, and in 2035 changed from -1.6 percent to -1.5 percent. These changes result in total Climate Initiatives

program reductions in 2020 of -5.0 percent instead of the draft -5.1 percent, and in 2035 of -6.3 percent instead of draft -6.6 percent.

The Post Sustainability Institute v. ABAG
State of California First Appellate Dist., Division Two, Case No. A144815
Alameda County Superior Court, Case No. RG13699215

PROOF OF SERVICE

I am a resident of the United States, employed in the City and County of Sacramento. My business address is 455 Capitol Mall, Suite 801, Sacramento, California 95814. I am over the age of 18 years and not a party to the above-entitled action.

On November 23, 2015, a true copy of the RESPONDENTS' REQUEST FOR JUDICIAL NOTICE was electronically filed with the Court of Appeal, First Appellate District, Division Two through truefiling.com. Notice of this filing will be sent to those below who are registered with the Court's efiling system. Those who are not registered will receive a hard copy via first-class U.S. Mail, postage thereon fully prepaid and deposited in a mailbox maintained by the United States Postal Service in Sacramento, California.

Timothy V. Kassouni timothy@kassounilaw.com KASSOUNI LAW 621 Capitol Mall, Ste. 2025 Sacramento, CA 95814 Facsimile 916-930-0033 *Counsel for Plaintiff and Appellant* THE POST SUSTAINABILITY INSTITUTE; ROSA KOIRE; MICHAEL SHAW	Court Clerk Alameda County Superior Court 1225 Fallon Street, Room 109 Oakland, CA 94612 Supreme Court of California 350 McAllister Street San Francisco, CA 94102

I declare under penalty of perjury that the foregoing is true and correct and that this Proof of Service was executed this 23rd day of November 2015, at Sacramento, California.

_____/s/_____
Stephanie Richburg