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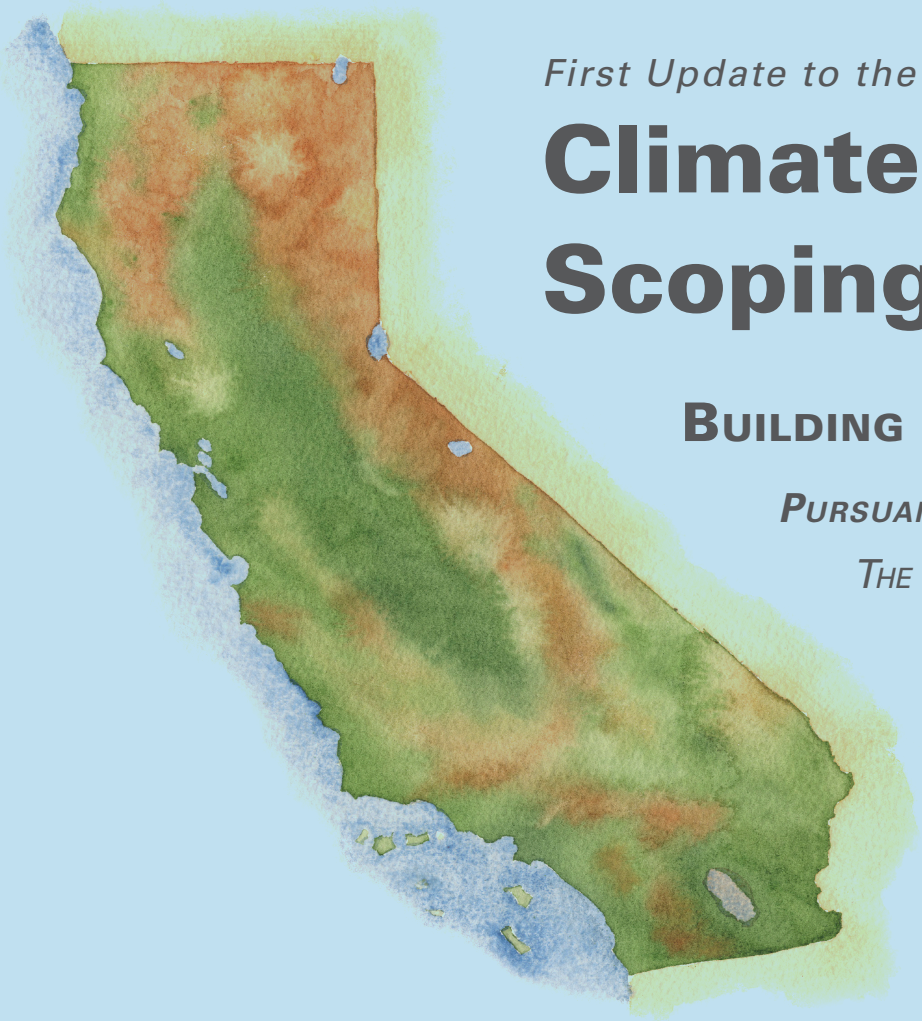

First Update to the

Climate Change Scoping Plan

Building on the Framework

Pursuant to AB 32

The California Global Warming Solutions Act of 2006

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The California Global Warming Solutions Act of 2006

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Executive Summary

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

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

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

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

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

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

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

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

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

First Update to the Climate Change Scoping Plan

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

Progress to Date

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

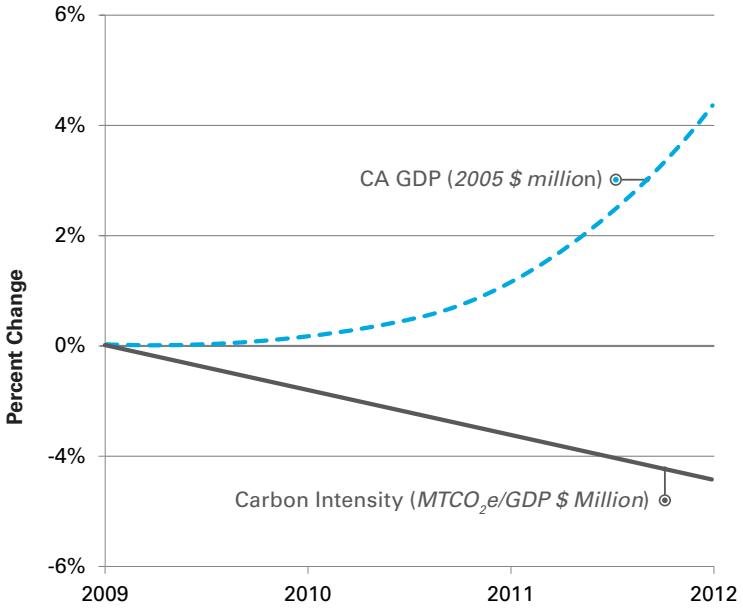
Collectively, these actions are evidence of California's ability to show that it is possible to break the historical connection between economic growth and associated increases in energy demand, combustion of carbon-intensive resources, and pollution. We have shown it is possible to break this chain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

Cleaner and More Efficient Energy

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

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

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



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

Source: DOF & 2012 GHG Inventory

Cleaner Transportation

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

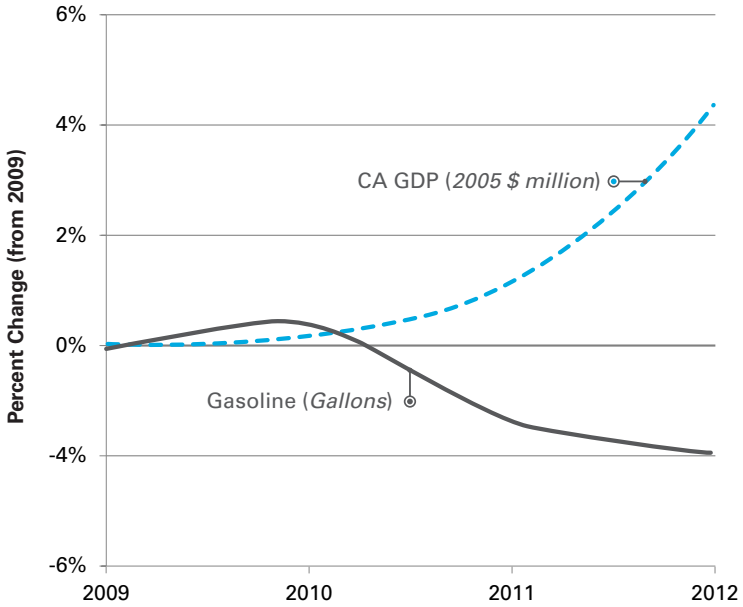
California's Low Carbon Fuel Standard (LCFS) is beginning to drive the production of a broad array of cleaner fuels. Since its launch in 2011, the regulation has generated a multitude of unique approaches for cleaner fuels. The LCFS is driving the necessary transition to cleaner fuels and is providing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

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

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

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

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



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

Source: DOF & BOE

Cap-and-Trade Program

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

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

Building on the Framework

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

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

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

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

The Great Unifier

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

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

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

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

Mid-Term Target

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

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

Sector-Specific Actions

Energy

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

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

Transportation, Land Use, Fuels, and Infrastructure

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

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

Agriculture

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

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

Water

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

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

Waste

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

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

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

Natural and Working Lands

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

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

Short-Lived Climate Pollutants

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

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

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

Green Buildings

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

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

Courage, Creativity, and Boldness

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

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

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

I. Introduction: Building on the Framework

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

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

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

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

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

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

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

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

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

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

B. Building on California's Environmental Legacy

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

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

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

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

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

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

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

SUCCESS STORY

Propel Fuels Moves to California

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

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

C. Initial Scoping Plan

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

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

Key elements of the initial Scoping Plan included the following:

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

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

D. Purpose of Update

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

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

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

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

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

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

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

E. Process for Developing the Update

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

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

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

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

Climate Action Team

California Environmental Protection Agency

Governor's Office of Planning and Research

California Air Resources Board

Business, Consumer Services, and Housing Agency

Government Operations Agency

California Natural Resources Agency

California Department of Public Health

Office of Emergency Services

California Transportation Agency

California Energy Commission

California Public Utilities Commission

Department of Food and Agriculture

Department of Forestry and Fire Protection

Department of Fish and Wildlife

Department of Transportation

Department of Water Resources

Department of Resources, Recycling and Recovery

State Water Resources Control Board

The focus areas include:

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

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

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

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

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

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

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

II. Latest Understanding of Climate Science

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

Scientific Expert Reviewers

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

B. Achieving Climate Stabilization

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

C. Climate Pollutants

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

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

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

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

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

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

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

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

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

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

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

Table 1: Global Warming Potential for Selected Greenhouse Gases*

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

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

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

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

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

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

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

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

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

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

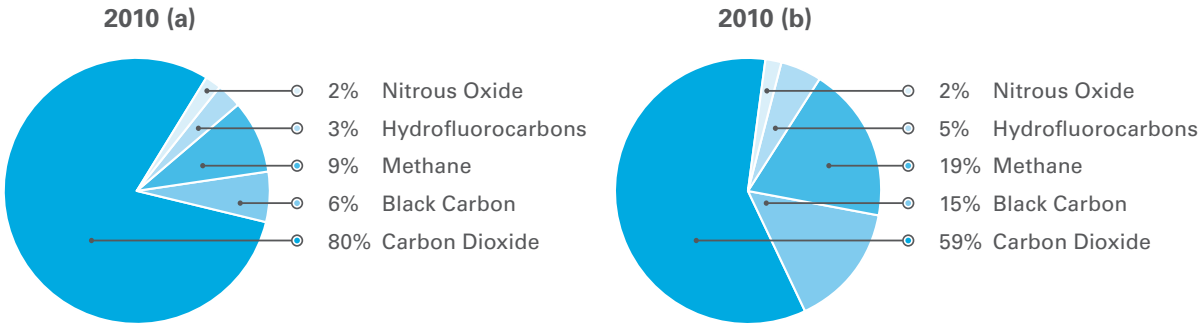
30 Hu, A., Y. Xu, C. Tebaldi, W. M. Washington, and V. Ramanathan. 2013. "Mitigation of short-lived climate pollutants slows sea-level rise." Nature Climate Change 3(5): 1–5, doi:10.1038/nclimate1869. *www-ramanathan.ucsd.edu/files/pr194.pdf*.

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

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

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

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



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

1. Black Carbon

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

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

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

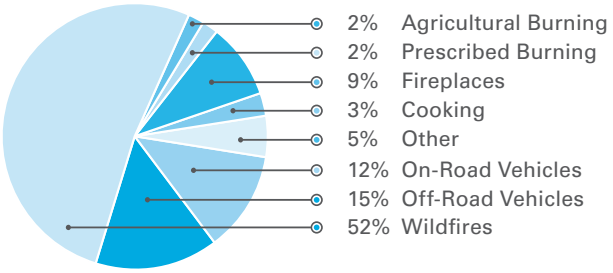
34 Shindell, D., J. C. I. Kuylenstierna, E. Vignati, R. van Dingenen, M. Amann, Z. Klimont, S. C. Anenberg, N. Muller, G. Janssens-Maenhout, F. Raes, J. Schwartz, G. Faluvegi, L. Pozzoli, K. Kupiainen, L. Höglund-Isaksson, L. Emberson, D. Streets, V. Ramanathan, K. Hicks, N. T. K. Oanh, G. Milly, M.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

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

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

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

Figure 2: California Black Carbon Emissions Sources (2010)



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

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

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

Table 2: Programs Resulting in Black Carbon Emission Reductions

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

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

2. Methane

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

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

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

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

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

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

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

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

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

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

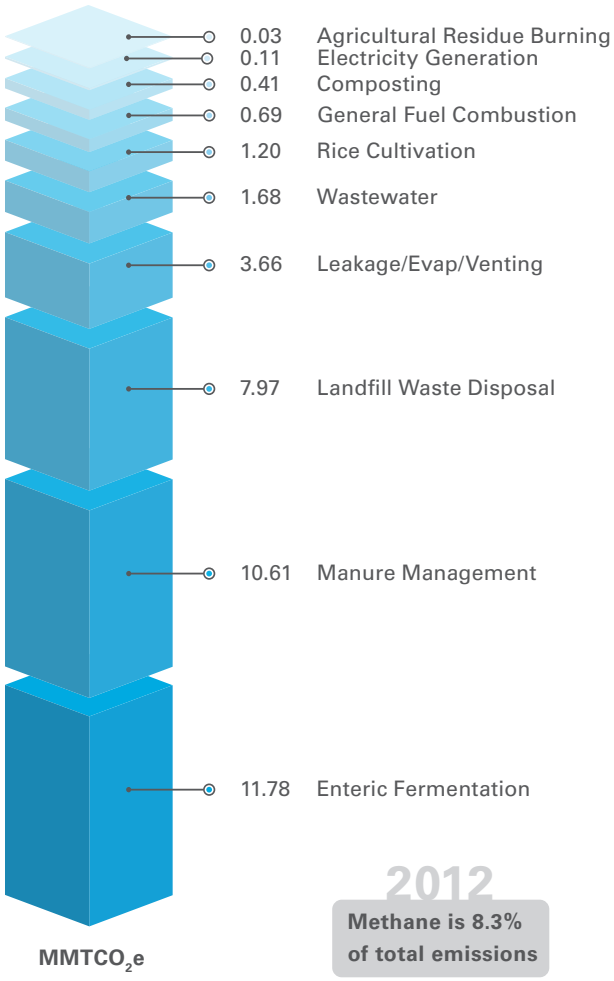
40 Holmes, C. D., M. J. Prather, O. A. Sovde, and G. Myhre. 2013. "Future methane, hydroxyl, and their uncertainties: Key climate and emission parameters for future predictions." Atmospheric Chemistry and Physics 13: 285–302.

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

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

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

Figure 3: California Methane Emission Sources (2012)



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

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

Table 3: Programs Resulting in Methane Emission Reductions

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

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

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

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

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

SUCCESS STORY

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

3. Hydrofluorocarbons

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

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

Table 4: Programs Resulting in HFC Emission Reductions

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

D. Greenhouse Gas Monitoring Efforts

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

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

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

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

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

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

E. Adjusting the 2020 Statewide Limit

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

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

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

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

www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

III. California's Approach to Climate Change

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

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

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

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

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

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

A. Preserve the California Lifestyle

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

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

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

SUCCESS STORY

THE CITY OF BENICIA CALIFORNIA

The City of Benicia

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

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

B. Foster Resilient Economic Growth

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

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

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

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

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

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

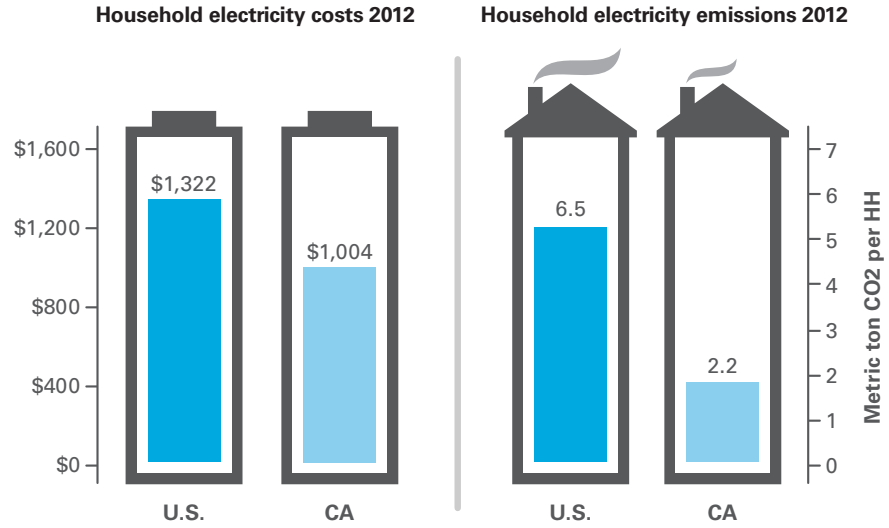
49 Pricewaterhouse Coopers, "National Venture Capital Association MoneyTree Report."

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

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

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

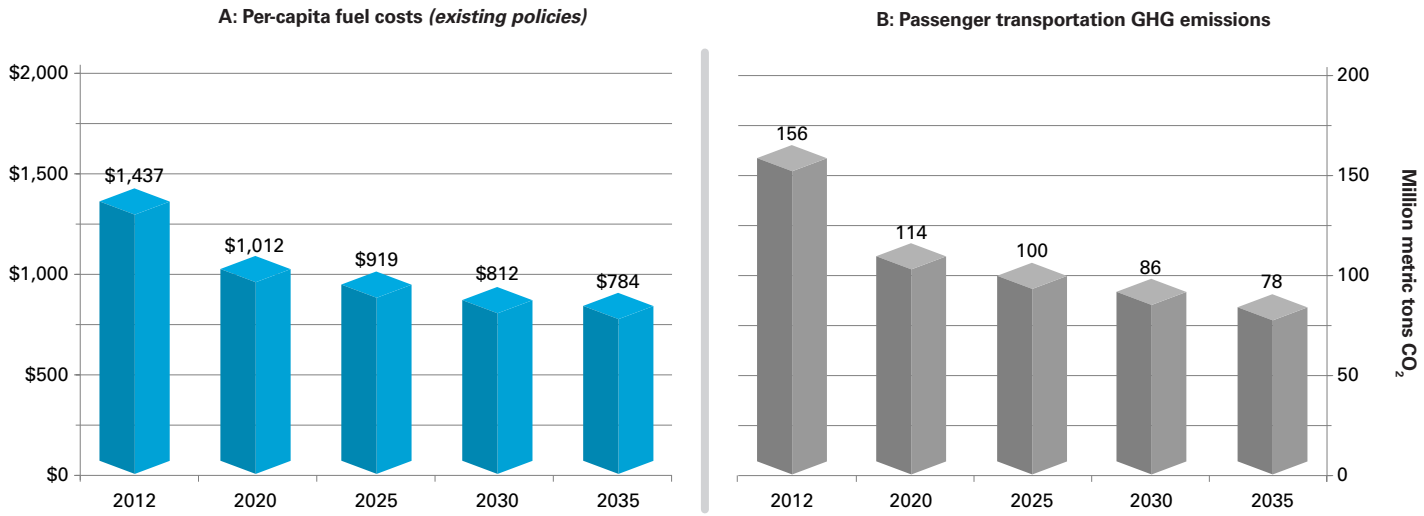
Figure 4: Average Household Expenditures on Electricity and Associated GHG Emissions in the United States and California[53]



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

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

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



53 California GHG emissions include imported electricity.

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

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

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

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

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

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

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

SUCCESS STORY

Anheuser-Busch InBev

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

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

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

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

C. Strengthen the Natural Environment

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

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

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

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natural_gas/latest_thinking/unlocking_energy_efficiency_in_the_us_economy.

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

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

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

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

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

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

D. Improve Public Health and Social and Environmental Justice

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

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

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

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

E. Rely on Science and Foundational Research

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

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

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

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

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

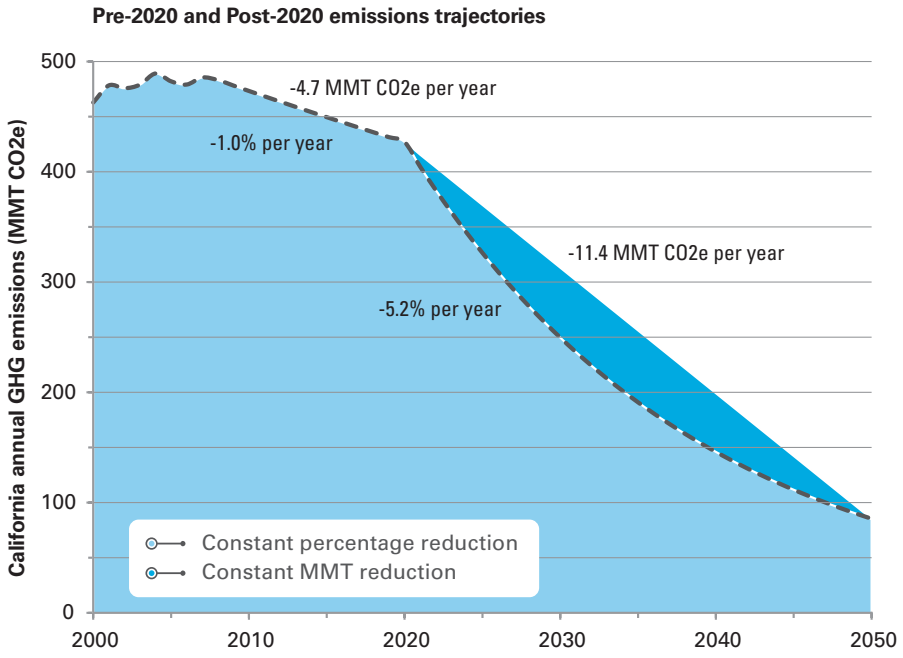
improvements can be achieved in transportation, buildings, and industry; that the electricity sector will have to be essentially zero carbon; and that electricity or hydrogen will have to power much of the transportation sector, including almost all passenger vehicles, and that near-zero carbon biofuels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

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

F. Charting a Path to 2050

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

Figure 6: Framing the Path to 2050



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

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

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

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

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

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

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

IV. Accomplishments and Next Steps

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

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

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

A. Key Economic Sectors

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

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

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

1. Energy

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

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

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

Electricity and Natural Gas

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

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

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

Energy Efficiency

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

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

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

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

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

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

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

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

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

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

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Kaiser Permanente

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

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

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

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

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

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

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

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

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

Demand Response

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

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

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

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

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

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

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

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

Renewable Energy

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

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

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

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

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

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

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

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

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

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

Energy Storage

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

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

Combined Heat and Power

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

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

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

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

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

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

Industry

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

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

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

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

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

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

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

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

Oil and Natural Gas Production

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

Maintaining Momentum

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

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

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

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

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

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

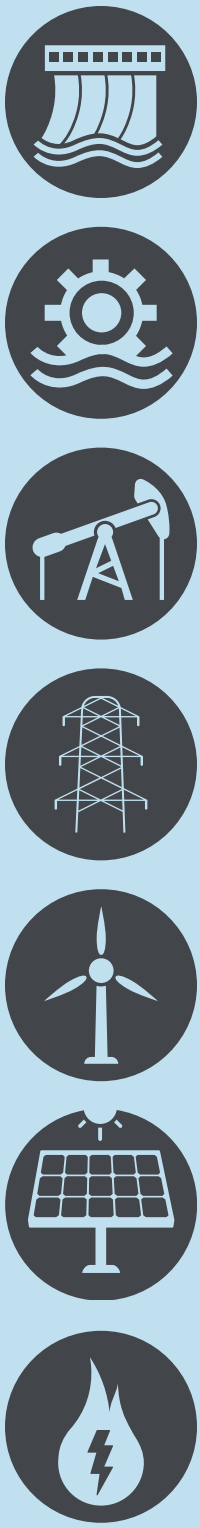
The program should maintain consistency with the State's broader energy policies, such as those articulated in the loading order and the initial Scoping Plan, and be designed to further advance key State energy programs and needs such as energy efficiency and demand-response efforts, renewable energy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

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

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

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

Key Recommended Actions for the Energy Sector



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

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

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

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

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

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

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

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

Building on California's Existing Policy Framework

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

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

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

Efficient Vehicle and Engine Technology and Zero Emissions Technology Development

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

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

SUCCESS STORY

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

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

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

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

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

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

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

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

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

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

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

Low-Carbon Fuels

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

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

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

Transportation, Land Use, and Housing

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

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

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

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

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

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

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

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

Systems Efficiencies

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

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

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

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

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

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

Integrated Policy Planning in the Sustainable Freight Strategy

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Supporting Planning and Market Development through Targeted Investments

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

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

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

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

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

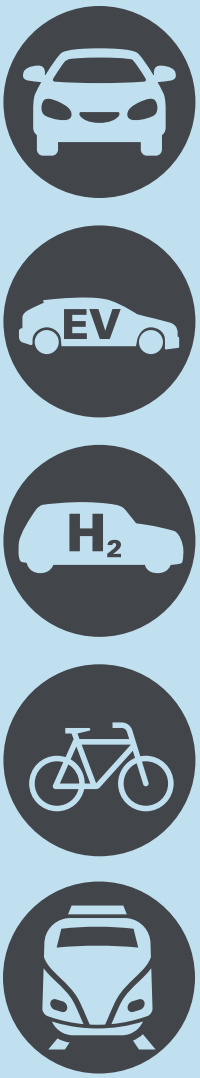
Investment throughout California in projects that modernize the passenger rail system and link seamlessly to local public transit systems will continue to build public transit ridership and shift travelers from single-occupancy vehicles to public transport. As a start, in 2008, voters approved Proposition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

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

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

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

Key Recommended Actions for the Transportation System



Vehicle Technology

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

Fuels

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

Transportation, Land Use, and Housing

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

Sustainable Freight Strategy

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

Investments

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

3. Agriculture

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

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

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

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

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

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

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

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

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

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

Maintaining Momentum

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

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

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

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

Nitrogen Management

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

SUCCESS STORY

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

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

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

Manure Management

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

Soil Management Practices

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

Water and Fuel Use

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

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

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

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

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

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

Highly Efficient Conventional and Organic Agriculture Systems

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

Research, Technical Assistance, and Incentives

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

Key Recommended Actions for the Agriculture Sector

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

4. Water

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

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

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

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

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

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

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

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

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

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

Maintaining Momentum

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

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

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

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

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

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

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

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

Key Recommended Actions for the Water Sector

Funding

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

Technology

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

Administration

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

Education

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

5. Waste Management[86]

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

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

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

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

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

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

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

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

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

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

Maintaining Momentum

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

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

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

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

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

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

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

Key Recommended Actions for the Waste Sector

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Maintaining Momentum

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

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

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

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

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

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

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

Research and Emission Inventory Updates

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

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

Integrating Biological Systems

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

Forest Planning and Actions

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

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

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

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

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

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

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

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

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

Rangelands and Wetlands Planning and Actions

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

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

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

Urban Forests

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

Funding Needs

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

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

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

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

Key Recommended Actions for Natural and Working Lands

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

7. Short-Lived Climate Pollutants

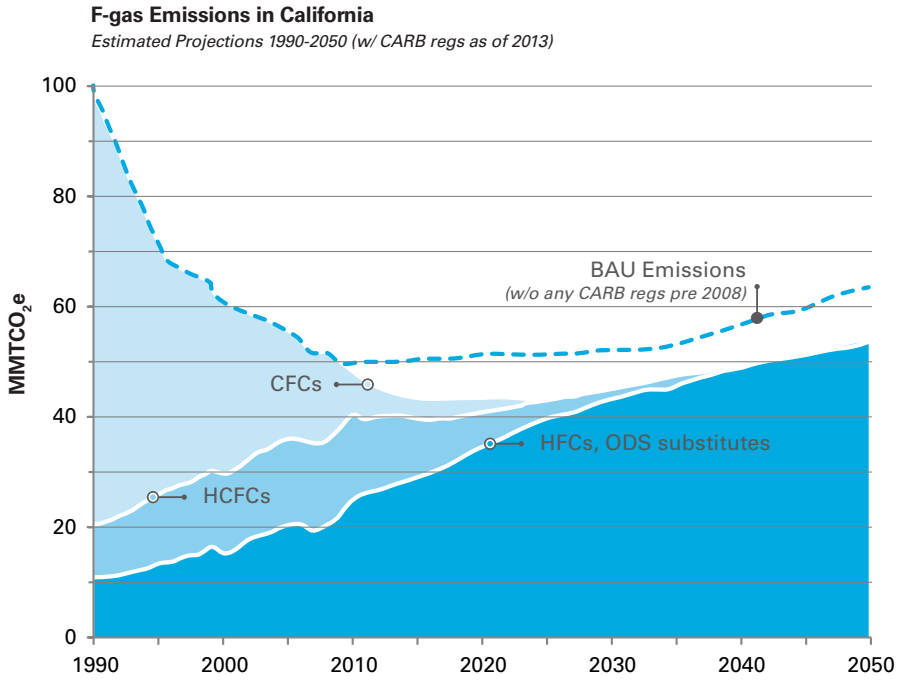
Mitigation of short-lived climate pollutants (SLCPs)—which include black carbon, methane, tropospheric ozone, and some hydrofluorocarbons (HFCs)—produces immediate climate benefits and is an important complement to efforts to reduce emissions of CO_2. Many short-lived climate pollutants are already regulated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

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

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

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

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



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

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

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

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

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

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

Maintaining Momentum

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

High-GWP F-gas Phasedown

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

Low-GWP Requirements

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

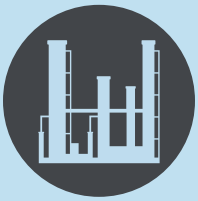
ODS Recovery and Destruction

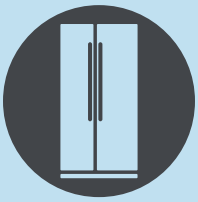
The Montreal Protocol has reduced ODS emissions significantly (by almost 60 percent) by reducing the production and consumption of ODSs. However, it appears that end-of-life emissions from legacy equipment are still significant. Due to higher demand and therefore higher value of recovered ODSs, there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

High-GWP Fee

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

Key Recommended Actions for Short-Lived Climate Pollutants





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

8. Green Buildings

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

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

Leading the Way with State Buildings

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

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

California Green Building Standards

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

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

Voluntary Programs at the Local Level

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

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

Greening Existing Buildings

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

Maintaining Momentum

Zero Net Carbon Buildings

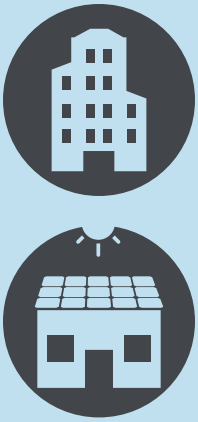
Zero net carbon buildings will be key as we continue to pursue an integrated approach to reduce new and existing building-related impacts that combine climate and air quality programs. To this end, the State will be developing new emission reduction programs for State buildings, schools, homes, and commercial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

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

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

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

Key Recommended Actions for Green Buildings



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

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

9. Cap-and-Trade Regulation

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

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

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

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

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

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

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

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

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

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

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

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

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

Maintaining Momentum

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

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

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

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

B. Progress to Date

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

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

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

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

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

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

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

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

1. Key Accomplishments

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

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

2. GHG Emissions Trends

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

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

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

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

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

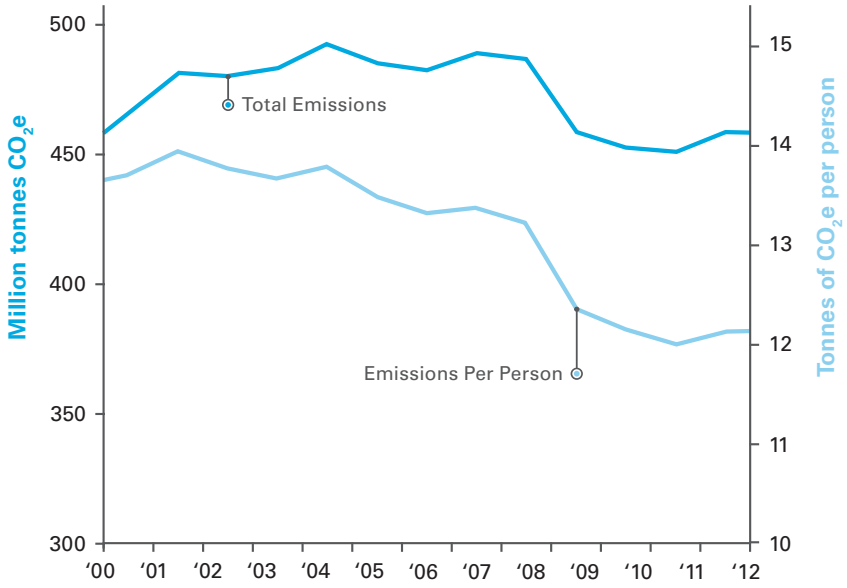
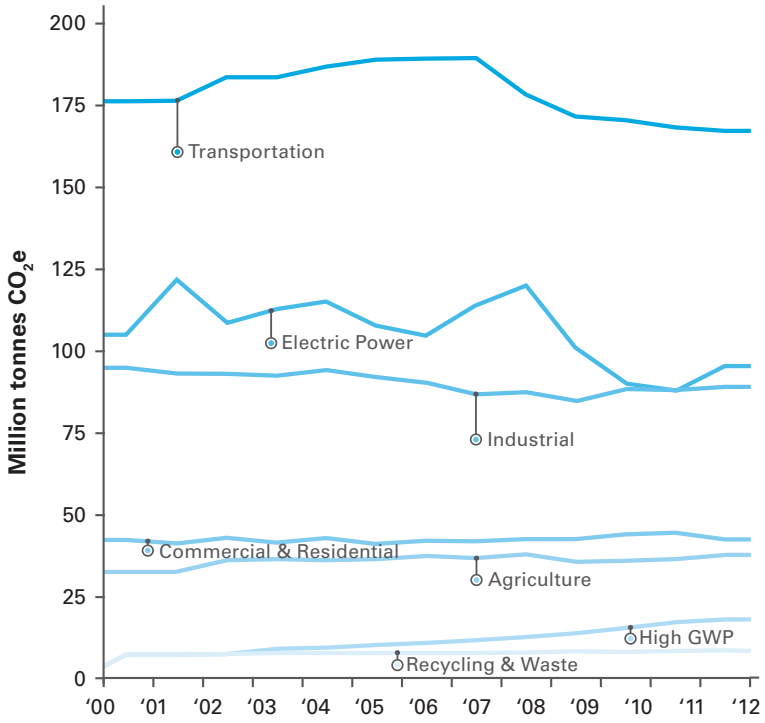


Figure 8b: California Sectoral GHG Emissions (2000-2012)



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

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

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

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

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

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

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

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

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

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

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

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

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

3. Emission Reductions to Meet the 2020 Statewide Limit

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

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

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

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

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

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

Table 5: Meeting the 2020 Emissions Target

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

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

C. Next Steps

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

Table 6: Summary of Recommended Actions by Sector

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

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

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

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

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

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

V. Achieving Success

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

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

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

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

A. Integrate and Coordinate Planning

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

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

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

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

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

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

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

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

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

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

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

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

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

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

B. Transportation, Land Use, and Housing Planning Development

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

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

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

SUCCESS STORY

Local Governments in Action

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

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

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

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

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

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

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

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

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

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

C. Investments

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Table 8: Proposed SB 535 Implementation Process

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

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

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

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

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

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

Table 9: Funding of Specific Areas to Support AB 32

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

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

D. Expanding Climate Actions

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

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

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

1. Support Sustainable Choices by Households and Businesses

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

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

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

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

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

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

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

2. Enable Local and Regional Leadership

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

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

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

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

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

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

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

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

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

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

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

SUCCESS STORY

COOLCALIFORNIA
CITY CHALLENGE

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CoolCalifornia City Challenge

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

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

Community-wide Emissions Reduction Target

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

Local Government Financing Mechanisms and Incentives

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

3. Coordinate with Subnational, Federal, and International Partners

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

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

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

Interstate Partnerships

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

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

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

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

Federal Collaborations

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

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

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

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

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

International Engagement

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

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

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

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

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

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

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

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

VI. Evaluations

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

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

A. Economic Analysis

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

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

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

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

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

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

Ex Ante Assessment of Potential Costs and Benefits

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

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

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

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

SUCCESS STORY

California Local Governments

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

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

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

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

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

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

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

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

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

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

Ex Post Assessment of Realized Costs and Benefits

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

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

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In pursuit of guidance, ARB has engaged a group of Economic Advisors to assist in the development of the work plan to achieve the first objective and estimate the ex post economic impact of AB 32. The Advisors are helping to identify the metrics and methodologies that are best suited to identify the overall costs and benefits of AB 32. More details on macroeconomic modeling of the overall impact of AB 32 and ex post analysis will be included in future updates to the Scoping Plan.

During the implementation of AB 32, California has been collecting data toward the second objective of the ex post assessment—identifying the distributional impacts of AB 32. Through mandatory requirements and voluntary reporting, facility-level data are being collected, and California is beginning the process to analyze, both internally and externally though contracted researchers, how putting a price on carbon changes the behavior and economic health of California businesses and individuals. The data will be used to inform microeconomic models estimating the direct and indirect costs of AB 32, including expenditures on energy, capital, and labor. This analysis will allow the impacts of AB 32 to be quantified over a variety of time horizons, geographic regions, industrial sectors, and income groups, and will provide flexibility in the interactions of regulatory policies. Further, California will continue to track technological developments and the various pathways that industries use to comply with environmental regulations in order to better understand program costs.

The ex post assessment of economic impacts will also inform the design of California's long-term climate change regulatory portfolio. Estimating the economic impact of the current suite of AB 32 measures will provide guidance in establishing long-term emission targets. Assessing the costs and environmental benefit of each regulatory measure over time can lead to modifications

of specific measures as well as the mix of programs within AB 32. This will ensure that the interaction of regulatory measures achieves the goals of AB 32. Thus, the ex post assessment can inform the scope, scale, and stringency of measures in the climate change mitigation portfolio to achieve California's long-term emission targets.

Ongoing Economic Assessment

In addition to the longer-term objectives of the ex post assessment, there are analyses under way to estimate the facility-level regulatory costs and benefits of AB 32 on specific sectors, to inform near-term regulatory modifications. Currently, two analyses are under way at ARB to assess the ability of industrial entities in the Cap-and-Trade Program to maintain competitiveness while incorporating the carbon price into their production processes. In each analysis, external researchers are reevaluating the leakage classification, a measure of the energy intensity and trade exposure of an industrial sector, of California producers using facility-level data on energy consumption, trade flows, and market transfers.[118] The results of the leakage analyses will be used to inform the level of transition assistance needed to minimize leakage in the industrial sector in the third compliance period of the Cap-and-Trade Program. Results are expected by 2016.

External research has also informed the longer-term design of measures under AB 32— most notably the Cap-and-Trade Program and the LCFS—to identify the link between program design and the California economy. For example, the Market Simulation Group (MSG) was established under contract to inform ARB on issues pertaining to market rules and efficiency. It has provided input in assessing program costs, as well as the supply and demand for allowances in the Cap-and-Trade Program.[119] In addition, ARB co-sponsored a symposium in 2012 that brought together economic researchers and regulators to identify the metrics required for the effective analysis of the Cap-and-Trade Regulation.[120] Academic researchers are also providing input to ARB on the design of the LCFS and the near-term cost of compliance.[121] Discussions between regulators and expert economists has spawned ongoing research that is helping to inform the work plan for the ex post analysis of AB 32.

California agencies have also actively engaged the general public and stakeholders to ensure that the economic costs of AB 32 measures are not overly burdensome to specific sectors or income groups. ARB has conducted workshops on the economic costs of LCFS and the Cap-and-Trade Program and solicited comments on internal white papers discussing potential options for cost containment.[122] Gaining insight into the economic market conditions faced by stakeholders allows for the more accurate modeling of economic impacts under AB 32 and provides a measure of some of the compliance costs faced by covered entities.

Along with the collection of data and the active engagement of researchers and stakeholders, ARB is also monitoring the impact of AB 32 on the supply and demand of energy in California. Partnering with the Federal Energy Regulatory Commission (FERC) and CAISO, ARB is monitoring energy and fuel markets to identify the impact of AB 32 on energy markets and the wholesale energy costs faced by industrial, commercial, and residential consumers.[123] These analyses will assist ARB in identifying areas in which to improve the design and stringency of Scoping Plan measures in order to achieve AB 32 emissions goals with minimal economic impact.

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118 Stephen Hamilton of Cal Poly San Luis Obispo and a team of researchers from UC Berkeley are conducting an analysis on the food processing sector, while Meredith Fowlie of UC Berkeley and a team of researchers from Stanford, Resources for the Future, and Clark University are conducting an analysis that covers all remaining industrial sectors. The results of these analyses will be publically available on the ARB website upon completion.

119 The draft analysis is available at *http://ei.haas.berkeley.edu/pdf/Forecasting%20CA%20Cap%20and%20Trade.pdf*.

120 More information is available at *www.bren.ucsb.edu/events/AB32.htm*.

121 The analysis of the LCFS and compliance costs is available at *www.des.ucdavis.edu/faculty/Lin/California_LCFS.pdf*.

122 The LCFS white paper is available at *www.arb.ca.gov/fuels/lcfs/regamend13/20130522ccp_conceptpaper.pdf*; the Cap-and-Trade Program white paper is available at *www.arb.ca.gov/cc/capandtrade/meetings/062513/arb-cost-containment-paper.pdf*.

123 More information is available at *www.caiso.com/Documents/2013SecondQuarterReport-MarketIssues_Performance-Aug2013.pdf* and *www.ferc.gov/EventCalendar/Files/20121220111740-A-4-Presentation.pdf*.

Achieving Near-Term and Long-Term Goals

The Cap-and-Trade allowance price can be used as a proxy for the cost of some GHG emission reductions (those that remain after reductions from the other AB 32 regulatory measures have occurred). By projecting the allowance price through 2020, models estimate the overall cost of a portion of the emissions abatement required under AB 32. Recent analyses suggest that the allowance price in 2020 will likely be near the price floor at the time, around $17 per metric ton.[124]These analyses highlight the uncertainty inherent in the projection of future market conditions, as well as the critical need to identify a "Business as Usual" emissions baseline. While there is much uncertainty in these analyses, the projected allowance prices are lower than the allowance price projected by ARB in the 2010 Updated Economic Analysis to the Scoping Plan.[125] ARB estimated that the 2020 emissions limit could be met with an allowance price of $21 per metric ton and an associated 0.1 to 0.2 percent change in Gross State Product relative to the forecasted 2020 "Business as Usual" baseline.

The similarity of the external estimates of the 2020 allowance price and the projected allowance price in the 2010 Updated Economic Analysis to the Scoping Plan may offer evidence that the assessment of the projected economic impacts of AB 32 is reasonable and that California can reach the near-term 2020 emissions limit without sacrificing economic stability.

The assessment of economic impacts will continue as California develops a climate mitigation portfolio to achieve its long-term climate change mitigation goals. The assessment of the overall economic impacts of the current suite of AB 32 measures will inform the design of the long-term regulatory portfolio as well as the analysis of its impact. However, extending the time horizon of the assessment of economic impacts will present new challenges. Regulatory and climate uncertainty, as well as the performance and costs of existing AB 32 measures, will need to be incorporated in the estimation of potential economic impacts of the long-term climate change mitigation portfolio.

Isolating the specific macroeconomic effects of AB 32 from other economic volatility will continue to present a significant challenge as California looks to the future and achieving long-term climate goals. Long-term economic shifts will need to be incorporated into the assessment of economic impacts. For example, household energy demand and vehicle miles traveled will be influenced by demographic changes in the California population, changes in land use, and the built environment. These issues are the direct focus of regional planning agencies and sustainable community legislation and will require the inclusion of policy interaction and jurisdictional overlap in the long-run modeling of policies affecting energy demand.

Challenges will also arise in estimating the long-term effects of AB 32 across sectors, jurisdictions, and natural resources. The promulgation of climate change mitigation and adaption policies worldwide has highlighted the importance of understanding the far-reaching impacts, both in terms of costs and co-benefits, of climate change and climate change regulations. In 2011, ARB acknowledged the importance of analyzing the impact of the Cap-and-Trade Regulation on localized air quality impacts, special status species, sensitive habitats, and federally protected wetlands in the Adaptive Management Plan. Measuring the long-term impacts of AB 32 will require new methodologies to parse the impacts of individual climate mitigation polices across sectors, jurisdictions, and natural resources. Accounting for the co-benefits and the economic costs of AB 32 will allow California to maximize emission reduction towards long-term climate change mitigation targets while also maximizing the benefits, through improved air quality and natural resources for all Californians.

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124 In $US 2013 (the price floor is currently at $11.34 and rises five percent plus inflation each year). See, for example, the MSG report linking in footnote 105.

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

ARB will continue to consult with external experts to develop new analytical tools and methods to incorporate these issues in the assessment of economy-wide and distributional impacts of California's long-term climate change mitigation portfolio.

B. Climate Change and Public Health Assessment

Climate change has been identified as the greatest health threat of the twenty-first century.[126] As described in Chapter II, in California, climate change is expected to increase temperatures, change precipitation patterns, increase the frequency and severity of extreme weather events, and increase wildfires and sea level rise—all of which could have significant impacts on the health of California's residents.

Efforts to reduce GHGs minimize the impacts that climate change will have on human health. In addition to combatting climate change and its subsequent health impacts, many of these efforts have additional direct and indirect public health impacts. It is challenging to assess the magnitude of health impacts that result specifically from AB 32 mitigation measures. However, assessing the directionality of the relationship between many mitigation actions and health based on current empirical literature indicates that overall, the State's climate control program has many health co-benefits, particularly for chronic diseases. In the instances in which mitigation measures may be at odds with positive health outcomes, California must ensure that positive health outcomes are maximized as we address climate change. Local governments, and in particular local public health departments, are important partners in this work.

Assessing the Health Impacts of AB 32 Implementation

As with economic impacts, efforts to fully quantify the health impacts due to Scoping Plan measures remain challenging and are complicated by many factors. Communities and individuals are influenced by a multitude of factors, including socioeconomic conditions, occupational and environmental exposures, the natural and built environments, and personal choices. The influence of all these factors impairs the ability to assign causation between a discrete set of policies, such as the State's climate program, and quantified health impacts. In addition, the long time scale over which certain health impacts may appear—particularly for chronic diseases—complicate attribution to specific actions. Efforts to quantify health impacts by modeling the reduction of co-pollutants to estimate health impacts associated with reductions of GHG measures are difficult because they rely on assumptions about what would have happened if those measures had not been implemented. Assessing the magnitude of health impacts that result specifically from AB 32 mitigation measures remains challenging; however, the directionality of the relationship between many mitigation actions and health can be evaluated using current empirical literature. Efforts are now under way to develop health co-benefit modeling tools to be used in conjunction with regional transportation demand models used by California's Metropolitan Transportation Organizations to help quantify health co-benefits of active transport in future Sustainable Community Strategies (Table 10). For instance, the Strategic Growth Council has convened a Technical Advisory Committee to provide recommendations on the development and use of a health module as part of the Urban Footprint model—a scenario development and modeling tool designed to inform planners on the impacts of development decisions. In addition, CDPH has advanced a model—the Integrated Transport and Health Impact Modeling tool (ITHIM)—that quantifies the health impacts of active transportation and low carbon driving scenarios. The ITHIM model is currently being evaluated by MPOs for use in their regional planning processes.

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

Table 10: Current Models Designed to Quantify Health Co-Benefits of Sustainable Community Strategies

Model	Timeline
Urban Footprint	SGC Advisory Committee recommendations anticipated Spring 2015
Integrated Transport and Health Impact Modeling Tool (ITHIM model)	Under evaluation by MPOs

Health Impacts of Unmitigated Climate Change

Left unchecked, climate change will affect health in a number of ways. Increasing temperatures from climate change will increase the severity and frequency of heat waves. As California saw in the 2006 heat wave, which resulted in over 650 excess deaths, over 16,000 excess emergency department visits and almost 1,200 excess hospitalizations,[127, 128] extreme heat events create a significant risk of adverse health effects and heat-related mortality. Older adults with chronic health problems, and agriculture, construction, and other outdoors workers are particularly at high risk for adverse effects of extreme heat. Increasing temperatures may exacerbate air pollution in California; in particular, ozone and fine particulate matter.[129] In addition to increasing air pollutants directly, higher temperatures will also likely increase and intensify wildfires in the State, exacerbating poor regional air quality.[130] An increase in air pollution can increase the number of cases of exacerbation of asthma, allergies, and cardiovascular and respiratory diseases, as well as incidents of cancer, neurological and reproductive disorders, and premature death.[131] These impacts are especially felt among our most vulnerable populations, including children, elderly, people with cardiovascular or respiratory diseases, low-income communities, and people without access to health insurance.[132] Changes in climate can also affect the prevalence and geographic location of food-, mosquito-, and vector-borne diseases. While hard to predict, it is possible for infectious diseases like West Nile Virus and Lyme disease to become more prevalent in California as the climate changes.[133] Extreme weather events can lead to both physical and mental health problems.[134] In addition, climate change is associated with higher pollen levels, which contribute to allergies and asthma attacks.[135] Additional climate change impacts, including changes in precipitation patterns, can threaten the quality and supply of water, endanger agriculture production, and lead to many other health-impacting consequences.

The impacts of climate change will not affect everyone the same way. Climate change is expected to more seriously affect the health and well-being of the communities in our society that are the least able to prepare for, cope with, and recover from its impacts. For instance, low-income communities and communities of color are expected to be hit harder by extreme heat, extreme weather events, and worsened air pollution; and are more sensitive to the economic stresses associated with climate change, like increased prices for basic needs and threat of job loss in the agricultural and tourism sectors.[136] If this "climate gap" is not addressed, climate change will exacerbate many of the health and social disparities among California residents. Fortunately,

127 Hoshiko, S., P. English, D. Smith, and R. Trent. 2010. "A simple method for estimating excess mortality due to heat waves, as applied to the 2006 California heat wave." Int J Public Health 55(2): 133–7.
128 Knowlton, K., M. Rotkin-Ellman, G. King, et al. 2009. "The 2006 California heat wave: Impacts on hospitalizations and emergency department visits." Environ Health Perspect 117(1): 61–7.
129 Drechsler, D. M. 2009. Climate Change and Public Health in California.
130 Ibid.
131 CARB. ARB Fact Sheet: Air Pollution and Health. *www.arb.ca.gov/research/health/fs/fs1/fs1.htm*.
132 Shonkoff, S., R. Morello-Frosch, M. Pastor, and J. Sadd. 2009. Environmental health and equity impacts from climate change and mitigation policies in California: A review of the literature. California Climate Change Center. *www.energy.ca.gov/2009publications/CEC-500-2009-038/CEC-500-2009-038-D.PDF*.
133 Drechsler, D. M., N. Motallebi, M. Kleeman, D. Cayan, K. Hayhoe, L. S. Kalkstein, N. Miller, S. Sheridan, J. Jin, and R. A. VanCuren. 2005. Public health-related impacts of climate change in California.
134 CDC. 2013. CDC's Climate Change and Health Program: *www.cdc.gov/nceh/information/climate_and_health.htm*.
135 Ibid.
136 Ibid.

many of the actions that reduce GHG emissions also improve the health and well-being of these vulnerable communities, providing an opportunity to address many of our current environmental and health disparities.

Health Impacts of AB 32 Mitigation Measures

Climate change mitigation efforts not only help combat the direct adverse health impacts of climate change, many of the strategies laid out in the Scoping Plan have additional health co-benefits—many of which can improve existing health disparities. In addition, these climate strategies have implications for chronic disease—which accounts for the vast majority of ill health in California. Chronic disease and injury account for 80 percent of deaths in California, and affect the lives of millions of Californians. Chronic disease is also the key driver of health inequities, lost workforce productivity, and rising health care costs.[137]

The strategies California has employed to reduce GHG emissions from the transportation sector include cleaner and more fuel-efficient vehicles and land use strategies that reduce vehicle miles traveled and promote active transport (bicycling and walking—alone and in combination with public transit.) Putting cleaner and more fuel-efficient vehicles and heavy-duty trucks on the road is reducing GHGs and criteria air pollutants and toxics, including NO_x (which forms ozone and $PM_{2.5}$) and directly emitted $PM_{2.5}$ (which includes toxic diesel PM). Since statewide monitoring efforts began in 2000, $PM_{2.5}$ levels have decreased by an average of four percent each year.[138] Strategies that will help us achieve our 2050 climate goals, including zero emission vehicles and increased electrification of goods movement, will further reduce air pollutants and bring health co-benefits throughout the State. These improvements will particularly benefit many low-income communities of color, who are disproportionately exposed to traffic-related air pollutants.[139]

The impact that our built environment—including land use decisions, transportation systems, and our buildings—has on human health and well-being has long been recognized.[140] Statewide efforts to reduce GHG emissions through integrated land use and transportation planning will fundamentally change our communities, bringing with it public health benefits. The Sustainable Community Strategies (SCSs) adopted by Metropolitan Planning Organizations are planning for communities in a way that reduces travel demand per person, provides greater mobility options, increases access to employment and services, and creates more vibrant surroundings. Reducing vehicle travel will reduce GHG emissions and improve regional air quality. For instance, Southern California's 2012–2035 Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS) is expected to result in a 24 percent reduction in total pollution-related health incidences, saving over $1.5 billion per year in total costs.[141] In an effort to improve mobility options for California residents, the RTP/SCSs are also increasing opportunities for residents to use bicycling and walking as travel alternatives. Active transportation increases physical fitness and improves mental health.[142, 143] The health benefits of physical activity are extensive and well documented: physical activity—even in modest amounts—has been linked with a decreased risk of cardiorespiratory diseases, type 2 diabetes, breast and colon cancer, depression, cognitive

137 CDPH. 2013. The Burden of Chronic Disease and Injury. *www.cdph.ca.gov/programs/Documents/BurdenReportOnline%2004-04-13.pdf*.

138 ARB staff analysis.

139 Shonkoff, S., R. Morello-Frosch, M. Pastor, and J. Sadd. 2009. Environmental health and equity impacts from climate change and mitigation policies in California: A review of the literature. California Climate Change Center. *www.energy.ca.gov/2009publications/CEC-500-2009-038/CEC-500-2009-038-D.PDF*.

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

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

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

143 Ewing, R., T. Schmid, et al. 2008. "Relationship Between Urban Sprawl and Physical Activity, Obesity, and Morbidity." Urban Ecology 567–582.

decline, all-cause mortality, and improved musculoskeletal health.[144] These regional plans are not just providing more travel options, they also have implications for other health-related factors, like improved access to health services and employment opportunities and safer, more cohesive neighborhoods. The SCS plans created by regions are key mechanisms for improving factors that have indirect but broad implications for the health and well-being of California's communities.

Climate change strategies that also reduce urban heat islands improve public health and help build climate change resiliency. Increasing urban tree canopy and green space combats climate change directly through sequestration of GHGs and indirectly by reducing ambient air temperatures[145] and reducing the energy needed to heat and cool buildings.[146] The cooling effects of urban trees reduce urban heat islands and can lessen the severity of extreme heat events. Additional health-related benefits of urban trees include reduced air pollutants,[147] reduced noise from traffic,[148] and other psychological and social benefits that help decrease stress and aggressive behavior.[149, 150, 151] Cool roofs and cool pavements also combat climate change while cooling our communities.[152]

Strategies to build more energy-efficient, green buildings—if done right—also can have public health benefits. Improving indoor air quality through source reduction and strategies such as high-efficiency air filtration can greatly improve indoor air quality and occupant health. The State's green building code (CALGreen) includes both required and voluntary measures that improve public health. A number of these measures help assure healthful indoor air quality, such as those addressing chemical emissions from composite wood products, carpets, resilient flooring materials, paints, adhesives, sealants, and insulation, as well as those addressing ventilation. ARB has been active in improving building indoor air quality by sponsoring and conducting research, regulating indoor air cleaners and consumer products, and helping to develop green building standards and guidelines that both reduce GHG emissions and protect indoor air quality.

Reducing the use of nitrogen fertilizers can reduce GHG emissions and improve water quality. Many Californians live in agricultural areas that have water nitrogen levels well above national health-based standards.[153] Central Valley residents in areas with contaminated drinking water must also spend far more than average to purchase safe water, reducing the ability to spend on other health-protective necessities such as food and housing.[154]

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

145 Trees can lower outdoor air temperatures by as much as 9°F (5°C) through evapotranspiration: EPA. 1992. Cooling our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing. U.S. Environmental Protection Agency, Office of Policy Analysis, Climate Change Division. p. 32.

146 Akbari, H., D. Kurn, S. Bretz, and J. Hanford. 1997. "Peak power and cooling energy savings of shade trees." Energy and Buildings 25:139–148. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 5)

147 Nowak, D. J., D. E. Crane, and J. C. Stevens. 2006. "Air pollution removal by urban trees and shrubs in the United States." Urban Forestry and Urban Greening. 4(2006):115–123. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 6)

148 Nowak, D. J., and J. F. Dwyer. 2007. Understanding the Benefits and Costs of Urban Forest Ecosystems. In: Kuser, J. E. Handbook of Urban and Community Forestry in the Northeast. New York: Kluwer Academic/Plenum Publishers. 25–46. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 9)

149 Wolf, K. 1998. Urban Nature Benefits: Psycho-Social Dimensions of People and Plants. Center for Urban Horticulture, College of Forest Resources, University of Washington, Fact Sheet #1. Seattle, Washington. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 9)

150 Laverne, R. J., and K. Winson-Geideman. 2003. "The Influence of Trees and Landscaping on Rental Rates at Office Buildings." Journal of Arboriculture 29(5): 281–290. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 9)

151 Kuo, Francis E., and W.C. Sullivan. 2001. "Environment and Crime in the Inner City: Does Vegetation Reduce Crime?" Environment and Behavior 33(3): 343–367. (Accessed via Reducing Urban Heat Islands: Compendium of Strategies - Trees and Vegetation, p. 9)

152 U.S. EPA. No date. Reducing Urban Heat Islands: Compendium of Strategies — Cool Roofs.

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

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

Ongoing Evaluation

As California looks beyond 2020, there will be many opportunities to address long-standing air quality and public health issues through the implementation of sustainable community strategies, the expanded deployment of zero and near-zero emission vehicles in the light- and heavy-duty sectors, and the more efficient use of electricity and natural gas. But we must be mindful of how current and future strategies are implemented, so that they maximize the health benefits while minimizing unintended negative health impacts. For instance, pursuing more compact, transit-oriented development will help reduce GHG emissions and regional air pollutants; however, without appropriate preventative measures, it may have the potential to displace current residents who are disproportionately from low-income and minority communities, as well as to increase near-roadway exposure for some individuals. Additional efforts are needed to prevent any adverse health impacts that may be exacerbated by future land use and transportation decisions. ARB is pursuing research to help improve health impacts from near-roadway exposure.

While the Cap-and-Trade Regulation is designed to reduce GHG emissions, co-benefits such as reductions in criteria and toxic air pollutants, are expected to follow. However, concerns have been raised that these reductions in criteria and toxic air pollutants may not occur in some areas, or that the Cap and Trade Program may exacerbate some localized air pollution impacts. To address these concerns, ARB is working with CAPCOA to design elements of a Cap-and-Trade adaptive management process to identify and respond to concerns about the potential for localized emission increases due to the Cap-and-Trade Regulation. The effort will involve a transparent process to collect, review, and evaluate data to determine if any potential adverse localized air quality impacts might have occurred as a result of implementing Cap-and Trade. If a potential impact is identified through this process, ARB is committed to developing appropriate responses through a public process, including consideration and approval by the Board as necessary.

Despite the difficulties in quantifying the health impacts that result from AB 32 implementation, additional action can be taken to better understand the relationship between climate control measures and health impacts. Several efforts undertaken by the California Department of Public Health will aid in this endeavor, including the development of land use/transportation health impact assessment tools and the development of health community data and indicators to facilitate monitoring and tracking of progress. Additional effort will be needed to advance the development and adoption of tools to evaluate the health benefits of land use and transportation planning, as well as to better educate policymakers, local officials, and the public of these impacts. Moving forward, ARB will continue to monitor and track statewide air pollution levels and community pollutant levels to ensure that our policies and programs continue to improve air quality for all Californians. In addition, ARB will continue to ensure that efforts to reduce GHG emissions through the building sector continue to simultaneously improve indoor air quality and occupant health and safety. Continued research and analysis is needed on the short- and long-term health co-benefits of climate strategies to help communities maximize the positive impacts of local actions.

Federal air quality requirements could be an important driver in influencing how and when California achieves mid-term climate targets. The South Coast and San Joaquin Valley Air Quality Management Districts, together home to more than half of the State's population, must reduce emissions of smog-forming pollutants by about 90 percent below 2010 levels by 2032 to meet the National Ambient Air Quality Standards. Since many of the technologies to reduce smog-forming pollution are the same as those to reduce GHG emissions, and recognizing that it is imperative to integrate planning to meet multiple objectives, complying with federal air quality standards will likely accelerate climate action in California.

In addition, ARB will continue to evaluate ways to monitor the public health of disadvantaged communities. As with economic impacts, communities and individuals are subjected to a multitude of factors that affect their health; consequently, teasing out the impacts of one discrete set of policies, such as the climate program, is very challenging.

C. Environmental Justice and Disadvantaged Communities

State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. ARB is committed to considering environmental justice in every program and process.

In 2001, ARB adopted Policies and Actions for Environmental Justice (Policies) to provide a framework for incorporating environmental justice into its programs. The Policies apply to all communities in California, but recognize that environmental justice issues have been raised mostly in the context of low-income and minority communities. These Policies are intended to promote the fair treatment of all Californians and cover the full spectrum of ARB activities. The Policies recognize the need to engage community members as ARB develops and implements its programs. ARB is committed to work closely with all stakeholders, environmental and public health organizations, industry, business owners, other State and local agencies, and all other interested parties, to successfully implement these Policies.

Climate change will present additional challenges to those that environmental justice communities are already facing. Climate change has both direct and indirect impacts on health. These health effects disproportionately impact vulnerable individuals—the young, elderly, and people with chronic illness—and people in environmental justice communities.

Climate change will affect human health, infrastructure, and transportation systems, as well as energy, food, and water supplies. Environmental justice communities may face greater challenges to adapting to climate change due to limited resources. To the extent feasible, the State should work to identify and address any adverse effects of the State's climate programs, policies, and activities on environmental justice communities. In addition, the State must ensure that its climate programs, policies and actions also result in benefits to environmental justice communities.

Potential Impacts and Benefits to Environmental Justice Communities

The implementation of air pollution control programs in California at the federal, State, and local levels targeting GHGs, criteria pollutants, and air toxics will together result in a reduction of air pollution throughout the State. These statewide emission reductions are intended to improve the health of all of California's residents. Specifically, the implementation of the Scoping Plan will result in significant GHG emission reductions in California, accompanied by criteria and toxic pollutant emission reductions at the State and local level. ARB will work to ensure that implementation of the Scoping Plan and all of its programs do not adversely affect environmental justice communities. ARB will continue to work closely with the local air districts to monitor air pollution to ensure that emission reductions at the State, local, and regional levels are occurring as intended, and that environmental justice communities are also sharing in the benefits of cleaner air.

In addition, as part of a focused effort, ARB will continue to work with CAPCOA to design elements of a Cap-and-Trade adaptive management process to identify and respond to concerns about the potential for localized emission increases due to the Cap-and-Trade Regulation. The effort will involve a transparent process to collect, review, and evaluate data to determine if any potential adverse localized air quality impacts might have occurred as result of implementing Cap-and-Trade. If a potential impact is identified through the process, ARB is committed to developing appropriate responses through a public process, including consideration and approval by the Board as necessary.

Environmental justice communities will also benefit directly from the expenditure of Cap-and-Trade auction proceeds. SB 535 requires CalEPA to identify disadvantaged communities based on geographic, socioeconomic, public health, and environmental hazard criteria for purposes of

expending Cap-and-Trade auction proceeds. SB 535 also requires that at least 25 percent of Cap-and-Trade auction proceeds be allocated to projects that benefit these communities, and at least ten percent of the proceeds be allocated to projects located in the communities.

To the extent feasible, all State, regional, and local government agencies with a role in implementing AB 32 should employ available data sources to help target resources, programs, incentives, and enforcement efforts to ensure that residents of EJ communities receive benefits from climate-related efforts and to guard against worsening conditions or creating new environmental justice problems.

Assessing the Effects of AB 32 Climate Change Programs in Environmental Justice Communities

ARB, in coordination with CalEPA and the Office of Environmental Health Hazard Assessment (OEHHA), is working on developing a method to assess the effects of California's climate change mitigation efforts on environmental justice communities. AB 32 requires that, to a feasible extent, ARB must ensure that activities undertaken to address climate change do not disproportionately impact disadvantaged communities and that those communities also benefit from statewide efforts to reduce GHG emissions.

The Environmental Justice Advisory Committee, formed pursuant to AB 32, has expressed significant interest in the development of metrics for tracking, assessing, and quantifying the potential impacts and benefits of the State's climate programs, policies, and actions on California's economy, environment, and public health, particularly with respect to environmental justice communities.

Tools such as CalEnviroScreen (released by CalEPA and OEHHA) have been developed to evaluate multiple indicators of environmental and socioeconomic vulnerability in disadvantaged communities. These tools do not show the impacts of any single program, but are intended to evaluate a community's vulnerability to pollution's adverse effects.

In contrast, the effort discussed here attempts to focus on the impacts of AB 32 programs that reduce GHGs and other climate change pollutants. Any effort to track the effects of AB 32 will require, at a minimum, the identification of indicators that could be tied to the programs of interest and a method for assessing those indicators. An effective and meaningful evaluation of AB 32 programs must rely on indicators expected to fluctuate with government, community, and industry actions to implement climate change mitigation programs.

Project Concept

ARB staff, in coordination with CalEPA, OEHHA and other agencies, is undertaking an effort to assess the effects (benefits and potential impacts) of AB 32 programs on disadvantaged communities. The key objective is to develop a quantitative mechanism to gauge the effectiveness of AB 32 programs with respect to disadvantaged communities. Specifically, to help address the question "Is the implementation of AB 32 programs fulfilling the statutory responsibility to provide benefits and avoid disproportionate harmful impacts to the extent feasible in those communities?"

ARB is developing a multi-phase approach, beginning with identifying sources of existing available and accessible data. This first phase would look at changes in emissions of multiple air pollutants at individual facilities and include a visual tool to support ready public access to those data. ARB will rely on a process of extracting and reviewing criteria and toxics emissions information, developed by and in concert with the local air districts, in order to understand localized impacts. The next phase would expand in scope to encompass entire disadvantaged communities (per SB 535), reflecting emissions from both facilities and mobile sources in

each area. In a later phase, we would include relevant emission reduction and economic data from projects funded through the investment of Cap-and-Trade auction proceeds to benefit disadvantaged communities. Table 11 below describes the phases of the proposed approach. The Scoping Plan Economic Advisors, other State agencies (like OEHHA), and local air districts may aid ARB by supplementing these data and analyses, which would provide an expanded view.

Existing data sources include the following:

- California Electronic Greenhouse Gas Reporting Tool (Cal e-GGRT)
  - Cal e-GGRT is California's Mandatory Greenhouse Gas Emissions Reporting Program that provides quality assured and third-party verified emissions data from sources that contribute the most to Statewide GHG emissions.
- California Emission Inventory Development and Reporting System (CEIDARS)
  - CEIDARS data are the result of facility reports to air districts that are passed to ARB. CEIDARS provides facility criteria and toxic emissions data.
- EMissions FACtors for emissions from California's on-road vehicles (EMFAC)
  - EMFAC is California's model for estimating GHG, criteria and toxic emissions from on-road vehicles operating in California.
- Off-Road Motor Vehicles and Equipment
  - Category-specific methods and inventory models are being developed for specific regulatory support projects to replace the OFFROAD model. The following ARB website lists the categories that have been or are being updated with new methods and data: *www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles*.

The goal is to provide an evaluation of the effects of AB 32 programs, considering multiple variables, including greenhouse gases, criteria pollutants, and toxic air contaminants. This assessment would not only meet the goals of the Cap-and-Trade Adaptive Management Plan but would also include impacts not otherwise attributed to Cap-and Trade. The results of this assessment would provide an evaluation of the effects of all AB 32 programs on disadvantaged communities. Data collected could provide information needed for ARB to plan and implement investment, regulatory, or policy responses to any identified adverse localized impacts on specific disadvantaged communities.

Staff intends to present this effort as part of the Cap-and-Trade Adaptive Management Plan public workshops scheduled for mid-2014. Additionally, staff anticipates that with the Cap-and-Trade Adaptive Management Plan, an update on the progress of this effort will be presented to the Board before the end of 2014.

Table 11: Project Phases for Assessing the Effects of AB 32 Programs on Disadvantaged Communities

Phase	Description
Phase 1 Collect and Make Available Facility Data	The focus will be on facilities that are required to report consistent with ARB's Mandatory Reporting Regulation. We will compile several years of climate, criteria pollutant, and air toxics emissions data for these facilities. We will also make this information available for review and analysis by the public, including communities, academics, and government.
Phase 2 Evaluate Facility Emissions Data	Analyze the information collected in Phase 1. We intend to utilize the data evaluation process developed for the Cap-and-Trade Adaptive Management Plan and annually provide a summary of findings for public review.
Phase 3 Collect and Make Available Community Data	The focus will be on disadvantaged communities as defined by CalEPA under SB 535. We will integrate "community-level" mobile source emission data and investment data from Cap-and-Trade auction proceeds. In this phase, we will also quantify trends and provide data biennially for public review and analysis.
Phase 4 Evaluate Community Data	Conduct a detailed analysis of the information collected in Phase 3. We will summarize our findings and biennially release results for public review.
Phase 5 Respond to Evaluations in Scoping Plan	Respond to Phase 4 results and discuss project progress in the next Update to the Climate Change Scoping Plan.

Outreach and Community Capacity Building

As climate policy and programs are developed and implemented, community capacity building through education and outreach efforts—as well as integration of community members into the decision making process—are critical components of helping to ensure that the needs of these communities are known and addressed. Additional effort is needed in communities that are geographically, linguistically, and/or economically isolated. Collaboration with trusted sources of information, such as community-based organizations, regional climate collaboratives, and culturally appropriate messaging techniques, are recommended.

Environmental Justice Advisory Committee

To ensure environmental justice needs and concerns are integrated into the State's climate programs, ARB reconvened the Environmental Justice Advisory Committee (Committee) to advise the Board on the Update. On March 21, 2013, the Board appointed members based on nominations received from environmental justice organizations and community groups.

Environmental Justice Advisory Committee		
Martha Dina Argüello	Physicians for Social Responsibility	Los Angeles
Nicole Capretz *(Served on EJAC until August 2013)*	Environmental Health Coalition	San Diego
Gisele Fong	End Oil	Los Angeles
Tom Frantz	Association of Irritated Residents	Central Valley
Kevin Hamilton	Clinica Sierra Vista	Central Valley
Rey León	Valley LEAP	Central Valley
Penny Newman *(Appointed to EJAC but unable to serve)*	Center for Community Action and Environmental Justice	Inland Empire
Luis Olmedo	Comite Civico Del Valley	Imperial Valley
Susan Riggs *(Served on EJAC until March 2014)*	San Diego Housing Federation	San Diego
Kemba Shakur	Urban Releaf	Bay Area
Mari Rose Taruc	Asian Pacific Environmental Network	Bay Area
Monica Wilson	Global Alliance for Incinerator Alternatives	Bay Area
Ryan Briscoe Young *(Served on EJAC until April 2014)*	The Greenlining Institute	Statewide

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

D. Environmental Analysis

ARB prepared an environmental analysis (EA) of the Scoping Plan Update pursuant to its regulatory program certified by the Secretary of the Natural Resources Agency (14 CCR 15251(d); 17 CCR 60000–60008). The draft EA is included as Appendix F. In accordance with Public Resources Code section 21080.5 of CEQA, public agencies with certified regulatory programs are exempt from certain CEQA requirements, including but not limited to those preparing environmental impact reports, negative declarations, and initial studies (14 CCR 15250). The resource areas from the CEQA Guidelines Environmental Checklist are being used as a framework for assessing the potential for significant impacts (17 CCR 60005(b)).

A draft EA was released for a 45-day public review on March 15, 2014. ARB summarized and responded in writing to all comments submitted on the EA in a supplemental response document for the Board to consider for approval along with the Update.

VII. Conclusions

California is forging a path forward in the fight against climate change. By expanding on existing policies and developing new ones, we are steadily bending the arc of economic growth in our state in a cleaner, more sustainable direction. And while climate change demands it, the steps we are taking to cut emissions are the very actions we should be taking anyway to build for the future in California.

Sustainability and climate action have increasingly become part of the DNA of who we are and how we, as Californians, see ourselves. It is now as inconceivable to pump unlimited amounts of carbon pollution into the atmosphere as it was once to spew mercury, lead, sulfur dioxide, or arsenic into the air.

Day by day, in steady steps of visible progress, we are seeing the emergence of a clean energy future. Solar panels are commonplace, whether on roofs, commercial warehouses, or in shiny ground-based arrays across the State. Thousands of wind turbines have become part of the California clean energy panorama, their blades describing slow graceful arcs as they generate more than 4,000 megawatts of pollution-free energy.

Electric vehicles are a common sight on our streets and highways, and each day brings more charging stations to parking structures and shopping malls. Biofuel is available at retail outlets. Even big-rigs are getting a climate makeover as trailer skirts, low-rolling resistance tires, and aggressively aerodynamic cabs mean less wind resistance, lower fuel costs, and fewer emissions.

These efforts aren't just cutting greenhouse gases. They are cleaning our air; helping to better preserve water, and agricultural lands, and other critical natural resources; powering the growth of new long-term economic drivers in the state; and helping to pull together and better align public policy priorities across programmatic silos.

As California takes these steps, public support for action also continues to grow. Recent polls show that 79 percent of Californians believe global warming is happening, and a majority want to see more action by the State; 73 percent say corporations and industry need to do more; 70 percent feel they, themselves, should be doing more to address the issue.

This public consensus aligns with the dictates of science, which tell us unequivocally that we must continue on the path we are on, and even accelerate our efforts in the coming years.

That is exactly what this Update does. It builds on California's framework for climate action with a range of strategies that will keep pushing our state toward a cleaner, more sustainable future. It is a continuation of what we have already begun. Now is the time to make it a reality.

California Environmental Protection Agency

Air Resources Board

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