

**Climate Change Scoping Plan
First Update**

Discussion Draft for Public Review and Comment

October 2013

Pursuant to AB 32
The California Global Warming Solutions Act of 2006

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for the State of California

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EXECUTIVE SUMMARY

This document is the draft Update to the initial Scoping Plan, which was built on the principle that a balanced mix of strategies is the best way to cut emissions and grow the economy in a clean and sustainable direction. This Update, required by AB 32, the California Global Warming Solutions Act of 2006, continues with that approach and focuses on three key questions: How have we done over the past five years? What is needed to continue the prescribed course of action to 2020? And what steps must we take in the coming years to continue cutting emissions and growing the economy to meet our long-term climate goals?

California's plan for reducing emissions is comprised of strategies to encourage efficiency in the use of energy and resources, decarbonize our energy and fuel supply, and reduce our demand for greenhouse gas (GHG) emissions-intensive goods. This Update builds upon the initial Scoping Plan with new strategies and expanded measures. The Update identifies opportunities to leverage existing and new funds to drive GHG emission reductions through strategic planning and targeted program investments.

This Update was developed by 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 also reflects public input and recommendations from business, environmental, environmental justice, and community-based organizations. This draft initially will be presented to the Air Resources Board at its October 2013 public meeting.

Progress to Date: A Transformation Under Way

California is on track to meet the goals of AB 32, which envisioned a more efficient California with a vibrant clean economy and attractive investment opportunities. To this end, the State has implemented a comprehensive suite of strategies across sectors that are moving California toward a clean energy future.

Cleaner and More Efficient Energy

California has made tremendous strides in harnessing its abundant renewable energy resources. Currently, about 23 percent of the State's electricity comes from renewable resources. This will increase to at least 33 percent by 2020 under new requirements set in place by Governor Brown 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.

California also 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. New green building standards now in effect for homes and businesses, and new standards for appliances, are also continuing to drive ever-greater efficiency

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gains. For example, over the next 10 years more efficient televisions and other “plug loads” will save enough energy to power more than one million homes.

Cleaner Transportation

California has taken a number of innovative actions to cut emissions from the transportation sector.

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 has helped to displace 2 billion gallons of gasoline and diesel; the equivalent of taking half a million vehicles off the road. 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 first GHG vehicle standards, adopted in 2004, are delivering both carbon dioxide (CO₂) reductions and savings at the pump. Now the federal GHG emissions standard, California’s policies paved the way to deliver these benefits nationwide. The transition to a fleet of lower-emitting, more-efficient vehicles in California will continue beyond 2020 as the result of a package of advanced clean car regulations adopted by ARB in 2012, covering model years 2017–2025. These regulations will ultimately drive down GHG emissions by about half, compared to today’s average vehicle.

California’s pioneering zero emission vehicle (ZEV) regulation is also driving a transformation of the fleet. As a result of ARB’s 2012 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 vehicles are driven, through more sustainable transportation, land use, and housing planning. The state is leading those efforts with programs and plans that encourage a change in land use patterns and a shift to cleaner modes of transportation, including expanded transit, passenger rail, and high-speed rail service. To date, seven Metropolitan Planning Organizations have adopted Sustainable Community Strategies. In addition to helping drive GHG 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 get into a car.

Cap-and-Trade Program

Last year, California successfully launched the most comprehensive Cap-and-Trade Program in the world. As the cap is gradually reduced over time, this program will play a key role in ensuring that California remains on track to meet its 2020 reduction target,

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and will play an important role in achieving cost-effective reductions beyond 2020. The program is also sending a clear signal to California businesses that investment in clean, low carbon technologies will be rewarded.

In 2014, California will link its Cap-and-Trade Program with Québec's. By demonstrating one way to link cap-and-trade programs and increase opportunities for emission reductions, this linkage will represent another important step in California's efforts to collaborate with other partners to address climate change.

Facing the Future

Despite the progress CA has made, it is clearer than ever that additional action to cut greenhouse gas emissions is needed. Scientific evidence indicates that global emissions must be reduced 80 percent below 1990 levels by 2050 to achieve climate stabilization. Reaching this goal will require California to accelerate the pace of emission reductions that we achieve over the coming decades.

A midterm target should be adopted that will drive continued progress toward meeting the 2050 goal. A target that reflects the scientifically-based level of emission reductions the state needs to achieve by 2030 will help guide ongoing and future policy decisions and provide a clear market signal for continued investment in low-carbon technologies.

The actions we have already taken provide a solid foundation to build from. However, reaching our longer-term targets will require continued commitment to changing how we generate, transmit, and consume electricity; how we transport people and goods throughout our state; how we plan, design, and build our communities; the way we use water, energy, and other resources in our homes, businesses, and industries; and how we manage and protect our natural and working lands.

As we continue this transformation, we must work to ensure our efforts simultaneously support a healthy economy, improve air quality, and protect and improve public health—especially for our most vulnerable communities. And we must do so in the face of a growing population, while simultaneously adapting to the climate change impacts we are already facing. This will require careful coordination among policymakers at all levels of government.

Meeting these challenges will not be easy, but failing to continue on the current path to reduce emissions will have grave consequences. Increasingly dangerous heat waves, more frequent and prolonged drought, diminished snowpack, continued sea level rise, extreme wildfires—and the devastating economic impacts associated with these changes—are some of the realities California will continue to face from unchecked climate change.

While California is working aggressively to reduce its GHG emissions, we recognize that climate change is a global problem with global impacts. The reality is that California alone cannot effectively avert the impacts of global climate change. California will need

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to continue to be a global leader in addressing climate change, helping drive critically needed actions in other states, provinces, and nations around the world.

Meeting the Challenge Ahead

This Update charts the path that California must continue to take in a number of key sectors to steadily drive down GHG emissions as we approach 2020 and begin to look further into the future.

The sectors highlighted in this Update comprise the majority of California's economy. Each sector provides unique opportunities to achieve emission reductions while achieving long-term economic and environmental sustainability. Important interconnections among the sectors exist and can be seized upon to produce synergistic approaches to cutting emissions.

Energy

California's energy sector is responsible for about 40 percent of the GHG inventory. California has already identified numerous opportunities to reduce emissions in this sector, through efficiency, decarbonization, and conservation. The Update details a strategy to continue efficiency improvements through new small appliance standards; increased use of renewable electricity generation; increased distributed efficient generation sources, including expanded combined heat and power (CHP) generation; and a commitment to zero net energy homes and commercial buildings.

Looking beyond 2020, California will need to continue to transform the energy sector with wholesale changes to its current electricity and natural gas systems. Developing a near zero emission strategy for the energy sector will require efficient next-generation technology; vast new low carbon generation resources; a robust transmission and distribution infrastructure; and carbon capture, utilization, and sequestration for the remaining fossil generation.

Transportation, Land Use, Fuels, and Infrastructure

The transportation sector is the largest source of GHG emissions in California. It is also the primary source of smog-forming and toxic air pollution. Changing California's transportation sector to one dominated by zero emission vehicles, powered by electricity and hydrogen, is essential to meeting federal air quality standards and long-term climate goals. Achieving the 2050 target will require dramatically improving vehicle energy efficiency, widespread electrification of on-road vehicles, development of low carbon liquid fuels, and smarter, more integrated land use planning and development.

Agriculture

The agriculture sector is a key economic driver for California. The state provides food to support local, national, and global populations. There are a range of opportunities to achieve emission reductions in the sector in ways that will enhance the long-term sustainability of the state's valuable agricultural resources. To provide a foundation for

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taking action to cut emissions in the agriculture sector, it will be necessary to develop a comprehensive plan that identifies potential reduction goals, emission reduction and sequestration opportunities, and needs for additional research and incentives.

Water

As the lifeblood of our state, water serves a range of critical purposes in California. To ensure this precious resource is managed as effectively as possible, the state needs to employ a range of creative approaches that will cut GHG emissions, maximize efficiency and conservation, and enhance water quality and supply reliability, while also addressing growing climate adaptation needs.

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 goals. State policy and regulatory frameworks must be developed that allow for and incentivize effective regional integrated planning and implementation. Pricing policies will also need to be utilized to maximize efficiency and conservation efforts in the water sector.

Waste

California's goal of reaching 75 percent recycling and composting by 2020 provides an opportunity to achieve substantial GHG 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.

The primary source of GHG emissions from the waste sector is the direct emission of methane from the decomposition of organic material in landfills. The waste sector plan will provide 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 goal will require substantial growth in the collection, recycling, and manufacturing industries within California. This Update sets forth a series of actions to support this industrial growth, including the State's procurement of recycled-content products, and calls on California to manage its waste at home. Developing this industry here helps ensure that the GHG emission reductions, environmental co-benefits, and job growth all benefit California.

Natural and Working Lands

Three-quarters of California's landmass is comprised of natural and working lands, such as forests, rangelands, and wetlands. These lands provide a multitude of economic and environmental benefits. They will also play an increasingly important role in California's efforts to prepare for and adapt to the impacts of climate change.

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California needs a comprehensive strategy to protect, manage, and conserve these lands in ways that maximize opportunities to achieve GHG reductions and carbon sequestration. A “Forest Carbon Plan” should be developed to describe the actions necessary to ensure that California’s forests are managed to optimize emission reduction and sequestration opportunities.

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 short-lived climate pollutants (SLCP) like black carbon, methane, and hydrofluorocarbons. Though these pollutants remain in the atmosphere for relatively short lifetimes compared to carbon dioxide, they have an outsized contribution to warming relative to their concentrations and are key ingredients in the formation harmful air contaminants. In addition to furthering goals to protect public health, actions to cut SLCPs can deliver immediate benefits to California’s climate.

California needs to build on its progress of reducing SLCPs by taking a comprehensive approach to further cutting these emissions, particularly where efforts will result in air quality and public health co-benefits. In addition to pursuing existing strategies already under way, ARB will develop a short-lived climate pollutant strategy by 2016 that will include an inventory of sources and emissions, the identification of research gaps, and a plan for developing necessary control measures.

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 the challenge of climate change will require “courage, creativity, and boldness.” It will require California to continue to lead the world in pioneering bold and creative strategies to create a cleaner, more sustainable economy. It will depend on continuing to partner and collaborate with other state, national, and global leaders as we work toward common goals. And it will require the engagement of California’s citizens in creating and supporting low carbon, high-quality lifestyles.

We are on the right path. Our actions are driving down GHG emissions; spurring innovation across a range of clean and advanced technology sectors; improving the air Californians breathe; and creating more livable communities. 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.

I. Introduction

I. Introduction

Assembly Bill 32, the California Global Warming Solutions Act of 2006 (AB 32, Statutes of 2006, Chapter 488), created a comprehensive, multi-year program to reduce greenhouse gas (GHG) emissions in California to 1990 levels by the year 2020. It required the California Air Resources Board (ARB or Board) to prepare and adopt a scoping plan for achieving the maximum technologically feasible and cost-effective GHG emission reductions by 2020. The initial Scoping Plan was developed in 2008 and contained a mix of strategies that combined direct regulations, market-based approaches, voluntary measures, policies, and other emission reduction programs. The Plan must be updated at least every five years to evaluate the mix of AB 32 policies to ensure that California is on track to meet the targets set out in the legislation. The AB 32 legislative language is included in Appendix A.

The passage of AB 32, and its ongoing implementation, has put California on a path to reducing climate-changing 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 1990 emission levels by 2020 is transformative in its own right, reducing emissions by 80 percent by 2050—as scientific assessments suggest is required to avoid the worst impacts of climate change—will require a fundamental shift to efficient, clean energy in every sector of the economy. Continuing progress along this path 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 after 2020.

A. California's 2020 and 2050 Climate Goals

Under AB 32, California has established a unique, comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective GHG emission reductions. AB 32 requires ARB to perform the following specific tasks:

- 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 (MMTCO₂e) GHG emissions.
- Adopt a regulation requiring GHG emission reporting. In December 2007, the Board adopted 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.

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- Develop a scoping plan for achieving the maximum technologically feasible and cost-effective GHG emission reductions to achieve 1990 GHG emission levels and update the report every five years. This report is the first update to the Scoping Plan.
- Maintain and continue GHG emission reductions beyond 2020.

In addition to the statutory 2020 emissions target, Executive Order S-3-05 and Governor Brown's Executive Order (EO) B-16-2012 establish long-term climate goals for California to reduce GHG emissions to 80 percent below 1990 levels by 2050 (EO B-16-2012 is specific to the transportation sector). These 2050 goals are 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 (CO₂e) and reduce the likelihood of catastrophic climate change.

Meeting these goals requires a coordinated and cohesive statewide strategy based on informed decisions that draws on research, technology, infrastructure, the State's policy priorities, and potential co-benefits. Planning must begin now to 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. 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 the cleantech sector. 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 first 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 help 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.

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.

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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.
- 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.

C. Purpose of Update

This Update identifies the next steps for California's leadership on climate change. While California continues on its path to meet its 2020 emissions goal, 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 toward the objectives of AB 32, defines California's climate change priorities and activities for the next several years, and 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 emissions of GHGs by 2020.
- Recommendations for establishing a 2030 emission reduction target that aligns with the State's mid-century climate goal.
- 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.

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Progressing toward California's 2050 climate target will require that GHG reduction rates be significantly accelerated. Emissions from 2020 to 2050 will have to decline at more than twice the rate needed to reach the 2020 emissions limit.

In addition to our climate goals, California must also 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 almost 90 percent in much of California 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, and 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 midterm 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.

D. 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.

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 sectors to evaluate the challenges, opportunities, and next steps:

- Energy.
- Transportation, Land Use, Fuels, and Infrastructure.
- Agriculture.
- Water.
- Waste Management.
- Natural and Working Lands.

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

I. Introduction

State agency workgroups for each of the key areas were formed in early 2013 and met several times in 2013. The workgroups provided recommendations for defining a path forward in each area for meeting the State's long-term GHG emission reductions goal, which are discussed further in Chapter V.

AB 32 requires ARB to convene an Environmental Justice Advisory Committee (EJAC) to advise it in developing the Scoping Plan and any other pertinent matters in implementing AB 32 (Health and Safety Code 38591). The Board convened the EJAC in 2007 to advise the Board on the development of the first Scoping Plan. The Board reconvened the EJAC to advise it on the development of this Update. Prior to releasing its initial recommendations, the EJAC met twice to evaluate the six focus areas discussed above and the role of cap-and-trade after 2020. Many of the EJAC's recommendations are consistent with the general path outlined in this draft Update; however, in many areas the EJAC is recommending a different approach or additional work. The EJAC is expected to meet again to provide comments on this draft report.

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 consult with the Economic Advisors throughout the completion of this Update and 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.

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. ARB received nearly 100 written comments on the concepts presented at the workshops, and these comments can be viewed at: <http://www.arb.ca.gov/lispub/comm2/bccommlog.php?listname=2013-sp-update-ws>.

ARB also held numerous meetings and conference calls with individuals and stakeholder groups such as industry associations, environmental groups, and small businesses on specific issues or recommendations to address in this Update. ARB considered input from all stakeholders when developing this draft Update. Likewise, comments on this draft of the Update will be considered as the final report is developed.

I. Introduction

ARB plans to hold a workshop on the draft Update in October to solicit public input. In addition, the staff will present the draft Update to the Board at the October 24–25, 2013, Board meeting to provide an opportunity for Board input. The final proposed Update will be released in mid-November 2013, along with the environmental analysis, and will be considered by the Board at the December 12–13, 2013, Board meeting.

II. Latest Understanding of Climate Science

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. Addressing climate-warming pollutants with much 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.

Climate scientists agree that the climate warming trends observed over the past century are most certainly attributed to human activities and are proceeding at an unprecedented rate. Climate change is measured by examining long-term changes in features associated with average weather, such as temperature, wind patterns, and precipitation. Since the development of the Scoping Plan, even stronger scientific evidence continues to mount that documents that the climate is changing. This evidence includes rising temperatures, shifting snow and rainfall patterns, and increased incidence of extreme weather events.

The recently released Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, Climate Change 2013: The Physical Science Basis confirms the increasing scientific consensus that human activity is contributing to climate change.² The report underscores the growing body of scientific evidence confirming the serious detrimental impacts of increasing GHG emissions. While the IPCC Fifth Assessment includes a discussion of recent scientific reports of relatively stable global average temperatures over the past decade and a half, the report is careful to point out that warming over the last century is attributable to increases in GHG pollution from human activities. Furthermore, the report details other indicators of climate change, such as record high temperatures in the Northern Hemisphere, advancing sea level rise, and ocean acidification, as the result of increased GHG burden (principally CO₂) in the atmosphere. As documented in the report, newly available climate data underscores the complexity of the climate system. Scientific debate regarding the multiple effects of increasing climate pollution is important as we continue our mitigation efforts. The next version of this draft Update, which ARB plans to make available for public review in November, will have a more detailed discussion of the latest scientific understanding of climate science based on the IPCC Fifth Assessment Report.

California is particularly vulnerable to the effects of climate change and faces a range of impacts, including increases in extreme heat, wildfires, drought, extreme storms, and coastal flooding and erosion. Climate change is also likely to affect air quality and water availability. California's efforts to reduce GHG emissions and avoid the worst impacts of climate change must occur in parallel with planning and preparation for climate change that is already occurring, as well as potential future impacts. The Natural Resources Agency is preparing an update to the 2009 California's Climate Adaptation Strategy, the *Safeguarding California Plan*, which is expected to be released in 2014.

² <http://www.ipcc.ch/report/ar5/wg1>.

II. Latest Understanding of Climate Science

There is growing recognition within the scientific community of the important impact that short-lived climate pollutants have on climate change. Although there is no precise definition of short-lived climate pollutants, these are generally pollutants such as black carbon and methane that have much shorter atmospheric lifetimes—on the order of days to decades—than CO₂. Unlike short-lived climate pollutants, CO₂ lingers in the atmosphere and affects climate for more than 100 years. Black carbon, in particular, is also a toxic air pollutant. Reducing emissions of short-lived climate pollutants can offer significant air quality and public health benefits, in addition to slowing the rate of climate change.

A. Continuing Evidence of Climate Change

Climate change impacts are occurring faster and with more severity than previously predicted. California's Office of Environmental Health Hazard Assessment recently published the report, [Indicators of Climate Change in California](#), which tracks trends in GHG levels that influence climate, changes in the state's climate, and the impacts of climate change on California's environment and people.

The most recent published science on climate change indicates the following:

- Summer sea ice in the Arctic is decreasing in extent and mass far more rapidly than previously predicted.
- The Greenland and West Antarctic ice sheets are melting more rapidly than predicted.³
- The world's carbon sinks (land and ocean) are becoming less efficient at removing CO₂ from the atmosphere.

Scientific research indicates that over time, about half of anthropogenic (human-made) CO₂ has been absorbed by the oceans. Recent studies suggest that oceans are becoming less able to absorb as much CO₂ as they have historically, and may be less able to buffer against climate change.⁴ By absorbing massive amounts of CO₂, the acidity of ocean surface waters has increased by approximately 30 percent, negatively impacting corals, plankton, and shellfish. Ocean acidification is a growing concern as atmospheric CO₂ levels increase and excess nutrients fuel large algal blooms in coastal ocean habitats that deplete oxygen in subsurface waters and release CO₂ as they decay. These interactions have important biological and food security implications, as the coastal ocean supports most of the global fish and shellfish production.⁵

³ Bevis, M. et al. 2012. "Bedrock displacements in Greenland manifest ice mass variations, climate cycles and climate change. *Proceedings of the National Academy of Sciences*. DOI: [10.1073/pnas.1204664109](https://doi.org/10.1073/pnas.1204664109).

⁴ Vichi, M., A. Navarra, and P. G. Fogli. 2013. "Adjustment of the natural ocean carbon cycle to negative emission rates." *Climatic Change* 118:1, 105–118. Online publication date: May 1, 2013.

⁵ Sunda, W. G. and W. Cai. 2012. "Eutrophication Induced CO₂-Acidification of Subsurface Coastal Waters: Interactive Effects of Temperature, Salinity, and Atmospheric P_{CO2}." *Environ. Sci. Technol.* 46 (19) 10651–10659. DOI: [10.1021/es300626f](https://doi.org/10.1021/es300626f).

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B. Achieving Climate Stabilization

Scientific research indicates that an increase in the global average temperature of 2°C (36°F) above pre-industrial levels (about 1.1°C [34 °F] above present levels) poses severe risks to natural systems and human health and well-being. Essentially all scientific bodies agree that stabilizing climate at or below 450 parts per million CO₂ equivalent (ppm CO₂e) by 2100 will increase the chance of limiting the global average temperature increase to 2°C above pre-industrial levels.⁶ To achieve this goal, significant reduction in emissions of CO₂ and other GHGs is necessary, given the current ambient concentration of these gases already accumulated in the atmosphere.

In May 2013, the Mauna Loa monitoring station, located at the top of Hawaii's Mauna Loa volcano, recorded daily CO₂ concentrations above 400 ppm,⁷ substantially higher than the 316 ppm recorded when the station made its first measurements in 1958. Scientists have also found that the rate of CO₂ accumulation in the atmosphere has been increasing steadily, from about 0.7 ppm a year in the 1950s to 2.1 ppm a year in the last 10 years. Because anthropogenic CO₂ emissions outpace the rate that natural carbon sinks can remove them, keeping emission rates constant will not stabilize atmospheric concentrations of CO₂; therefore, they will continue to affect climate change. Emission reductions in excess of about 80 percent relative to whatever peak global emissions rate may be reached, are required to stabilize CO₂ concentrations.

Although stabilizing climate below 450 ppm CO₂ equivalent is important, it does not mean that once that level is reached, temperatures will stabilize immediately. 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 CO₂ ("transient climate change") reflects only about half the eventual total warming ("equilibrium climate change").

To prevent exceeding the 450 ppm CO₂e threshold, developed countries must reduce their emissions by about 40 percent below recent amounts by 2030. 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 2030.⁸ 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).⁹ And 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 2030.¹⁰

⁶ Cao, L., and K. Caldeira. 2008. "Atmospheric CO₂ stabilization and ocean acidification." *Geophys. Res. Lett.* 35. L19609, doi:10.1029/2008GL035072.

⁷ Monastersky, R. 2013. "Global carbon dioxide levels near worrisome milestone." *Nature* 497: 13–14. http://www.nature.com/polopoly_fs/1.12900%21/menu/main/topColumns/topLeftColumn/pdf/497013a.pdf.

⁸ IEA. 2008. World Energy Outlook 2008, International Energy Agency. <http://www.worldenergyoutlook.org/publications/2008-1994/>.

⁹ Cleetus, R. et al. 2009. Climate 2030: A National Blueprint for a Clean Energy Economy. Union of Concerned Scientists. May. www.ucsusa.org/blueprint.

¹⁰ 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.

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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. To reduce the global concentration to 450 ppm after delaying action 10 years, it would cost an additional \$3.5 trillion, compared to levels of investment needed if low carbon strategies were to be adopted immediately.¹¹

C. Preparing for Climate Change in California

Climate change is already affecting California's infrastructure, natural resources, and communities, with even larger impacts projected in the future. Sea levels have risen by as much as seven inches along the California coast over the last century, increasing erosion and pressure on the State's infrastructure, water supplies, and natural resources.¹² 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.¹³ The report noted that, in addition to sea level rise, increased storm intensities, storm surges, and associated saltwater intrusion threaten freshwater supplies in the Sacramento–San Joaquin River Delta. Flooding threatens existing levees and many low-lying areas in the Delta and Central Valley. Increased average temperatures with decreased winter snowfall, as well as snowmelt and rainwater runoff occurring earlier in the year, threaten the State's major water supply—the Sierra Nevada snowpack and timed downstream reservoir releases.

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. 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 in heavily air-conditioned California. Reduced Sierra snowpack and reduced runoff and water flows in late spring and summer will adversely affect hydroelectric generation and operation of the California State Water Project.¹⁴ More extreme hot days, fewer cold nights, and shifts in the water and growing cycles are affecting the health and prosperity of California. Forest and wildland fires are becoming more frequent and intense due to dry seasons that start earlier and end later. Agriculture is especially vulnerable to altered temperature, changing rainfall patterns, and new pest problems.

http://www.pbl.nl/sites/default/files/cms/publicaties/PBL_2012_Greenhouse-gas-emission-reduction-targets-for-2030_500114023.pdf.

¹¹ IEA. 2013. *Redrawing the Energy Map: World Energy Outlook Special Report*. International Energy Agency. June 10. www.worldenergyoutlook.org/energyclimatemap.

¹² National Research Council Report. 2012. *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future*. National Academies Press. http://www.nap.edu/catalog.php?record_id=13389.

¹³ California Climate Change Center. 2012. *Our Changing Climate 2012, Vulnerability & Adaptation to the Increasing Risks from Climate Change in California*. California Climate Change Center. Retrieved from <http://www.energy.ca.gov/2012publications/CEC-500-2012-007/CEC-500-2012-007.pdf>.

¹⁴ California Energy Commission 2009. *Potential Impacts of Climate Change on California's Energy Infrastructure and Identification of Adaptation Measures*. January. CEC-150-2009-001.

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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 is developing an update, the *Safeguarding California Plan*, to be released in 2014. 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, many 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.

D. Short-Lived Climate Pollutants

Greenhouse gases have different lifetimes in the atmosphere, ranging from a few years to thousands of years, and some gases are more effective than others at warming the planet. For each GHG, a global warming potential (GWP) has been calculated to reflect how long it remains in the atmosphere, on average, and how strongly it absorbs energy. Gases with a higher GWP absorb more energy per pound than gases with a lower GWP, and thus contribute more to global warming. The short-lived climate pollutants (SLCP) include black carbon, methane, and hydrofluorocarbons (HFC)s. Table 1 shows the GWP of selected greenhouse gases.

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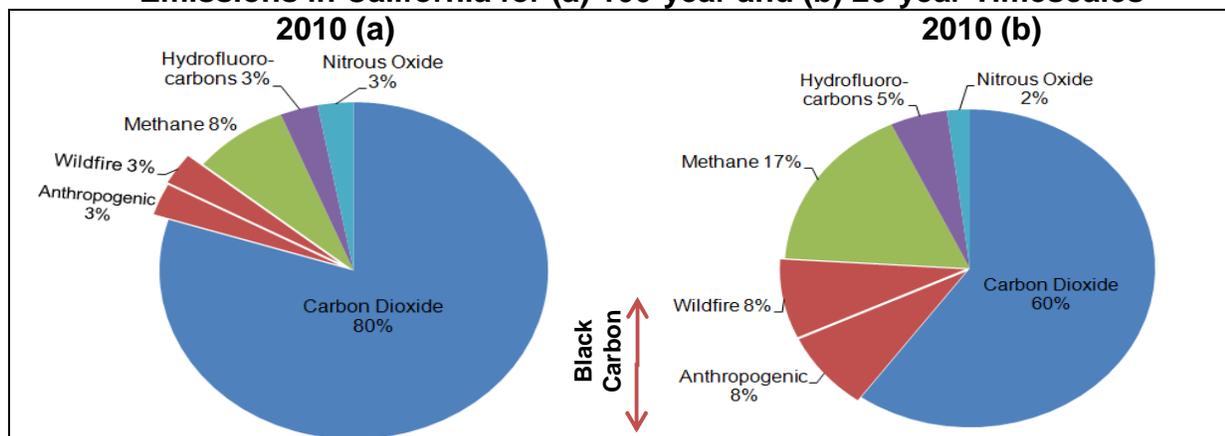
Table 1: Global Warming Potential for Selected Greenhouse Gases*

Pollutant	SLCP	Global Warming Potential (20-year)	Global Warming Potential (100-year)*
Carbon dioxide		1	1
Methane	Yes	72	25
Nitrous oxide		289	298
Sulfur hexafluoride		16,300	22,800
Hydrofluorocarbons	Yes	437–6,350	124–4,470
Perfluorocarbons		5,210–8,630	7,390–12,200
Black carbon	Yes	3,200	900
Nitrogen trifluoride		12,300	17,200

* The 20 and 100-year global warming potential estimates are from the IPCC 2007 Fourth Assessment review, except for the black carbon global warming potential estimate, which is based on a major scientific assessment of the black carbon radiative forcing published early this year (*Bond et al.*¹⁵).

Short-lived climate pollutants have atmospheric lifetimes ranging from a few days to a few decades, but during these shorter lifetimes they are very potent. Because they are removed from the atmosphere rather quickly, reducing their emissions results in immediate climate and air quality benefits. The relative contribution of different climate pollutants for 100-year and 20-year time horizon in California is shown in Figure 1. The use of GWP with a time horizon of 20 years has been proposed to better capture the importance of the SLCPs. A 20-year time frame gives a better perspective on the speed at which SLCP controls will benefit the atmosphere relative to carbon dioxide emission controls. If a shorter time horizon is chosen to examine near-term effects of SLCPs (i.e., 20 years), the contributions of the SLCPs to climate change are even greater, primarily due to their higher GWPs.

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



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

¹⁵ 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.

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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 III, ARB will develop a short-lived climate pollutant strategy by 2016 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 (PM₁₀ 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.^{16,17}

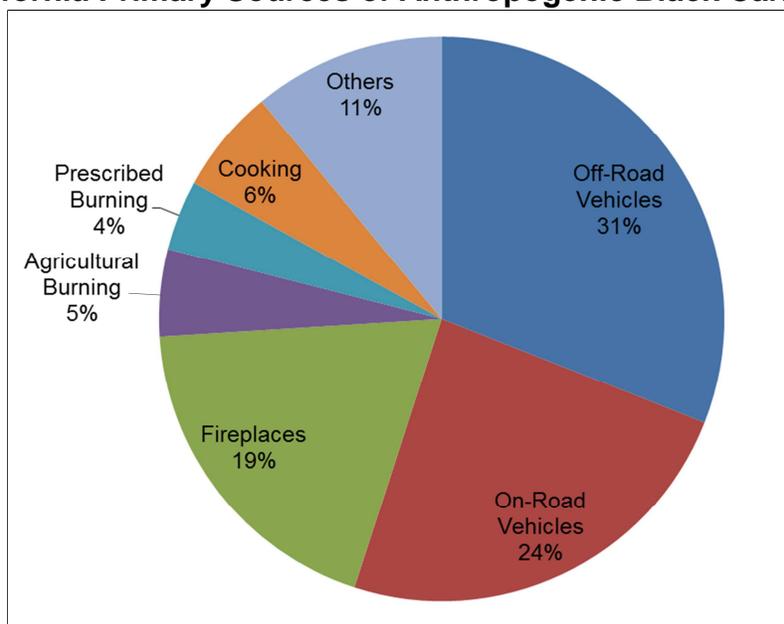
The main sources of black carbon in California are wildfires, off-road vehicles (locomotives, marine vessels, tractors, excavators, dozers, etc.), on-road vehicles (cars, trucks, and buses), fireplaces, agricultural waste burning, and prescribed burning (planned burns of forest or wildlands). Figure 2 shows the statewide contribution from anthropogenic sources of black carbon in 2010, excluding wildfires, which are highly intermittent but a significant source—almost 50 percent of the total black carbon emissions.

¹⁶ UNEP and WMO. 2011. *Integrated Assessment of Black Carbon and Tropospheric Ozone*. United Nations Environment Programme (UNEP) and World Meteorological Organization (WMO).

¹⁷ Shindell, Drew, Johan C. I. Kuylenstierna, Elisabetta Vignati, Rita van Dingenen, Markus Amann, Zbigniew Klimont, Susan C. Anenberg, Nicholas Muller, Greet Janssens-Maenhout, Frank Raes, Joel Schwartz, Greg Faluvegi, Luca Pozzoli, Kaarle Kupiainen, Lena Höglund-Isaksson, Lisa Emberson, David Streets, V. Ramanathan, Kevin Hicks, N. T. Kim Oanh, George Milly, Martin Williams, Volodymyr Demkine, and David 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](https://doi.org/10.1126/science.1210026).

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Figure 2: California Primary Sources of Anthropogenic Black Carbon Emissions



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 emission reduction benefits.

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. Diesel 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 reducing black carbon emissions.

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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
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 Standards (U.S. EPA)	1999, 2002, 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 (CH₄) is the principal component of natural gas, and it is also a potent and short-lived climate pollutant. It is the second most prevalent GHG emitted in the United States from human activities.

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).

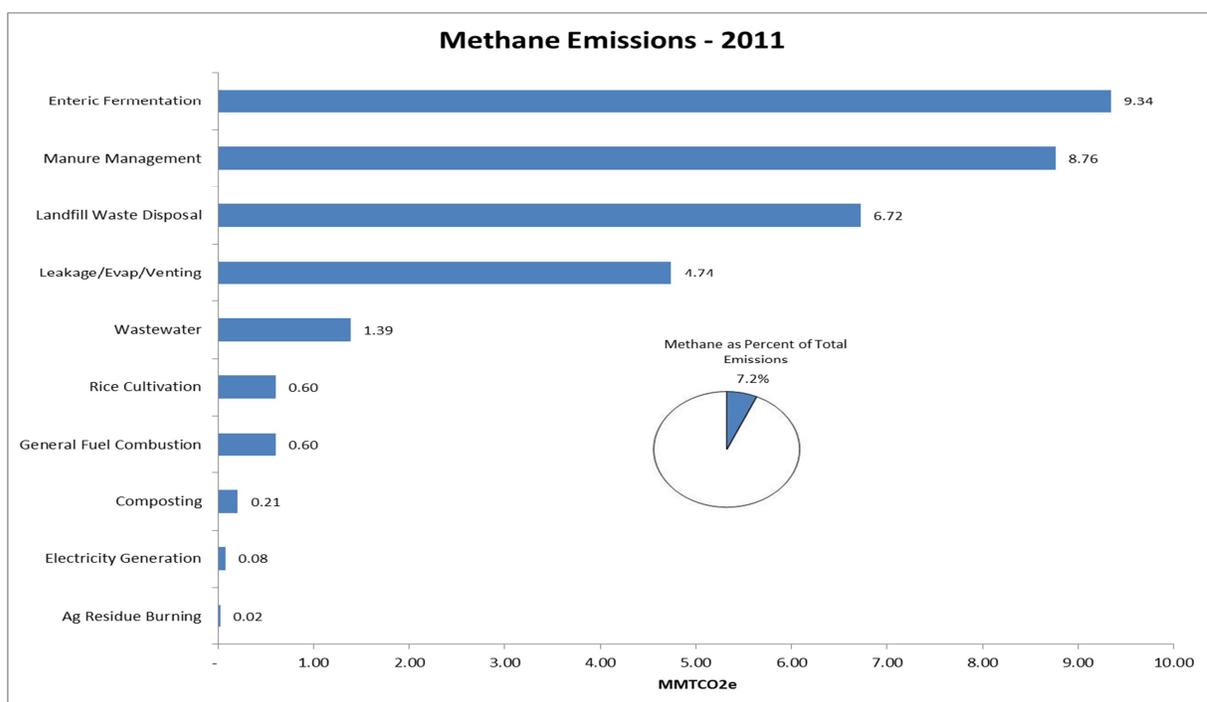
Methane is generated in landfills during the natural process of bacterial decomposition of organic material. Many factors influence the quantity and composition of the gas generated, including the types and age of waste buried in the landfill, the quantity and types of organic compounds in the waste, and the moisture content and temperature of the waste. California has adopted several measures focused on controlling methane

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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, the 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 (AB 341) 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 (2011)



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 reductions associated with the installation of a biogas control

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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 (US 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. 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.

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

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, and are the fastest growing climate forcers in the United States, as well as in many other countries. 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

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program for small cans of motor vehicle 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

E. Adjusting the 2020 Target

The Scoping Plan relied on the IPCC's 1996 Second Assessment Report (SAR) to assign the GWPs of greenhouse gases. Recently, in accordance the United Nations Framework Convention on Climate Change (UNFCCC), international climate agencies have agreed to begin using the GWP values in the IPCC's Fourth Assessment Report (AR4) that was released in 2007. The more recent GWP values referenced in the AR4 incorporate the latest available science and are therefore regarded as more accurate than the SAR values. ARB is beginning to transition to the use of the AR4 GWPs in its climate change programs. In this Update, ARB has begun the transition by using the AR4 GWPs to develop estimates of GHG emissions and potential emission reductions. To put these estimates in the right context, ARB has also recalculated the 1990 GHG emissions level with the AR4 GWPs. Using the AR4 GWPs, the 427 MMTCO₂e 1990 emissions level and 2020 GHG emissions limit, established in response to AB 32, would be slightly higher, at 431 MMTCO₂e.

III. Progress Toward the 2020 Goal

III. Progress Toward the 2020 Goal

California is on track to meet the AB 32 2020 GHG emission reduction goal.

The 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 reductions 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 are 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 envisioned by AB 32: to reduce GHG emissions to 1990 levels by 2020, and to achieve the maximum technologically feasible and cost-effective reductions on an ongoing basis. Today, many of the State’s GHG emission reduction measures and initiatives set forth in the original 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 GHG goal but will also provide numerous additional public health and environmental benefits.

We measure progress toward the 2020 goal 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.¹⁸ To assess whether California will meet the 2020 goal, it is necessary to estimate the expected emission reductions from these measures in 2020 based on the regulatory requirements.
- **Evaluating emission trends:** Each year, ARB updates the 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

¹⁸ The State Agency Greenhouse Gas Reduction Report Card is available at : http://www.climatechange.ca.gov/climate_action_team/reports/2013_CalEPA_Report_Card.pdf.

III. Progress Toward the 2020 Goal

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 has used both of these methods to evaluate progress toward the 2020 target in this Update.

A. Key Accomplishments

California has undertaken a number of notable ground-breaking 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.

B. Progress by Scoping Plan Sector

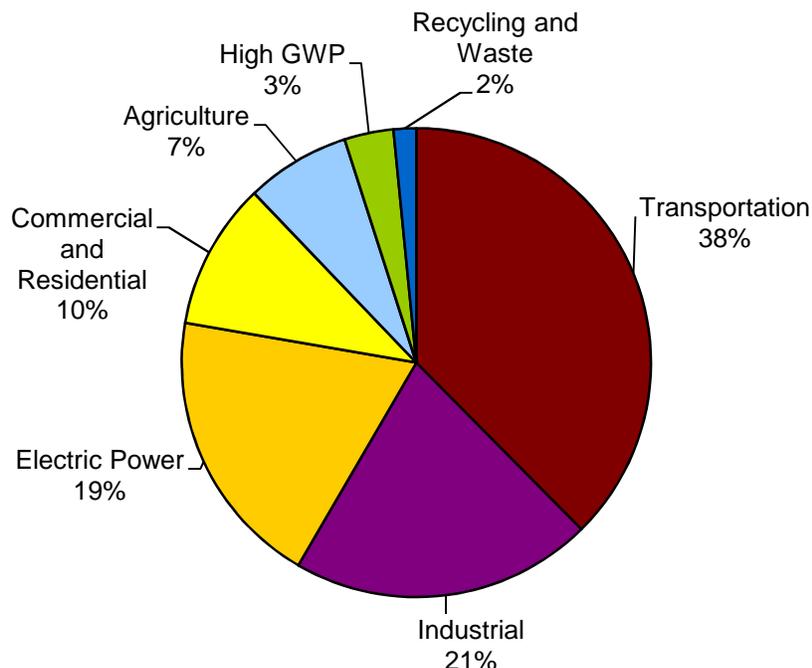
The Scoping Plan recommended specific GHG emission reduction measures in California's major economic sectors. Figure 4 shows the relative share of GHG emissions from the major sectors in 2011 by emission source.

Scoping Plan Adopted Measures

- | | |
|--|---|
| ✓ Cap-and-Trade | ✓ Advanced Clean Cars |
| ✓ Refrigerant Management Program | ✓ Low Carbon Fuel Standard |
| ✓ High GWP Consumer Products | ✓ Energy Efficiency Audits for Large Facilities |
| ✓ Semiconductor Manufacturing | ✓ SF ₆ Leak Reduction in Electrical Appliances |
| ✓ Mobile Air Conditioners | ✓ Tire Pressure |
| ✓ Heavy Duty Trucks | ✓ High-Speed Rail |
| ✓ Shore Power for Ocean-going Vessels | ✓ Mandatory Commercial Recycling |
| ✓ California Solar Initiative | ✓ Water Efficiency |
| ✓ 33 Percent Renewable Portfolio Standard | ✓ Landfill Methane Capture |
| ✓ Sulfur Hexafluoride (SF ₆) Reductions from Gas Insulation Switchgear | ✓ Building and Appliance Energy Efficiency Standards |

III. Progress Toward the 2020 Goal

Figure 4: Statewide 2011 GHG Emissions by Sector



Some of the sector names in the Update discussions below do not match the sectors in Figure 4. This is because of overlap between the sectors and, in some cases, the emissions being counted in a different location. This includes the sector update discussions on Energy, Water, Green Buildings, and Forests. The Energy Sector Update discusses measures to reduce GHG emissions resulting from both natural gas and electricity. In Figure 4 this applies to GHG emissions from electricity (Electric Power Sector) and GHG emissions from natural gas from the Commercial and Residential Sector and Industrial Sector. The Water Sector Update discusses measures that affect sources in the Electrical Power Sector in Figure 4. Measures discussed in the Green Building Sector Update affects largely new construction, which would affect electricity and natural gas sources included in the Commercial and Residential Sector in Figure 4. Forest emissions are not listed on Figure 4 since current estimates show that more CO₂ is being sequestered from the atmosphere into new woody biomass (trees and brush) and other plant material than is being emitted to the atmosphere.

The following sections provide an update on the progress that has been made in each sector of the Scoping Plan, including the status of each individual measure using the numbering convention from the initial Scoping Plan. The Cap-and-Trade Regulation, approved by the Board in 2011, overarches several sectors and is included as its own discussion.

III. Progress Toward the 2020 Goal

1. Transportation Sector

The transportation sector—including transportation fuels, land use, infrastructure, and travel activity—is the largest contributor to GHG emissions in the State, due primarily to California’s 25 million passenger vehicles. Because of its size, it is critical that the transportation sector achieve significant emission reductions toward the State’s 2020 goal.

California has a long history of improving the environmental footprint of transportation-related activities, and has, over the last nine years, taken significant steps to reduce GHG emissions in this sector. California’s GHG efforts on transportation began in 2002 when the Legislature passed AB 1493 (Pavley, Chapter 200, Statutes of 2002), the Pavley bill. ARB approved regulations to implement the Pavley bill in 2004. The Scoping Plan identified several GHG emission reduction measures for the transportation sector. These included reducing GHG emissions from cars, reducing the carbon content of fuels, a reduction of vehicle use or vehicle miles traveled (VMT), and inclusion of transportation fuels in the Cap-and-Trade regulation. To date, regulations are in place to achieve 23 MMT of GHG emission reductions in 2020. Reductions have been largely, but not exclusively, focused on light-duty vehicles, and are being achieved through a three-pronged approach: (1) regulations, (2) incentives, and (3) transportation, land use, and housing planning. A coordinated approach that will involve all three strategies is currently being developed to reduce California’s freight emissions.

Regulations

ARB’s Advanced Clean Cars program, developed in part through collaboration with U.S. EPA and National Highway Traffic Safety Administration (NHTSA), will cut GHG emissions from new passenger vehicles in 2025 by half, compared to today’s fleet mix. The Advanced Clean Cars program also includes an updated Zero Emission Vehicle rule, which requires plug-in electric or hydrogen fuel cell vehicles to account for about 15 percent of new vehicle sales in California by 2025.

Executive Order (EO) B-16-12, issued by Governor Brown in 2012, reaffirmed California’s commitment to reduce transportation emissions that contribute to climate change and supports the Advanced Clean Car Program. The EO established a 2050 GHG reduction target for the transportation sector of 80 percent from 1990 levels. The EO also called for 1.5 million zero emission vehicles on California’s roadways by 2025, along with zero emission vehicle purchasing requirements for State government fleets. In 2013, the Governor’s Office released the ZEV Action Plan identifying specific strategies and actions that State agencies will take to meet milestones of the Executive Order. California currently has 40,000 ZEVs on its roadways, more than any other state.

To reduce GHG emissions from fuels, the Board adopted the first-in-the-nation Low Carbon Fuel Standard in 2009. This regulation requires a minimum of 10 percent reduction in carbon intensity of transportation fuels by 2020. In addition to reducing

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carbon intensity it will also diversify the fuel pool, which in turn will lead to less susceptibility to gasoline and diesel price spikes. As a result of California's leadership, other states and countries are pursuing the development of carbon-intensity fuel measures.

ARB is currently developing a regulation establishing GHG emission reduction requirements for all medium- and heavy-duty vehicles and engines manufactured for use in California. The regulation will harmonize with a GHG emission reduction rule adopted by the U.S. EPA in 2011 that will apply to the manufacture of new trucks and engines used nationally between 2014 and 2018. It is anticipated that Phase 1 of the regulation will be adopted by the Board in December of 2013.

During Phase 2 of the regulation, ARB will work in concert with the U.S. EPA and the NHTSA to establish more stringent GHG emission reduction requirements for medium- and heavy-duty vehicles and engines, and may include new national GHG emission reduction requirements for trailers. ARB expects that Phase 2 of the regulation will be considered for adoption by the Board in 2016.

Incentives

Incentive funding is essential to spur fleet turnover and the development of the advanced technologies critical to meeting California's GHG emission reduction goals. Through the Carl Moyer Memorial Air Quality Standards Attainment Program, Proposition 1B Funding, and AB 118 Air Quality Improvement Program, ARB provides funding for advanced technologies that reduce criteria pollutant and air toxic emissions, often with concurrent climate change benefits. To date about \$140 million has been dedicated to these technologies, which include: rebates for light-duty clean cars, vouchers for hybrid and zero emission heavy-duty trucks, and technology demonstrations such as hybrid tugboat retrofits. In addition, the California Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program invests \$100 million annually to develop and deploy advanced technology fuels, fueling infrastructure, vehicles, and workforce skills necessary operate and maintain these new technologies. Finally, Senate Bill 99 creates an active transportation program, which is funded at an annual level of \$129 million.

Transportation, Land Use and Housing Planning

As a result of Senate Bill 375 (Steinberg, Chapter 728, Statutes of 2008), the Sustainable Communities and Climate Protection Act of 2008, ARB set per-capita passenger vehicle GHG emission reduction targets for California's metropolitan regions in California. The goal of SB 375 is to reduce GHG emissions from passenger vehicles through location efficiency. This is accomplished through better-integrated regional transportation, land use, and housing planning, with housing that is denser and with transit access to jobs and services. Regional and local planning agencies are responsible for developing Sustainable Communities Strategies (SCS) as part of the federally required Regional Transportation Plan and State-required general plan housing elements. Sustainable Communities Strategies promote more travel and housing choices through greater access to alternative forms of transportation (including

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public transit, biking, and walking) and development patterns where people can live, work, and play without having to drive great distances. Implementation of these strategies hinges on local actions to realize the GHG reductions envisioned in the regional SCSs. SB 375 implementation strategies are designed to support local development of “transit priority projects,” or transit-oriented development (TOD).

In 2008, voters approved Proposition 1A, authorizing nearly \$10 billion in state bonds for the United States’ first high-speed rail (HSR) line, which would connect the San Francisco Bay Area with Los Angeles. Construction of the HSR system is expected to begin on the first 130 miles of the line in the San Joaquin Valley later in 2013, with the first train expected to begin operation in 2022. The HSR, in conjunction with targeted investments in intercity and commuter rail and urban transit systems, will change the way people travel throughout California.

Future Freight Efforts

To date, ARB’s focus in the transportation sector has been on reducing emissions through the efficient movement of people. Although ARB has adopted some strategies to address the heavy-duty fleet, more needs to be done. As a result, ARB is working on a collaboratively developed 2014 Sustainable Freight Strategy. This strategy is a comprehensive approach to addressing emission reductions from freight transport in California, including emissions from trucks, ships, port activities, and locomotives. The strategy will identify a clear vision for a longer-term sustainable freight initiative, and a broad-based coalition to develop, fund, and implement a sustainable freight system.

ARB will be considering measures intended to require or further promote the use of zero emission trucks or other zero emission technologies to transport intermodal containers from marine ports to near-dock railyards by 2020 in the South Coast and Bay Area. The mechanism to implement the measures could be a combination of ARB regulations, local air district indirect source rules, lease conditions, port tariffs, incentive contracts, and/or other means.

The status of each Scoping Plan transportation measure is summarized in Table 5.

Table 5: Status of Transportation Measures

Transportation Measures		Status of Measure/Board Consideration Dates
T-1	Advanced Clean Cars	January 2012
T-2	Low Carbon Fuel Standard	April 2009 (early action item)
T-3	Regional Transportation-Related Greenhouse Gas Targets	Targets Approved September 2010. Major urban regions have adopted SCSs that meet, and in some cases exceed, the targets.

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Transportation Measures		Status of Measure/Board Consideration Dates
T-4	Vehicle Efficiency Measures 1. Tire Pressure 2. Fuel Efficiency Tire Program 3. Low Friction Oil 4. Solar Reflective Automotive Paint and Window Glazing	March 2009 (early action items) Under consideration by United States Department of Transportation Part of Advanced Clean Cars program Part of Advanced Clean Cars program
T-5	Ship Electrification at Ports (Shore Power)	December 2007 (early action item)
T-6	Goods Movement Efficiency Measures 1. Port Drayage Trucks ----- 2. Transportation Refrigeration Units Cold Storage Prohibition 3. Cargo Handling Equipment, Anti-Idling, Hybrid, Electrification 4. Goods Movement Systemwide Efficiency Improvements 5. Commercial Harbor Craft Maintenance and Design Efficiency 6. Clean Ships 7. Vessel Speed Reduction	December 2007 (early action item) ----- Sub-measures 2–7 and others are being considered in the development of the 2014 Sustainable Freight Strategy
T-7	Heavy-Duty Vehicle GHG Emission Reduction • Tractor-Trailer GHG Regulation • Heavy Duty Greenhouse Gas Standards for New Vehicle and Engines (Phase I)	December 2008 (early action item) Anticipated late 2013
T-8	Medium- and Heavy-Duty Vehicle Hybridization Voucher Incentive Project	April 2009 (early action item)
T-9	High-Speed Rail	Construction contract awarded June 2013

2. Energy Sector (Electricity and Natural Gas)

California’s energy sector includes a complex system of production, transmission and distribution, and end uses. Presently, about 40 percent of the State’s total GHG emissions are associated with the energy sector and, therefore, efforts to reduce energy-related emissions are a key component of the Scoping Plan. Emission reduction efforts within the energy sector will become increasingly important in the near future as more economic activities such as transportation and freight movement are electrified.

California’s energy policies have long prioritized energy efficiency and conservation. California has a track record of decades of rigorously evaluated, cost-effective energy efficiency improvements across all sectors of the economy. The Scoping Plan continued these priorities by advancing a host of innovative and aggressive building,

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appliance, electronic, and water-efficiency standards that are certain to maintain California's leadership in this area.

California has made remarkable progress in developing and implementing new policies and strategies to reduce GHG emissions within the State's energy sector. Consistent with the State's loading order,¹⁹ the California Energy Commission (CEC) and California Public Utilities Commission (CPUC) have adopted a suite of 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.

In 2006, the California Legislature created the nation's first emission performance standard for centralized power generation (SB 1368; Perata, Chapter 598, Statutes of 2006), specifically to reduce the carbon dioxide content of power procured by the State's electric utilities. The U.S. EPA is currently proposing an equivalent carbon dioxide emission performance standard for the nation's power plants.

The Scoping Plan envisioned achieving the majority of the GHG emission reductions for the energy sector from four key programs: building and appliance energy efficiency standards; the 33 percent Renewable Portfolio Standard (RPS); the Million Solar Roofs program; and the Cap-and-Trade regulation. The Scoping Plan also included transportation-related programs that affect energy-sector emissions, such as port electrification requirements and increased penetration of electric vehicles. The status of these programs was discussed in the previous section. The energy sector is tasked with achieving 25 MMT of greenhouse gas reductions by 2020, with almost half of the reductions from energy efficiency programs, which must be adequately funded and efficiently delivered in order to meet that goal.

Energy Efficiency

A variety of appliance, building, and electronic energy efficiency programs represent the State's top priority in reducing the need for 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 this year and are now 25 percent more efficient for residential construction and 30 percent more efficient for non-residential construction.²⁰ The CEC also adopted aggressive energy efficiency standards for televisions in 2009, and first-in-the-nation energy efficiency standards for battery chargers in 2012.²¹

¹⁹ 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.

²⁰ Computed from *California Energy Demand, 2012–2022 Final Forecast*, June 2012, Form 2.2 on Committed Energy Impacts.

²¹ CEC. 2013. California Energy Commission 2012 Accomplishments.

http://www.energy.ca.gov/releases/2013_releases/2012_Accomplishments.pdf.

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Appliance Standards

The CEC is currently in the pre-rulemaking phase to consider additional appliance types for coverage by Title 20 appliance standards. Appliances being considered include consumer electronics, lighting, water appliances, and several additional appliance types. Future California Title 20 updates and corollary collaborative work with the U.S. Department of Energy on appliance standards should focus both on realizing cost-effective energy savings and on incorporation of features that can assist in grid resilience and responsiveness.

Proposition 39

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 2.75 billion over five years) to support energy efficiency and clean energy projects in California's public schools (K–12) and community colleges.

Local Governments

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.

State Buildings

Governor Brown also 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 buildings by 10 percent by 2015, and 20 percent by 2020.²²

Existing Buildings

Assembly Bill 758 (Skinner, Chapter 470, Statutes of 2009), requires the CEC to develop and implement a comprehensive energy efficiency program for all of California's existing buildings. The CEC is currently drafting an Action Plan for 758, which will propose solutions for energy efficiency issues in California's existing buildings.

As called for in the draft Action Plan for the Comprehensive Energy Efficiency Program for Existing Buildings, California should accomplish the following:

- Improve code compliance rates with Title 24 Building Standards for existing building upgrade projects. This will require much greater, ongoing emphasis on code-related outreach, education, and training, as well as ongoing enforcement action. California should consider developing or adopting low-cost permitting platforms that local building departments could adopt.

²² Executive Order B-18-12, issued on April 25, 2012. See <http://gov.ca.gov/news.php?id=17508>.

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- Develop energy disclosure approaches and programs that build on existing efforts in California and other states, expanding them to the broadest range of building types, including State buildings in alignment with Governor Brown's Executive Order B-18-12.
- Collaborate with the real estate and property management industries in crafting aggressive but practical solutions for achieving high penetration of efficiency upgrades to all existing buildings.
- Finally, California should enhance usability of Title 24 Building Standards as applied to additions and alterations to existing buildings.

Zero Net Energy

Achieving the State's zero net energy (ZNE) building goals is another 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. The CPUC's Big Bold Energy Efficiency Strategies, later updated in 2011, state that all new residential buildings shall be ZNE by 2020, new commercial buildings shall be ZNE by 2030, and half of existing commercial buildings shall be retrofitted to ZNE 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. Working with the CPUC, the CEC is currently developing a definition for ZNE Code compliant buildings that it will publish in the 2013 Integrated Energy Policy Report. As part of this effort, ARB and the CEC should analyze alternatives to the use of natural gas for heating, cooking, and industrial processes, such as electrification or other non-GHG emitting alternatives, 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 a statewide program requiring all new residential and commercial construction to operate with zero net energy use.

Renewable Energy

In 2011, the Legislature passed and Governor Brown signed a bill creating the nation's most aggressive RPS program. The program increases and extends California's requirement for local electric utilities to serve their customers' electricity needs with clean renewable energy from 20 percent by 2010 to 33 percent by 2020. The State has also established a separate but related renewable energy policy to the 33 percent RPS. As part of his Clean Energy Jobs Plan, Governor Brown set an aggressive target of adding 8,000 megawatts (MW) of centralized, large-scale renewable facilities and 12,000 MW of distributed renewable generation by 2020. Of the 12,000 MW distributed renewable generation goal, 4,000 MW has already come online.

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California has made substantial progress in developing new, in-state renewable generating resources to support the RPS and the governor's goals. Approximately 2,000 MW of new renewable capacity came online in 2012,²³ 1,600 MW of which is wind generation. Another 2,000 MW of renewable generation is scheduled to come online before the end of 2013. California is now the nation's second largest producer of wind power.²⁴ The California Independent System Operator, the main operator of the State's electricity grid, witnessed a number of record-breaking events for renewable generation during 2013. Wind generation in April reached 4,000 MW of on-line capacity, and solar generation reached 2,000 MW of on-line capacity in June.

California now leads the nation in the amount of solar photovoltaic capacity.²⁵ In 2012, California became the first state to install more than 1,000 megawatts of new solar capacity in a single year, from a combination of utility-scale projects and customer installations.²⁶ The State's Million Solar Roofs program enacted in 2006 (Senate Bill 1, Murray, Chapter 132) is driving much of this effort. The incentive-based program set a target for 3,000 MW of self-generative solar, including solar water heating, by 2017. To date, over 1,400 MW of self-generating solar capacity has been installed under the incentives provided by this program.

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, Statutes 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, 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 MMTCO₂e.

²³ California Public Utilities Commission, *Renewables Portfolio Standard Quarterly Report*, 3rd and 4th Quarter 2012, <http://www.cpuc.ca.gov>.

²⁴ Wisner, Ryan, and Mark Bolinger. 2012. 2011 Wind Technologies Market Report. Lawrence Berkeley National Laboratories. U.S. Department of Energy. DOE/GO-102012-3472. August.

²⁵ 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.

²⁶ Marshall, J. 2013. California Still Tops in Renewable Energy Rankings. <http://www.pgecurrents.com/2013/08/22/california-still-tops-in-renewable-energy-rankings/>. Accessed August 23, 2013.

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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 Scoping Plan. 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 and CEC to ensure the Scoping Plan goal of 4,000 MW of new CHP is achieved by 2020, and that Governor Brown's goal for 6,500 MW of additional installed capacity can be met by 2030.

The status of each Electricity and Natural Gas measure in the Scoping Plan is summarized in Table 6 below:

Table 6: Status of Electricity and Natural Gas Measures

Electricity and Natural Gas Measures		Status of Measure
E-1	1. Building Energy Efficiency – Electricity	2013 Building standards adopted and begin implementation January 1, 2014.
	2. Appliance Energy Efficiency Standards – Electricity	CEC adopted and implemented standards for battery chargers and television sets. New standards for other appliances are currently under development.
	3. Utility Energy Efficiency Programs – Electricity	Programs being implemented.
CR-1	1. Building Energy Efficiency – Natural Gas	2013 Building standards adopted and begin implementation January 1, 2014.
	2. Appliance Energy Efficiency – Natural Gas	New standards under development.
	3. Utility Energy Efficiency Programs – Natural Gas	Programs being implemented.
CR-2	Solar Water Heating (CSI Thermal Program)	Program being implemented. 700 projects to date.
E-2	Combined Heat and Power	AB1613, enacted in 2007, being implemented. CPUC adopted standard contracts for CHP systems and set targets for CHP procurement.
E-3	33 Percent Renewable Portfolio Standard	SBx1 2, enacted in 2011, being implemented by CPUC, CEC, and publically owned utilities.
E-4	Senate Bill 1 Million Solar Roofs (California Solar Initiative, New Solar Home Partnership, Public Utility Programs)	Greater than 1,400 MW installed to date.

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3. Water Sector

A safe and reliable water supply is critical to California. As noted in the State's Climate Change adaptation strategy: "Water is the lifeblood of California's natural and human systems. For more than 200 years, California water and flood management systems have provided the foundation for the State's economic and environmental vitality and provide water supply, sanitation, hydropower, recreation, and flood protection."

Water is a critical component of the State's economy and has implications for almost all sectors discussed in the Scoping Plan. For purposes of the Plan, the water sector includes groundwater and surface water resources and the infrastructure for its storage, conveyance, use, treatment, and recycling from these sources.

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 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 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. 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 reduce water use consumption by directing State agencies and departments to reduce their overall water use by 10 percent by 2015 and 20 percent by 2020.²⁷

²⁷ See Executive Order B-18-12, issued on April 25, 2012.

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The status of each water measure in the Scoping Plan is summarized in Table 7.

Table 7: Status of Water Measures

Water Measures		Status of Measure
W-1	Water Use Efficiency	State agencies are reducing water usage.
W-2	Water Recycling	State Water Resources Control Board (SWRCB) is funding recycled water development projects.
W-3	Water System Energy Efficiency	CEC has adopted standards for water efficiency. CPUC has ordered IOUs to invest in energy and water efficiency.
W-4	Reuse Urban Runoff	SWRCB is funding numerous stormwater reuse projects.
W-5	Renewable Energy Production	DWR is contracting from renewable energy projects. The CEC is researching biogas technologies.
W-6	Water Public Goods Charge	The program has been evaluated but is not being implemented at this time.

4. Green Buildings

Buildings represent the second largest source of statewide GHG emissions when accounting for electricity, natural gas, and water consumption during ongoing operations and maintenance. Additional GHG emissions also result 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 affect transportation patterns and infrastructure needs and result in varying GHG impacts. Residential energy retrofits are also an important avenue for increasing energy efficiency and reducing GHG emissions. As the largest construction industry sector, residential construction affords the greatest potential for maximizing the benefits of green technologies. Emission reductions from green buildings are reflected in the electricity and natural gas sectors.

Green buildings utilize an integrated approach to improving the design and construction of new buildings as well as retrofitting, maintaining and operating existing buildings, which assists in reducing GHG emissions from multiple sectors; energy, water, waste, and transportation. Green buildings are designed, constructed, operated, and maintained to maximize energy efficiency, conserve water, and minimize waste; and they are strategically located to encourage people to walk, bike, or take public transit rather than drive cars. In the last five years, California has solidified its commitment to green building; leading the way with State buildings and improving building standards, and continuing to raise the bar with voluntary programs at the local level.

To address the impacts of GHG emissions from buildings, the Scoping Plan included a Green Building Strategy to expand the use of green building practices and reduce the

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carbon footprint of California's buildings. The Scoping Plan acknowledged that the design and construction of new green buildings, as well as the sustainable maintenance, operation, and renovation of existing buildings, would result in significant GHG emission reductions.

The Scoping Plan identified a single Green Building measure, "GB-1," with a broad description of potential actions or strategies by building type, including greening new and existing State buildings, public schools, residential housing, and commercial buildings. Since 2008, the Green Building measure has been implemented under four key programs and initiatives; the State Green Building Initiative (Executive Order B-18-12), California Green Building Standards (CALGreen) Code, Beyond Code, and Existing Building Retrofits, which collectively form the basis for the strategy.

State Green Building Initiative

State agencies are leading by example, by reducing the GHG impacts of new and existing state buildings. In April 2012, Governor Brown signed Executive Order B-18-12 directing State agencies and departments to take immediate action for state government buildings to serve as models for green building. The EO requires State agencies to:

- Reduce grid-based energy purchases by at least 20 percent by 2018.
- Reduce entity-wide GHG emissions by 10 percent by 2015 and 20 percent by 2020.
- Participate in demand-response programs to reduce energy use in State-owned or leased facilities.
- Achieve Leadership in Energy and Environmental Design (LEED) "Silver" certification for new and renovated State-owned and leased buildings.
- Retrofit half of the existing buildings to be ZNE buildings by 2025.
- Install electric vehicle charging stations to accommodate future infrastructure demand.

Since 2008, over 100 State buildings have achieved LEED certification. State agencies have been able to achieve a four percent reduction in total energy use and an 18 percent reduction in energy use intensity compared to a 2003 baseline, despite a 12 percent increase in State building square footage over that time.

California Green Building Standards

One of the main aspects of "greening" 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 code requirements and introduced new standards for reducing water use, provisions for 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

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became mandatory on a statewide basis. Effective January 2014, the CALGreen Code will also apply to existing buildings that undergo additions or alterations. In addition to mandatory standards, the CALGreen Code still includes voluntary standards, also known as “Tiers,” that offer model building code language for local governments to adopt more advanced measures beyond the mandatory measures.

Beyond Code

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 one hundred 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. 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.

Existing Building Retrofits

While building standards for new construction are useful to reduce the impacts of climate change, existing buildings offer the greatest potential to reduce building-related GHG emissions. Fifty-five percent of existing residential buildings and 40 percent of nonresidential buildings were constructed before California’s building energy efficiency standards were established. California recognized the opportunity and importance of retrofitting existing residential and commercial buildings with the adoption of Assembly Bill 758 in October 2009, which requires the CEC to develop and implement a comprehensive energy efficiency program for all of California’s existing buildings. The Energy Commission has conducted a pilot of different energy efficiency and finance programs using American Recovery and Reinvestment Act (ARRA) funds.

Other voluntary efforts are under way to green existing homes and commercial buildings. Over five hundred buildings have been certified to the LEED for Existing Buildings rating system, which certifies that buildings are retrofit, operated, and maintained to rigorous green building standards.

In the Scoping Plan, most of GHG savings from green building measures were accounted for in the Electricity, Natural Gas, Waste, and Water sectors. Consequently, ARB did not attribute the GHG emission reductions to the green building sector as part of the AB 32 2020 goal, but rather accounted for the associated reductions in other sectors. The Scoping Plan stated that more research was needed to better quantify GHG reductions of these efforts to ensure that reductions are not “double counted.” A

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few research studies have been completed, and others are still under way to continue to evaluate this research gap. Additional research is needed to evaluate overall energy use and associated GHG emissions of ZNE buildings. On-site natural gas combustion at ZNE buildings, even if offset by photovoltaic generation of electricity, will still result in direct stationary combustion and generation of GHG emissions. ZNE buildings research findings can be used to develop guidelines that optimize ZNE building performance with zero GHG emissions. Zero emission buildings may be the wave of the future as we move toward the next generation of solutions to assist California with achieving 2050 climate goals.

The status of green building measures in the Scoping Plan is summarized in Table 8.

Table 8: Status of Green Buildings Measures

	Green Building Measure	Status of Measure
GB-1	1. State Green Building Initiative (Greening New and Existing State Buildings)	Green Buildings Executive Order B-8-12, signed April 2012.
	2. Green Building Standards Code (Greening New Public Schools, Residential and Commercial Buildings)	California Building Standards Commission adopted the 2010 CALGreen codes. 2013 CALGreen codes become effective January 2014.
	3. Beyond Code (Greening New Public Schools, Residential and Commercial Buildings)	Over 100 local governments have adopting green building standards that are more stringent than State standards.
	4. Existing Buildings (Greening Existing Homes and Commercial Buildings)	CEC is implementing AB 758.

5. Industry Sector

The Industry sector covers 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. These GHG emissions result primarily from stationary source combustion processes, such as boilers and furnaces. Most emission reductions from this sector will be realized through California's Cap-and-Trade program, which includes large industrial sources (i.e., sources emitting more than 25,000 MTCO₂e per year). These sources began complying with an emissions cap starting January 1, 2013. The Cap-and-Trade program is discussed in the next section of this chapter.

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As with other sectors covered by the Cap-and-Trade regulation, ARB also assessed GHG-emitting facilities in California to determine potential direct regulation measures that could be implemented at these facilities.

The Scoping Plan included a measure that would require 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 approved the energy efficiency assessment regulation in 2010 and 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. Two reports have been released, and the remaining three are anticipated to be released in the fall of 2013. After their release, ARB will develop preliminary findings and recommendations for all of the sectors. 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.

Fugitive emissions from industrial facilities (primarily methane emissions) are not part of the Cap-and-Trade program. Accordingly, other direct regulations considered for this sector included measures for industrial sources with significant fugitive GHG emissions—oil and gas extraction, natural gas transmission, and refineries.

The Scoping Plan proposed the development of a measure to reduce venting and fugitive emissions associated with oil and gas production. These emissions come from various sources, such as compressor seals, storage tanks, and leaking components such as valves, flanges, and connectors. ARB undertook a survey of the industry to improve the emissions inventory for this sector. The key findings of this survey are influencing our approach to developing this measure, which is scheduled for Board consideration in 2014.

The Scoping Plan also proposed the development of a measure to address fugitive methane emissions from natural gas transmission and distribution. Initial evidence indicates that methane emissions in California may be undercounted, and that one potential source of these emissions is the natural gas transmission and distribution system. ARB conducted a survey in 2008 of the natural gas transmission and distribution system in California. Based on the survey, the vast majority of the GHG emissions from this sector are from distribution pipeline leaks. Because the emission factors used to estimate these emissions are dated and not California-specific, ARB is currently updating these emission factors via field measurements of fugitive emissions from natural gas distribution pipelines in California. 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.

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While the Cap-and-Trade program covers most of the GHG emissions from refineries, it does not include emissions that would be covered by two potential refinery measures: Refinery Flare Recovery Process Improvements, and Removal of Methane Exemption from Existing Refinery Regulations.

Using historical data, ARB had estimated in the Scoping Plan that GHG reductions could be achieved cost-effectively by installing additional flare gas recovery capacity to capture and reroute gases headed to the flare back to the refinery. However, in recent years, local air district flare emission reduction programs have significantly reduced routine flaring emissions from refineries. ARB does not believe that an additional statewide measure to address refinery flaring would be cost-effective at this time.

Because methane has very low photochemical reactivity, it does not contribute significantly to smog formation and has therefore been historically exempt from the local air districts' volatile organic compound (VOC) regulations, such as refinery leak detection and repair programs. However, because methane is a powerful GHG and short-lived climate pollutant, ARB has begun 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 for refineries and other industrial sources with potential for fugitive methane emissions.

The status of each industry-related measure is summarized in Table 9.

Table 9: Status of Industry Measures

Industry Measures		Status of Measure/Board Consideration Dates
I-1	Energy Efficiency and Co-Benefits Audits for Large Industrial Sources	July 2010
I-2	Oil and Gas Extraction GHG Emission Reduction	Expected 2014
I-3	GHG Emissions Reduction from Natural Gas Transmission and Distribution	Under evaluation
I-4	Refinery Flare Recovery Process Improvements	Equivalent measure implemented by local air districts
I-5	Incorporation of Methane into Air District Rules for Major Industrial Sources to Reduce Fugitive Emissions/Leaks	Under evaluation in collaboration with local air districts

6. 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

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Cap-and-Trade program in the world. The Cap-and-Trade regulation ensures progress toward the emissions target included in AB 32 and provides businesses the greatest flexibility to reduce emissions at the lowest possible cost.

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 ton of greenhouse gases. Each regulated entity must hold allowances 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 will have to turn in more allowances or offset credits. Companies that can cut their GHG emissions will 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 Cap-and-Trade regulation recognizes offset protocols for four project areas: forestry, urban forestry, manure digesters, and the destruction of ozone-depleting substances. ARB has proposed an additional compliance offset protocol for the destruction of fugitive mine methane, and are also 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.

The Cap-and-Trade regulation is being implemented in two stages. Electric generating utilities, electricity importers and large industrial facilities are subject to the program beginning in 2013, and fuel distributors are added to the program 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 depend upon estimates of "business as usual" emissions in the future. 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 are credited in 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 target will be met because the regulation sets a firm limit on 85 percent of California's GHG emissions.

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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 four 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 auction proceeds. More discussion of auction proceeds and other investments is included in Chapter VI.

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 this year. 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 amount of future allowances to be used for compliance should prices get too high. The continuation of the Cap-and-Trade Program post-2020 will enhance the effectiveness of the new cost containment mechanism proposal.

On January 1, 2014, California is scheduled to link its program with the Canadian Province of Québec. California and Québec have worked together to harmonize their regulations and coordinate on a joint auction platform and tracking system. ARB will be providing a report on the status of linkage implementation to the governor and Cal/EPA on November 1, 2013.

As part of the Cap-and-Trade regulation, the Board also approved an Adaptive Management Plan to monitor for unintended consequences of the Cap-and-Trade regulation. The Plan requires ARB to develop systems to monitor for 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 monitoring for potential localized impacts. As part of this effort, ARB staff is proposing amendments to the Mandatory Greenhouse Gas Emissions Reporting Regulation, to collect information on emission increases in criteria and toxic air contaminants from covered entities. ARB has contracted with the University of California (UC), Davis, and is working with forestry experts from around the country to develop a proposed monitoring approach to understand potential forest impacts resulting from implementation of the Protocol under Cap-and-Trade.

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7. Recycling and Waste Management Sector

The Recycling and Waste Management Sector covers all aspects of solid waste and materials management, including landfills; recycling, reuse, and remanufacturing of recovered material; composting, anaerobic/aerobic digestion, and municipal solid waste (MSW); biomass combustion; and landfilling. This sector also includes market development programs, such as the State's environmentally preferable and recycling-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, it is important to note that recycling and reduction of waste will also reduce upstream GHG emissions associated with producing and transporting products. Although many of these upstream GHG emissions happen outside of California, California's waste policies can help reduce global GHG emissions. In California, regulations have been adopted to reduce emissions from the waste sector by 2 MMT. Mechanisms are being explored that can provide even greater GHG emission reductions.

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 939) that required cities and counties to reduce the amount of waste going to landfills by 50 percent by 2000. With the adoption of Assembly Bill 341 (Chesbro, Chapter 476, Statutes of 2011) in 2011, a clear mandate was established to achieve even more significant waste reductions by 2020, setting a goal of 75 percent of the solid waste generated to be source reduced, recycled, or composted by 2020. As a co-benefit to achieving the AB 341 mandate, it is estimated that in aggregate about 20 to 30 MMTCO₂e will be reduced by 2020 compared to business as usual.²⁸

The 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. To achieve the greater level of recycling now required by AB 341, multiple alternative pathways for waste processing will need to occur. These pathways include: enhanced recycling/reuse/remanufacturing, composting and anaerobic digestion, and traditional biomass conversion. These actions, taken together in partnership with CalRecycle, local jurisdictions, and air agencies will allow California to maintain a leadership role in reducing GHG emissions from the waste sector.

Since approval of the Scoping Plan, progress has been made in reducing methane emissions from California's landfills and diverting waste material. ARB adopted the Landfill Methane Control Measure in 2009, and additional actions are now being considered that could provide even greater reductions of methane, such as the implementation of best management practices at landfills, consideration of phasing

²⁸ Most of the estimated emissions benefits will be outside of California, since the majority of the recyclable commodities are currently reprocessed outside the state.

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organics out of landfills, and /or including landfills in the Cap-and-Trade regulation. The Mandatory Commercial Recycling regulation, adopted by CalRecycle in 2012, increases commercial waste diversion.

The Board also approved two resolutions directing staff 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 facilities, landfilling, and the treatment of biomass. In addition, staff was directed to propose 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.

As a result of the Board directives, ARB and CalRecycle staff have developed a Waste Management Sector Plan in consultation with affected agencies and stakeholders. The Waste Management Sector Plan identifies an integrated vision for California for addressing waste-related issues, future GHG emission reductions, and the waste reduction goals outlined in AB 341. It identifies ways the State can further reduce emissions from the waste sector, such as:

- Increasing production and markets for compost and other organics.
- Promoting the use of anaerobic and aerobic digestion in the State.
- Expanding Extended Producer Responsibility (EPR) to place a shared responsibility for end-of-life product management on the producers, and all entities involved in the product chain.
- Encouraging procurement of recycled-content products to lessen the impact that goods and services have on human health and the environment compared to competing products serving the same purpose.
- Phasing organics out of landfills and/or including landfills in the Cap-and-Trade program.

The Waste Management Sector Plan can be found at:

<http://www.arb.ca.gov/cc/waste/pub.htm>.

The status of each recycling and waste measure identified in the Scoping Plan is summarized in Table 10.

Table 10: Status of Recycling and Waste Measures

Recycling and Waste Sector Measures		Status of Measure/ Board Consideration Date
RW-1	Landfill Methane Control Measure	June 2009 (early action item)
RW-2	Increasing the Efficiency of Landfill Methane Capture	Ongoing

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Recycling and Waste Sector Measures		Status of Measure/ Board Consideration Date
RW-3: Sub strategy 1	Mandatory Commercial Recycling	Adopted by CalRecycle January 2012
RW-3: Sub strategy 2	Increase Production and Markets for Compost and Other Organics	Ongoing
RW-3: Sub strategy 3	Anaerobic/Aerobic Digestion	Ongoing
RW-3: Sub strategy 4	Extended Producer Responsibility (EPR)	Ongoing
RW-3: Sub strategy 5	Environmentally Preferable Purchasing (EPP)	Ongoing

8. Forests Sector

California has a vast forest land base covering approximately 33 million acres, or roughly a third of the state. Approximately 60 percent of California's forests are on federal land, while about 40 percent of them are privately owned. Forests play a critical role in the State's carbon balance. Forests have the ability to remove CO₂ from the atmosphere and store or sequester it long-term as carbon in woody biomass and other plant material. Through conservation and management efforts, atmospheric removal of carbon through sequestration can be greater than the atmospheric emissions from processes such as fire, decomposition of wood, or harvest.

The State's forests also include urban trees. Trees in urban environments, or "urban forests," not only sequester CO₂, but also provide significant shading and other cooling benefits that reduce urban temperatures and energy needs.

The Scoping Plan included a Sustainable Forest Target. The goal of this Target was to maintain the current net forest sink. This could be achieved using the mechanisms provided by the Forest Practice Rules, timberland conversion regulations, fire safety requirements, and forest improvement assistance programs, as well as the California Environmental Quality Act (CEQA), which requires avoidance or mitigation of forest carbon losses to conversion.

The Plan also identified other opportunities to realize additional net carbon uptake by trees, including:

- 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 previously covered with native forests.
- Establishing forest areas where the preceding vegetation was not forest.

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- Planting trees in urban areas.
- Using urban forest wood waste for biopower.
- Reducing vegetative fuels that could feed wildfires and using this waste for biopower.

The Board of Forestry and Fire Protection (BoF) has been evaluating the adequacy of existing forest regulations and programs for achieving GHG reductions and ensuring carbon sequestration in the forest sector. 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.

Additionally, ARB has undertaken studies to improve the forest GHG emission inventory. In 2011, ARB contracted with researchers from the University of California, Berkeley, to improve the current estimates of forest carbon stocks and emissions. Researchers are using a carbon stock change approach based on field measurements (Forest Inventory and Analysis data) and remote sensing methods. The inventory has also been expanded to include additional land types including grasslands, scrublands, and wetlands. Once completed, the results should provide up-to-date forest carbon stock and emissions data for California. The work also includes development of a system to enable ARB to estimate future statewide GHG emissions and CO₂ uptake.

CAL FIRE, in conjunction with the U.S. Forest Service and researchers at the University of California (UC) Davis has also been developing GHG inventory data for urban forests and is continuing to refine and update those data over time.

Greenhouse gas inventory methods will continue to be refined over time. Improvements to ongoing GHG reporting systems will include refinements to methods and incorporating 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; Blumenfeld, Chapter 289, Statutes of 2012), with the first major changes in forest sector legislation in 10 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. A co-benefit of this legislation could be GHG reductions from prevention of forest biomass loss through wildfire disturbance.

While some progress has been made in the forest sector, additional work is necessary, including improving California's forest inventory data. With appropriate investments and sound science-based policy, California's forests can provide a tremendous opportunity to meet our climate goals. Over time, efforts in the forest sector will also 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.

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The status of the forest measure in the Scoping Plan is summarized in Table 11.

Table 11: Status of Forest Sector Measures

Forest Sector Measure		Status of Measure
F-1	Sustainable Forest Target	Ongoing

9. High Global Warming Potential Gases

High global warming potential (GWP) gases are those that, on a per-ton basis, contribute to global warming at a level many times greater than carbon dioxide. These gases have been in use for years, primarily in refrigerators, air conditioners, and foam insulation. High-GWP gases account for three percent of California's statewide GHG emissions inventory. A majority of the emissions are comprised of HFCs, with a smaller percentage from perfluorocarbons (PFCs), sulfur hexafluoride (SF₆), and nitrogen trifluoride (NF₃). Although only three percent of today's statewide inventory, the emissions of high-GWP gases are expected to increase in California due to the replacement of ozone-depleting substances (ODS) with HFCs, in response to the Montreal Protocol mandates. Significant effort will be needed to control these emissions as the ODS are phased out.

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 their 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 6.5 MMT of GHG emission reductions in 2020: (1) use of lower-GWP alternatives for certain consumer products and new motor vehicle AC systems, and (2) avoiding currently used high-GWP gases from release 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-GWPs 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 from motor vehicle air-conditioning systems in vehicle models manufactured in 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

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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 no HFCs 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. Details of the phase-down schedule are still being developed.

The status of each high-GWP measure in the Scoping Plan is summarized in Table 12.

Table 12: High Global Warming Potential Gases Measures

High-GWP Gases Measures		Status of Measure/Board Consideration Dates
H-1	Motor Vehicle Air-Conditioning Systems: Reduction of Refrigerant Emissions from Non-Professional Servicing	January 2009 (early action item)
H-2	SF ₆ Limits in Non-Utility and Non-Semiconductor Applications	February 2009 (early action item)
H-3	Reduction of Perfluorocarbons in Semiconductor Manufacturing	February 2009 (early action item)
H-4	Limit Use of Compounds with High Global Warming Potentials in Consumer Products	June 2008 (early action item)
H-5	1. Low Global Warming Potential Refrigerants for New Motor Vehicle Air-Conditioning Systems	Part of Advanced Clean Cars program
	2. Air Conditioner Refrigerant Leak Test During Vehicle Smog Check	Measure not feasible at this time
	3. Refrigerant Recovery from Decommissioned Refrigerated Shipping Containers	Measure not feasible at this time
	4. Enforcement of Federal Ban on Refrigerant Release During Servicing or Dismantling of Motor Vehicle Air-Conditioning Systems	Measure not feasible at this time
H-6	1. Stationary Equipment Refrigerant Management Program – Refrigerant Tracking/Reporting/Repair/Deposit Program	December 2009 (early action item)

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High-GWP Gases Measures		Status of Measure/Board Consideration Dates
	2. Stationary Equipment Refrigerant Management Program – Specifications for Commercial and Industrial Refrigeration	Measure not feasible at this time
	3. Foam Recovery and Destruction Program	Measure not feasible at this time
	4. SF ₆ Leak Reduction Gas Insulated Switchgear	February 2010
	5. Alternative Suppressants in Fire Protection Systems	Measure not feasible at this time
	6. Residential Refrigeration Early Retirement Program	Measure not feasible at this time
H-7	Mitigation Fee on High-GWP Gases	Measure not feasible at this time

10. Agricultural Sector

The agricultural sector includes on-site emissions from farm animals, equipment, crop production, and agricultural management practices. Emission sources in the agriculture sector include enteric fermentation (primarily belching by an animal), manure management, rice cultivation, energy use (including fuel combustion), crop residue burning, and soil management practices (fertilizer and manure applications). In 2011, agricultural sources accounted for about 7 percent of California's total GHG emissions.

California's agricultural sector presents unique challenges to controlling GHG emissions due to its wide diversity of crop and livestock production across the state. The Scoping Plan considered voluntary steps to reduce GHG emissions in the agricultural 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 from dairies was discussed as a Scoping Plan strategy in the agricultural sector. In September 2008, the Board approved the Climate Action Registry's manure digester protocol to establish methods for quantifying GHG emission reductions from anaerobic digesters installed at dairies. In October 2011, the Board adopted ARB's Livestock Projects Compliance Offset Protocol to allow for the generation of offset credits for use in California's Cap-and-Trade program. The voluntary installation of anaerobic digesters at dairies has not increased in California as was originally 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 industry stakeholders, to remove obstacles to digester installations. Critical to this is the continued effort to evaluate the many co-benefits of manure management

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through digesters. The evaluation will examine the potential for successful voluntary efforts to be more widely adopted in the State. 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 by the next Scoping Plan Update due by 2018.

The Scoping Plan also called for research on baseline nitrous oxide (N₂O) emissions from the use of fertilizers, to improve the GHG inventory. ARB, CEC, and the California Department of Food and Agriculture (CDFA) have been coordinating and funding research to determine baseline N₂O 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.

The Scoping Plan identified a number of other potential GHG-reduction activities in this sector, including improving agriculture water use efficiency, increasing the efficiency of or electrifying agricultural water pumps, using biomass-based fuels, and increasing carbon sequestration on agricultural lands.

CDFA, in partnership with scientists at UC Davis and with funding from the CEC, have undertaken research to evaluate 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. CDFA is working with ARB to expand use of biomass-based transportation fuels as a regulatory pathway under the Low Carbon Fuel Standard.

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

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

The status of the agriculture measure in the Scoping Plan is summarized in Table 13.

Table 13: Status of Agriculture Measure

Agriculture Measures		Status of Measure/Board Consideration Date
A-1	Methane Capture at Large Dairies	December 2010

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C. Impacts

1. California Environmental Quality Act Environmental Assessment

ARB is preparing 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). 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)). The EA will be released for a 45-day public review and comment period with the proposed Scoping Plan Update to be released later this fall.

ARB will summarize and respond in writing to any comments submitted on the EA in a supplemental response document that will be considered by the Board for approval prior to final action on the Scoping Plan Update.

2. Meeting the Target

This section discusses how ARB assessed progress toward meeting the 2020 target. As California is in the early stages of implementation, these evaluations will be ongoing through 2020. This section also discusses the public health, environmental justice, and economic evaluations that will be conducted as the Scoping Plan continues to be implemented.

a. GHG Emissions Trends

In 2006, Assembly Bill 1803 mandated that ARB prepare, maintain, and update California's 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 (CO₂), methane (CH₄), nitrous oxide (N₂O), sulfur hexafluoride (SF₆), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs), which are often referred to as the "six Kyoto gases," plus nitrogen trifluoride (NF₃). The emission estimates of the seven gases are typically expressed in terms of million tonnes of carbon dioxide equivalents (MMTCO₂e). The emissions of the non-carbon dioxide gases are converted in CO₂e units based on their global warming potential relative to that of carbon dioxide.

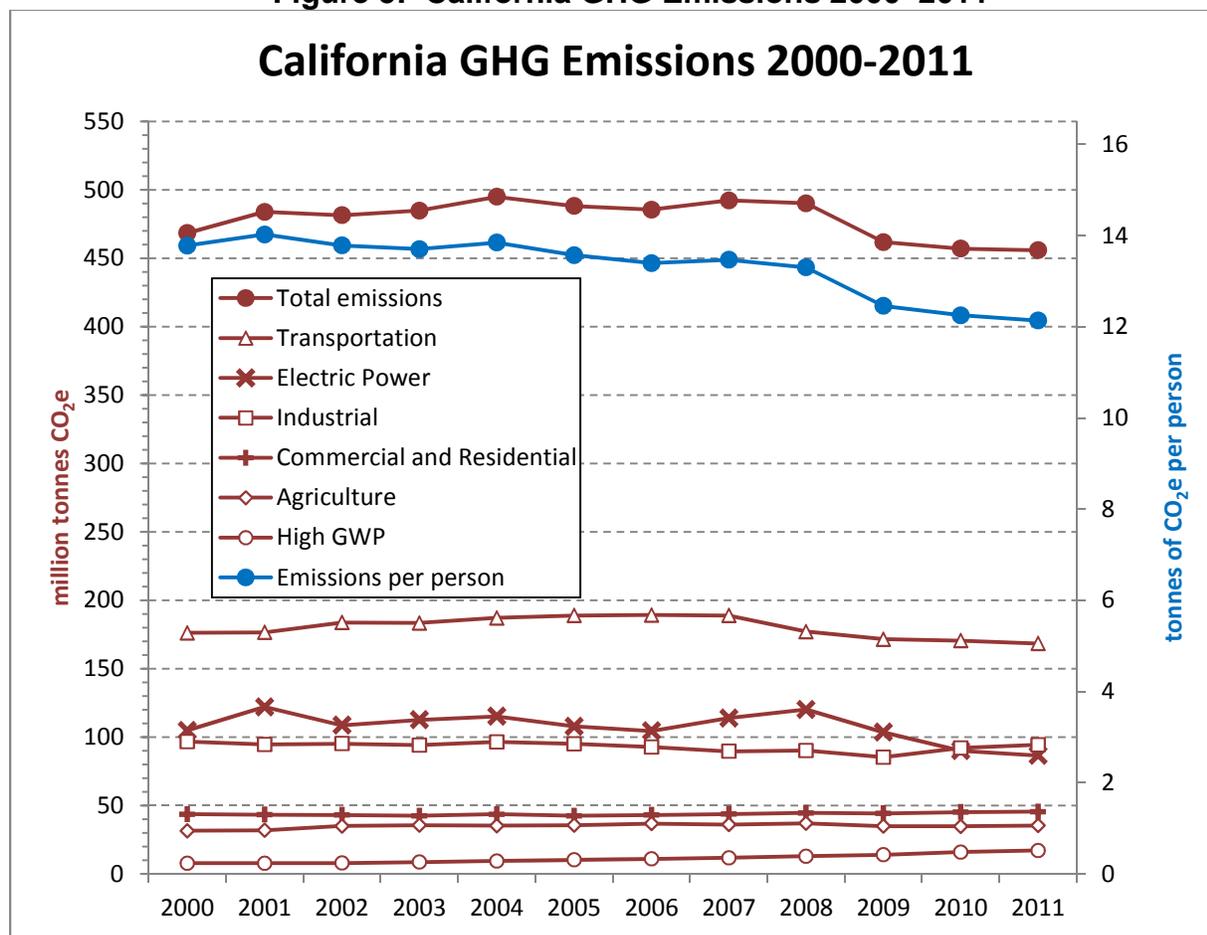
The California GHG inventory is structured and aligned with the Guidelines for National Greenhouse Gas developed by the IPCC. Emission estimates rely primarily on state, regional, or national data sources. The inventory also incorporates methodology and data from the Inventory of U.S. Greenhouse Gas Emissions and Sinks, published by the

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U.S. EPA. Starting in 2009, 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's GHG inventory on its Greenhouse Gas Emission Inventory website, at <http://www.arb.ca.gov/cc/inventory/inventory.htm>. A technical support document detailing the data sources and methods used to develop the inventory is also available for download from ARB's Greenhouse Gas Emission Inventory website. The current inventory compiles statewide anthropogenic GHG emissions from 2000 through 2011, using consistent sets of data and methods to allow for the detection of trends over time (Figure 5). ARB updated the GHG emission inventory in this Update to be based on GWPs in the IPCC's Fourth Assessment Report.

Figure 5: California GHG Emissions 2000–2011



Over the last decade, the total statewide GHG emissions decreased from 468 MMTCO₂e in 2000 to 456 MMTCO₂e in 2011, a decrease of 2.7 percent. The emissions in 2011 are the lowest of the twelve-year period, while 2004 had the highest emissions, with 495 MMTCO₂e. During the same period, California's population grew by 10.5 percent. As a result, California's per capita GHG emissions have decreased by

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11.9 percent between 2000 and 2011. The recent recession had a major impact between 2008 and 2009, when emissions decreased by almost 6 percent. Other changes reflect ongoing early implementation of Scoping Plan measures, energy efficiency actions, renewable power requirements, and hydrology (rain and snow fall). In 2011, emissions continued to decrease in the transportation and electric power sectors. 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 2011, constituting 37 percent of California's GHG emission inventory. Emissions decreased by 4.4 percent between 2000 and 2011. Emissions from on-road vehicles constituted over 92 percent of the transportation sector. These emissions have declined each year since 2006, 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 consumed 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 17 percent from 2000 to 2011. California produces almost 70 percent of its electricity within the state and imports the rest. Emissions from in-state electricity generation decreased by approximately 37 percent between 2001 and 2011. During that period, electricity consumption grew from 250.4 terawatt hours (TWh) in 2001 to 272.6 TWh in 2011, with a peak of 287.8 TWh in 2008.

Over the last eleven years, on average, hydropower provided 17 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 CO₂e 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.

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 been relatively flat, decreasing by 2.4 percent between 2000 and 2011. Associated with the recession, a decline of 5.4 percent was observed in 2009. However, emissions grew by 7.8 percent from 2009 to 2010, and by 2.5 percent from 2010 to 2011. 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 2006 and 2010, cement plant emissions declined 43 percent,

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reflecting a large decrease in demand due to the crisis in housing and construction, as well as the closure of two cement plants in the State over the period.

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 for providing energy for commercial businesses. Emissions increased by 4 percent between 2000 and 2011.

Emissions from residential fuel combustion showed little variation over the last eleven years, ranging from a low in 2005 of 28.2 million tonnes to a high in 2011 of 29.9 million tonnes. However, 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 2011, suggesting that the fuel consumption per housing unit has declined. As with other sectors, coincident with the recession, commercial sector emissions dropped 4 percent between 2008 and 2009, but in 2010 began to increase again to 14.9 MMTCO₂e in 2011.

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 12 percent between 2000 and 2011. Agricultural fuel use and soil preparation were the only categories that saw their GHG emissions decrease from 2000 to 2011. Agricultural energy use decreased by 4 percent from 2000 to 2011. On the other hand, emissions from manure management increased 26 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 118 percent between 2000 and 2011. 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 14 percent between 2000 and 2011.²⁹ Emissions from landfills constitute more than 96 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 30 million in 2011. The decrease in annual landfill deposits is not seen in landfill emissions however, since it is the total waste-in-place accumulated since the landfills' opening that drives the amount of landfill gas generated.

²⁹ See Recycling and Waste sector discussion earlier in this chapter for a discussion of additional GHG emission reductions associated with upstream activities.

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b. Emission Reductions to Meet the 2020 Target

This section describes how estimated 2020 emissions from adopted and anticipated measures are used to evaluate progress toward the 2020 target.

AB 32 required ARB to determine California's 1990 statewide GHG emissions level, which would become California's 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 MMTCO₂e, based on the IPCC's Second Assessment Report. As discussed in Chapter II, since 2007, most national and international climate change organizations have moved to the IPCC's Fourth Assessment Report, which updated the science for the potency, or GWP, of high global warming potential gases like methane and HFCs. ARB is proposing to update the 2020 goal, weighting the 1990 emissions with GWPs from the IPCC's Fourth Assessment Report. The new target would be 431 MMTCO₂e, approximately a one percent increase from the 427 MMTCO₂e target adopted by the Board in 2007. In addition, to assess progress toward the target 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 to meet the 2020 emissions limit. To determine the amount of GHG emission reductions needed to meet the 1990 level, ARB developed a forecast of 2020 emissions in a business-as-usual scenario (2020 BAU), 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 were implemented. ARB subtracts the estimated reductions from adopted and anticipated measures in 2020 to determine whether the 2020 target is within reach (Table 14). The Cap-and-Trade regulation provides a firm cap, ensuring that the 2020 emission target will be achieved. 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.

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Table 14: Meeting the 2020 Emissions Target

Category	2020 (MMT)
AB32 Baseline 2020 Forecast Emissions	509
Expected Reductions from Sector-Based Measures	
Energy	25
Transportation	23
High GWP	5
Waste	2
Cap-and-Trade Reductions	23*
2020 Target	431

*Cap-and-Trade emission reductions depend on the emission forecast.

c. Climate Change and Public Health Impacts

Climate change has been identified as the greatest health threat of the twenty-first century.³⁰ 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 will 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. Although it is challenging to assess the magnitude of health impacts that result specifically from AB 32 mitigation measures, 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.

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, and the natural and built environment. 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

³⁰ Costello, A., et al. 2009. “Managing the health effects of climate change.” *The Lancet* 373: May 16, 2009. <http://www.ucl.ac.uk/global-health/project-pages/lancet1/ucl-lancet-climate-change.pdf>.

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appear—particularly for chronic diseases—may 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 integrate health co-benefit modeling tools into 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.

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,^{31,32} extreme heat events create a significant risk of adverse health effects and heat-related mortality. 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.³³ In addition to increasing air pollutants directly, higher temperatures will also likely increase and intensify wildfires in the State, exacerbating poor regional air quality.³⁴ An increase in air pollution can increase incidents of asthma, allergies, cardiovascular and respiratory diseases, cancer, neurological and reproductive disorders, and premature death.³⁵ These impacts are especially felt among our most vulnerable populations, including children, elderly, people with respiratory diseases, low-income communities, and people without access to health insurance.³⁶ 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

³¹ 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.

³² 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.

³³ Drechsler, D. M., N. Motallebi, M. Kleeman, D. Cayan, K. Hayhoe, L. S. Kalkstein, N. Miller, S.

Sheridan, J. Jin, and R. A. VanCuren. 2006. *Public health-related impacts of climate change in California*.

³⁴ Ibid.

³⁵ CARB. ARB Fact Sheet: Air Pollution and Health. <http://www.arb.ca.gov/research/health/fs/fs1/fs1.htm>.

³⁶ 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. <http://www.energy.ca.gov/2009publications/CEC-500-2009-038/CEC-500-2009-038-D.PDF>.

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climate changes.³⁷ Extreme weather events can lead to both physical and mental health problems.³⁸ In addition, climate change is associated with higher pollen levels, which contribute to allergies and asthma attacks.³⁹ 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 the impacts of climate change. 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.⁴⁰ If this “climate gap” is not addressed, climate change will exacerbate many of the health and social disparities among California residents. Fortunately, 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.⁴¹

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 are 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.⁴²

³⁷ 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*.

³⁸ CDC. 2013. CDC’s Climate Change and Health Program: http://www.cdc.gov/nceh/information/climate_and_health.htm.

³⁹ Ibid.

⁴⁰ Ibid.

⁴¹ CDPH. 2013. *The Burden of Chronic Disease and Injury*.

<http://www.cdph.ca.gov/programs/Documents/BurdenReportOnline%2004-04-13.pdf>.

⁴² ARB staff analysis.

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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.⁴³

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.⁴⁴ 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. In Southern California for instance, their 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.⁴⁵ 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.^{46,47} 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 decline, all-cause mortality, and improved musculoskeletal health.⁴⁸ 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.

⁴³ 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. <http://www.energy.ca.gov/2009publications/CEC-500-2009-038/CEC-500-2009-038-D.PDF>.

⁴⁴ U.S. EPA. 2013. *Out Built and Natural Environments. A Technical Review of the Interactions Among Land Use, Transportation, and Environmental Quality*. Second Edition, <http://www.epa.gov/smartgrowth/pdf/b-and-n/b-and-n-EPA-231K13001.pdf>.

⁴⁵ SCAG. 2012–2035 RTP/SCS; American Lung Association Analysis: <http://www.lung.org/associations/states/california/assets/pdfs/advocacy/smart-growth/smart-growth-analysis.pdf>.

⁴⁶ Atkinson, M., and L. Weigand. 2008. A Review of Literature: The Mental Health Benefits of Walking and Bicycling. <http://www.pdx.edu/ibpi/sites/www.pdx.edu/ibpi/files/Mental%20Health%20Benefits%20White%20Paper.pdf>.

⁴⁷ Ewing, R., T. Schmid, et al. 2008. “Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity.” *Urban Ecology* 567–582.

⁴⁸ PAGAC. 2008. *Physical Activity Guidelines Advisory Committee Report, 2008*. U.S. Department of Health and Human Services.

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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 temperatures⁴⁹ and reducing the energy needed to heat and cool buildings.⁵⁰ 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,⁵¹ reduced noise from traffic,⁵² and other psychological and social benefits that help decrease stress and aggressive behavior.^{53,54,55} Cool roofs and cool pavements also combat climate change while cooling our communities.⁵⁶

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 which 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 from 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.

⁴⁹ 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.

⁵⁰ 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)

⁵¹ 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)

⁵² 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)

⁵³ 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)

⁵⁴ 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)

⁵⁵ 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)

⁵⁶ U.S. EPA. No date. *Reducing Urban Heat Islands: [Compendium of Strategies — Cool Roofs](#)*.

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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.⁵⁷ 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.⁵⁸

Looking Toward 2020 and Beyond

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 post-2020 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 expected to reduce emissions of both GHG emissions and criteria and toxic air pollutants, there are concerns that it may not improve, or may exacerbate some localized air pollution impacts. To address this, ARB is developing an Adaptive Management program, which will outline the process to identify potential localized emission increases caused by the Cap-and-Trade regulation and establish a process to address unanticipated adverse local air quality impacts.

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. 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.

⁵⁷ UC Davis. 2011. *Addressing Nitrate in California's Drinking Water*. <http://groundwaternitrate.ucdavis.edu/>.

⁵⁸ Pacific Institute. 2001. *The Human Costs of Nitrate-contaminated Drinking Water in the San Joaquin Valley*. http://www.pacinst.org/wp-content/uploads/2013/02/nitrate_contamination3.pdf.

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d. 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. These 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 citizens. 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.

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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 10 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.

Assessment of Impacts and Benefits to Environmental Justice Communities

There is significant interest in the development of rigorous metrics for monitoring, 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.

There is inherent difficulty in establishing a cause and effect of any individual air pollution program, regulation, or measure in isolation. One cannot simply toggle each individual effort to see which ones are gaining the most benefits relative to others. One can only measure trends of air pollution concentrations over time to ascertain whether the control programs, in concert, are yielding the intended effect.

Given these challenges, ARB will work with the Department of Public Health, the Office of Environmental Health Hazard Assessment, local air districts, and environmental justice communities and organizations to evaluate the feasibility of potential methods for monitoring, assessment, and quantification. Metrics from tools such as CalEnviroScreen could be utilized to evaluate climate-related programs. Additional monitoring and research may help support development of these methods and provide additional data specific to environmental justice communities.

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.

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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 2013 Scoping Plan Update.

On March 21, 2013, the Board appointed members based on nominations received from environmental justice organizations and community groups.

The EJAC has met twice; once specifically to develop recommendations on this draft Update. The Committee focused that discussion on each Scoping Plan sector and

developed comprehensive recommendations for ARB to consider in drafting this Update. The Committee’s “Initial Recommendations to Inform Development of the 2013 Update to the AB 32 Scoping Plan” provided recommendations for each Scoping Plan sector, Cap-and-Trade, and overarching environmental justice policy. The initial recommendations included specific GHG emission reduction measures, an emphasis on co-benefits (such as criteria and toxic air pollution emission reductions), increased employment opportunities, and the need for monitoring and assessing potential impacts of the State’s climate programs. The full list of initial recommendations can be found in Appendix E.

The Committee’s recommendations are being considered in the development of the Update. Some recommendations have been incorporated into this draft, and others may be integrated where appropriate, prior to the next release of this report.

e. Economic Impacts

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, the net impact of AB 32 even after full implementation will be small in relation to the \$2 trillion California

<u>Environmental Justice Advisory Committee</u>		
Martha Dina Argüello	Physicians for Social Responsibility	Los Angeles
Nicole Capretz	Environmental Health Coalition	San Diego
Gisele Fong	End Oil	Los Angeles
Tom Frantz	Association of Irrigated Residents	Central Valley
Kevin Hamilton	Clinica Sierra Vista	Central Valley
Rey León	Valley LEAP	Central Valley
Penny Newman	Center for Community Action and Environmental Justice	Inland Empire
Luis Olmedo	Comite Civico Del Valle	Imperial Valley
Kemba Shakur	Urban Releaf	Bay Area
Mari Rose Taruc	Asian Pacific Environmental Network	Bay Area
Susan Riggs Tinsky	San Diego Housing Federation	San Diego
Monica Wilson	Global Alliance for Incinerator Alternatives	Bay Area
Ryan Briscoe Young	The Greenlining Institute	Statewide

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economy, making it difficult to isolate its economic impact.⁵⁹ In addition, the global recession and California's subsequent recovery complicate the assessment of the economic impact of the suite of regulatory measures that are being implemented under AB 32. The challenging economic landscape requires careful analysis of the costs and benefits of AB 32 on industries and individuals in California. The assessment of the economic impacts of AB 32 can inform the design of California's long-term climate goals and actions while fostering economic growth.

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 dispersed among sectors 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 projected and actual economic costs and benefits of AB 32.

Prior to implementation of regulatory measures under AB 32, both the projected macro- and microeconomic costs of the suite of regulatory measures were assessed. Now California turns to the task of collecting data and identifying the methodologies that will be used to assess the realized economic impact of AB 32 as measures are fully implemented. During the implementation phase, the State continues to monitor the overall costs of the regulatory measures under AB 32 and is working to ensure that the benefits of AB 32 are fully captured throughout California. Through engagement with external economic experts, researchers, and stakeholders, the State also plans to establish a roadmap for the macro- and microeconomic assessment of the realized economic costs and benefits of AB 32.

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.⁶⁰ Pursuant to AB 32, ARB has conducted two full-scale analyses, as part of the 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 found 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 2020.⁶¹ However, uncertainty remains as to the

⁵⁹ Details available at <http://www.ccsce.com/PDF/Numbers-July-2013-CA-Economy-Rankings-2012.pdf>.

⁶⁰ The AB 32 text is available at http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf.

⁶¹ 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. Scoping Plan. http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf; ARB. 2010. Updated Economic Analysis to the Scoping Plan. <http://www.arb.ca.gov/cc/scopingplan/economics->

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actual impacts of AB 32 regulatory measures on California's industries and consumers. In addition, the range of potential economic impacts 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 State and federal regulations present challenges in the identification of a "business as usual" baseline against which to evaluate the impacts of AB 32.

While the macroeconomic analyses provide important information, the models used in these assessments do not always provide highly specific detail about individual industries or technologies. This detailed information 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.⁶² For regulatory measures adopted under AB 32, assessments of the engineering and other economic costs, as well as economic benefits have been included as part of the regulatory package. These assessments require gathering industry-specific information regarding the engineering and economic costs of regulatory compliance on businesses, estimating indirect and induced impacts of these costs, and an estimate of the corresponding expected environmental benefit. While the scale, scope, and assumptions used in these assessments are regulation-specific, these industry-level assessments provide additional data as to the proposed costs and benefits of AB 32.⁶³

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 potential impacts to the implementation of measures outlined in the Scoping Plan. These measures include the Renewable Portfolio Standard (RPS), Advanced Clean Cars, Low Carbon Fuel Standard (LCFS), high-global warming potential gas measures, and the Cap-and-Trade program. With program implementation under way, new economic analyses are required to assess the realized costs and benefits of AB 32 on the California economy as well as businesses, individuals, and disadvantaged communities within the state. Looking beyond implementation, assessing the impact of the current suite of AB 32 regulatory measures will provide guidance in establishing long-term emissions targets and designing

[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. Analysis of ARB's Scoping Plan. <http://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*. <http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=00000000001015510>; 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>.

⁶² The APA text is available at <http://www.leginfo.ca.gov/cgi-bin/displaycode?section=gov&group=11001-12000&file=11346-11348>.

⁶³ Regulatory documents are available through ARB's Climate Change Programs at <http://www.arb.ca.gov/cc/cc.htm>.

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regulatory programs beyond 2020. The ongoing analysis of regulatory measures will also inform the long-term scope of the AB 32 portfolio. Assessing the costs and environmental benefit of each regulatory measure over time can lead to program modification and the improved interaction of regulatory measures as California moves toward long-term climate goals.

As Scoping Plan measures are implemented, ARB will be expanding efforts to consider the macroeconomic impacts, as well as the impacts of AB 32 on specific businesses and household groups. Additional macroeconomic analyses will be conducted when the regulatory measures under AB 32 have been more fully implemented and are at full stringency. As economic impacts may not be immediately realized upon

implementation, continued

macroeconomic analysis allows for a comprehensive analysis of lagged economic indicators such as structural changes in employment and production. With future macroeconomic analyses in mind, ARB has engaged a group of Economic Advisors to identify the metrics and methodologies that are best suited to identify the realized costs and benefits of AB 32. More details on

macroeconomic modeling and *ex post* analyses will be included in future updates to the Scoping Plan.

Economic Advisors

Larry Goulder	Stanford University
Matt Kahn	UCLA
Charles Kolstad	Stanford University
Steven Levy	Center for Continuing Study of the California Economy
Isha Ray	UC Berkeley
Robert Stavins	Harvard University

During implementation of AB 32, ARB has focused on identifying the metrics and data that can inform microeconomic assessments of the realized costs and economic benefits of AB 32. Through mandatory and voluntary reporting requirements, facility- and household-level data are being collected and ARB is beginning the process to analyze, both internally and externally through contracted researchers, how putting a price on carbon changes the behavior and economic health of California businesses and individuals. Household and facility-level models estimating the direct and indirect costs of AB 32, including expenditures on energy, capital, and labor, will allow the impacts of AB 32 to be quantified over a variety of time horizons and will provide flexibility in the interactions of industrial sectors and regulatory policies. These microeconomic models will also facilitate the assessment of the distribution of the costs and benefits of AB 32 regulatory measures among industrial sectors, geographic regions, and Californians.

The collection of data is in the preliminary stages, with full assessment of direct and indirect regulatory costs and benefits to be conducted in the coming years. However, there are specific sectors that require a more timely assessment of facility-level regulatory costs and benefits. Currently, there are two analyses under way at ARB assessing 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

III. Progress Toward the 2020 Goal

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.⁶⁴ 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. They are expected by 2016.

External research has also informed the regulatory design of measures under AB 32, most notably the Cap-and-Trade program, to ensure that economic costs are compatible with the continued growth of California's economy. For example, the Market Simulation Group (MSG) was established under contract to inform ARB on issues pertaining to market rules and efficiency and has provided input in assessing program costs as well as the supply and demand for allowances in the Cap-and-Trade program.⁶⁵ In addition, ARB co-sponsored a symposium in 2012 bringing together economic researchers and regulators to identify the metrics required for the effective analysis of the Cap-and-Trade regulation.⁶⁶ Discussions between regulators and expert economists spawned ongoing research that is helping to inform the *ex post* analysis of AB 32.

ARB has also actively engaged the general public and stakeholders to ensure that the economic costs of AB 32 regulations are compatible with continued economic growth. ARB has conducted a workshop 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.⁶⁷ Gaining insight into the economic market conditions faced by stakeholders allows for the more accurate modeling of economic impacts under AB 32.

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 the California Independent Systems Operator, 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.⁶⁸ These

⁶⁴ Steve Hamilton of Cal Poly 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 analyses that covers all remaining industrial sectors. The results of these analyses will be publically available on the ARB website upon completion.

⁶⁵ The draft analysis is available at

<http://ei.haas.berkeley.edu/pdf/Forecasting%20CA%20Cap%20and%20Trade.pdf>.

⁶⁶ More information is available at <http://www.bren.ucsb.edu/events/AB32.htm>.

⁶⁷ The LCFS white paper is available at

http://www.arb.ca.gov/fuels/lcfs/regamend13/20130522ccp_conceptpaper.pdf; the Cap-and-Trade program white paper is available at <http://www.arb.ca.gov/cc/capandtrade/meetings/062513/arb-cost-containment-paper.pdf>.

⁶⁸ More information is available at http://www.caiso.com/Documents/2013SecondQuarterReport-MarketIssues_Performance-Aug2013.pdf and <http://www.ferc.gov/EventCalendar/Files/20121220111740-A-4-Presentation.pdf>.

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analyses will assist ARB in identifying areas in which to improve Scoping Plan measures in order to achieve the AB 32 emissions goals with minimal economic impact.

Looking Toward 2020

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, around \$17 per metric ton.⁶⁹ These analyses highlight the uncertainty inherent in the projection of future market condition 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.⁷⁰ ARB estimated that the 2020 emissions target 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 2020 emissions target without sacrificing economic growth. The assessment of economic impacts will continue to be refined through the guidance and input of researchers and economic advisors both for 2020 and beyond.

⁶⁹ In \$US 2013 (the price floor is currently at \$10.71/ton and rises 5 percent plus inflation each year). See, for example, the MSG report linking in footnote 8.

⁷⁰ The projected allowance price of \$21/ton (\$US 2007) corresponds to -0.2 percent change in gross state product in 2020. Available at http://www.arb.ca.gov/cc/scopingplan/economics-sp/updated-analysis/updated_sp_analysis.pdf.

IV. California, Interstate, Federal, International Climate Change Mitigation Efforts

IV. California, Interstate, Federal, and International Climate Change Mitigation Efforts

California's state agencies are working closely with each other, as well as with local and regional partners, to achieve the State's climate change goals and broader environmental protection goals. California has established itself as a national and international leader in addressing and combating climate change.

A number of collaborative efforts at all levels of government are helping to maximize success in reducing GHG emissions and promoting sustainability within communities. Continued cooperation among agencies to prioritize and create policies, programs, incentives, guidance, and funding is necessary for California to achieve its climate change goals. Additionally, as called for in AB 32, ARB has an active program to monitor the development of climate mitigation programs by other states, the federal government, and internationally, to coordinate California's climate program with other jurisdictions and to encourage maximally cost-effective action.

A. State Government Efforts

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 and Bioenergy Action Plans, 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, environmental media, and state bureaucracies. In recognition of this, the State has established interagency workgroups to provide coordinated policies and strategies in various key areas where GHG reductions are needed to meet California's 2020 goal. 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

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sector that supports the storage, transport, and delivery of water in California while ensuring that the State continues to maintain water quality and adequate supplies of water. 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 inter-agency, 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.

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

B. Local and Regional Government Efforts

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.

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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.

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 in Action

- This year the City of Palo Alto has 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, 1 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, including the demonstration of an electric taxi corridor; purchase of electrical 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. In its first three years, SCEIP provided \$56.5 million in funding to over 1,700 property owners in the county.

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 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

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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.⁷¹ 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.⁷² 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.⁷³ 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 emissions inventory methodology for municipal operations, U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, and climate action plan templates and monitoring and tracking tools developed through the Statewide Energy Efficiency Collaborative in coordination with ARB and OPR.

Many of the State's air districts, as well as the California Air Pollution Control Officers Association (CAPCOA)—an organization comprised of local air districts in the state—have provided information, guidance, and training to help local government agencies address climate change in climate action plans and through suggested mitigation in CEQA documents. Districts are also investing in low carbon technologies and fueling infrastructure, as well as permitting major sources of GHGs under the Clean Air Act. ARB is collaborating with CAPCOA to identify local and regional initiatives and priorities for the next version of this Update. Additional guidance on developing local plans to address GHG emissions is being developed by the Governor's Office of Planning and Research.

⁷¹ Bedsworth, L. W., and E. Hanak. 2013. "Climate policy at the local level: Insights from California." *Global Environmental Change* 23: 664–677.

⁷² ICLEI Local Governments for Sustainability, Membership status as of September 2013

⁷³ Office of Planning and Research. 2012. *Annual Planning Survey Results 2012*.
http://www.opr.ca.gov/docs/2012_APSR.pdf.

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C. Interstate, Federal, and International Policy Coordination

California has established itself as a national and international leader in addressing and combating climate change. The release of the 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 both climate change mitigation and adaptation, 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 to enable effective adaptation. 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 longstanding leadership in environmental protection and leadership. Coordinating and promoting climate action at the interstate, federal, and international levels benefits the State by helping to protect the climate system, and consequently California's people and resources. These efforts also expand the promise of clean energy and economic development based on green jobs, enhancing the competitiveness of the State's businesses, workers, and economy.

1. Interstate

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 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

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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 regional Cap-and-Trade program recommendations, ongoing consultation with the Regional Greenhouse Gas Initiative, and an agreement with the Pacific Coast Collaborative to serve as a formal basis for cooperative action, a forum for leadership and information sharing, and a common voice on issues faced by the region.

2. Federal

Since the Scoping Plan, federal climate mitigation policy has undergone dramatic changes. 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.
- 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 carbon pollution standards for power plants under the federal Clean Air Act. As U.S. EPA moves forward to promulgate 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.

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3. International

As one of the largest economies in the world, California has committed itself 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 regulation in several countries. Recognizing that multiple 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. 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 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.

Most 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 bilateral cooperation on climate, clean energy, and development and sharing of low carbon programs and policies.

V. Continuing Progress Beyond 2020

V. Continuing Progress Beyond 2020

California is well on its way to meeting its 2020 emission goals, but it will need to continue and expand current programs to accelerate progress and achieve another 80 percent emission reduction by 2050.

Many other jurisdictions are beginning to develop 2030 and 2050 GHG targets and plans, and now is the time for California to begin considering the longer-term as well. Bridging the gap between the State's 2020 GHG target and 2050 goal will require ongoing changes in the way electricity is generated, transmitted, and consumed; the way vehicles, fuels, and systems move people and goods throughout California and its economy; the way we approach energy and water consumption, and waste in our homes and businesses; and the way we plan our communities, manage our natural resources and natural lands, and continue to grow our agricultural sector.

This chapter discusses the challenges California faces and possible pathways forward that could scale current progress to 2050 while meeting its other environmental goals, such as ambient air quality standards. It includes a discussion of a midterm GHG emission target and recommendations for six sectors of California's economy to begin developing a comprehensive strategy to reduce GHG emissions by 2030 and 2050.

A. Post-2020 Progress to Date

Through AB 32 and related measures, California has a very certain trajectory of declining emissions to 2020. Beyond 2020, California's emissions are likely to continue to gradually decline through 2030, due to existing programs. However, the scale of reductions is less than is needed after 2020, and without additional actions, emissions are likely to begin increasing again in the 2030s, when population and economic growth begin to outweigh emission reductions from current policies.

This scenario was illustrated in ARB's 2012 [Vision for Clean Air: A Framework for Air Quality and Climate Planning](#). Across the entire transportation sector, emissions are expected to gradually decline from 2020 to 2030 by about five percent, based on existing policies and regulations. After that, emissions begin a gradual increase to about 2010 levels by 2050.

B. Snapshots from 2050

Achieving the highly efficient, low carbon economy necessary to reach the 2050 target will require aggressive development and deployment of the cleanest technologies. A number of studies produced in recent years provide a glimpse into such a future, illustrating the mix of technologies necessary to reduce energy-related emissions in California to 80 percent below 1990 levels by 2050.⁷⁴

⁷⁴ ARB staff reviewed seven such studies:

- Greenblatt, J., et al. 2011. "California's Energy Future, The view to 2050: Summary report." California Council on Science and Technology. [CCST]

V. Continuing Progress Beyond 2020

The studies share many common conclusions. They generally show that 80 percent reductions are technically achievable, mostly with technologies that are commercially available today, but that rapid market penetration will be required to significantly accelerate emission reductions through the following:

- Energy demand reduction via efficiency and activity changes.
- Large-scale electrification of on-road vehicles and building and industrial appliances.
- Decarbonization of electricity and fuel supplies through renewable or other near-zero carbon technologies.

Each study explores varying combinations of strategies within these three categories, with some common trends:

- Large, ongoing efficiency improvements in transportation, buildings, and industry can be readily achieved.
- A large amount of electrification for light-duty vehicles, rail, buses, and a few heavy-duty categories is necessary.
- A large amount of electrification of space and water heating in buildings and machinery in industrial operations is also necessary.
- Near-zero carbon electricity supply is essential, particularly as the electricity grid supplies energy for transportation and traditional residential, commercial, and industrial activities.
- Advanced, low carbon liquid fuels and reduced vehicle travel are important and highly influential in reducing transportation sector emissions.
- While energy and transportation represent the largest emission sources that will need to be addressed, better use of natural carbon sinks and pursuing reductions within many other GHG-emitting sectors is also needed.
- Aggressive strategies in all areas need to be coordinated and initiated immediately to enable sufficient market uptake by 2050.

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- Williams, J. H., et al. 2011. "The Technology Path to Deep Greenhouse Gas Emissions cuts by 2050: The pivotal role of electricity." *Science Express* [E3]
 - Wei, M., et al. 2013. "Deep carbon reductions in California require electrification and integration across economic sectors." *Environmental Research Letters* 7: 1–9. [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. [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. [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. [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. [UCD-2]

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The studies vary in several important assumptions, however. The differences suggest that there exist several pathways to deep emission reductions in 2050, and they highlight key market and policy uncertainties that could affect future emissions:

- Baseline population and economic forecasts.
- Assumptions regarding vehicle travel demand and user behavior.
- Levels of technology availability, including hydrogen and fuel cell vehicles; carbon capture, utilization, and sequestration (CCUS); and biomass resources for low carbon fuels or power.
- Levels of “load balancing” needed to balance high levels of intermittent renewable power on the electricity grid.

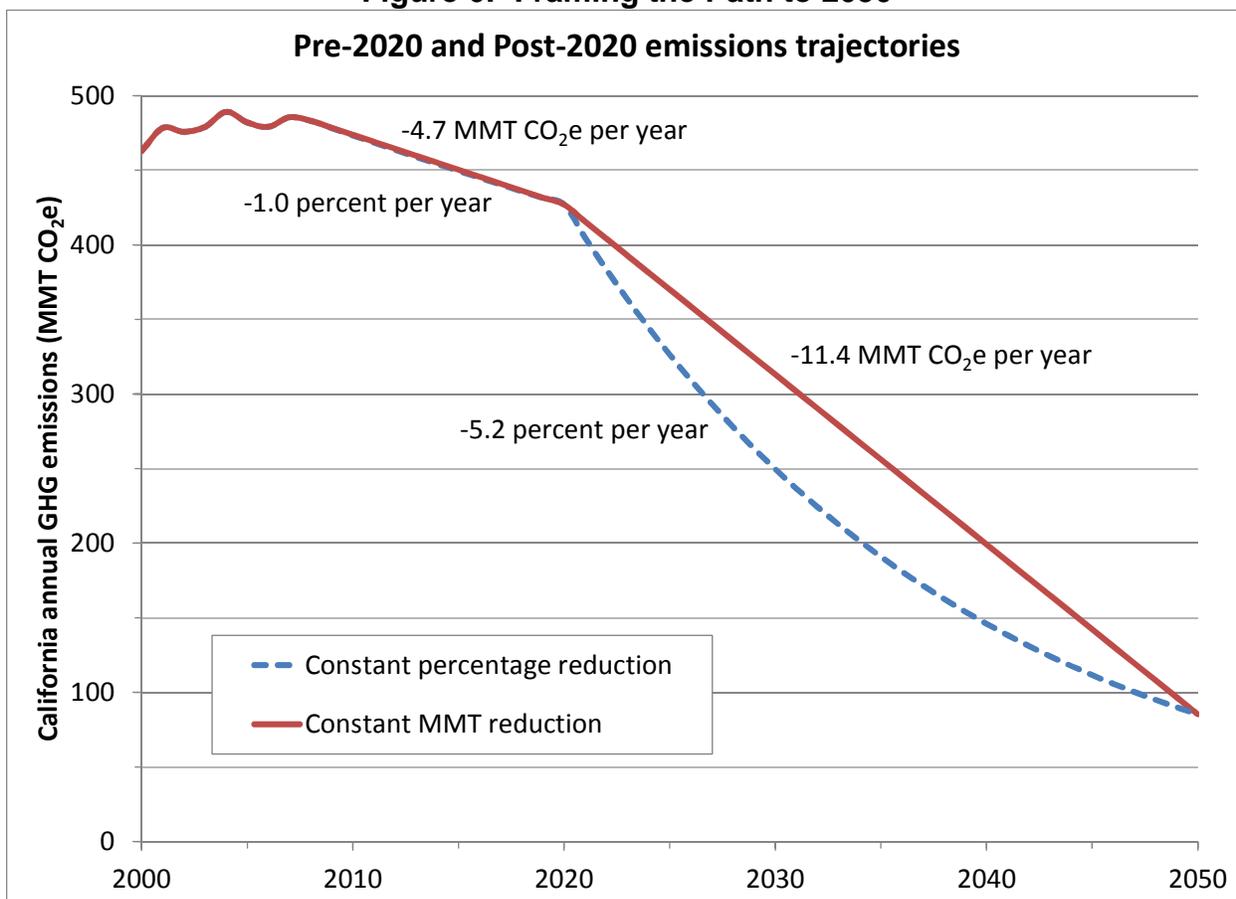
California will need to evaluate these factors, as well as their projected cost, to determine the best path for the future. Although further analysis is needed, the remainder of this chapter tees up some of the challenges, and some initial steps that California can take to begin the discussion about how it should address the challenge of long-term GHG emission reductions strategies necessary to achieve deep GHG emission reductions common across most studies.

C. 2030 Emissions Target

Clearly, a significant gap remains between the ongoing progress and the 2050 GHG target. Progressing toward California’s 2050 climate targets will require significant acceleration of GHG reduction rates. Emissions from 2020 to 2050 will have to decline several times faster than the rate needed to reach the 2020 emissions limit (Figure 6).

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Figure 6: Framing the Path to 2050



But 2050 is too distant to form the basis for a credible policy regime for ongoing emission reductions. A midterm target should be established to frame the next suite of emission reduction measures and ensure continued progress toward scientifically based targets. Such a target will also provide greater levels of market certainty in the near term, while allowing the flexibility to review and adjust course based on future technology and market conditions.

California needs a 2030 target that is consistent with the level of reduction needed in the developed world to stabilize warming at 2°C and aligns with targets under consideration elsewhere. The European Commission has recommended that the European Union adopt an emissions target of 40 percent below 1990 levels by 2030. This target has been endorsed by the Dutch government and the United Kingdom, which has committed to reduce its emissions by 50 percent below 1990 levels within the 2022–2027 time frame. Germany has set a 2030 emissions target of 55 percent below 1990 levels. The United States, in support of the Copenhagen Accord, pledged to emission reductions of 42 percent below 2005 levels in 2030 (33 percent below 1990 levels).

This level of reduction is achievable in California. In fact, if California meets its range of existing policy goals (such as 12,000 MW of renewable distributed generation by 2020,

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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 achieving the 80 percent reduction goal by 2050. Additional measures, including locally driven measures and those necessary to meet federal air quality standards in 2032, could lead to even greater emission reductions.

D. Overarching Needs for a Post-2020 Transition

Continuing the transition to a highly efficient, low carbon, electrified economy will require increasing levels of investment and technology development and deployment on a major scale. Reaching a 2030 or 2050 goal requires a coordinated approach to set future investment, planning, and research policies in the State that align across sectors.

For example, 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 costs for electric transportation. Likewise, 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. California's efforts to promote growth in bioenergy for such varied applications as transportation fuels, heat production, and electricity generation will also have ramifications for the agricultural, natural lands, water, and waste management sectors. All of this will have direct or indirect effects on land use that will require a closely coordinated effort with locally driven GHG emission reduction initiatives. These economic interconnections will require careful policy coordination between and across all levels of government as the State plans for ongoing GHG emission reductions.

1. Technology Refinement, Development, and Deployment

To achieve the significant GHG reductions that will be necessary to meet post-2020 goals, innovative technologies must be refined, developed, and deployed that can either further control GHG emissions or reduce the use of fossil fuels. Many of the technologies needed to achieve a low carbon future exist but either they are not widely deployed or they require additional refinements to enhance performance and become more economically viable. Some examples include energy storage systems, advanced biofuels, and CCUS.

In the energy sector, the 33 percent Renewables Portfolio Standard is the primary driver for de-carbonizing the electricity supply. However, adding more variable renewable resources such as wind and solar creates challenges for system reliability and prompts the need for cleaner, distributed energy stored throughout the grid. Energy storage technologies provide valuable added benefits to improve power stability, quality, and reliability and allow development of a more intelligent electricity network (smart grid). Further research is needed to provide cost-effective energy storage, as well as to perfect the systems needed to fully reap the benefits of energy storage to the

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electrical grid. In addition to energy storage and natural gas coupled with carbon capture, use, and storage, the energy section also recognizes demand response as a critical mechanism to address reliability issues stemming from a larger renewable portfolio. Additional demand response research and development is also needed.

Carbon-neutral biofuels represent an alternative to fossil fuels where electrification is not feasible. Developments in advanced, or second-generation, biofuels could allay concerns about the impact of biofuels on food supply and provide an alternative to landfill disposal for organic waste. Development of novel biofuels derived from algae grown with biowaste nutrients can provide solutions that minimize the use of land and fresh water. However, second-generation biofuels must overcome technological and cost barriers before they are viable for large-scale use.

Carbon capture, utilization, and sequestration can fill the void where low carbon electricity and biofuels are not feasible. The capture and long-term geologic storage of carbon dioxide may represent one way to “green up” fossil fuels and further mitigate climate change. However, significant work must still be done to ensure that sequestered emissions are not eventually released into the atmosphere and to demonstrate the project on a large scale in California.

2. Transportation, Land Use, and Housing Planning 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 of 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 infrastructure. Recently adopted regional SCSs 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. Location efficient affordable transit-oriented development (TOD), for example, has been estimated to yield VMT reduction of 20 to 40 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

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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 fuel 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 2001.⁷⁵ 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, and that 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 reductions. The next generation of regional integrated plans (SCS), if implemented, will 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 2050 goal. 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.

3. Supporting 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. According to a recent Lawrence

⁷⁵ Dutzik, Tony and Phineas Baxandall. 2013. *A New Direction: Our Changing Relationship with Driving and the Implications for America's Future*. US PIRG Education Fund and Frontier Group. Spring.

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Berkeley National Laboratory (LBNL) study,⁷⁶ changes in behavior can result in 8 to 17 percent energy savings. This indicates the essential role individuals and businesses must play in addressing our climate challenges, especially in the post-2020 world. In many cases however, we are limited in our options to make sustainable, healthy decisions. Moving forward, it will be essential to expand the range of options Californians have to live sustainable, healthy lives.

Part of this process includes understanding how factors such as social norms, economics, and values can influence individual and business decisions around energy usage, travel, and product consumption. For instance, a better understanding of why people may not choose to use public transit in certain situations or why people buy or do not buy electric vehicles, can lead to improved services, greater incentives, and better technology—turning what was once not really an option into another viable mode of transportation. This understanding can help us identify strategies to give Californians workable options that reduce their carbon footprints and improve their quality of life.

4. Coordinated Infrastructure Planning and Development

In addition to supporting a transition to more sustainable land use practices, the State should assume a more comprehensive leadership role to ensure that the infrastructure needed to achieve California's emission reduction goals is planned and developed in a coordinated, timely, and environmentally responsible manner. Consideration of the impacts of climate change on infrastructure siting decisions in line with State's emission reduction goals is also essential. The current system of siloed planning and development responsibility among multiple State agencies for such varied systems as transportation, energy, water, and forest and waste management is not an effective model for the future. The State's efforts to maximize GHG emission reductions within these systems will require an increasing level of policy coordination and planning overlap.

To be successful, California will need to employ a much more rigorous level of multiple-system planning and coordination. For example, siting and developing the much-needed transmission infrastructure to access renewable resource areas could be facilitated and potentially be made much more cost effective by maximizing the use of State or county highway rights-of-way in more rural and undeveloped areas.

Various State, local, and regional agencies (such as regional council of governments, water agencies, local agency formation commissions and local air districts) could also provide a greater role in providing leadership and technical assistance to coordinate, streamline, and reduce the cost of local government permitting activities. For example, the preparation of planning guidelines, model ordinances, and programmatic Environmental Impact Reports for the siting of small-scale, community-based renewable generating systems (such as solar PV or cogeneration systems) can help guide and

⁷⁶ 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.

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facilitate local government planning and siting activities, and reduce permitting costs and delays.

E. Recommendations to Transition Beyond 2020

Under the Scoping Plan, GHG emission sources were grouped by major economic sectors to better define, organize, and determine control strategies for each. The original economic sectors were too specific to translate into a broader post-2020 evaluation, particularly since certain economic sectors have overlapping and influential elements that should be evaluated and addressed more holistically. Six key focus areas comprising major components of the State's economy were identified to evaluate and describe the larger transformative actions within California's broad economy that will be required to meet the State's more expansive emission reductions goal for 2050.

The focus areas include:

- Energy.
- Transportation, Land Use, Fuels, and Infrastructure.
- Agriculture.
- Water.
- Waste Management.
- Natural and Working Lands.

These focus areas have overlapping and competing interests that will require careful coordination in the State's future policies and strategies. The topic areas were chosen based on their ability to address concerns that underlie all sectors of the economy. As such, each of the focus areas are not contained to a single economic sector, but have far-reaching impacts within many sectors. For example, much of the transportation sector is expected to be electrified in the future. This creates demand for more electrical generation. Add to this a growing population and an expectation that more and more industrial and commercial facilities will electrify in lieu of using fossil fuels, and the result is a heavy burden on the electricity sector.

Similarly, water delivery and use in California is very energy intensive. Implementing programs that strongly support water conservation can greatly benefit the electricity sector by reducing the need for electricity to move, treat, and heat water. Producing electricity requires large volumes of water. Promoting a system that maximizes renewable energy, energy efficiency, and conservation can greatly reduce water demands that might otherwise be 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.

In addition, beyond 2020, the effects of climate change will need to be a critical consideration as planning, development, and implementation of our climate goals moves forward. The effects of climate change are already evident in California. Sea

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levels have risen, water supplies are dwindling, temperatures are increasing, and severe wildfires are much more frequent. Achieving a highly efficient, low carbon economy will require aggressive development and deployment of the cleanest technologies, as well as increased system efficiencies. Planning must also take into account not only the estimated 50-million-resident increase in the California population by 2050, but also a population that will be increasingly racially and ethnically diverse, and where nearly 1 in 5 residents will be 60 years and older.

As we transition to address our future climate goals, the way in which the State, local, and regional governments (and others) have historically addressed environmental, resource, and economic issues will need to change. No longer will it be satisfactory to “silo” issues and deal with them one by one. The transformation that is necessary to reach our climate goals will require a cohesive effort that brings together economic, environmental, political, and public policy goals to find the right balance.

Additionally, the State will need to plan and adjust quickly to the impacts of climate change. More than ever before, it will be critical for State government to set clear priorities and provide clear direction and leadership. Local and regional cooperation and partnership will also be critical in meeting our goals.

1. Energy

Develop a near zero emission strategy to reduce greenhouse gas emissions in the energy sector, reduce energy costs, and maintain reliability of the electrical grid.

California’s energy sector includes both electricity and natural gas systems, and is a complex system of production, transmission and distribution, utility service operations, and consumption by diverse end users. Energy is a common thread that runs through all sectors of California’s economy. It is also one of the State’s largest contributors to GHG emissions.

Reducing energy sector emissions will require wholesale changes to the State’s current electricity and natural gas systems. The State will need to take on a key leadership role in setting policies, establishing market rules, implementing programs, regulating utility activities, and supporting the development of advanced technologies. Strong partnerships with federal and local governments, utilities, industry, environmental groups, universities, national laboratories, and others will also be needed to spur and deploy innovation.

To reach the State’s long-term goals, the energy sector must strive to achieve near-zero net energy buildings, much greater efficiencies from the existing building stock, highly efficient businesses, low carbon electricity generation, sustainable bioenergy systems, a mostly electrified transportation system, and a highly flexible and robust transmission and distribution system.

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The uncertainty of technological and economic changes over the next several decades will require the State to pursue a portfolio of GHG emission reduction strategies, where each strategy will help ratchet down emissions. This diversified approach will also help California manage uncertainty and reduce the risks to the energy system related to GHG emission reduction efforts.

The path forward has a number of challenges that must be overcome. For example, increasing energy efficiency is vital to both electrical grid stability and the reduction of greenhouse gases. Educating consumers on the benefits of energy efficiency is a key requirement for achieving expanded deployment of energy efficiency technologies. Despite recent progress, significant challenges remain for higher levels of consumer participation in energy efficiency programs, and in purchasing energy efficient products, particularly in existing buildings. For example, many homeowners, landlords, and commercial/industrial property owners and managers are unwilling to spend significant amounts of money on energy efficient products, despite the savings evidence. Making efficiency products more attractive to consumers remains an ongoing challenge for utilities and will require a sustained and continued investment in consumer education.

Recommendations to Maintain Momentum

California will be unable to achieve the needed GHG emissions by simply continuing current trends. There is no single party or agency that has complete responsibility for the energy sector. The State needs an overarching energy plan to ensure that long-term climate goals can be achieved.

The plan should address a number of important administrative, financial, and technological issues to guide investment and planning in the electricity sector. For example, the plan should evaluate and recommend the most appropriate combination of clean energy technologies, which include clean flexible gas units, demand response advancements, large- and small-scale storage systems, carbon capture, use and storage, and energy conservation practices that can be used to maximize decarbonization of the State's centralized power generating system at the lowest cost. In addition, strategies should be included to ensure that any necessary new centralized power plants are specifically located in areas that will maximize overall system efficiency and provide needed resource adequacy and voltage support for the transmission system. Recommended actions for how the State can best consolidate and coordinate the planning, development, and operation of the State's transmission system should also be included.

At the electricity distribution level, the plan should recommend strategies and actions to expedite the development and implementation of small-scale energy storage systems, and micro-grid and "smart-grid" technology deployment to maximize renewable and distributed resource integration. As utilities modernize their aging infrastructure, they need to integrate cutting-edge infrastructure, especially on distribution systems, to enable two-way power flow and increased communication and controls. These technologies will help alleviate the challenges posed when adding more distributed

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energy onto the grid. At the same time, actions to strengthen and expedite California's policies for achieving ZNE homes and businesses in new and existing construction, and for maximizing energy conservation and demand response participation within the consumer electricity market, should be a priority.

The plan should address emerging clean energy technologies. Examples include proposing policies to advance the development and deployment of vehicle charging infrastructure and integration with the electricity system, and to advance bioenergy research, development, and deployment. At the regional level, the plan should recommend policies and strategies for continuing California's collaboration with the Western Electricity Coordinating Council toward developing multi-state GHG reduction strategies within the western electricity system. For example, a regional energy imbalance market could help reduce GHG emissions by coordinating and resolving over-generation issues and renewable forecasting errors.

The purpose and functions of utilities may also need to evolve as California increasingly shifts toward more renewable and distributed energy integration. A new utility business model may need to be developed to ensure that utilities remain financially viable under a transitioning energy system.

Key Recommended Actions for the Energy Sector

Energy Efficiency, Demand Response, and Combined Heat and Power:

- Develop efficiency standards for new and existing residential and commercial buildings and appliances.
- Develop appropriate financing systems or mechanisms, such as leveraged credit, deferred payment options, and capital sources, to support a robust and self-sustaining energy efficiency retrofit and clean energy investment market.
- Develop educational/outreach programs to enhance effectiveness of energy efficiency and demand-response programs.
- California's energy agencies should develop a framework for the use of demand response as an electricity grid services provider.
- Monitor and evaluate effectiveness of energy efficiency and demand-response programs.
- Evaluate and clearly define procurement strategies for CHP facilities.

Renewable Energy:

- Evaluate the potential for expanding or revising the Renewable Portfolio Standard to maximize GHG emission reductions.
- Promote research and development of bioenergy generation projects, where siting does not interfere with air quality goals.

Transmission and Distribution:

- Expand and upgrade the transmission and distribution system, including the development and implementation of micro-grid and smart-grid technologies.
- Resolve and implement interconnection reforms.

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- Develop a procurement mechanism so all resources capable of providing integration services can do so.
- Implement existing and evaluate appropriate expansion of procurement targets for energy storage projects.

Natural Gas-Fueled Generation:

- Site new central electricity generating plants and associated infrastructure in locations that maximize system efficiency.
- Decarbonize natural gas generation via carbon capture, use, and storage or other mechanisms.

Research, Development and Demonstration in the Following Areas:

- Advanced energy efficiency and demand response technologies.
- Carbon capture, use, and storage.
- Large- and small-scale energy storage.
- Smart- and micro-grid technologies.
- Bioenergy technology.
- Renewable technologies with lower environmental impacts.
- Solar thermal technology for process, space, and water heating.
- Advanced CHP technologies.
- Stationary fuel cell technologies.

2. Transportation, Land Use, Fuels, and Infrastructure

Enable a fundamental transition of the transportation sector—how communities develop and expand, how people travel, how freight is moved, and what fuels are used.

Ultimately, widespread use of electricity and hydrogen as transportation fuels from low carbon sources, with low carbon renewable fuels being used where internal combustion engines cannot feasibly be replaced.

The transportation sector is the largest source of GHG emissions in California, projected to account for 35 percent of the emissions in 2020. It is also the primary source of smog-forming and toxic air pollution. Changing California's transportation sector to one dominated by ZEVs powered by electricity and hydrogen is essential to meeting federal air quality standards and 2050 climate goals. Such a transition may have co-benefits such as reduced water pollution as well. In 2012, Governor Brown reaffirmed California's commitment to reduce transportation emissions in Executive Order B-16-2012, where he set targets of 1.5 million ZEVs on California roads by 2025 and reducing sector-wide emissions by 80 percent below 1990 levels by 2050.

As outlined in various 2050 scenario studies for California, achieving the governor's 2050 target will require dramatically improved vehicle energy efficiency, widespread electrification of on-road vehicles, development of low carbon liquid fuels for applications that cannot be easily electrified, and smarter, more integrated land use planning and development.

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Specifically, for California communities and passenger transportation, this effort entails developing communities with a range of mobility options, including easy and equitable access to public transit, active transportation (biking and walking), and other alternative modes of transportation. It requires improved public transit and rail service, powered by zero or near-zero technologies, and improved connectivity among vehicle modes. Vehicle efficiency will continue to improve, and markets for ZEVs will take off, so that when people do choose to travel by car, they will still travel with zero emissions.

For freight transportation, achieving the State's emissions targets means moving goods more efficiently and with zero or near-zero emissions, optimizing movement of freight between modes, and accelerating speed of throughput and expanding system capacity. It requires significant improvements in vehicle efficiencies, and a continual reduction in the carbon intensity of fuels used in trucks and rail, including hydrogen and electricity. Successfully reducing emissions in the freight sector can, and must, support the competitiveness of California's logistics, warehousing, trucking, and shipping industries, while effectively integrating with the national and international freight transportation system.

These changes in passenger and freight transportation can only be enabled with a similar transition to a decarbonized energy sector.

Recommendations to Maintain Momentum

California has an effective policy framework for addressing transportation sector emissions, especially in the light-duty sector, which targets the sector from each angle: vehicle efficiency, transportation fuel carbon intensity, and transportation demand. Natural extensions of this policy framework, coupled with targeted investment and strategic market support, will keep the transportation sector on track to meet ongoing emission reduction targets.

In terms of vehicle efficiency, the Advanced Clean Cars regulation will reduce GHG emissions from new light-duty vehicles by about 4.5 percent per year, from 2017–2025. Continuing progress at about 5 percent per year would reduce new vehicle emissions to about 125 grams of carbon dioxide per mile (gCO₂/mi) and to below 100 g CO₂/mi by 2035. These levels of efficiency can be achieved cost-effectively.

Similarly, for Class 8 heavy-duty vehicles, U.S. EPA's "Phase I" GHG standard will reduce new vehicle emissions by about 4–5 percent per year from 2014–2018. This level of reduction can also continue beyond the current rulemaking, and an additional 5 percent annual improvement through 2025 or 2030 is feasible and cost-effective—using commercially available technologies and advanced transmissions, hybridization, improved trailer aerodynamics, and other technologies. Significant, ongoing vehicle efficiencies can be achieved in Class 3–Class 7 trucks as well, and will be partly enabled by improvements in light-duty vehicles.

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For fuels, California has an effective, scalable framework in place to ensure ongoing emission reductions and progress to 2050 climate targets. The Low Carbon Fuel Standard will reduce the carbon intensity of transportation fuels by at least 10 percent in 2020. Fuels will come under California's Cap-and-Trade program in 2015. Together, the programs provide a structure to ensure that necessary emission reductions are achieved and to provide an effective market signal to accelerate innovation and development of cleaner fuels. Continuing these policies to ensure that carbon intensity continues to decline will help to ensure that California meets its ongoing emission reduction targets.

Continued progress to develop and scale markets for low carbon biofuels is an important component of California's fuel and transportation policies, especially outside of the light-duty sector. Many companies are scaling up production of advanced, very-low carbon biofuels, and renewable natural gas projects that provide "negative" carbon intensity fuel for vehicles are coming online. California's fuel policies and supporting investment—especially through the AB 118 program—are critical drivers supporting these growing industries.

Natural gas has an important niche role to play in contributing to California's air quality and GHG emissions goals in the transportation sector. Heavy-duty natural gas vehicles may offer significantly lower NO_x emissions than current diesel technology, and slight improvements in GHG emissions. Increasing penetration of natural gas in the heavy-duty truck sector could help to meet midterm air quality targets, but natural gas use will have to be mostly phased out to meet 2050 climate targets. In addition, liquefied natural gas could be an important fuel in the shipping sector, which cannot be easily electrified. It would provide important air quality benefits on a global scale and help to avoid increasing black carbon deposits in the Arctic.

California also has a number of important planning tools available to reduce vehicle travel demand, expand mobility options, and improve goods movement. Coordinated planning is critical to achieve deep emission reductions in the transportation sector, and should include the development of the 2015 State Implementation Plans, the California Freight Mobility Plan, the 2040 California Transportation Plan, the ARB-led Sustainable Freight Strategy, and regional sustainable community strategy development and implementation. These planning efforts will need to identify the infrastructure needed to support full-scale deployment of advanced technologies and expanded access to active transportation. Tools developed to support these planning efforts should emphasize the needs of vulnerable communities, as recommended by EJAC, including, but not limited to: access to affordable public transit, electric vehicle charging, or other low carbon fueling infrastructures; accessible low-cost housing; and localized public health benefits. The Strategic Growth Council should take a lead role in supporting local and regional planning agencies. The State needs to support regional and local implementation of SCSs and locally driven GHG emission reductions by providing access to financial resources and incentives that are necessary to achieve the GHG reduction targets.

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Zero emission vehicles are a critical element of all aspects of California's transportation policy framework. They will play an increasingly important role contributing to the State's vehicle and fuel standards and integrated planning efforts, and are essential to meeting 2050 climate targets. The State must continue to support the market not only through regulation, including the ZEV program, but also through continued support for vehicle incentives, infrastructure investments to support electric charging stations, and additional policies and planning efforts to ensure that value is returned to consumers and that ZEVs integrate effectively into our electricity grid, communities, and daily lives. California should further support commercial markets of ZEVs through policies such as reduced peak demand charges for electricity, through plug-in vehicle charging rates that strongly encourage off-peak charging both at home and at public chargers, and by streamlining local permitting, siting, and utility interconnection for charging infrastructure. The State should continue to support and monitor the market and consider extending the ZEV program if warranted—for example, by 1 percentage point per year after 2025. Moreover, actions to support ZEVs should not be limited to light-duty vehicles; State and local agencies should evaluate options for full deployment of zero emission trucks, including the potential for transporting containers between the ports and near-dock rail yards in the South Coast Air Basin by 2020.

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

But additional, targeted financial and policy support and investment—including continued ZEV purchase incentives for electric and fuel cell vehicles—is needed to help during the transition, and to help local communities plan and build the active transportation and public transit alternatives (including integrated public transit and high-speed rail) that are increasingly in demand and necessary to meet ongoing emissions targets. The State has existing funding programs for many of these activities, but funding is limited, and will need to be enhanced or extended beyond currently allocated resources.

For example, existing State rebates for light-duty zero emission and plug-in hybrid vehicles is consistently oversubscribed, yet continued public commitment is necessary at this time to support full-scale commercialization and consumer acceptance of these vehicles. The State will need to provide funding for advanced technology freight demonstration projects and pilot deployments of vehicles and equipment. 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 locomotive, marine vessels, port-yard trucks, and other cargo handling equipment. The State will support development of large-scale renewable and low carbon fuel production facilities, and provide funding for research to evaluate the reactivity and leak rates from compressed

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natural gas/liquefied natural gas (CNG/LNG) storage and vehicles, and to determine if natural gas infrastructure can be utilized for future hydrogen distribution.

With the long time frames necessary to realize the full benefits from transportation strategies, it is critical to start planning and implementing as soon as possible to put the State on the trajectory for reaching the 2032 ozone standard and 2050 climate change goals. As these actions and policies are implemented, they will need to be consistent with principles and criteria, as recommended by EJAC, which ensure access, equity, and benefits to vulnerable communities.

Key Recommended Actions for Transportation, Land Use, Fuels, and Infrastructure

Planning:

- Coordinate development of the 2015 State Implementation Plans, the California Freight Mobility Plan, the 2040 California Transportation Plan, the Sustainable Freight Plan, and regional planning efforts.
- Support regional planning, local leadership, and implementation of adopted SCSs to help ensure that the expected GHG reductions are achieved.

Funding and Market Transitions:

- Invest in and support growing markets for clean passenger transportation (including incentives for zero emission and plug-in hybrid vehicles), advanced technology trucks and equipment; low carbon transportation fuels and energy.
- Provide funding for advanced technology freight demonstration projects and pilot deployments of vehicles and equipment.
- Support investment in active transportation and other VMT reduction strategies.
- Support development of large-scale renewable and low carbon fuel production facilities.
- Pursue research in the following areas: distribution of and aggregated benefits of sustainable community strategies; support growth of the clean passenger and commercial vehicle markets.
- Evaluate reactivity of and leak rates from CNG/LNG storage/vehicles and the ability of NG infrastructure to be utilized for hydrogen distribution.
- Assess the role of natural gas in the low carbon transportation fuel future and evaluate the benefits and availability of renewable transportation fuels.

Regulations:

- Adopt: U.S. EPA's existing "Phase I" heavy-duty truck GHG standard and co-develop a "Phase II" standard.
- During the midterm review for the Advanced Clean Cars rule, explore additional vehicle fleet efficiency improvements and further GHG reductions beyond 2025 for light-duty vehicles; review the state of the ZEV market and consider whether an expansion of the ZEV rule beyond 2025 is appropriate.
- Promulgate regulations that support commercial markets for low carbon transportation fuels including: vehicle-grid integration; reducing peak demand

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charges for electricity; plug-in vehicle charging rates that encourage off-peak charging.

3. Agriculture

Increase efforts to identify and encourage implementation of agricultural GHG emission reduction management practices that provide co-benefits to air and water quality. Promote sustainable agricultural practices using existing or newly established conservation measures, provide a framework for climate adaptation, maintain the food supply for a growing population, minimize cost, and support sound practical research and technology.

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.

The agricultural sector includes on-site emissions from farm animals, as well as crop production and management. In 2011, agriculture sources accounted for about seven percent of California's total GHG emissions. Sources of emissions in this sector include 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 (CH₄), carbon dioxide (CO₂), and nitrous oxide (N₂O).

There are a great number of emission reduction and carbon sequestration opportunities that could be realized in the agricultural sector. However, because of limited research, and the wide variety of farm sizes, crops, and animals produced, there are very few one-size-fits-all emission reduction or carbon sequestration practices in the agricultural sector.

Given the variability in agricultural operations throughout the State, the number of potential GHG sources at each operation, and the number of potential co-beneficial management practices for each source, one approach to reducing GHG emissions from agriculture in California is to consider emission reduction goals for general agricultural operation categories, such as manure management, fertilizer use, or water use. To meet certain goals, farmers and ranchers could employ different emission reduction management practices, which have other benefits, including greater yields and operational cost savings, from a menu of GHG emission reduction options. This would provide each operation with the flexibility to choose combinations of GHG emission reduction management practices that have co-benefits are appropriate for their specific operations. In most cases, pursuing the GHG emission reduction practices would build on existing efforts farmers are already employing to increase operational efficiency,

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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 are in need of additional research. These opportunities may yield multiple savings in agricultural resources to growers based on the co-benefits of the strategies below.

Nitrogen Management

Nitrogen fertilizers applied to crops release N₂O, a significant agricultural source of GHGs. Additional research is needed to evaluate the potential for emission reductions and the need for incentives to reduce N₂O from agricultural fertilizer applications.

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, soil tillage also releases large quantities of CO₂ 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—both carbon and short-lived climate pollutants.

Water and Fuels

Greenhouse gas 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 could be used for agricultural operations.

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 (reducing the GHG emissions associated with the energy needed to deliver the water), which may also reduce fertilizer use, all of which can reduce costs and emissions.

The agriculture sector can also play a role in producing fuel. Although fuels derived from plant matter or biofuels eventually produce CO₂, there is no net addition of CO₂ to the atmosphere from the feedstock, as it is re-captured by plants during its growth cycle. Biofuel production is a renewable energy resource that reduces reliance on fossil-based fuels. Fueling equipment with on-site or nearby generated fuels such as biomass and biogas can also reduce emissions and fuel costs, as can effective irrigation methods and technologies.

Animal Production

Livestock and the manure it produces can generate significant amounts of methane. Approximately half of the methane generated from livestock comes from manure storage lagoons. The methane generated from those lagoons can be captured by

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covering the lagoons and can be used to produce energy or renewable fuel (e.g., a digester). A number of other practices to potentially reduce methane emissions from livestock include using recommended feeding practices, dietary additives, and agents that impact digestion efficiency.

Preserving Agricultural Lands

Recent research has shown that GHG emissions from urban areas are approximately 70 times greater than those from agricultural lands on a per-acre basis. As California's population increases, pressures to convert agricultural and rangelands also increase. Protecting and conserving these lands will be important in meeting our long-term climate goals.

While more comprehensive data on carbon in California's agricultural and rangelands are needed, these lands should be protected from conversion pressures and degradation that could result in carbon emissions, particularly where such protection and conservation actions provide other important climate benefits, such as improving watershed conditions.

Key Recommended Actions for the Agriculture Sector

Sector Goals and Management Practices

Evaluate the potential for establishing agricultural sector goals for specific sources. Identify additional research needs and, where promising, develop a recommended menu of management practices that could be employed to reduce GHG emissions and maximize biological carbon sequestration. Where possible, management practices should also provide co-benefits such as improving water or air quality.

Nitrogen Management

- Evaluate and leverage existing and ongoing State agency efforts for the reporting of synthetic fertilizer usage in agriculture to provide baseline emissions and guide the development of potential emission reduction measures.

Water and Fuel Use

- Develop programs and inter-agency efforts to promote and incentivize precision irrigation, monitoring of water use, maximization of existing agricultural pump efficiency, and replacement of diesel agricultural water pumps with electric pumps, to reduce GHG emissions from water use in agricultural operations.
- Address economic, infrastructure, and regulatory hurdles regarding the input of digester biogas into natural gas pipelines and bioenergy into the electric grid.
- Develop programs to promote and incentivize the use of the cleanest, most efficient, and well-maintained equipment for agricultural operations and fuel equipment with on-site or nearby generated fuels such as biomass and biogas.

Animal Production

- Conduct further research to understand and quantify the impacts of practices to reduce direct methane emissions from livestock manure and digestive processes.

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Preserving Agricultural Lands

- Work with local planning agencies and departments to align ongoing farmland preservation efforts with local and regional land use planning efforts.
- Promote funding for the Williamson Act State subvention program to be used for at-risk agricultural and rangelands on the urban/suburban edge.

Outreach and Support

- Develop a California-specific technology, research, and an information clearing house of successful GHG reduction, carbon sequestration, and product and resource conservation practices.
- Provide additional targeted agricultural support services to provide outreach and education to help farmers and ranchers understand GHG emission reduction practices that are either required and/or enabled by available incentives.

4. Water

Maximize the efficient use of California's surface and ground water supplies through integrated policies and strategies that reduce the carbon footprint of water while meeting the needs of a growing population, improving public safety, fostering environmental stewardship, and supporting a stable State economy.

In addition to being an essential element for all life, a reliable 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 fresh water supply 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, and therefore 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 electricity generators, 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 use, conveyance, storage, conservation, and treatment of water and wastewater. Greenhouse gas emissions from the water sector come primarily from the energy used to 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.

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Recommendations to Maintain Momentum

The primary mechanism to reduce water-related energy use is through 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.

Successfully meeting the water sector goals will also require synthesizing State policies and balancing multiple policy objectives. Integrated policies that support multiple objectives, such as flood protection, sustainable agriculture, and renewable energy development, will be a critical requirement for the water sector. New business models will need to be developed for both water supply and wastewater treatment agencies, wherein wastewater is utilized as a resource and water supply agencies develop pricing and rate structure designs that still adequately fund public water systems to deliver safe and reliable water supplies. Conservation-adjusted business plans, investments in efficient water infrastructure, and self-generation of energy will need to become industry norms. Finally, local, regional, and State agencies will need to work together to collect data, provide financial assistance, and set standards to maintain affordable rates while keeping water safe to drink, especially in disadvantaged communities.

Achieving industry-wide shifts will require sustained State leadership and new policy and regulatory frameworks that account for water supply, water and energy use, and water quality standards with regional flexibility and funding. The vision for the water sector also assumes a regional focus for integrated planning, project implementation, and governance. Future success in reducing the water sector's carbon footprint will require effective agency strategies tied to regional goals and management.

Pricing policies can help deter waste, encourage efficiency, and require those who use the most to pay the costs of assuring the water supply. It is important that policies are designed to promote water use efficiency and protect the ability of low-income households to purchase minimum necessary water supplies.

California should 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 evaluate competing water use demands and trade-offs.

Interagency coordination such as the recent efforts of the State Water Resources Control Board to develop the Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling (once-through cooling) showed that coordination among agencies is possible without drastic revamping 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

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Plan, the Safeguarding California Plan for preparing for climate risks, the California Water Plan, the Delta Plan, the Bay Delta Conservation Plan, and the Integrated Regional Water Management Strategic Plan.

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. For example, the State should continue coordination of various water-planning efforts through bodies such as the Water Plan State Agency Steering Committee, which includes a wide range of State entities working on a variety of policies and programs affecting water supply and quality. Achieving efficient and aligned policies across agencies may require alterations to agency authorities and decision-making procedures.

The State will need to assume a greater role in developing policies, providing financial and regulatory incentives, and employing regulatory oversight to:

- Advance regional and integrated supply, quality, and demand management.
- Ensure that water utilities meet aggressive water conservation targets while maintaining financial viability.
- Improve assessment and sustainable management of groundwater.
- Improve water and energy use data collection, data dissemination among State agencies and to the public, and use of data to make a complete and accurate assessment of whether 2020 GHG reduction targets are being met.

Key Recommended Actions for the Water Sector

Funding:

- Increase non-traditional water supplies and make water and wastewater conveyance, treatment, and distribution systems more energy efficient.
- Provide regional funding for local water management plans, water and energy efficiency projects (particularly for upgrades to older buildings), and climate change mitigation and adaptation activities.

Technology:

- Increase water conservation and energy efficiency in agricultural and food processing sectors, industrial processes, and residential and commercial buildings.
- Update and implement new water-related energy conservation measures and energy efficiency standards for water use.
- Support resource-recovering wastewater treatment sector projects.
- Collect data on water use and related energy used for water services.

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Administration:

- Assess impacts of decoupled water rates and develop rate and revenue structures to decouple municipal utility programs.
- Develop policies with local partners that thoroughly and accurately reflect the economic, social, and environmental value of water in California.
- Develop pricing and rate structure policies that promote water use efficiency while ensuring that low-income households are able to purchase minimum necessary water supplies.
- Develop partnerships between electric utility and water utility programs and develop model programs in agricultural irrigation, landscape irrigation, and other water use areas.
- Develop and implement a groundwater management strategy that contributes to enhanced water quality and water supply reliability.
- Modify State and regional water board policies, permits, and monitoring guidelines to reflect regional climate change scenarios and other best-available climate science.
- Facilitate partnerships between local water, wastewater, and energy utilities to further implement joint water-energy programs.
- Enable a greater State role in developing policies, providing financial and regulatory incentives, and employing regulatory oversight.

Education:

- Promote water-energy conservation outreach and education.

5. Waste Management

Develop a comprehensive and sustainable waste management system for California that maximizes reducing, recycling, and composting material (diversion); supports the development of appropriate infrastructure and markets for reused waste; and reduces the volume of waste generated.

California's waste management sector is an integrated system of activities and infrastructure that includes municipal solid waste generation and disposal, landfills, composting operations, recycling facilities, product manufacturing, alternative energy production, and agricultural operations.

The comprehensive nature of the waste sector has important ramifications for other focus areas evaluated in the updated Scoping Plan. For example, efforts to divert green wastes or biomass from the waste stream overlaps with 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 diversion, recycling, and reuse programs may have implications for the transportation, fuels, and land use focus area.

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The challenges to meeting the State's GHG and waste reduction goals need to be addressed with the understanding that California must take full ownership for the wastes 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.

The State should maximize recycling and diversion from landfills and build the necessary infrastructure to support a sustainable, low carbon waste management system within California. The State must also work with residents and producers to reduce the volume of waste generated. A regional focus for integrated planning, project implementation, and waste management governance should be emphasized.

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 diverted 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.

The current waste management infrastructure will need to be expanded to accommodate the increases in recycling and remanufacturing of waste material that is envisioned. This would mean more facilities and technologies that can use organics from the waste stream, as well as more remanufacturing facilities for the various types of recycled material. As an increasing amount of recycled material is diverted and recovered from the landfills, and the infrastructure for handling the recycled material is developed, markets for the recycled, reused, and remanufactured materials need to grow, including through increased state procurement of recycled-content product. Coupled with the increased recycling is an increased amount of residual waste materials generated from non-disposal alternatives (such as ash from biomass combustion). Markets are needed for these materials if non-disposable alternatives are to be viable in California. Incentives and research into potential usage of the residual materials will assist with market build up.

Considering additional requirements on public agencies to increase procuring products with low-waste or no-waste attributes will help reduce their carbon footprint beyond current practices. 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.

To achieve the vision for the waste management sector, certain overarching actions are recommended. 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

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sustainable waste management system to grow in California. Additional research to better characterize emissions for various materials and processes, and for the best use of waste management alternatives will also be needed. Finally, actions to identify opportunities to further expand and maximize various waste management alternatives will need to be pursued. This may include implementing regulatory or statutory actions to further reduce GHG emissions, to promote “best management” practices, and to phase out organic materials at landfills and/or consider including landfills in the Cap-and-Trade program.

Key Recommended Actions for the Waste Sector

- Coordinate with other agencies, districts, and jurisdictions to streamline the permitting process and address conflicting requirements, including cross-media issues, especially for new and upgraded composting and anaerobic digestion facilities.
- Consider regulatory actions to further reduce GHG emissions and remove organic wastes at landfills.
- Explore funding mechanisms for activities to accomplish GHG and waste reduction goals, and to build adequate recycling manufacturing and composting/anaerobic digestion infrastructure for non-landfill alternatives.
- Develop more accurate GHG emission factors for various materials, processes, and landfill emissions.
- Pursue various waste management alternatives, including recycling, composting, anaerobic digestion, and bioenergy processes.
- Initiate a public education campaign to promote the carbon reduction benefits of increased waste diversion and recycling.
- Improve State procurement of recycled-content materials through better education, purchasing requirements, and product information.
- Develop standardized product quality requirements from composting and anaerobic digestion processes.

6. Natural and Working Lands

Enhance, protect, and conserve California’s natural and working lands to reduce GHG emissions and manage and increase carbon storage as part of a larger suite of sustainable management objectives that also provide multiple co-benefits, including preparing for climate risks and safeguarding California resources and people.

In recognition of the importance of natural and working lands in meeting our long-term GHG emission reductions goal, the Update expands the focus of natural lands from forests to include other land types. The Natural and Working Lands Sector in this Update consists of: forests (including woodlands and urban forests), rangelands (including shrub lands and grasslands), and wetlands. Rangeland, also addressed under the Agriculture Sector, generally refers to grass and shrub lands that are under

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contract or agreement, to be grazed by livestock. Lands in this sector include rangelands but also include non-grazed shrub lands and grasslands.

Natural and working lands can act as both a source of GHG emissions and a carbon sink to remove CO₂ from the atmosphere. These lands make up approximately 75 percent of California's land area. When sustainably managed, the potential for natural and working lands to reduce GHGs and sequester carbon is significant and will be critical to reaching 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 quality, air quality, species habitat, recreation, jobs, products, flood protection, nutrient cycling and soil productivity, reduced heat-island effect, and reduced energy use. Carbon management of these lands must be integrated with the broader suite of resource management objectives for those lands.

Activities to enhance carbon storage, such as reforestation or restoration, may require some time to fully realize carbon benefits. 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 sequestration, but are necessary to maintain healthy forests that are more efficient at GHG sequestration and more resilient to future climate conditions and reduce the capacity of natural and working lands to sequester carbon. 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 and actions identified below, and strategic investments, efforts to enhance, protect, and conserve California's natural and working lands can result in 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.

Recommendations to Maintain Momentum

Forest Policy

California forests should be managed to ensure that forests provide net carbon storage even in the face of increased threats from wildfire, pests and disease, and conversion pressures. Forest carbon inventory and assessments should be continually maintained and refined to support such management activities, and appropriate funding and incentives must also be provided to support such activities.

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Rangeland and Wetlands Policy

In the absence of comprehensive California rangeland carbon data and comprehensive California wetlands carbon data, rangelands and wetlands should be protected from conversion pressures and degradation that could result in 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 actions provide other important climate benefits, such as improving watershed conditions and flood protection, and providing habitat and connectivity for climate-stressed species.

Inventory Development and Research

There are significant data gaps in California's inventory for natural and working lands, particularly with respect to carbon flux in rangelands and wetlands. Forest inventory data also require refinement. Additional work is needed to refine the GHG/carbon inventory method for forests and rangelands, and to develop an inventory for wetlands, to inform carbon management activities in California.

In addition, work is needed to prioritize and conduct additional research on GHG emissions and sequestration, as well as on outcomes of specific practices to maximize carbon uptake on California's natural and working lands.

Planning and Actions to Support Sector Vision

Forests

CAL FIRE and the Board of Forestry and Fire Protection (BoF) should investigate and make recommendations on actions to ensure that the State's forests are operating as a net carbon sink and establishing realistic quantitative carbon sequestration goals for the Forest Sector (the "Forest Carbon Plan"). This investigation should include a review of Forest Practice Regulations and recommendations for best management practices or additional regulatory measures or amendments needed to minimize emissions and enhance carbon storage associated with silvicultural treatments.

Land Use Planning to Enhance, Protect, and Conserve Natural and Working Lands

Local and regional land use policies need to more fully incorporate and emphasize conservation; avoid conversion of forests, rangelands, and wetlands; and promote urban forestry and green infrastructure.

Funding

Funding is critical to address the needs in this sector, yet it is far below historic levels and in some cases does not currently exist. Outcomes of actions on natural and working lands often occur on a decadal scale. Action within the next 10 years is critical so long-term benefits can be fully realized in the 2050 time frame. Funding sources

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must be identified, particularly where funds from existing sources can be leveraged effectively.

The California Natural Resources Agency (CNRA) and Cal/EPA should convene a climate investment working group to develop specific recommendations regarding individual and combinations of approaches for funding actions to ensure that California's forests provide net carbon storage. The initial focus on developing forest climate investment mechanisms is predicated on the fact that California forest carbon data are currently more developed than carbon data for California rangelands and wetlands; however, funding to support data development and to support protection, restoration, and improved management for rangelands and wetlands will also be important, and is discussed further below. Funding recommendations from the forest climate investment workgroup 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 California's forests provide net carbon storage.
- Recommendations regarding the development and implementation of a competitive grant program.
- Recommendations regarding types of forest climate investments that might be supported by varying levels of funding support from Cap-and-Trade auction revenues. (Development of strategic prioritization guidelines for the expenditure of any Cap-and-Trade auction revenues is further discussed below.)
- Recommendations regarding the process for dedicating a portion of Yield Tax Revenue to fund forest climate investments.

With respect to both rangelands and wetlands, funding is needed to support the development of comprehensive carbon data. Funding is also needed to protect rangelands and wetlands from conversion pressures and degradation that could result in carbon emissions, and to enable restoration and improved management practices to increase carbon storage. With respect to rangelands, additional funding for the Williamson Act State subvention program could be used for at-risk rangelands on the urban/suburban edge.

Additional support is also needed for urban forest programs that 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.

Strategic prioritization guidelines should be developed for the expenditure of any funds available for forest, rangeland, or wetland investments that further the Sector Vision.

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Developing prioritization guidelines will help optimize outcomes. As different governmental entities and different stakeholders are potentially implicated in the management of forest, rangelands, and wetlands, separate prioritization guidelines should be developed for each land type.

All funding programs for investments in natural and working lands to achieve the Sector Vision should include provisions for monitoring, evaluation of program outcomes, and refinement of programs over time.

Key Recommended Actions for Natural and Working Lands

Inventory Development and Research

- Conduct research to fill data gaps in California's inventory, particularly with respect to carbon flux in rangelands and wetlands. Forest inventory data also requires refinement.

Planning and Actions

- Evaluate and make recommendations on actions to ensure that the State's forests are operating as a net carbon sink and establishing realistic quantitative carbon sequestration goals for California forests.
- Work with local and regional land use agencies to ensure that policies incorporate and emphasize conservation of natural and working lands and promote urban forestry and green infrastructure.

Funding

- Convene a forest climate investment working group to develop specific recommendations regarding approaches for funding actions to ensure that California's forests provide net carbon storage.
- Expand urban forestry and green infrastructure programs and investments, particularly in California's environmental justice communities.
- Investigate funding opportunities to protect rangelands and wetlands from conversion pressures and degradation that could result in carbon emissions, and to enable restoration and improved management practices to increase carbon storage.
- Develop strategic prioritization guidelines for the expenditure of any funds available for forest, rangeland, or wetland investments that further the Sector Vision.
- Develop provisions for monitoring GHG reduction actions and investments, evaluating outcomes, and refining programs and priorities over time.

F. Cap-and-Trade Post 2020

The Cap-and-Trade program is a vital component in achieving both California's near- and long-term GHG emissions targets. Over the long-term, the Cap-and-Trade program incentivizes GHG emission reductions associated with the production of energy and goods and encourages consumers to reduce emissions as the price of carbon is

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embedded in goods and services. ARB has implemented the Cap-and-Trade program in such a way that the carbon price will gradually be incorporated into the purchasing decisions of companies, consumers, and market participants, leading toward an economy in which the embedded carbon price drives clean energy innovation and spurs economic growth.

Sending the market a signal today that Cap-and-Trade will continue beyond 2020 is critical to fully realizing the benefits of the program. ARB will develop post-2020 emissions caps to reflect the establishment of a 2030 midterm target. The program will need to reflect the inclusion of any additional trading partners and may need to include broader emissions scope. Establishing the California-Québec partnership is an important step toward this goal. California has also been working in partnership with other state, provincial, and national governments.

G. Post-2020 Considerations

Meeting California's long-term climate goals will require continued emission reductions beyond those outlined in the Scoping Plan. Determining the right path for California to achieve those long-term climate goals will require aggressive action to be balanced with technological feasibility, cost-effectiveness, and potential impacts to California's economy. It will also be important to consider the co-benefits of action—from improved resource management, to greater mobility, to improved air quality for disadvantaged communities. Further work is needed to refine the tools necessary to perform analyses of potential strategies 20 or 40 years into the future.

Economic Impacts

In anticipation of the need to conduct comprehensive, robust evaluations of economic impacts, ARB will continue to consult with external experts to develop new analytical tools and methods that will address both the economy-wide and distributional impacts resulting from post-2020 mitigation efforts. As has been the case with projecting pre-2020 effects, isolating the specific macroeconomic effects of AB 32 from other economic volatility presents a significant challenge. Other long-term economic shifts will also need to be incorporated into the long-run models. For example, household energy demand and vehicle miles traveled will be influenced by demographic changes in the California population, as well as changes in land use and the built environment that are the direct focus of regional planning agencies and sustainable community legislation.

ARB will also consult with external experts regarding ways to assess business competitiveness, potential benefits to the California economy from the implementation of the State's aggressive climate change policies, and potential benefits to disadvantaged communities.

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Air Quality and Public Health

Federal air quality requirements will be an important driver in California that could influence how and when the State achieves midterm climate targets. The South Coast and San Joaquin Valley Air Quality Management Districts, together home to more than half of Californians, 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, so teasing out the impacts of one discrete set of policies, such as the climate program, is very challenging.

VI. Funding GHG Emission Reduction Strategies

VI. Funding GHG Emission Reduction Strategies

Incentives and funding are critical components for successful implementation of near- and longer-term GHG emission reduction strategies.

Incentives and funding are critical components for successful implementation of California's 2020 and post-2020 climate goals. Many strategies in the Scoping Plan relied on funding to achieve emission reductions by 2020. As we look forward to 2030 and 2050, funding will also play an important role both in supporting the research and analysis needed to determine the best path forward, as well as making strategic investments now to meet future goals.

A. Meeting the 2020 Climate Goal

The Scoping Plan contained a comprehensive array of strategies to reduce GHG emissions in California and acknowledged the important role strategic investments and financial incentives play in moving the State toward the 2020 goal. The Scoping 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 measures in the Scoping Plan rely on funding to achieve the full benefits, including energy efficiency, forestry management, and local land use planning.

The Scoping Plan focused on potential State proceeds from auction of allowances under the Cap-and-Trade regulation. The Scoping Plan identified a number of potential uses of allowances and revenue, including achieving environmental co-benefits, funding energy efficiency and renewable resource development, providing incentives to local government, delivering rebates to consumers, and funding research, development, and deployment.

Although the Scoping Plan focused on auction proceeds, there are many other funding programs that are working in tandem at the federal, State, and local levels that achieve reductions for areas identified in the Scoping Plan and encourage the transition to a clean economy. For example, since 2008, the California Energy Commission 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 to help meet California's climate change goals. The program invests \$100 million annually to develop and deploy advanced technology fuels, fueling infrastructure, vehicles, and workforce skills necessary to operate and maintain these new technologies. In addition, the Air Quality Improvement Program (AQIP), ARB's portion of AB 118, continues to provide incentive funding 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

VI. Funding GHG Emission Reduction Strategies

reauthorized through 2023,⁷⁷ providing about \$1 billion in public investments over the next decade to reduce GHG, criteria, and toxic emissions.

Some of the existing federal, State, and regional incentive programs are highlighted in Table 15.

Table 15: Existing Regional, State, and Federal Incentive Programs

<p>Regional Programs</p> <ul style="list-style-type: none">• Clean truck and bus 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.
<p>State Programs</p> <ul style="list-style-type: none">• 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 funding for energy efficiency, weatherization, and solar installations.• 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).
<p>Federal Programs</p> <ul style="list-style-type: none">• 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.

*(HCD) Housing and Community Development; **(CDFW) California Department of Fish and Wildlife

⁷⁷ Assembly Bill 8, 2013.

VI. Funding GHG Emission Reduction Strategies

In 2013, the Administration developed an Investment Plan to guide the investment of proceeds from the Cap-and-Trade auction—expected to be one of the largest 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 Investment Plan contained the following investment principles to guide the expenditure of these auction proceeds:

- 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.

B. Future Funding Opportunities

Continued investment in existing programs will help maintain the 2020 limit; however, extensive additional strategies are needed in sustainable community planning and development, clean transportation, clean energy, energy efficiency, and natural resources to make progress toward post-2020 goals.

Chapter V discusses the challenges to meeting the post-2020 GHG goals for the energy, transportation, water, agriculture, waste, and natural lands sectors, and identifies some actions California can take now to begin developing a long-term GHG mitigation strategy. Funding is needed to fill information gaps and analyze the trade-offs associated with different policy choices. In addition, there are some strategic investments that can be made now which will continue to provide benefits in the long term. Investments in many of these priorities will yield long-term environmental and economic benefits for California; for example, investment in developing and deploying agricultural management practices can reduce GHG emissions while maintaining or enhancing crop yields.

C. Recommendations for Near- and Long-Term Funding Priorities

Looking forward, the State will need to make targeted, priority investments with the limited funding available. Funding sources such as the Greenhouse Gas Reduction

VI. Funding GHG Emission Reduction Strategies

Fund⁷⁸ (auction proceeds), the Alternative and Renewable Fuel and Vehicle Technology Program (AB 118), EPIC, and the Proposition 39: Clean Energy Job Creation Fund provide opportunities to continue to invest in California's clean economy.

California must plan how best to invest the numerous sources of potential funding to maximize GHG emission reductions and co-benefits. Funding should be balanced among programs that will make progress toward the 2020 goal and investments that will continue California's long-term transformation to a low carbon economy. For example, State rebates to encourage zero and near-zero emission vehicle deployment, as well as the installation of the needed infrastructure, will help California meet its 2020 GHG goal and will also help move the State more quickly to the widespread adoption of zero emission vehicles needed to achieve long-term climate goals.

Funding should be focused on specific programs that can quickly and effectively support AB 32 objectives, provide for multi-year GHG reductions, institutionalize climate change into decision making, and be consistent with the Investment Plan. For near-term investment, California should focus on programs that can meet both near-term and longer-term objectives, as shown in Table 16. Programs such as sustainable community development and forests can provide near-term benefits while also laying the foundation for future, more ambitious projects.

⁷⁸ 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.

VI. Funding GHG Emission
Reduction Strategies

Table 16: Funding of Specific Areas to Support AB 32

- Sustainable community development and implementation.
- Expansion of established programs:
 - affordable transit-oriented development (TOD) and infill housing development that cut VMT
 - rebates and grants for ZEVs and advanced technology demonstrations
 - residential energy efficiency financing mechanisms
 - weatherization retrofits
 - residential solar retrofits
 - water efficiency/conservation
 - industrial energy efficiency
 - diesel pump replacement
 - Recycling Market Development Zones loans
 - waste reduction, recycling, and composting/anaerobic digestion.
- Forests and urban forestry.
- Investment in research, development, and deployment.
- Large infrastructure projects.
- Wide-scale implementation of sustainable freight transport strategies.
- Renewable and low carbon energy.
- Agricultural management practices and land conservation.
- Bioenergy.
- Water conservation and efficiency.
- Wetlands and rangelands.

VII. Conclusions

VII. Conclusions

Over the past five years, California has been forging a path forward in the fight against climate change. The range of programs covers every sector of the State's economy, and we can now say with certainty that addressing climate change has become part of the DNA of the State's policies.

California's action and successes kept the promise of fighting climate change alive in the nation even while action stalled in Congress. We led on GHG standards for cars that were adopted at the national level, and now we are seeing a new chapter of federal engagement on climate change, with tougher proposed limits on the dirtiest forms of energy production in the nation. Other nations are following California's example.

This marks nothing less than a paradigm shift in thought and action. 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.

In the process, and on a day-to-day basis, fighting climate change has also become part of the DNA of who we are and how we see ourselves in California. It is perhaps ironic, but inevitable, that California, the birthplace of car culture, is now the world capital of the world's cleanest vehicles.

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, more fuel efficiency, and fewer GHG emissions.

This visible transformation is the result of a suite of State policies that directly target climate change by slashing GHGs at their source. And it is the result of the full support—the hearts and goodwill—of the people of California. In 2010, Californians overwhelmingly stymied an effort to put AB 32 on hold. That 62 percent majority vote sent a clear message that Californians knew that fighting climate change and protecting the environment could absolutely go hand-in-hand with continued economic progress.

That vote, and the wisdom of the California electorate, has been proven right. California's economy continues to rise out of the depths of the recession at a nation-leading pace, even as we move toward cleaner energy.

VII. Conclusions

And public support continues to grow. But now Californians are also expressing increasing concern about climate change. According to a study by Yale University (*Climate Change in the Californian Mind*)⁷⁹ 79 percent of Californians believe global warming is happening, and a majority of Californians want to see **more** action by the State. Tellingly, 73 percent say corporations and industry need to do more and 70 percent feel they, themselves, should be doing more to address the issue.

That public consensus aligns with the dictates of science, covered in the earlier pages of this Update. That science tells us unequivocally that we must continue on the path we are on, but essentially redouble our efforts in the coming years—while there is still time.

This first Update sets forth a broad framework for continued emission reductions beyond 2020. This will position us to accelerate the rate at which California will reduce GHG emissions by the mid-century mark.

This approach will not come without a cost. Californians understand that. Cleaning up pollution has never been cost-free, but the results in clean air and public health have been visible and beneficial far beyond the original outlay.

When it comes to climate change, that calculus of return on investment is starkly and abundantly more compelling: the cost of doing nothing is exorbitantly expensive. Waiting will only cost more, and any steps we take in the future will be less effective.

Taking the course of action to make California's Climate Action Plan a reality on a year-by-year basis will take commitment and a continued clear-eyed understanding of the dangers we face.

We must continue what we have begun. Climate change is here, now.

Children in kindergarten today will be entering the workforce in 2030. How will they travel to work? In vehicles that run on electricity or hydrogen; on clean biofuels, by taking a short, convenient, and safe walk or bike trip? Will it be commonplace to see tens of thousands of battery-electric cars plugging into the grid during the hottest hours of the day to supply additional electricity to handle peak loads with their stored energy?

Will we see hybrid big-rigs carrying freight and cargo containers running on electricity when they can, and clean fuels when they must?

Will more of our children, and more of us now reading this Plan, live in communities where biking, walking, and public transit are really viable, commonplace options? Will

⁷⁹ Leiserowitz, A., G. Feinberg, P. Howe, and S. A. Rosenthal. 2013. *Climate Change in the Californian Mind*. Yale University. New Haven, CT: Yale Project on Climate Change Communication. <http://environment.yale.edu/climate-communication/>.

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our children live in houses or apartments that do not use any additional energy to heat or cool—that actually generate enough energy to be off the grid? Will landfills, the concept of generating waste, and going to the corner gas station to fill up be foreign to the generations that follow us? Will the grid be refashioned to accommodate more renewables and more local energy generation?

These and other questions will be answered by our actions and our commitment in the coming years. We have made great progress in the last five. Now is the time to take this Update and make it a reality.

We must continue to establish our new legacy as the world leader in fighting climate change. As Californians, we must continue to make extraordinary accomplishments in technology, research, design, and innovation. There is a reason the world looks to California for the new, the exciting, and the unexpected. This Update is the roadmap to the future we expect for ourselves, to keep us on the path that leads to a thriving clean energy economy, and to a better world, for the Golden State, and for our children.