CALIFORNIA
AIR RESOURCES BOARD

California's 2017 Climate Change Scoping Plan

The strategy for achieving California's 2030 greenhouse gas target

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November 2017

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Decades of Leadership

From the first law to protect rivers from the impact of gold mining in 1884, to decades of work to fight smog, the Golden State has set the national – and international – standard for environmental protection. California pushes old boundaries, encounters new ones, and figures out ways to break through those as well. This is part of the reason why California has grown to become both the 6th largest economy in the world, and home to some of the world's strongest environmental protections. And, we have seen our programs and policies adopted by others as they seek to protect public health and the environment.

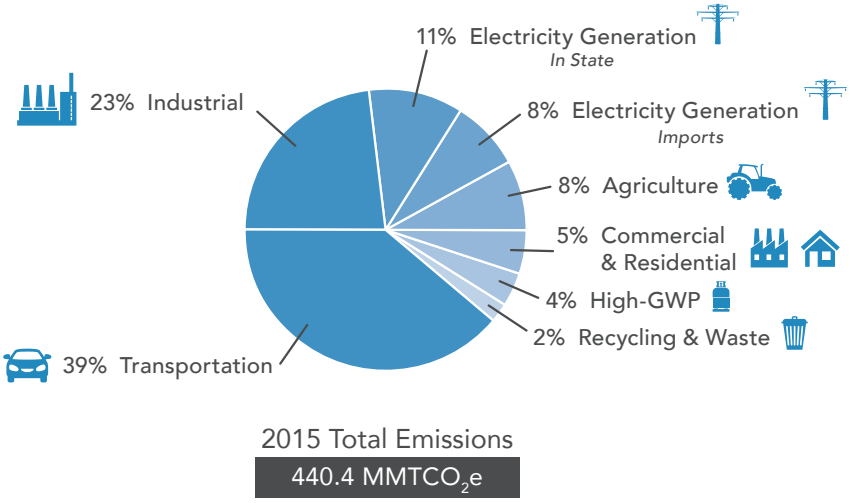
Governor Brown signs SB 32 recommitting California's efforts to curb climate change.

California's approach to climate change channels and continues this spirit of innovation, inclusion, and success. The 2030 target of 40 percent emissions reductions below 1990 levels guides this Scoping Plan, as the economy evolves to reduce greenhouse gas (GHG) emissions in every sector. It also demonstrates that we are doing our part in the global effort under the Paris Agreement to reduce GHGs and limit global temperature rise below 2 degrees Celsius in this century.

California's 2017 Climate Change Scoping Plan: The Strategy for Achieving California's 2030 Greenhouse Gas Target (Plan) builds on the state's successes to date, proposing to strengthen major programs that have been a hallmark of success, while further integrating efforts to reduce both GHGs and air pollution. California's climate efforts will:

- Lower GHG emissions on a trajectory to avoid the worst impacts of climate change;
- Support a clean energy economy which provides more opportunities for all Californians;
- Provide a more equitable future with good jobs and less pollution for all communities;
- Improve the health of all Californians by reducing air and water pollution and making it easier to bike and walk; and
- Make California an even better place to live, work, and play by improving our natural and working lands.

California Carbon Emissions



The Climate Imperative – We Must Act

The evidence that the climate is changing is undeniable. As evidence mounts, the scientific record only becomes more definitive – and makes clear the need to take additional action now.

In California, as in the rest of the world, climate change is contributing to an escalation of serious problems, including raging wildfires, coastal erosion, disruption of water supply, threats to agriculture, spread of insect-borne diseases, and continuing health threats from air pollution. The drought that plagued California for years devastated the state's agricultural and rural communities, leaving some of them with no drinking water at all. In 2015 alone, the drought cost agriculture in the Central Valley an estimated $2.7 billion, and more than 20,000 jobs. Last winter, the drought was broken by record-breaking rains, which led to flooding that tore through freeways, threatened rural communities, and isolated coastal areas. This year, California experienced the deadliest wildfires in its history. Climate change is making events like these more frequent, more catastrophic and more costly. Climate change impacts all Californians, and the impacts are often disproportionately borne by the state's most vulnerable and disadvantaged populations.

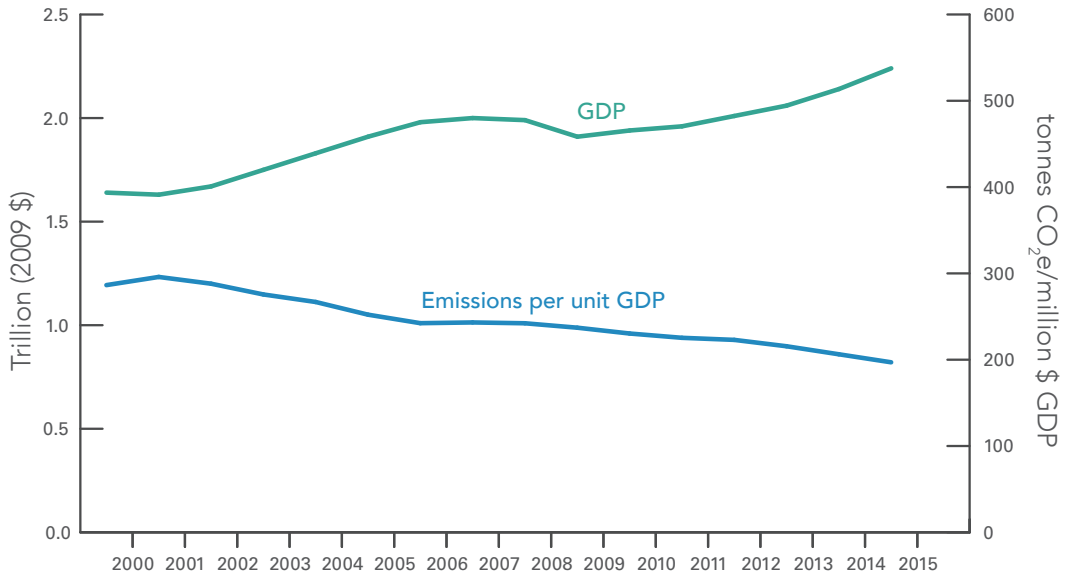
CALIFORNIA
is already experiencing
the impacts of
CLIMATE CHANGE

IN 2015 THE DROUGHT COST THE AGRICULTURE INDUSTRY IN THE CENTRAL VALLEY AN ESTIMATED $2.7 BILLION & 20,000 JOBS

California is on Track – But There is More to Do

Although the California Global Warming Solutions Act of 2006 – also known as AB 32 – marked the beginning of an integrated climate change program, California has had programs to reduce GHG emissions for decades. The state's energy efficiency requirements, Renewable Portfolio Standard, and clean car standards have reduced air pollution and saved consumers money, while also lowering GHG emissions.

Environmental Progress and a Resilient Economy

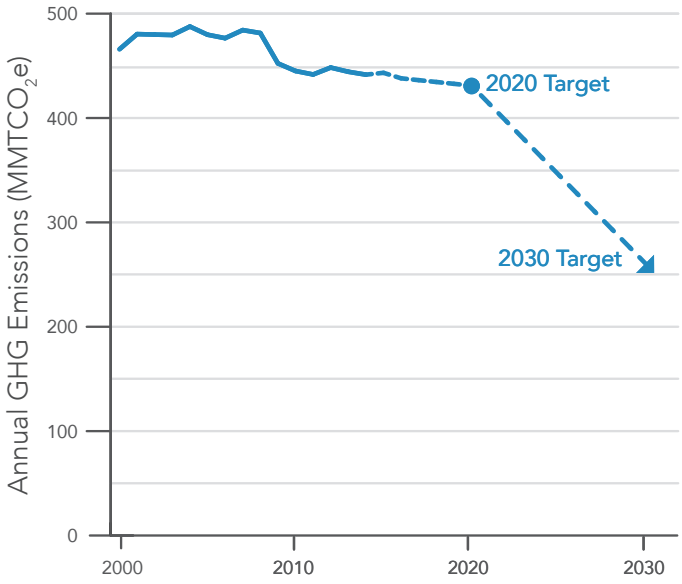


The California economy has grown while becoming less carbon intensive.

AB 32 set California's first GHG target called on the state to reduce emissions to 1990 levels by 2020. California is on track to exceed its 2020 climate target, while the economy continues to grow. Since the launch of many of the state's major climate programs, including Cap-and-Trade, economic growth in California has consistently outpaced economic growth in the rest of the country. The state's average annual growth rate has been double the national average – and ranks second in the country since Cap-and-Trade took effect in 2012. In short, California has succeeded in reducing GHG emissions while also developing a cleaner, resilient economy that uses less energy and generates less pollution.

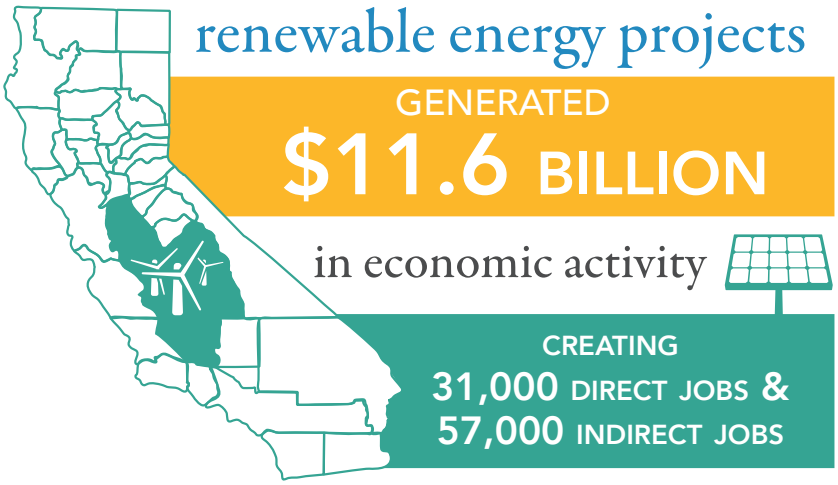
Importantly, the State's 2020 and 2030 targets have not been set in isolation. They represent benchmarks, consistent with prevailing climate science, charting an appropriate trajectory forward that is in line with California's role in stabilizing global warming below dangerous thresholds. As we consider efforts to reduce emissions to meet the State's near-term requirements, we must do so with an eye toward reductions needed beyond 2030. The Paris Agreement – which calls for limiting global warming to well below 2 degrees Celsius and pursuing efforts to limit it to 1.5 degrees Celsius – frames our path forward.

California's Path Forward



California's Path to 2030

Executive Order B-30-15 and SB 32 extended the goals of AB 32 and set a 2030 goal of reducing emissions 40 percent from 2020 levels. This action keeps California on target to achieve the level of reductions scientists say is necessary to meet the Paris Agreement goals. This is an ambitious goal – calling on the State to double the rate of emissions reductions. Nevertheless, it is an achievable goal.



This Plan establishes a path that will get California to its 2030 target. Given our ambitious goals, this Plan is built on unprecedented outreach and coordination. Over 20 state agencies collaborated to produce the Plan, informed by 15 state agency-sponsored workshops and more than 500 public comments. The broad range of state agencies involved reflects the complex nature of addressing climate change, and the need to work across institutional boundaries and traditional economic sectors to effectively reduce GHG emissions. As part of the Plan development, alternative strategies were considered and evaluated, ranging from carbon taxes to individual facility caps to relying solely on sector-specific regulations. In addition, efforts were made to ensure that the Plan would benefit all Californians. To this end, the Environmental Justice Advisory Committee (EJAC), a Legislatively created advisory body, convened almost 20 community meetings throughout California to discuss the climate strategy, and held 19 meetings of its own to provide recommendations on the Plan.

This Plan draws from the experiences in developing and implementing previous plans to present a path to reaching California's 2030 GHG reduction target. The Plan is a package of economically viable and technologically feasible actions to not just keep California on track to achieve its 2030 target, but stay on track for a low- to zero-carbon economy by involving every part of the state. Every sector, every local government, every region, every resident is part of the solution. The Plan underscores that there is no single solution but rather a balanced mix of strategies to achieve the GHG target. This Plan highlights the fact that a balanced mix of strategies provides California with the greatest level of certainty in meeting the target at a low cost while also improving public health, investing in disadvantaged and low-income communities, protecting consumers, and supporting economic growth, jobs and energy diversity. Successful implementation of this Plan relies, in part, on long-term funding plans to inform future appropriations necessary to achieve California's long-term targets.

California's Climate Policy Portfolio

- Double building efficiency
- 50% renewable power
- More clean, renewable fuels
- Cleaner zero or near-zero emission cars, trucks, and buses
- Walkable/Bikeable communities with transit
- Cleaner freight and goods movement
- Slash potent "super-pollutants" from dairies, landfills and refrigerants
- Cap emissions from transportation, industry, natural gas, and electricity
- Invest in communities to reduce emissions

California's Climate Vision

Create Inclusive Policies and Broad Support for Clean Technologies

Remarkable progress over the past 10 years has put the global energy and transportation sector on a transformative path to cleaner energy. Far outpacing previous predictions, today solar and wind power are often less expensive than coal or natural gas, and they now comprise the majority of global investment in the power sector. Electric vehicle battery costs have tumbled even more quickly than solar costs, while performance has improved dramatically, and the auto industry is committed to an electric future.

California's policies have created markets for energy efficiency, energy storage, low carbon fuels, renewable power – including utility-scale and residential-scale solar – and zero-emission vehicles. Our companies are thriving, making those markets grow. California is home to nearly half of the zero-emission vehicles in the U.S., 40 percent of North American clean fuels investments, the world's best known electric car manufacturer, and the world's leading ride-sharing services. California is further advancing efficient land use policies that reduce auto dependency. Altogether, we're unleashing nonlinear transitions to clean energy and clean transportation technologies that will put California on the path to meeting our 2030 target and the goals of the Paris Agreement.

California is home to

NEARLY **50%** OF THE ZEVs IN THE U.S.

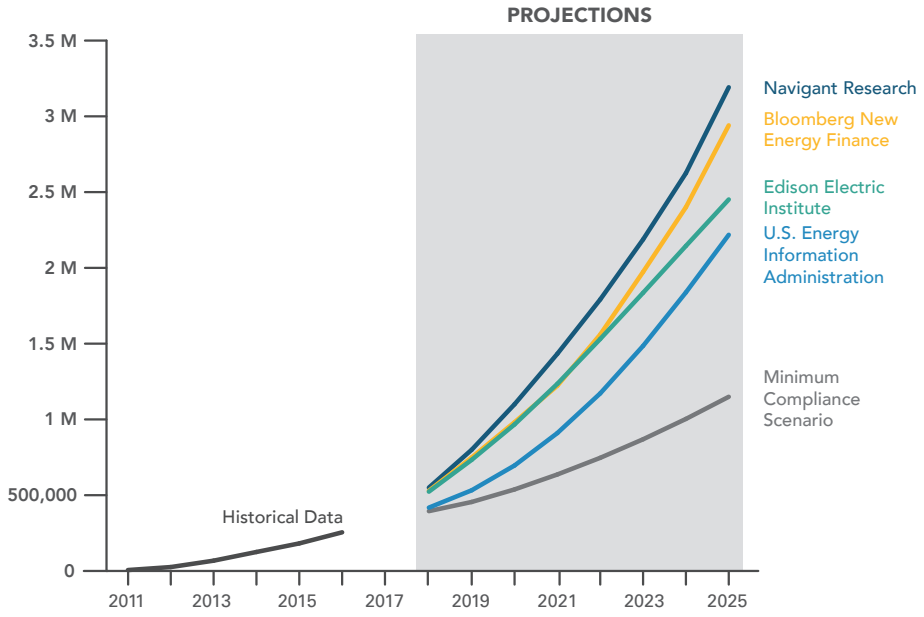
40% OF NORTH AMERICAN **CLEAN FUEL** INVESTMENTS

&

90% OF TOTAL U.S. INVESTMENT IN **CLEAN TRANSPORTATION**

California policymaking has succeeded through thoughtful planning, bolstered by an open public process that solicits the best ideas from a wide array of sources, and by integrating effective regulation with targeted investments to provide broad market support for clean technologies. A key element of California's approach continues to be careful monitoring and reporting on the results of our programs and a willingness to make mid-course adjustments. As the State looks to 2030 and beyond, all sectors of the economy must benefit from these ideas to create a new and better future.

Cumulative California ZEV Sales Projections



Experience has shown clean technology and markets continue to outpace expectations.

Legislative Leadership on Climate

The California Legislature has shaped the State's climate change program, setting out clear policy objectives over the next decade:

- 40% reduction in GHG emissions by 2030;
- 50% renewable electricity;
- Double energy efficiency savings;
- Support for clean cars;
- Integrate land use, transit, and affordable housing to curb auto trips;
- Prioritize direct reductions;
- Identify air pollution, health, and social benefits of climate policies;
- Slash "super pollutants";
- Protect and manage natural and working lands;
- Invest in disadvantaged communities; and
- Strong support for Cap-and-Trade.

The benefits of innovative technologies need to reach all residents and businesses. Air pollution reductions and the associated health benefits should be targeted to communities where they are needed most. All Californians need access to clean transportation options that enable healthy communities to develop and thrive, including walking, cycling, transit, rail, and clean vehicle options.

Although GHG reductions can help to reduce harmful air pollution, California must concurrently employ other strategies to accelerate reductions of pollutants from large industrial sources that adversely impact communities. Newly passed AB 617 strengthens existing criteria and toxic air pollutant programs and our partnerships with local air districts to further reduce harmful air pollutants and protect communities. More fundamentally, AB 617 establishes a comprehensive statewide program – the first of its kind – to address air pollution where it matters most: in neighborhoods with the most heavily polluted air.

California's Goals

California's environmental justice and equity movement is establishing a blueprint for the nation and world. The State is pioneering targeted environmental and economic development programs to help those most in need. So far, half of all California Climate Investments, stemming from the State's Cap-and-Trade-Program, have been used to provide benefits in the 25 percent of California communities that are most disadvantaged by environmental and socio-economic burdens. By increasingly engaging with, and investing in, these communities – investing in technical assistance resources, holding listening sessions, improving our programs, and accelerating our efforts to bring the cleanest technologies to mass market – all California residents can have clean air to breathe, clean water to drink, and opportunities to participate in the cleaner economy.

Achieving Success in Equity and Access

- Continue to engage local organizations and invest in disadvantaged communities to ensure broad access to clean technologies;
- Ensure air pollution reductions happen where they are needed the most;
- Integrate across programs and agencies to ensure complementary policies provide maximum benefits to disadvantaged communities;
- Implement California Energy Commission and CARB recommendations to overcome barriers to clean energy and clean transportation options for low-income residents;
- Provide energy-efficient affordable housing near job centers and transit; and
- Implement AB 617 to dramatically improve air quality in local communities through targeted action plans.

Enhance Industrial Efficiency & Competitiveness

California leads the country in manufacturing and industrial efficiency. For every dollar spent on electricity, our manufacturers produce 55 percent more value than the national average. And the efficiency of California industry continues to grow at rates faster than the national average. High efficiency rates, coupled with the Cap-and-Trade Program's firm emission cap, allow economic activity to increase without corresponding increases in GHG emissions. In other words, the more California produces, the better it is for the planet. Maintaining and extending our successful programs – from the Cap-and-Trade Program and Low Carbon Fuel Standard to zero-emission, renewable energy and energy efficiency programs – will reduce GHGs, increase energy cost savings, offer businesses flexibility to reduce emissions at low cost and provide clear policy and market direction, and certainty, for business planning and investment. This will encourage continued research, evaluation, and deployment of innovative strategies and technology to further reduce emissions in the industrial sector through advances in energy efficiency and productivity, increased access to cleaner fuels, and carbon capture, utilization and storage.

Action on HFCs

Hydrofluorocarbons (HFCs) represent one of the biggest opportunities to reduce GHGs in the State through 2030 due to their high climate impacts, and in many cases, offer energy efficiency and financial savings, as well. The world recently agreed to phase down their use, but California has committed to move more quickly, in line with the scope of the opportunity for cost-effective emissions reductions in the State.

Achieving Success in Industrial Efficiency and Competitiveness

- Evaluate and implement policies and measures to continue reducing GHG, criteria, and toxic air contaminant emissions from sources such as refineries;
- Improve productivity and strengthen economic competitiveness by further improving energy efficiency and diversifying fuel supplies with low carbon alternatives;
- Prioritize procurement of goods that have lower carbon footprints
- Support and attract industry that produces goods needed to reduce GHGs; and
- Cut energy costs and GHG emissions by quickly transitioning to efficient HFC alternatives.

Prioritize Transportation Sustainability

California's transportation system underpins our economy. The extensive freight system moves trillions of dollars of goods each year and supports nearly one-third of the state economy and more than 5 million jobs. The way we plan our communities impacts everything from household budgets to infrastructure needs, productivity lost to congestion, protection of natural and working landscapes, and our overall health and well-being. And transportation is the largest source of GHG, criteria, and toxic diesel particulate matter emissions in the state.

RENEWABLE BIO DIESEL USE

has increased 7000% since 2011

California's ability to remain an economic powerhouse and environmental leader requires additional efforts to improve transportation sustainability with a comprehensive approach that includes regulation, incentives, and investment. This approach addresses a full range of transportation system improvements relating to efficient land use, affordable housing, infrastructure for cyclists and pedestrians, public transit, new vehicle technologies, fuels and freight. One example is the deployment of the nation's first high-speed rail system, which will include seamless connections to local transit.

The approach is working: California is home to nearly half of the country's zero-emission vehicles. Innovative alternative fuel producers and oil companies are bringing more low carbon fuels to market than required by the Low Carbon Fuel Standard. And, the State has committed to investing billions in zero-emission vehicles and infrastructure, land use planning, and active transportation options such as walking and biking. In fact, renewable fuels in the heavy-duty vehicle sector are displacing diesel fossil fuel as quickly as renewable power is replacing fossil fuels on the electricity grid. California's climate policies will also reduce fossil fuel use and decouple the state from volatile global oil prices. CARB's analyses show fossil fuel demand will decrease by more than 45 percent by 2030, which means Californians will be using less gasoline and diesel resulting in healthier air and cost-savings on transportation fuels. These benefits will be further amplified as we move away from light-duty combustion vehicles.

By re-doubling our efforts, California can make sure that markets tip quickly and definitively in the favor of electric cars, trucks, buses, and equipment, while increasing the use of clean, low carbon fuels where zero-emissions options are not yet available. Local transportation planning can make communities become healthier and more vibrant and connected – encouraging housing, walking, biking and transit policies that reduce GHGs and promote good quality of life. And, we can work to ensure that an efficient sustainable freight system continues to power our ever-growing economy.

Achieving Success in Transportation Sustainability

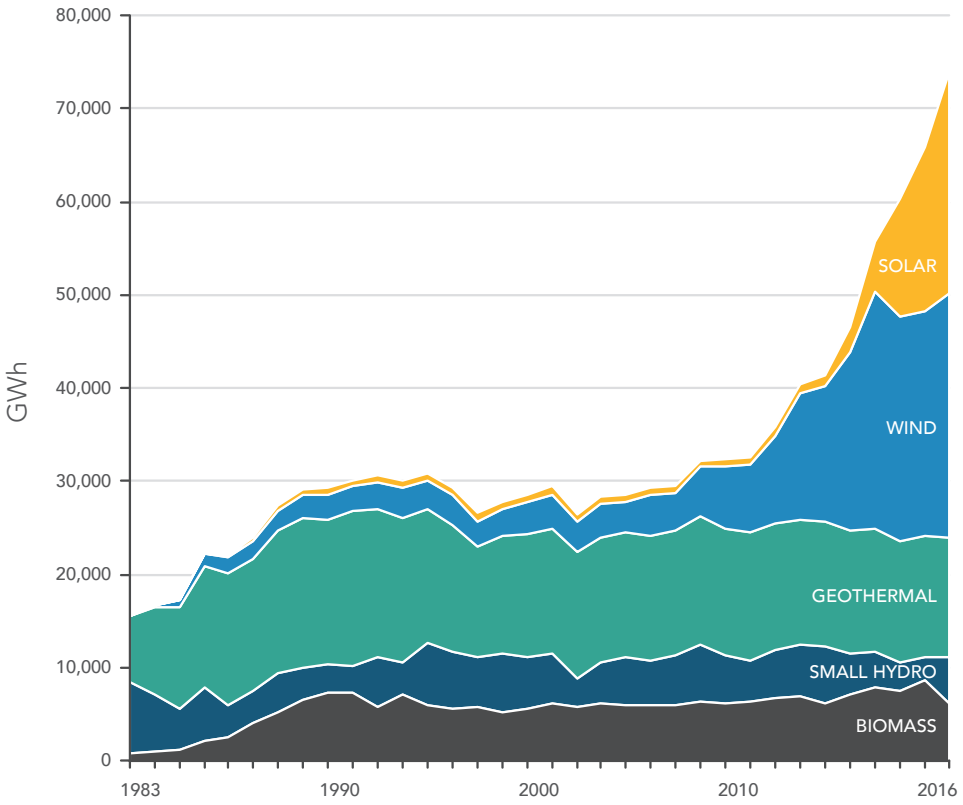
- Connect California's communities with a state-of-the-art high-speed rail system;
- Promote vibrant communities and landscapes through better planning efforts to curb vehicle-miles-traveled and increase walking, biking and transit;
- Build on the State's successful regulatory and incentive-based policies to quickly make clean cars, trucks, buses, and fuels definitive market winners;
- Coordinate agency activities to ensure that emerging automated and connected vehicle technologies reduce emissions; and
- Improve freight and goods movement efficiency and sustainability to enable California's continued economic growth.

Continue Leading on Clean Energy

California is well ahead of schedule in meeting its renewable energy targets. Wind and solar generation have grown exponentially in recent years, while hydroelectric, geothermal, and biomass have consistently contributed renewable power to our energy supply. Californians are the ones who will take action to meet energy efficiency targets, integrate renewable power through demand response, and drive demand for net zero energy buildings. This includes self-generation which also grew exponentially in recent years with installed solar totaling 2,000 megawatts (MW) in 2014 and 5,100 MW of the total statewide self-generation installed solar in 2015. By June 2017, solar installed in California was about 5,800 MW, far exceeding the State's goals.

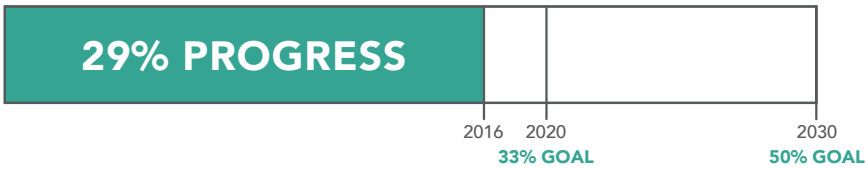
The Renewable Portfolio Standard, Carbon Pricing, and lower costs for renewable technology are delivering real environmental benefits.

Increasing Renewable Electricity Generation (in & out of state)



While at this time natural gas is an important energy source, we must move toward cleaner heating fuels and replicate the progress underway for electricity. As with electricity, this starts with efficiency and demand reduction, including building and appliance electrification where these advancements make sense. It calls for minimizing fugitive methane leaks throughout the system, including beyond California's borders where 90 percent of the natural gas used here originates. And, it includes using more renewable gas – a valuable in-state resource made from waste products – especially in the transportation sector. Replacing fossil fuels with renewable gas can reduce potent short-lived climate pollutants, and state policies should support this effort. Reducing demand for natural gas, and moving toward renewable natural gas, will help California achieve its 2030 climate target. However, switching from natural gas to electricity – where feasible and demonstrated to reduce GHGs – is needed to stay on track to achieve our long-term goals.

Reaching California's Clean Electricity Goals



The State's 3 largest investor-owned utilities are on track to achieve a 50% RPS by 2020.

Achieving Success in Clean Energy

- Effectively integrate at least 50 percent renewables as the primary source of power in the State through coordinated planning, additional deployments of energy storage, and grid regionalization;
- Utilize distributed resources and engage customers by making net zero energy buildings standard, implement Existing Buildings Energy Efficiency Action Plan to double existing building efficiency, and increase access to energy efficiency, renewable energy, and energy use data; and
- Reduce the use of heating fuels while concurrently making what is used cleaner by minimizing fugitive methane leaks, prioritizing natural gas efficiency and demand reduction, and enabling cost-effective access to renewable gas.

Put Waste Resources to Beneficial Use

Effectively managing waste streams is perhaps the most basic of environmental tenets. "Reduce, re-use, and recycle" is a mantra known even to elementary school students. For decades California law has reduced waste reaching landfills and recaptured value from waste streams through recycling and composting. California law requires reducing, recycling, or composting 75 percent of solid waste generated by 2020. The State also has specific goals for diverting organic waste, which decomposes in landfills to produce the super pollutant methane. State law also directs edible food to hungry families rather than having it discarded.

Capturing value from waste makes sense. As described in the Healthy Soils Initiative, compost from organic matter provides soil amendments to revitalize farmland, reduces irrigation and landscaping water demand, and potentially increases long-term carbon storage in rangelands. Organic matter can also provide a clean, renewable energy source in the form of bioenergy, biofuels, or renewable natural gas.

California should take ownership of its waste and adhere to a waste "loading order" that prioritizes waste reduction, re-use, and material recovery over landfilling. The State can take steps to reduce waste from packaging, which constitutes about one-quarter of California's waste stream. It can invest in and streamline in-state infrastructure development to support recycling, remanufacturing, composting, anaerobic digestion, and other beneficial uses of organic waste. And, it can help communities in their efforts to recover food for those in need.

Achieving Success in Putting Waste Resources to Beneficial Use

- Develop and implement programs, including edible food waste recovery, to divert organics from landfills and reduce methane emissions;
- Develop and implement a packaging reduction program; and
- Identify a sustainable funding mechanism to support waste management programs, including infrastructure development to support organics diversion.

Support Resilient Agricultural and Rural Economies and Natural and Working Lands

California's natural and working landscapes, like forests and farms, are home to the most diverse sources of food, fiber, and renewable energy in the country. They underpin the state's water supply and support clean air, wildlife habitat, and local and regional economies. They are also the frontiers of climate change. They are often the first to experience the impacts of climate change, and they hold the ultimate solution to addressing climate change and its impacts. In order to stabilize the climate, natural and working lands must play a key role.

Work to better quantify the carbon stored in natural and working lands is continuing, but given the long timelines to change landscapes, action must begin now to restore and conserve these lands. We should aim to manage our natural and working lands in California to reduce GHG emissions from business-as-usual by at least 15-20 million metric tons in 2030, to complement the measures described in this Plan.

Improved forest management on tribal lands has preserved almost 3 million metric tons of carbon in California and the revenues from the carbon offsets have been used to secure ownership of ancestral lands.

Natural and working lands can be better incorporated into California's climate change mitigation efforts by encouraging collaboration with local and regional organizations and increasing investment to protect, enhance, and innovate in our rural landscapes and communities. The State is partnering with tribes to preserve carbon, protect tribal forest lands and increase their land base. Transportation and land use planning should minimize the footprint of the built environment, while supporting and investing in efforts to restore, conserve and strengthen natural and working lands. California's forests should be healthy carbon sinks that minimize black carbon emissions where appropriate, supply new markets for woody waste and non-merchantable timber, and provide multiple ecosystem benefits. Rehabilitating and strengthening wetlands and tidal environments, and incorporating natural landscapes into urban environments will also help make natural and working lands part of the state's climate solution. Finally, California farmers can be a powerful force in the fight against climate change, in how they manage their lands, tend their crops, and husband their livestock.

Achieving Success in Supporting Resilient Agricultural and Rural Economies and Natural and Working Lands

- Protect, enhance and innovate on California's natural and working lands to ensure natural and working lands become a net carbon sink over the long-term;
- Develop and implement the Natural and Working Lands Implementation Plan to maintain these lands as a net carbon sink and avoid at least 15-20 metric tons of GHG emissions by 2030;
- Measure and monitor progress by completing CARB's Natural and Working Lands Inventory and implementing tracking and performance monitoring systems; and
- Unleash opportunity in the agricultural sector by improving manure management, boosting soil health, generating renewable power, electrifying operations, utilizing waste biomass, and increasing water, fertilizer, and energy use efficiency to reduce super pollutants.

Secure California's Water Supplies

Water is California's lifeblood. It sustains communities and drives the economy. An elaborate network of storage and delivery systems has enabled the state to prosper and grow. But this aging system was built for a previous time and is increasingly challenged by the realities of climate change and population growth.

The Water-Energy Nexus

- About 12% of the total energy used in the state is related to water, with 2% for conveyance, treatment and distribution, and 10% for end-customer uses like heating and cooling.
- The water-energy nexus provides opportunities for conservation of these natural resources as well as reduction of GHGs.

Producing, moving, heating and treating water demands significant energy and produces commensurately significant emissions. As California looks to the future, meeting new demands and sustaining prosperity requires increased water conservation and efficiency, improved coordination and management of various water supplies, greater understanding of the water-energy nexus, and deployment of new technologies in drinking water treatment, groundwater remediation and recharge, and potentially brackish and seawater desalination. State efforts must support systemic shifts toward conservation, efficiency, and renewable energy in the water sector.

Achieving Success in Securing California's Water Supplies

- Increase water savings by certifying innovative technologies for water conservation and developing and implementing new conservation targets, updated agricultural water management plans, and long term conservation regulations;
- Develop a voluntary registry for GHG emissions from energy use associated with water; and
- Continue to increase the use of renewable energy to operate the State Water Project.

Cleaning the Air and Public Health

The benefits of this Plan are broader than just climate change – implementation of the Plan will also help improve public health. The Plan incorporates freight and mobile source strategies which will deliver reductions in criteria and toxic air pollutants to improve air quality.

Climate Plan Provides Health Benefits in 2030

AVOIDED PREMATURE DEATHS	VALUE OF AVOIDED HEALTH IMPACTS	VALUE OF AVOIDED DAMAGES USING SOCIAL COST OF CARBON
~ 3,300	$1.2-1.8 billion	$1.9-11.2 billion

California continues to seek ways to improve implementation of its climate program and its ability to address the unique set of impacts facing the state's most pollution burdened communities. In addition, CARB's environmental justice efforts are intended to reach far beyond climate change. While this Plan provides a path for reducing GHG emissions in disadvantaged communities, it also includes new tools that will complement the Plan and lead to further air quality improvements.

In particular, implementation of AB 617 will improve air quality in local communities, in partnership with local air districts, using targeted investments in neighborhood-level air monitoring and the development of air pollution reduction action plans with strong enforcement programs. These plans will require pollution reductions from both mobile and stationary sources. Through these efforts, CARB anticipates, and will work for, increased data transparency and the adoption of new statewide air pollutant emission controls that will not only confer short-term benefits to those most in need of improvement, but which will ultimately benefit all Californians.

Under the leadership of CARB's first executive-level environmental justice liaison, the agency is also laying a roadmap to better serve California's environmental justice communities in the design and implementation across its broader programs.

Successful Example of Carbon Pricing and Investment

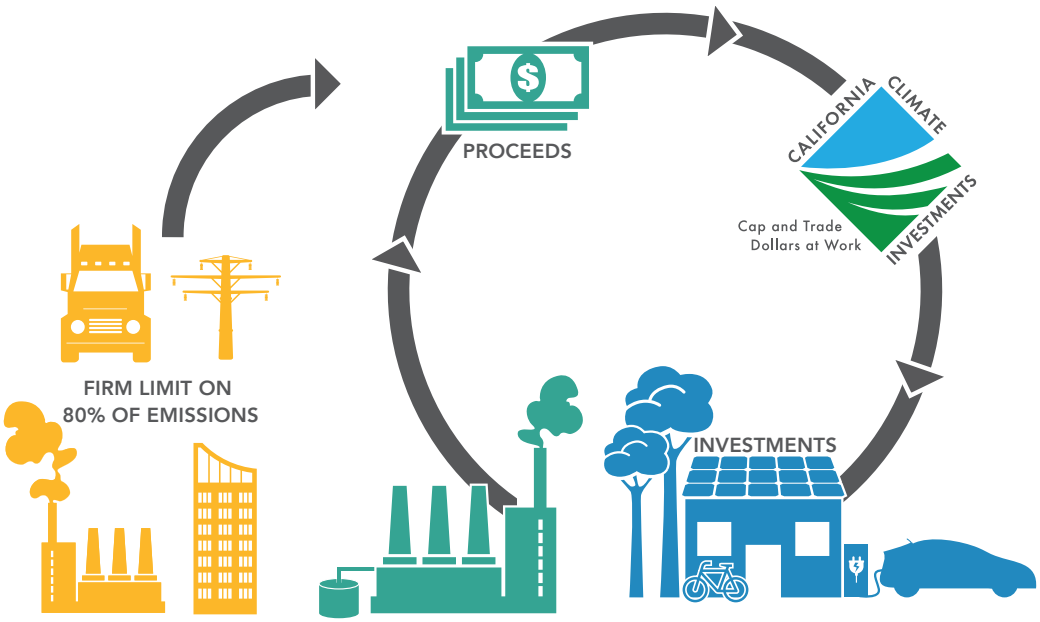
The Cap-and-Trade Program is fundamental to meeting California's long-range climate targets at low cost. The Cap-and-Trade Program includes GHG emissions from transportation, electricity, industrial, agricultural, waste, residential and commercial sources, and caps them while complementing the other measures needed to meet the 2030 GHG target. Altogether, the emissions covered by the Cap-and-Trade program total 80 percent of all GHG emissions in California. California's response to climate change has led to many innovative programs designed to reduce GHG emissions, including the Renewable Portfolio and Low Carbon Transportation Standards, but the Cap-and-Trade Program guarantees GHG emissions reductions through a strict overall emissions limit that decreases each year, while trading provides businesses with flexibility in their approach to reducing emissions. The Cap-and-Trade Program also generates revenue when the allowances to emit pollution are auctioned. Some of the revenue is returned directly to electricity ratepayers, and the rest is dedicated to reducing GHG emissions by making Legislatively directed investments in California with an emphasis on programs or projects that benefit disadvantaged and low-income communities.

Cap-and-Trade Program

- Firm, declining cap provides highest certainty to achieve 2030 target.
- Low cost GHG emission reductions minimize impact on consumers and economy.
- Flexibility for businesses
- Can be linked with similar programs worldwide.

Including the latest budget, approximately $5 billion has been appropriated to reduce GHG emissions, reduce air pollutant emissions where reductions are needed most, grow markets for clean technologies, and spur emissions reductions in sectors not covered by Cap-and-Trade. These investments are strengthening the economy and improving public health – especially in the areas of the state most burdened by pollution. So far, half of the $1.2 billion spent provides benefits to disadvantaged communities, and one-third of those investments were made directly in those communities.

California's Carbon Pricing & Investments Overview



California's Cap-and-Trade Program is the most comprehensive, effective, and well-designed carbon market on the planet. Today, the Program is linked with a similar program in Quebec and will link with a similar program in Ontario beginning in 2018. Nearly 40 countries and over 20 subnational entities – altogether representing nearly a quarter of global emissions – have developed, or are developing, emissions trading programs. Each of them looks to California and our linked Western Climate Initiative Partners as they design, implement, and refine their own programs.

Cap-and-Trade Dollars at Work (2017)

- Nearly 30,000 projects installing efficiency measures in homes
- 105,000+ rebates issued for zero-emission and plug-in hybrid vehicles
- 16,000+ acres of land preserved or restored
- 200+ transit agency projects funded, adding or expanding transit options
- 6,200+ trees planted in urban areas
- 1,100+ new affordable housing units under contract
- 50% of projects benefiting Disadvantaged Communities ($614M)
- 140,000+ total projects implemented

Fostering Global Action

Through the State's leadership in the Cap-and-Trade Program, innovative sector-specific policies that are reducing technology costs and GHG emissions, and community-scale engagement and investments to reduce GHGs and promote equity, California is playing a significant role in addressing global climate change.

Governor Brown has stated that climate change is the most important issue of our lifetime, and has promoted scientifically sound approaches to address climate change in California and beyond. He has participated in international climate discussions at the United Nations headquarters in New York, the United Nations Climate Change Conference in Paris, the Vatican, and the Climate Summit of the Americas in Canada – calling on other subnational and national leaders to join California in the fight against climate change. He has signed climate change agreements with leaders from Chile, China, the Czech Republic, Israel, Japan, Mexico, the Netherlands, other North American states and provinces, and Peru. He has joined an unprecedented alliance of heads of state, city and state leaders – convened by the World Bank Group and International Monetary Fund – to urge countries and companies around the globe to put a price on carbon. And California is a founding member of the International Zero Emission Vehicle (ZEV) Alliance, a coalition of national and subnational governments working to accelerate the adoption of ZEVs and make all new

cars zero emissions. Delegations from around the world travel to Sacramento to meet with the architects and implementers of California's climate policies to learn how to successfully combine strong greenhouse gas policies with a strong economy.

Perhaps most significant is the Under2Coalition. It is a global climate pact – spearheaded by Governor Brown – among states, provinces, countries, and cities all committing to do their part to limit the increase in global average temperatures below the dangerous levels. Signatories commit to either reducing greenhouse gas emissions 80 to 95 percent below 1990 levels by 2050 or achieving a per capita annual emission target of less than 2 metric tons by 2050. More than 200 jurisdictions from 38 countries and six continents have now signed or endorsed the agreement. Together, members of the Under2Coalition represent more than 1.2 billion people and $28.8 trillion in GDP, equivalent to 39 percent of the global economy.

Unleashing the California Spirit

This Plan is a declaration of California's path forward. It builds on the State's successful approach to addressing climate change and harnesses the California spirit to propel a cleaner economy, while serving as an example for others.

But this Plan will not be successful on its own. Our collective, and individual, efforts must reach every sector of California's economy, and every community in the state. As California faces the challenge of climate change, it will succeed as it always has – through open, inclusive processes, through support of clean technology markets, and through a relentless pursuit of a healthy California for all.

There should be no doubt that California is united in understanding the need to act, and in the will to act. Investments in clean, low-carbon options will pay off – for the environment and the economy. Investments and training in education and workforce development for a lower carbon economy are a critical part of this transition.

This Plan is only the beginning. All of the measures in the Plan will be developed in their own public process, shaped not just by the vision of this Plan, but also by the best understanding of the technology, costs and impacts on communities – and by input from a broad range of stakeholders and perspectives with the recognition that achieving the 2030 target is a milestone on our way to the deeper GHG reductions needed to protect the environment and our way of life. The Plan also proposes developing a long-term funding plan to inform future appropriations necessary to achieve our long-term targets, which will send clear market and workforce development signals.

Climate change presents unprecedented challenges, but just as we have always done, Californians will tackle them with innovation, inclusion and ultimately, success.

Chapter 1

Introduction

Background

In November 2016, California Governor Edmund G. Brown affirmed California's role in the fight against climate change in the United States, noting, "We will protect the precious rights of our people and continue to confront the existential threat of our time–devastating climate change." By working to reduce the threat facing the State and setting an example, California continues to lead in the climate arena. This Scoping Plan for Achieving California's 2030 Greenhouse Gas Target (Scoping Plan or 2017 Scoping Plan) identifies how the State can reach our 2030 climate target to reduce greenhouse gas (GHG) emissions by 40 percent from 1990 levels, and substantially advance toward our 2050 climate goal to reduce GHG emissions by 80 percent below 1990 levels. By selecting and pursuing a sustainable and clean economy path for 2030, the State will continue to successfully execute existing programs, demonstrate the coupling of economic growth and environmental progress, and enhance new opportunities for engagement within the State to address and prepare for climate change.

This Scoping Plan builds on and integrates efforts already underway to reduce the State's GHG, criteria pollutant, and toxic air contaminant emissions. Successful implementation of existing programs has put California on track to achieve the 2020 target. Programs such as the Low Carbon Fuel Standard and Renewables Portfolio Standard are delivering cleaner fuels and energy, the Advanced Clean Cars Program has put more than a quarter million clean vehicles on the road, and the Sustainable Freight Action Plan will result in efficient and cleaner systems to move goods throughout the State. Enhancing and implementing these ongoing efforts puts California on the path to achieving the 2030 target. This Scoping Plan relies on these, and other, foundational programs paired with an extended, more stringent Cap-and-Trade Program, to deliver climate, air quality, and other benefits.

In developing this Scoping Plan, it is paramount that we continue to build on California's success by taking effective actions. We must rapidly produce real results to avoid the most catastrophic impacts of climate change. The Scoping Plan identifies policies based on solid science and identifies additional research needs, while also recognizing the need for flexibility in the face of a changing climate. Ongoing research to better understand systems where our knowledge is weaker will allow for additional opportunities to set targets and identify actionable policies. Further, a long-term funding plan to inform future appropriations is critical to achieve our long-term targets, which will send clear market and workforce development signals.

Climate Legislation and Directives

California has made progress on addressing climate change during periods of both Republican and Democratic national and State administrations. California's governors and legislature prioritize public health and the environment. A series of executive orders and laws have generated policies and actions across State government, among local and regional governments, and within industry. These policies also have encouraged collaboration with federal agencies and spurred partnerships with many jurisdictions beyond California's borders. Moving forward, California will continue its pursuit of collaborations and advocacy for action to address climate change. The following list provides a summary of major climate legislation and executive orders that have shaped California's climate programs.

Assembly Bill 32 (AB 32) (Nuñez, Chapter 488, Statutes of 2006), the California Global Warming Solutions Act of 2006.

- Cut the State's GHG emissions to 1990 levels by 2020 with maintained and continued reductions post 2020.
- First comprehensive climate bill in California, a defining moment in the State's long history of environmental stewardship.

- Secured the State's role as a national and global leader in reducing GHGs.

Pursuant to AB 32, the California Air Resources Board (CARB or Board) prepared and adopted the initial Scoping Plan to "*identify and make recommendations on direct emissions reductions measures, alternative compliance mechanisms, market-based compliance mechanisms, and potential monetary and non-monetary incentives*" in order to achieve the 2020 goal, and to achieve "*the maximum technologically feasible and cost-effective GHG emissions reductions*" by 2020 and maintain and continue reductions beyond 2020. AB 32 requires CARB to update the Scoping Plan at least every five years.

Executive Order B-30-15

In his January 2015 inaugural address, Governor Brown identified actions in five key climate change strategy "pillars" necessary to meet California's ambitious climate change goals. These five pillars are:

- Reducing today's petroleum use in cars and trucks by up to 50 percent.
- Increasing from one-third to 50 percent our electricity derived from renewable sources.
- Doubling the efficiency savings achieved at existing buildings and making heating fuels cleaner.
- Reducing the release of methane, black carbon, and other short-lived climate pollutants.
- Managing farm and rangelands, forests, and wetlands so they can store carbon.

Consistent with these goals, Governor Brown signed Executive Order B-30-15 in April 2015:

- Establishing a California GHG reduction target of 40 percent below 1990 levels by 2030.
- Calling on CARB, in coordination with sister agencies, to update the AB 32 Climate Change Scoping Plan to incorporate the 2030 target.
- Building out the "sixth pillar" of the Governor's strategy–to safeguard California in the face of a changing climate–highlighting the need to prioritize actions to reduce GHG emissions and build resilience in the face of a changing climate.

Senate Bill 350 (SB 350) (De Leon, Chapter 547, Statutes of 2015), Golden State Standards

- Required the State to set GHG reduction planning targets through Integrated Resource Planning in the electricity sector as a whole and among individual utilities and other electricity providers (collectively known as load serving entities).
- Codified an increase in the Renewables Portfolio Standard (RPS) to 50 percent by 2030[1] and doubled the energy savings required in electricity and natural gas end uses as discussed in the Governor's inaugural address.

Senate Bill 32 (SB 32) (Pavley, Chapter 249, Statutes of 2016), California Global Warming Solutions Act of 2016: emissions limit and Assembly Bill 197 (AB 197) (E. Garcia, Chapter 250, Statutes of 2016), State Air Resources Board: greenhouse gases: regulations.

SB 32 affirms the importance of addressing climate change by codifying into statute the GHG emissions reductions target of at least 40 percent below 1990 levels by 2030 contained in Governor Brown's Executive Order B-30-15. The 2030 target reflects the same science that informs the agreement reached in Paris by the 2015 Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC), aimed at keeping the global temperature increase below 2 degrees Celsius (°C). The California 2030 target represents the most ambitious GHG reduction goal for North America. Based on the emissions reductions directed by SB 32, the annual 2030 statewide target emissions level for California is 260 million metric tons of carbon dioxide equivalent ($MMTCO_2e$).

The companion bill to SB 32, AB 197, provides additional direction to CARB on the following areas related to the adoption of strategies to reduce GHG emissions.

- Requires annual posting of GHG, criteria, and toxic air contaminant data throughout the State, organized by local and sub-county level for stationary sources and by at least a county level for mobile sources.
- Requires CARB, when adopting rules and regulations to achieve emissions reductions

1 *http://www.cpuc.ca.gov/renewables/*

and to protect the State's most affected and disadvantaged communities, to consider the social costs of GHG emissions and prioritize both of the following:
    - Emissions reductions rules and regulations that result in direct GHG emissions reductions at large stationary sources of GHG emissions and direct emissions reductions from mobile sources.
    - Emissions reductions rules and regulations that result in direct GHG emissions reductions from sources other than those listed above.
- Directs CARB, in the development of each scoping plan, to identify for each emissions reduction measure:
    - The range of projected GHG emissions reductions that result from the measure.
    - The range of projected air pollution reductions that result from the measure.
    - The cost-effectiveness, including avoided social costs, of the measure.

CARB has begun the process to implement the provisions of AB 197. For instance, CARB is already posting GHG, criteria pollutant and toxic air contaminant data. CARB also incorporated air emissions data into a visualization tool in December 2016 in response to direction in AB 197 to provide easier access to this data.[2]

Senate Bill 1383 (SB 1383) (Lara, Chapter 395, Statutes of 2016), Short-lived climate pollutants: methane emissions: dairy and livestock: organic waste: landfills

- Requires the development, adoption, and implementation of a Short-Lived Climate Pollutant Strategy.[3, 4]
- Includes the following specific goals for 2030 from 2013 levels:
    - 40 percent reduction in methane.
    - 40 percent reduction in hydrofluorocarbon gases.
    - 50 percent reduction in anthropogenic black carbon.[5]

Short-lived climate pollutants (SLCPs), such as black carbon, fluorinated gases, and methane, are powerful climate forcers that have a dramatic and detrimental effect on air quality, public health, and climate change. These pollutants create a warming influence on the climate that is many times more potent than that of carbon dioxide. In March 2017, the Board adopted the Short-Lived Climate Pollutant Reduction Strategy (SLCP Strategy) establishing a path to decrease GHG emissions and displace fossil-based natural gas use. Strategies include avoiding landfill methane emissions by reducing the disposal of organics through edible food recovery, composting, in-vessel digestion, and other processes; and recovering methane from wastewater treatment facilities, and manure methane at dairies, and using the methane as a renewable source of natural gas to fuel vehicles or generate electricity. The SLCP Strategy also identifies steps to reduce natural gas leaks from oil and gas wells, pipelines, valves, and pumps to improve safety, avoid energy losses, and reduce methane emissions associated with natural gas use. Lastly, the SLCP Strategy also identifies measures that can reduce hydrofluorocarbon (HFC) emissions at national and international levels, in addition to State-level action that includes an incentive program to encourage the use of low-Global Warming Potential (GWP) refrigerants, and limitations on the use of high-GWP refrigerants in new refrigeration and air-conditioning equipment.

Assembly Bill 1504 (AB 1504) (Skinner, Chapter 534, Statutes of 2010): Forest resources: carbon sequestration

- Requires the Board of Forestry and Fire Protection to adopt district forest practice rules and regulations in accordance with specified policies to, among other things, assure the continuous growing and harvesting of commercial forest tree species.
- Requires the Board of Forestry and Fire Protection to ensure that its rules and regulations that govern the harvesting of commercial forest tree species consider the capacity of forest resources to sequester carbon dioxide emissions sufficient to meet or exceed the sequestration target of 5 million metric tons of carbon dioxide annually, as established in the first AB 32 Climate Change Scoping Plan.

2 CARB. 2016. CARB's Emission Inventory Activities. *www.arb.ca.gov/ei/ei.htm*
3 CARB. Reducing Short-Lived Climate Pollutants in California. *www.arb.ca.gov/cc/shortlived/shortlived.htm*
4 Senate Bill No. 605. *leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB605*
5 Senate Bill No.1383. *leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB1383*

Senate Bill 1386 (SB 1386) (Wolk, Chapter 545, Statutes of 2016): Resource conservation, natural and working lands

- Declares it the policy of the State that protection and management of natural and working lands, as defined, is an important strategy in meeting the State's GHG reduction goals.
- Requires State agencies to consider protection and management of natural and working lands in establishing policies and grant criteria, and in making expenditures, and "implement this requirement in conjunction with the State's other strategies to meet its greenhouse gas emissions reduction goals."

Assembly Bill 398 (AB 398) (E. Garcia, Chapter 135, Statutes of 2017): California Global Warming Solutions Act of 2006: market-based compliance mechanisms: fire prevention fees: sales and use tax manufacturing exemption

- Clarifies the role of the State's Cap-and-Trade Program from January 1, 2021, through December 31, 2030, continuing elements of the current program, but requiring CARB to make some post-2020 refinements.
- Establishes a Compliance Offsets Protocol Task Force to provide guidance to CARB in approving new offset protocols that increase projects with direct, in-state environmental benefits.
- Establishes the Independent Emissions Market Advisory Committee to report annually on the environmental and economic performance of the Cap-and-Trade Program and other climate policies.
- Identifies legislative priorities for allocating auction revenue proceeds, to include but not be limited to: air toxic and criteria air pollutants from stationary and mobile sources; low- and zero-carbon transportation alternatives; sustainable agricultural practices that promote transition to clean technology, water efficiency, and improved air quality; healthy forests and urban greening; short-lived climate pollutants; climate adaptation and resiliency; and climate and clean energy research.

In addition, AB 398 requires CARB to designate the Cap-and-Trade Program as the mechanism for reducing GHG emissions from petroleum refineries and oil and gas production facilities in this update to the Scoping Plan. With respect to local air districts, AB 398 states that it does not limit or expand the district's existing authority, including the authority to regulate criteria pollutants and toxic air contaminants, except that it prohibits an air district from adopting or implementing a rule for the specific purpose of reducing emissions of carbon dioxide from stationary sources that are subject to the Cap-and-Trade Program.

Assembly Bill 617 (AB 617) (C. Garcia, Chapter 136, Statutes of 2017): Nonvehicular air pollution: criteria air pollutants and toxic air contaminants.

This bill was passed as a companion to AB 398 (E. Garcia, 2017) to strengthen air quality monitoring and reduce air pollution at a community level, in communities affected by a high cumulative burden of exposure to pollution. CARB is required to prepare a monitoring plan by October 1, 2018, that assesses the State's current air monitoring network with recommendations for a set of high-priority locations around the State to deploy community focused air monitoring systems. Local air districts must deploy air monitoring systems in the selected high priority locations by July 1, 2019. Thereafter, CARB will evaluate and select additional locations for community air monitoring on an annual basis. The air districts must also deploy air monitoring systems within one year of CARB's selection of the high-priority locations. In addition to the monitoring plan, the bill requires CARB to develop a statewide strategy to reduce criteria pollutants and toxic air contaminants (TACs) in communities affected by high cumulative exposure burdens through approved community emissions reduction programs developed by local air districts, in partnership with residents in the affected communities; requires CARB to establish a uniform system of annual reporting of criteria pollutants and TACs for the existing statewide air monitoring network; and expedites implementation of best available retrofit control technology in non-attainment areas.

Tables summarizing the legislation described in this section, along with other climate related legislation and programs are included in Appendix H and organized by sector.

Initial Scoping Plan and First Update to the Scoping Plan

The Initial Scoping Plan[6] in 2008 presented the first economy-wide approach to reducing emissions and highlighted the value of combining both carbon pricing with other complementary programs to meet California's 2020 GHG emissions target while ensuring progress in all sectors. The coordinated set of policies in the Initial Scoping Plan employed strategies tailored to specific needs, including market-based compliance mechanisms, performance standards, technology requirements, and voluntary reductions. The Initial Scoping Plan also described a conceptual design for a cap-and-trade program that included eventual linkage to other cap-and-trade programs to form a larger regional trading program.

AB 32 requires CARB to update the scoping plan at least every five years. The First Update to the Scoping Plan[7] (First Update), approved in 2014, presented an update on the program and its progress toward meeting the 2020 limit. It also developed the first vision for long-term progress beyond 2020. In doing so, the First Update laid the groundwork for the goals set forth in Executive Orders S-3-05[8] and B-16-2012[9]. It also identified the need for a 2030 mid-term target to establish a continuum of actions to maintain and continue reductions, rather than only focusing on targets for 2020 or 2050.

Building on California's Environmental Legacy

California's successful climate policies and programs have already delivered emissions reductions resulting from cleaner, more fuel-efficient cars and zero emission vehicles (ZEVs), low carbon fuels, increased renewable energy, and greater waste diversion from landfills; water conservation; improved forest management; and improved energy efficiency of homes and businesses. Beyond GHG reductions, these policies and programs also provide an array of benefits including improved public health, green jobs, and more clean energy choices. The 2030 GHG emissions reduction target in SB 32 will ensure that the State maintains this momentum beyond 2020, mindful of the State's population growth and needs. This Scoping Plan identifies a path to simultaneously make progress on the State's climate goals as well as complement other efforts such as the State Implementation Plans (SIPs) and community emissions reduction programs to help improve air quality in all parts of the State.

California's future climate strategy will require continued contributions from all sectors of the economy, including enhanced focus on zero- and near-zero emission (ZE/NZE) vehicle technologies; continued investment in renewables, such as solar roofs, wind, and other types of distributed generation; greater use of low carbon fuels; integrated land conservation and development strategies; coordinated efforts to reduce emissions of short-lived climate pollutants (methane, black carbon, and fluorinated gases); and an increased focus on integrated land use planning to support livable, transit-connected communities and conservation of agricultural and other lands. Requirements for GHG reductions at stationary sources complement efforts of local air pollution control and air quality management districts (air districts) to tighten criteria and toxics air pollution emission limits on a broad spectrum of industrial sources, including in disadvantaged communities historically located adjacent to large stationary sources. Finally, meeting the State's climate, public health, and environmental goals will entail understanding, quantifying, and addressing emissions impacts from land use decisions at all governmental levels.

Purpose of the 2017 Scoping Plan

This Scoping Plan incorporates, coordinates, and leverages many existing and ongoing efforts and identifies new policies and actions to accomplish the State's climate goals. Chapter 2 of this document includes a description of a suite of specific actions to meet the State's 2030 GHG limit. In addition, Chapter 4 provides a broader description of the many actions and proposals being explored across the sectors, including the natural resources sector, to achieve the State's mid and long-term climate goals.

Guided by legislative direction, the actions identified in this Scoping Plan reduce overall GHG emissions in California and deliver policy signals that will continue to drive investment and certainty in a low carbon

6 CARB. Initial AB 32 Climate Change Scoping Plan. Available at: *www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf*

7 CARB. First Update to the AB 32 Scoping Plan. Available at: *www.arb.ca.gov/cc/scopingplan/document/updatedscopingplan2013.htm*

8 *www.gov.ca.gov/news.php?id=1861*

9 *www.gov.ca.gov/news.php?id=17472*

economy. This Scoping Plan builds upon the successful framework established by the Initial Scoping Plan and First Update, while identifying new, technologically feasible, and cost-effective strategies to ensure that California meets its GHG reduction targets in a way that promotes and rewards innovation, continues to foster economic growth, and delivers improvements to the environment and public health, including in disadvantaged communities. The Plan includes policies to require direct GHG reductions at some of the State's largest stationary sources and mobile sources. These policies include the use of lower GHG fuels, efficiency regulations, and the Cap-and-Trade Program, which constrains and reduces emissions at covered sources.

Process for Developing the 2017 Scoping Plan

This Scoping Plan was developed in coordination with State agencies, through engagement with the Legislature, and with open and transparent opportunities for stakeholders and the public to engage in workshops and other meetings. Development also included careful consideration of, and coordination with, other State agency plans and regulations, including the Cap-and-Trade Program, Low Carbon Fuel Standard (LCFS), State Implementation Plan, California Sustainable Freight Action Plan, California Transportation Plan 2040, Forest Carbon Plan, and the Short-Lived Climate Pollutant Strategy, among others.

To inform this Scoping Plan, CARB, in collaboration with the Governor's Office and other State agencies, solicited comments and feedback from affected stakeholders, including the public, and the Environmental Justice Advisory Committee (EJAC or Committee). The process to update the 2017 Scoping Plan began with the Governor's Office Pillar Symposia, which included over a dozen public workshops, and featured a series of Committee and environmental justice community meetings.[10]

One key message conveyed to CARB during engagement with the legislature, EJAC, and environmental justice communities was the need to emphasize reductions at large stationary sources, with a particular focus on multi-pollutant strategies for these sources to reduce GHGs and harmful criteria and toxic air pollutants that result in localized health impacts, especially in disadvantaged communities. Other consistent feedback for CARB included the need for built and natural infrastructure improvements that enhance quality of life, increase access to safe and viable transportation options, and improve physical activity and related health outcomes.

Updated Climate Science Supports the Need for More Action

Climate scientists agree that global warming and other shifts in the climate system observed over the past century are caused by human activities. These recorded changes are occurring at an unprecedented rate.[11] According to new research, unabated GHG emissions could allow sea levels to rise up to ten feet by the end of this century–an outcome that could devastate coastal communities in California and around the world.[12]

California is already feeling the effects of climate change, and projections show that these effects will continue and worsen over the coming centuries. The impacts of climate change have been documented by the Office of Environmental Health Hazard Assessment (OEHHA) in the Indicators of Climate Change Report, which details the following changes that are occurring already:[13]

- A recorded increase in annual average temperatures, as well as increases in daily minimum and maximum temperatures.
- An increase in the occurrence of extreme events, including wildfire and heat waves.
- A reduction in spring runoff volumes, as a result of declining snowpack.
- A decrease in winter chill hours, necessary for the production of high-value fruit and nut crops.
- Changes in the timing and location of species sightings, including migration upslope of flora and fauna, and earlier appearance of Central Valley butterflies.

10 *www.arb.ca.gov/cc/scopingplan/scopingplan.htm*

11 Cook, J., et al. 2016. Consensus on consensus: A synthesis of consensus estimates on human-caused global warming. Environmental Research Letters 11:048002 doi:10.1088/1748-9326/11/4/048002. *iopscience.iop.org/article/10.1088/1748-9326/11/4/048002*.

12 California Ocean Protection Council. 2017. Rising Seas in California: An Update On Sea-Level Rise Science. *www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf*

13 Office of Environmental Health Hazard Assessment, Indicators of Climate Change (website): *oehha.ca.gov/climate-change/document/indicators-climate-change-california*

In addition to these trends, the State's current conditions point to a changing climate. California's recent historic drought incited land subsidence, pest invasions that killed over 100 million trees, and water shortages throughout the State. Recent scientific studies show that such extreme drought conditions are more likely to occur under a changing climate.[14,15] The total statewide economic cost of the 2013–2014 drought was estimated at $2.2 billion, with a total loss of 17,100 jobs.[16] In the Central Valley, the drought cost California agriculture about $2.7 billion and more than 20,000 jobs in 2015, which highlights the critical need for developing drought resilience.[17] Drought affects other sectors as well. An analysis of the amount of water consumed in meeting California's energy needs between 1990 and 2012 shows that while California's energy policies have supported climate mitigation efforts, the performance of these policies have increased vulnerability to climate impacts, especially greater hydrologic uncertainty.[18]

Several publications carefully examined the potential role of climate change in the recent California drought. One study examined both precipitation and runoff in the Sacramento and San Joaquin River basins, and found that 10 of the past 14 years between 2000 and 2014 have been below normal, and recent years have been the driest and hottest in the full instrumental record from 1895 through November 2014.[19] In another study, the authors show that the increasing co-occurrence of dry years with warm years raises the risk of drought, highlighting the critical role of elevated temperatures in altering water availability and increasing overall drought intensity and impact.[20] Generally, there is growing risk of unprecedented drought in the western United States driven primarily by rising temperatures, regardless of whether or not there is a clear precipitation trend.[21]

According to the U.S. Forest Service report, National Insect and Disease Forest Risk Assessment, 2013–2027,[22] California is at risk of losing 12 percent of the total area of forests and woodlands in the State due to insects and disease, or over 5.7 million acres. Some species are expected to lose significant amounts of their total basal area (e.g., whitebark pine is projected to lose 60 percent of its basal area; and lodgepole pine is projected to lose 40 percent). While future climate change is not modeled within the risk assessment, and current drought conditions are not accounted for in these estimates, the projected climate changes over a 15 year period (2013-2027) are expected to significantly increase the number of acres at risk, and will increase the risk from already highly destructive pests such as the mountain pine beetle. Extensive tree mortality is already prevalent in California. The western pine beetle and other bark beetles have killed a majority of the ponderosa pine in the foothills of the central and southern Sierra Nevada Mountains. A recent aerial survey by the U.S. Forest Service identified more than 100 million dead trees in California.[23] As there is usually a lag time between drought years and tree mortality, we are now beginning to see a sharp rise in mortality from the past four years of drought. In response to the very high levels of tree mortality, Governor Brown issued an Emergency Proclamation on October 30, 2015, that directed state agencies to identify and take action to reduce wildfire risk through the removal and use of the dead trees.

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14 Diffenbaugh, N., D. L. Swain, and D. Touma. 2015. Anthropogenic Warming has Increased Drought Risk in California. Proceedings of the National Academy of Sciences 112(13): 3931–3936.

15 Cayan, D., T. Das, D. W. Pierce, T. P. Barnett, M. Tyree, and A. Gershunov. 2010. Future Dryness in the Southwest US and Hydrology of the Early 21st Century Drought. Proceedings of the National Academy of Sciences 107(50): 21272–21276.

16 Howitt, R., J. Medellin-Azuara, D. MacEwan, J. Lund, and D. Summer. 2014. Economic Impacts of 2014 Drought on California Agriculture. *watershed.ucdavis.edu/files/biblio/DroughtReport_23July2014_0.pdf*.

17 Williams, A. P., et al. 2015. Contribution of anthropogenic warming to California drought during 2012–2014. Geophysical Research Letters *http://onlinelibrary.wiley.com/doi/10.1002/2015GL064924/abstract*.

18 Fulton, J., and H. Cooley. 2015. The water footprint of California's energy system, 1990–2012 Environmental Science & Technology 49(6):3314–3321. *pubs.acs.org/doi/abs/10.1021/es505034x*.

19 Mann, M. E., and P. H. Gleick. 2015. Climate change and California drought in the 21st century. Proceedings of the National Academy of Sciences of the United States of America, 112(13):3858–3859. *doi.org/10.1073/pnas.1503667112*.

20 Diffenbaugh, N. S., D. L. Swain, and D. Touma. 2015. Anthropogenic warming has increased drought risk in California. Proceedings of the National Academy of Sciences of the United States of America. 10.1073/pnas.1422385112. *www.pnas.org/content/112/13/3931.full.pdf*

21 Cook, B. I., T. R. Ault, and J. E. Smerdon. 2015. Unprecedented 21st century drought risk in the American Southwest and Central Plains. Science Advances 1(1), e1400082, doi:10.1126/sciadv.1400082.

22 Krist, F.J. Jr., J.R. Ellenwood, M.E. Woods, A.J. McMahan, J.P. Cowardin, D.E. Ryerson, F.J. Sapio, M.O. Zweifler, S.A. Romero. 2014. FHTET 2013 – 2027 National Insect & and Disease Forest Risk Assessment. FHTET-14-01 January 2014. Available at: *http://www.fs.fed.us/foresthealth/technology/pdfs/2012_RiskMap_Report_web.pdf*

23 USDA. 2016. New Aerial Survey Identifies More Than 100 Million Dead Trees in California. *www.usda.gov/wps/portal/usda/usdahome?contentid=2016/11/0246.xml&contentidonly=true*

Climate Impacts at the Community Level

The California Energy Commission Cal-Adapt tool provides information about future climate conditions to help better understand how climate will impact local communities.

cal-adapt.org

A warming climate also causes sea level to rise; first, by warming the oceans which causes the water to expand, and second, by melting land ice which transfers water to the ocean. Even if storms do not become more intense or frequent, sea level rise itself will magnify the adverse impact of any storm surge and high waves on the California coast. Some observational studies report that the largest waves are already getting higher and winds are getting stronger.[24] Further, as temperatures warm and GHG concentrations increase more carbon dioxide dissolves in the ocean, making it more acidic. More acidic ocean water affects a wide variety of marine species, including species that people rely on for food. Recent projections indicate that if no significant GHG mitigation efforts are taken, the San Francisco Bay Area may experience sea level rise between 1.6 to 3.4 feet, and in an extreme scenario involving the rapid loss of the Antarctic ice sheet, sea levels along California's coastline could rise up to 10 feet by 2100.[25] This change is likely to have substantial ecological and economic consequences in California and worldwide.[26]

While more intense dry periods are anticipated under warmer conditions, extremes on the wet end of the spectrum are also expected to increase due to more frequent warm, wet atmospheric river events and a higher proportion of precipitation falling as rain instead of snow. In recent years, atmospheric rivers have also been recognized as the cause of the large majority of major floods in rivers all along the U.S. West Coast and as the source of 30-50 percent of all precipitation in the same region.[27] These extreme precipitation events, together with the rising snowline, often cause devastating floods in major river basins (e.g., California's Russian River). It was estimated that the top 50 observed floods in the U.S. Pacific Northwest were due to atmospheric rivers.[28] Looking ahead, the frequency and severity of atmospheric rivers on the U.S. West Coast will increase due to higher atmospheric water vapor that occurs with rising temperature, leading to more frequent flooding.[29, 30]

Climate change can drive extreme weather events such as coastal storm surges, drought, wildfires, floods, and heat waves, and disrupt environmental systems including our forests and oceans. As GHG emissions continue to accumulate and climate disruption grows, such destructive events will become more frequent. Several recent studies project increased precipitation within hurricanes over ocean regions.[31, 32] The primary physical mechanism for this increase is higher water vapor in the warmer atmosphere, which enhances moisture convergence in a storm for a given circulation strength. Since hurricanes are responsible for many of the most extreme precipitation events, such events are likely to become more extreme. Anthropogenic warming by

24 National Research Council of the National Academy of Sciences. 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. National Academies Press.

25 California Ocean Protection Council. 2017. Rising Seas in California: An Update On Sea-Level Rise Science. *www.opc.ca.gov/webmaster/ftp/pdf/docs/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf*

26 Chan, F., et al. 2016. The West Coast Ocean Acidification and Hypoxia Science Panel: Major Findings, Recommendations, and Actions. California Ocean Science Trust, Oakland, California, USA.

27 Dettinger, M. D. 2013. Atmospheric rivers as drought busters on the U.S. West Coast. Journal of Hydrometeorology 14:1721 1732, doi:10.1175/JHM-D-13-02.1. *journals.ametsoc.org/doi/abs/10.1175/JHM-D-13-02.1*.

28 Warner, M. D., C. F. Mass, and E. P. Salath´e. 2012. Wintertime extreme precipitation events along the Pacific Northwest coast: Climatology and synoptic evolution. Monthly Weather Review 140:2021–43. *http://journals.ametsoc.org/doi/abs/10.1175/MWR-D-11-00197.1*.

29 Hagos, S. M., L. R. Leung, J.-H. Yoon, J. Lu, and Y. Gao, 2016: A projection of changes in landfalling atmospheric river frequency and extreme precipitation over western North America from the Large Ensemble CESM simulations. Geophysical Research Letters, 43 (3), 357-1363, *http://onlinelibrary.wiley.com/doi/10.1002/2015GL067392/epdf*.

30 Payne, A. E., and G. Magnusdottir, 2015: An evaluation of atmospheric rivers over the North Pacific in CMIP5 and their response to warming under RCP 8.5. Journal of Geophysical Research: Atmospheres, 120 (21), 11,173-111,190, *http://onlinelibrary.wiley.com/doi/10.1002/2015JD023586/epdf*.

31 Easterling, D.R., K.E. Kunkel, M.F. Wehner, and L. Sun, 2016: Detection and attribution of climate extremes in the observed record. Weather and Climate Extremes, 11, 17-27. *http://dx.doi.org/10.1016/j.wace.2016.01.001*.

32 NAS, 2016: Attribution of Extreme Weather Events in the Context of Climate Change. The National Academies Press, Washington, DC, 186 pp. *http://dx.doi.org/10.17226/21852*.

the end of the 21st century will likely cause tropical cyclones globally to become more intense on average. This change implies an even larger percentage increase in the destructive potential per storm, assuming no changes in storm size.[33,34] Thus, the historical record, which once set our expectations for the traditional range of weather and other natural events, is becoming an increasingly unreliable predictor of the conditions we will face in the future. Consequently, the best available science must drive effective climate policy.

California is committed to further supporting new research on ways to mitigate climate change and how to understand its ongoing and projected impacts. California's Fourth Climate Change Assessment and Indicators of Change Report will further update our understanding of the many impacts from climate change in a way that directly informs State agencies' efforts to safeguard the State's people, economy, and environment.[35, 36]

Together, historical data, current conditions, and future projections provide a picture of California's changing climate, with two important messages:

- Change is already being experienced and documented across California, and some of these changes have been directly linked to changing climatic conditions.
- Even with the uncertainty in future climate conditions, every scenario estimates further change in future conditions.

It is critical that California continue to take steps to reduce GHG emissions in order to avoid the worst of the projected impacts of climate change. At the same time, the State is taking steps to make the State more resilient to ongoing and projected climate impacts as laid out by the Safeguarding California Plan.[37] The Safeguarding California Plan is being updated in 2017 to present new policy recommendations and provide a roadmap of all the actions and next steps that state government is taking to adapt to the ongoing and inevitable effects of climate change. The Draft Safeguarding California Plan[38] is available and will be finalized after workshops and public comments. California's continuing efforts are vital steps toward minimizing the impact of GHG emissions and a three-pronged approach of reducing emissions, preparing for impacts, and conducting cutting-edge research can serve as a model for action.

California's Greenhouse Gas Emissions and the 2030 Target

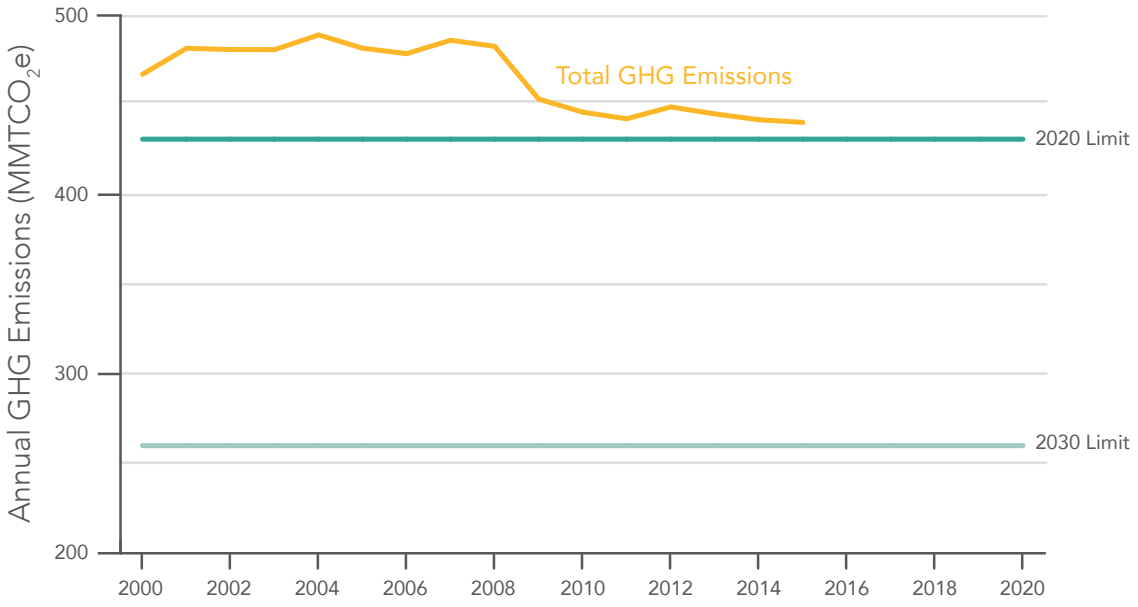
Progress Toward Achieving the 2020 Limit

AB 32 directs CARB to develop and track GHG emissions and progress toward the 2020 statewide GHG target. California is on track to achieve the target while also reducing criteria pollutants and toxic air contaminants and supporting economic growth. As shown in Figure 1, in 2015, total GHG emissions decreased by 1.5 $MMTCO_2e$ compared to 2014, representing an overall decrease of 10 percent since peak levels in 2004. The 2015 GHG Emission Inventory and a description of the methodology updates can be accessed at: *www.arb.ca.gov/cc/inventory/inventory.htm*.

Per California Health and Safety Code section 38505, CARB monitors and regulates seven GHGs to reduce emissions: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and nitrogen trifluoride (NF_3). The fluorinated gases are also referred to as "high global warming potential gases" (high-GWP gases). California's annual statewide GHG emission inventory has historically been the primary tool for tracking GHG emissions trends. Figure 1 provides the GHG inventory trend. Additional information on the methodology for the GHG inventory can also be found at: *www.arb.ca.gov/cc/inventory/data/data.htm*.

33 Sobel, A.H., S.J. Camargo, T.M. Hall, C.-Y. Lee, M.K. Tippett, and A.A. Wing, 2016: Human influence on tropical cyclone intensity. Science, 353, 242-246.
34 Kossin, J. P., K. A. Emanuel, and S. J. Camargo, 2016: Past and projected changes in western North Pacific tropical cyclone exposure. Journal of Climate, 29 (16), 5725-5739, *https://doi.org/10.1175/JCLI-D-16-0076.1*.
35 California's Fourth Climate Change Assessment. *http://resources.ca.gov/climate/safeguarding/research/*
36 Office of Environmental Health Hazard Assessment, Indicators of Climate Change (website): *https://oehha.ca.gov/climate-change/document/indicators-climate-change-california*
37 California Natural Resources Agency. 2017. Safeguarding California. *http://resources.ca.gov/climate/safeguarding/*
38 *http://resources.ca.gov/climate/safeguarding/*

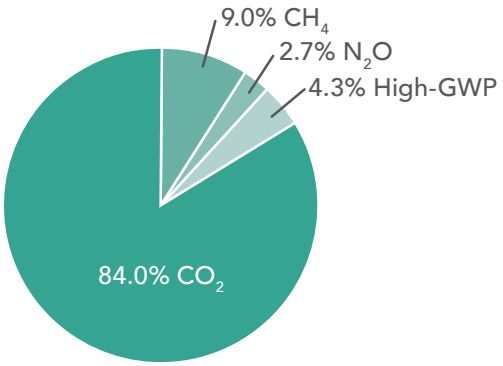
Figure 1: California GHG Inventory Trend



Carbon dioxide is the primary GHG emitted in California, accounting for 84 percent of total GHG emissions in 2015, as shown in Figure 2 below. Figure 3 illustrates that transportation, primarily on-road travel, is the single largest source of CO_2 emissions in the State. Upstream transportation emissions from the refinery and oil and gas sectors are categorized as CO_2 emissions from industrial sources and constitute about 50 percent of the industrial source emissions. When these emissions sources are attributed to the transportation sector, the emissions from that sector amount to approximately half of statewide GHG emissions. In addition to transportation, electricity production, and industrial and residential sources also are important contributors to CO_2 emissions.

Figures 2 and 3 show State GHG emission contributions by GHG and sector based on the 2015 GHG Emission Inventory.

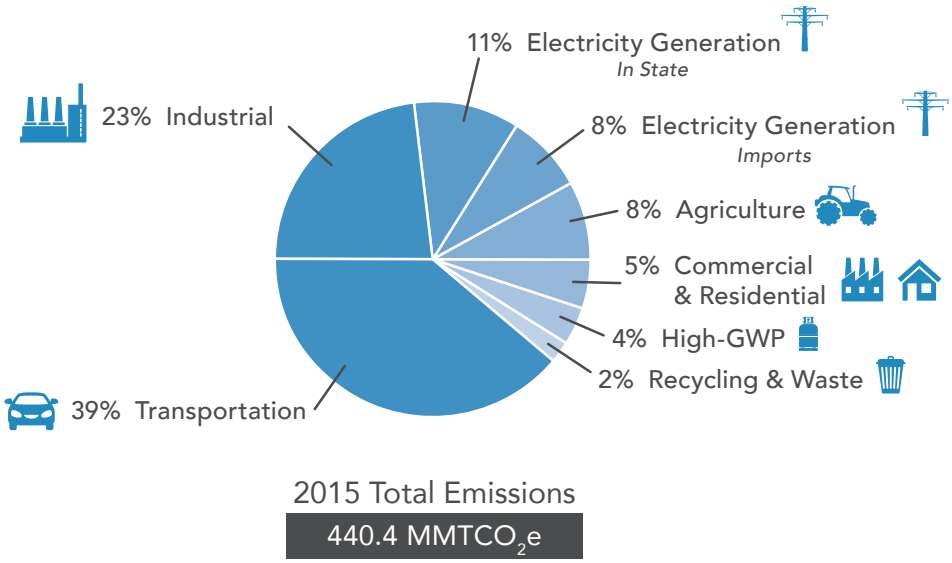
Figure 2: Emissions by GHG



2015 Total Emissions

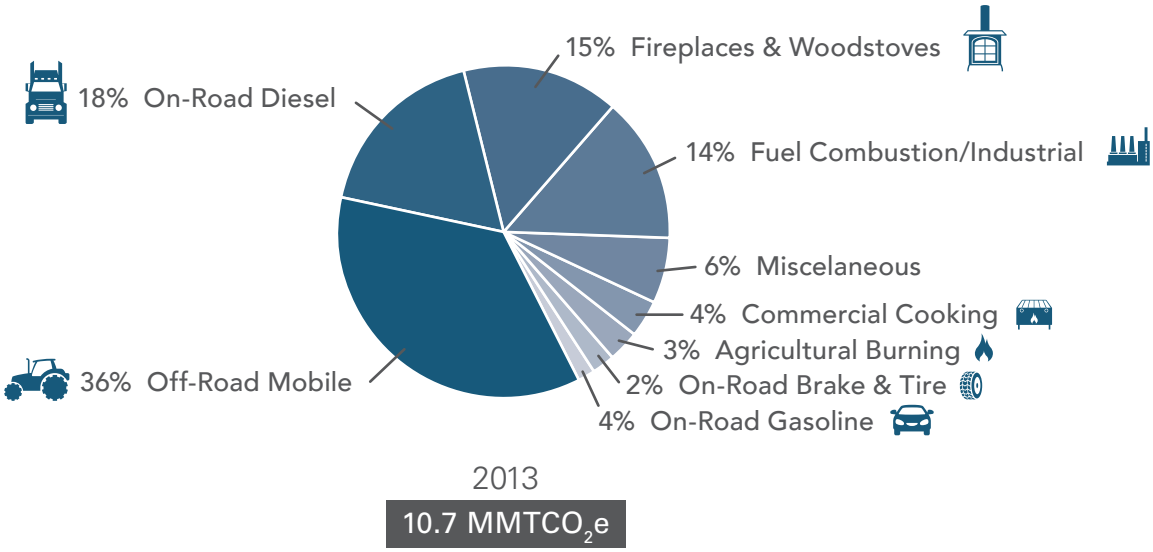
440.4 $MMTCO_2e$

Figure 3: Emissions by Sector



In addition, CARB has developed a statewide emission inventory for black carbon in support of the SLCP Strategy, which is reported in two categories: non-forestry (anthropogenic) sources and forestry sources.[39] The black carbon inventory will help support implementation of the SLCP Strategy, but is not part of the State's GHG Inventory that tracks progress towards the State's climate targets. The State's major anthropogenic sources of black carbon include off-road transportation, on-road transportation, residential wood burning, fuel combustion, and industrial processes (Figure 4). The forestry category includes non-agricultural prescribed burning and wildfire emissions.

Figure 4: California 2013 Anthropogenic Black Carbon Emission Sources*



*Using 100-year GWP

The exchange of CO_2 between the atmosphere and California's natural and working lands sector is currently unquantified and therefore, excluded from the State's GHG Inventory. A natural and working lands carbon inventory is essential for monitoring land-based activities that may increase or decrease carbon sequestration over time. CARB staff is working to develop a comprehensive inventory of GHG fluxes from all of California's

39 Per SB 1383, the SLCP Strategy only addresses anthropogenic black carbon.

natural and working lands using the Intergovernmental Panel on Climate Change (IPCC) design principles. CARB released the Natural and Working Lands Inventory with the 2030 Target Scoping Plan Update Discussion Draft.[40] This inventory provides an estimate of GHG emissions reductions and changes in carbon stock from some carbon pools in agricultural and natural and working lands. The CARB Natural and Working Lands Inventory includes an inventory of carbon stocks, stock-change (and by extension GHG flux associated with stock-change) with some attribution by disturbance process for the analysis period 2001-2010. Disturbance processes include activities such as conversion from one land category to a different category, fire, and harvest. The CARB Natural and Working Lands Inventory covers varieties of forests and woodlands, grasslands, and wetlands (biomass-stock-change only). The Inventory includes default carbon densities for croplands and urban/developed lands to facilitate stock-change estimation for natural lands that convert to cropland, natural lands that convert to developed lands, and for croplands that convert to developed lands.

Greenhouse Gas Emissions Tracking

As described above, California maintains an economy-wide GHG inventory for the State that is consistent with IPCC practices to allow for comparison of statewide GHG emissions with those at the national level and with other international GHG inventories. Statewide GHG emissions calculations use many data sources, including data from other State and federal agencies. However, the primary source of data comes from reports submitted to CARB through the Regulation for the Mandatory Reporting of GHG Emissions (MRR). MRR requires facilities and entities with more than 10,000 metric tons of carbon dioxide equivalent ($MTCO_2e$) of combustion and process emissions, all facilities belonging to certain industries, and all electric power entities to submit an annual GHG emissions data report directly to CARB. Reports from facilities and entities that emit more than 25,000 $MTCO_2e$ are verified by a CARB-accredited third-party verification body. More information on MRR emissions reports can be found at: *www.arb.ca.gov/cc/reporti\ng/ghg-rep/reported-data/ghg-reports.htm.*

All data sources used to develop the GHG Emission Inventory are listed in inventory supporting documentation at: *www.arb.ca.gov/cc/inventory/data/data.htm.*

Other State agencies, nonprofit organizations, and research institutions are developing and testing methodologies and models to quantify GHG fluxes from California's natural and working lands. CARB's ongoing work on the Natural and Working Lands Inventory will serve as one source of data to gauge the scope of GHG reduction potential from California's natural and working lands and monitor progress over time. CARB will evaluate other data sources and methodologies to validate or support the CARB inventory or project-scale tracking. Interagency work is also underway to integrate and account for the land use and management impacts of development, transportation, housing, and energy policies.

Greenhouse gas mitigation action may cross geographic borders as part of international and subnational collaboration, or as a natural result of implementation of regional policies. In addition to the State's existing GHG inventory, CARB has begun exploring how to build an accounting framework that also utilizes existing program data to better reflect the broader benefits of our policies that may be happening outside of the State. For GHG reductions outside of the State to be attributed to our programs, those reductions must be real and quantifiable, without any double counting, including claims to those reductions by other jurisdictions. CARB is collaborating with other jurisdictions to ensure GHG accounting rules are consistent with international best practices. Robust accounting rules will instill confidence in the reductions claimed and maintain support for joint action across jurisdictions. Consistency and transparency are critical as we work together with other jurisdictions on our parallel paths to achieve our GHG targets.

California's Approach to Addressing Climate Change

Integrated Systems

The State's climate goals require a comprehensive approach that integrates and builds upon multiple ongoing State efforts. As we address future mobility, we identify how existing efforts – such as the California Sustainable Freight Action Plan, Mobile Source Strategy, California Transportation Plan 2040, High-Speed

40 CARB. 2016. California Greenhouse Gas Inventory - Forests and Other Lands. *www.arb.ca.gov/cc/inventory/sectors/forest/forest.htm*

Rail,[41] urban planning, housing, and goals for enhancement of the natural environment – can complement each other while providing multiple environmental benefits, including air quality and climate benefits. The collective consideration of these efforts illuminates the synergies and conflicts between policies. For example, land disturbance due to increased renewables through utility scale wind and solar and transmission can release GHGs from soil and disturb grasslands and rangelands that have the potential to sequester carbon. Further, policies that support sustainable land use not only reduce vehicle miles traveled (VMT) and its related emissions, but may also avoid land disturbance that could result in GHG emissions or loss of sequestration potential in the natural environment. Identifying these types of trade-offs, and designing policies and implementation strategies to support goals across all sectors, will require ongoing efforts at the local, regional, and State level to ensure that sustainable action across both the built and natural environments help to achieve the State's long-term climate goals.

Promoting Resilient Economic Growth

California's strategic vision for achieving at least a 40 percent reduction in GHG emissions by 2030 is based on the principle that economic prosperity and environmental sustainability can be achieved together. Policies, strategies, plans and regulations to reduce GHG emissions help California businesses compete in a global economy and spur new investments, business creation, and jobs to support a clean energy economy. California's portfolio-based climate strategy can achieve great success when accompanied by consistent and rigorous GHG monitoring and reporting, a robust public process, and an effective enforcement program for the few that attempt to evade rules. The transition to a low-carbon future can strengthen California's economy and infrastructure and produce other important environmental benefits such as reductions in criteria pollutants and toxic air contaminants, especially in California's most vulnerable communities.

Actions that are presented in this Scoping Plan provide economic opportunities for the future, but progress toward our goals is already evident today. For example, in 2015, California added more than 20,000 new jobs in the solar sector. This was more than half of the new jobs in this industry across the nation. Employment in the clean economy grew by 20 percent between 2002 and 2012, which included the period of economic recession around 2008.[42] Shifting to clean, local, and efficient uses of energy reinvests our energy expenditures in our local economies and reduces risks to our statewide economy associated with exposure to volatile global and national oil and gas commodity prices. Indeed, a clean economy is a resilient economy.

Successfully driving economic transition will require cleaner and more efficient technologies, policies and incentives that recognize and reward innovation, and prioritizing low carbon investments. Enacting policies and incentives at multiple jurisdictional levels further ensures the advancement of land use and natural resource management objectives for GHG mitigation, climate adaptation, and other co-benefits. Intentional synergistic linkages between technological advances and resource stewardship can result in sustainable development. The development and implementation of Sustainable Communities Strategies (SCSs) pursuant to Senate Bill (SB) 375, which link transportation, housing, and climate policy, are designed to reduce per capita GHG emissions while improving air quality and expanding transportation and housing options. This Scoping Plan identifies additional ways, beyond SB 375, to promote the technologies and infrastructure required to meet our collective climate goals, while also presenting the vision for California's continuing efforts to foster a sustainable, clean energy economy.

Increasing Carbon Sequestration in Natural and Working Lands

California's natural and working lands make the State a global leader in agriculture, a U.S. leader in forest products, and a global biodiversity hotspot. These lands support clean air, wildlife and pollinator habitat, rural economies, and are critical components of California's water infrastructure. Keeping these lands and waters intact and at high levels of ecological function (including resilient carbon sequestration) is necessary for the well-being and security of Californians in 2030, 2050, and beyond. Forests, rangelands, farms,

41 California's High-Speed Rail is part of the International Union of Railways (UIC) and California signed the Railway Climate Responsibility Pledge, which was commended by the Secretary of the UN Framework Convention on Climate Change as part of achieving global 2050 targets.

42 California Business Alliance for a Clean Economy. 2015. Clean Energy and Climate Change Summary of Recent Analyses for California. *clean-economy.org/wp-content/uploads/2015/01/Clean-Energy-Climate-Change-Analyses_January2015.pdf*

wetlands, riparian areas, deserts, coastal areas, and the ocean store substantial carbon in biomass and soils.

Natural and working lands are a key sector in the State's climate change strategy. Storing carbon in trees, other vegetation, soils, and aquatic sediment is an effective way to remove carbon dioxide from the atmosphere. This Scoping Plan describes policies and programs that prioritize protection and enhancement of California's landscapes, including urban landscapes, and identifies next steps to ensure management actions are taken to increase the sequestration potential of those resources. We cannot ignore the relationships between energy, transportation, and natural working lands sectors or the adverse impacts that climate change is having on the environment itself. We must consider important trade-offs in developing the State's climate strategy by understanding the near and long-term impacts of various policy scenarios and actions on our State and local communities.

Improving Public Health

The State's drive to improve air quality and promote community health and well-being as we address climate change remains a priority, as it has for almost 50 years. The State is committed to addressing public health issues, including addressing chronic and infectious diseases, promoting mental health, and protecting communities from exposure to harmful air pollutants and toxins. Several of the strategies included in this Plan were primarily developed to help California achieve federal and State ambient air quality standards for air pollutants with direct health impacts, but they will also deliver GHG reductions. Likewise, some climate strategies, such as GHG reduction measures that decrease diesel combustion from mobile sources, produce air quality co-benefits in the form of concurrent reductions in criteria pollutants and toxic air contaminants.

Climate change itself is already affecting the health of our communities and is exacerbating existing health inequities. Those facing the greatest health burdens include low-income individuals and households, the very young and the very old, communities of color, and those who have been marginalized or discriminated against based on gender or race/ethnicity.[43] Economic factors, such as income, poverty, and wealth, are among the strongest determinants of health. Addressing climate change presents an important opportunity to improve public health for all of California's residents and to further our work toward making our State the healthiest in the nation.

The major provisions of AB 617 (C. Garcia, 2017), to be completed by 2020, will ensure that as the State seeks to advance climate policy to meet the 2030 target, we will also act locally to improve neighborhood air quality. AB 617 requires strengthening and expanding community level air monitoring; expediting equipment retrofits at large industrial sources that are located in areas that are in nonattainment for the federal and State ambient air quality standards; requiring development of a statewide strategy to further reduce criteria pollutants and toxic air contaminants in communities faced with high cumulative exposure levels; and local air district-developed community emissions reductions plans that identify emissions reductions targets, measures, implementation schedules, and enforcement plans for these affected communities. By identifying and addressing the disproportionate impacts felt today and by planning, designing, and implementing actions for a sustainable future that considers both climate and air quality objectives, we can be part of the solution to make public health inequities an issue of the past.

Environmental Justice

Fair and equitable climate action requires addressing the inequities that create and intensify community vulnerabilities. The capacity for resilience in the face of climate change is driven by living conditions and the forces that shape them. These include, but are not limited to, access to services such as health care, healthy foods, air and water, and safe spaces for physical activity; income; education; housing; transportation; environmental quality; and good health status. Strategies to alleviate poverty, increase access to economic opportunities, improve living conditions, and reduce health and social inequities will result in more climate-resilient communities. The transition to a low carbon California economy provides an opportunity to not only reduce GHG emissions, but also to reduce emissions of criteria pollutants and air toxins, and to create a healthier environment for all of California's residents, especially those living in the State's most disadvantaged communities. Policies designed to facilitate this transition and state-wide, regional, and local reductions,

43 California Department of Public Health (CDPH). 2015. The Portrait of Promise: The California Statewide Draft Plan to Promote Health and Mental Health Equity. A Report to the Legislature and the People of California by the Office of Health Equity. Sacramento, CA: California Department of Public Health, Office of Health Equity.

must also be appropriately tailored to address the unique characteristics of economically distressed communities throughout the State's diverse geographic regions, including both rural and highly-urbanized areas. Equity considerations must likewise be part of the deliberate and thoughtful process in the design and implementation of all policies and measures included in the Scoping Plan. And CARB must ensure that its ongoing engagement with environmental justice communities will continue beyond the development of the Scoping Plan and be included in all aspects of its various air pollution programs. Additional detail on CARB's efforts to achieve these goals is provided in Chapter 5.

It is critical that communities of color, low-income communities, or both, receive the benefits of the cleaner economy growing in California, including its environmental and economic benefits. Currently, low-income customers enrolled in the California Alternate Rates for Energy (CARE) Program or the Family Electric Rate Assistance (FERA) Program are also eligible to receive a rebate under the California Climate Credit, or a credit on residential and small business electricity bills resulting from the sale of allowances received by investor-owned utilities as part of the Cap-and-Trade Program. SB 1018 (Committee on Budget and Fiscal Review, Chapter 39, Statutes of 2012) and other implementing legislation requires that Cap-and-Trade Program auction monies deposited into the Greenhouse Gas Reduction Fund (GGRF) be used to further the purposes of AB 32 and facilitate reduction of GHG emissions. Investments made with these funds not only reduce GHG emissions, but also provide other environmental, health, and economic benefits including, fostering job creation by promoting in-state GHG emissions reduction projects carried out by California workers and businesses.

Further, SB 535 (De Leon, Chapter 830, Statutes of 2012) and AB 1550 (Gomez, Chapter 369, Statutes of 2016) direct State and local agencies to make significant investments using GGRF monies to assist California's most vulnerable communities. Under SB 535 (de León, Chapter 830, Statutes of 2012), a minimum of 25 percent of the total investments were required to benefit disadvantaged communities; of that, a minimum of 10 percent were required to be located within and provide benefits to those communities. Based on cumulative data reported by agencies as of March 2016, the State is exceeding these targets. Indeed, 50 percent of the $1.2 billion dollars spent on California Climate Investments projects provided benefits to disadvantaged communities; and 34 percent of this funding was used on projects located directly in disadvantaged communities.[44]

Environmental Justice Advisory Committee

Martha Dina Argüello	Physicians for Social Responsibility	Los Angeles
Colin Bailey	The Environmental Justice Coalition for Water	Sacramento
Gisele Fong	End Oil	Los Angeles
Tom Frantz	Association of Irritated Residents	Central Valley
Katie Valenzuela Garcia (Served until May 2017)	Oak Park Neighborhood Association	Sacramento
Sekita Grant (Served until June 2017)	The Greenlining Institute	Statewide
Kevin Hamilton	Central California Asthma Collaborative	Central Valley
Rey León	Valley LEAP	Central Valley
Luis Olmedo	Comité Civico Del Valle	Salton Sea Region
Kemba Shakur	Urban Releaf	Bay Area
Mari Rose Taruc	Asian Pacific Environmental Network	Bay Area
Eleanor Torres	The Incredible Edible Community Garden	Inland Empire
Monica Wilson	Global Alliance for Incinerator Alternatives	Bay Area

Environmental Justice Advisory Committee

AB 32 calls for CARB to convene an Environmental Justice Advisory Committee (EJAC), to advise the Board in developing the Scoping Plan, and any other pertinent matter in implementing AB 32. It requires that the Committee be comprised of representatives from communities in the State with the most significant exposure to air pollution, including, but not limited to, communities with minority populations or low-income

44 *www.arb.ca.gov/cc/capandtrade/auctionproceeds/cci_annual_report_2017.pdf*

populations, or both. CARB consulted 13 environmental justice and disadvantaged community representatives for the 2017 Scoping Plan process, starting with the first Committee meeting in December 2015. In February and April 2017, members of the California Air Resources Board held joint public meetings with the EJAC to discuss options for addressing environmental justice and disadvantaged community concerns in the Scoping Plan. The full schedule of Committee meetings and meeting materials is available on CARB's website.[45]

Starting in July 2016, the Committee hosted a robust community engagement process, conducting 19 community meetings throughout the State. To enhance this community engagement, CARB staff coordinated with staff from local government agencies and sister State agencies. At the community meetings, staff from State and local agencies participated in extensive, topic-specific "world café" discussions with local groups and individuals. The extensive dialogue between the EJAC, State agencies, and local agencies provided community residents the opportunity to share concerns and provide input on ways California can meet its 2030 GHG target while addressing a number of environmental and equity issues.

Environmental Justice Advisory Committee Recommendations

The Committee's recommendations for the Scoping Plan were informed by comments received at community meetings described above and Committee member expertise. Recommendations were provided for the sector focus areas, overarching environmental justice policy, and California Climate Investments. The Committee also sorted their recommendations into five themes: partnership with environmental justice communities, equity, economic opportunity, coordination, and long-term vision. Finally, the Committee provided direction that their recommendations are intended "to be read and implemented holistically and not independently of each other." The EJAC's recommendations, in their entirety, are included in Appendix A and available at *www.arb.ca.gov/cc/ejac/meetings/04262017/ejac-sp-recommendations033017.pdf*.

The Committee's overarching recommendations for partnership with environmental justice communities, equity, coordination, economic opportunity, and long-term vision include the following recommendations:

- Encourage long-term community engagement, a culture shift in California, and neighborhood-level solutions to promote the implementation of the State's climate plans, using strategies identified by the Committee.
- Improve the balance of reducing GHGs and compliance costs with other AB 32 goals of improving air quality in environmental justice communities while maximizing benefits for all Californians.
- Consider public health impacts and equity when examining issues in any sector and have CARB conduct an equity analysis on the Scoping Plan and each sector, with guidance from the Committee.
- Develop metrics to ensure actions are meeting targets and develop contingency plans for mitigation and adjustment if emissions increases occur as programs are implemented.
- Develop a statewide community-based air monitoring network to support regulatory efforts and monitor neighborhood scale pollution in disadvantaged communities.
- Coordinate strategies between State, federal, and local agencies for strong, enforceable, evidence-based policies to prevent and address sprawl with equity at the center.
- Maximize the accessibility of safe jobs, incentives, and economic benefits for Californians and the development of a just transition for workers and communities in and around polluting industries.
- Prioritize improving air quality in environmental justice communities and analyze scenarios at a neighborhood scale for all California communities.
- Ensure that AB 32 economic reviewers come from various areas around the State to represent insights on economic challenges and opportunities from those regions.
- Do not limit the Scoping Plan to examining interventions and impacts until 2030, or even 2050. Plan and analyze on a longer-term scale to prevent short-sighted mistakes and reach the long-term vision, as actions today and for the next 30 years will have impacts for seven generations.
- The Scoping Plan must prioritize GHG reductions and investments in California environmental justice communities first, before other California communities; and the innovation of new technologies or strategies to reach even deeper emissions cuts, whenever possible.
- Convene the Committee beyond the Scoping Plan development process.

The Committee's key Energy sector recommendations include:

- Developing aggressive energy goals toward 100 percent renewable energy by 2030, including a vision for a clean energy economy, and prioritizing actions in disadvantaged communities.

45 *www.arb.ca.gov/cc/ejac/ejac.htm*

- Setting goals for green buildings.
- Enforcing GHG reduction targets for existing buildings, and providing upgrades that enable buildings to use renewable energy technologies and water capture.
- Prioritizing and supporting community-owned technologies, such as community-owned solar, for environmental justice communities.

Key Water sector recommendations include:

- Encouraging water conservation and recycling.
- Prioritizing safe drinking water for all.

The Committee's key Industry sector recommendations include:

- Prioritizing direct emissions reductions in environmental justice communities.
- Replacing the Cap-and-Trade Program with a carbon tax or fee and dividend program.
- Eliminating offsets and the allocation of free allowances if the Cap-and-Trade Program continues.
- Analyze where GHG emissions are increasing and identify strategies to prevent and reduce such emissions in environmental justice communities.
- Committing to reductions in petroleum use.

The Committee's key Transportation sector recommendations include:

- Increasing access to affordable, reliable, clean, and safe mobility options in disadvantaged communities.
- Community-engaged land use planning.
- Maximizing electrification.
- Restricting sprawl and examining transportation regionally.
- Considering the development of green transportation hubs that integrate urban greening with transportation options and implement the recommendations of the SB 350 studies.

The Committee's key Natural and Working Lands, Agriculture, and Waste sector recommendations include:

- Reducing waste and mandating that local jurisdictions manage the waste they create.
- Returning carbon to the soil.
- Not burning biomass or considering it a renewable resource.
- Supporting healthy soils as a critical element to land and waste management.
- Integrating urban forestry within local communities.
- Exploring ways to allow and streamline the process for cultural and prescribed burning for land management and to prevent large-scale wildfires.
- Including an annual reduction of 5 million metric tons of CO_2e from natural and working lands.

The Committee's recommendations for California Climate Investments include:

- Ensuring near-term technologies do not adversely impact communities and long-term investments move toward zero emissions.
- Requiring GGRF projects to be transformative for disadvantaged communities as defined by each community.
- Eliminating funding for AB 32 regulated entities.
- Providing technical assistance to environmental justice communities so they can better access funding and resources.
- Prioritizing projects identified by communities and ensuring all applicants have policies to protect against displacement or gentrification.

In April 2017, EJAC members provided a refined list of priority changes for the Scoping Plan from the full list of EJAC recommendations. CARB staff responded to each priority recommendation, describing additions to the Scoping Plan or suggested next steps for recommendations beyond the level of detail in the Plan. Appendix A includes the Priority EJAC Recommendations with CARB Responses and full list of EJAC Recommendations.

More information about the Committee and its recommendations on the previous Scoping Plans and this Scoping Plan is located at: *www.arb.ca.gov/ejac*.

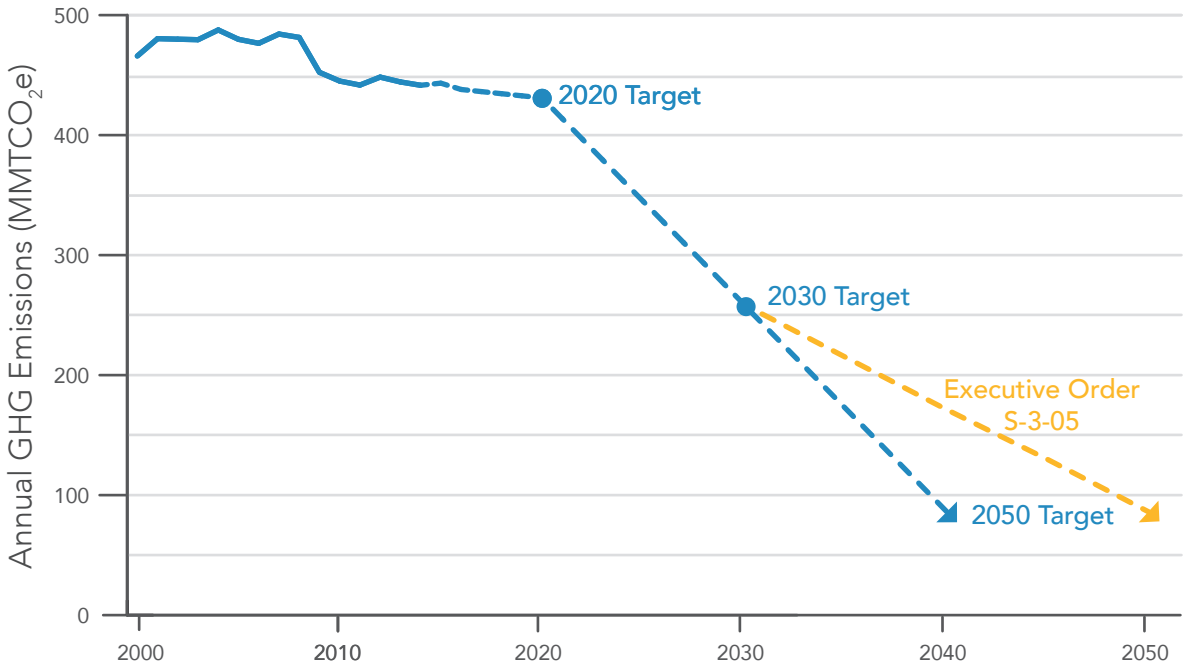
Setting the Path to 2050

The State's 2020 and 2030 targets have not been set in isolation. They represent benchmarks, consistent with prevailing climate science, charting an appropriate trajectory forward that is in-line with California's role in stabilizing global warming below dangerous thresholds. As we consider efforts to reduce emissions to meet the State's near-term requirements, we must do so with an eye toward reductions needed beyond 2030, as well. The Paris Agreement – which calls for limiting global warming to well below 2 degrees Celsius and aiming to limit it below a 1.5 degrees Celsius – frames our path forward.

While the Scoping Plan charts the path to achieving the 2030 GHG emissions reduction target, we also need momentum to propel us to the 2050 statewide GHG target (80 percent below 1990 levels). In developing this Scoping Plan, we considered what policies are needed to meet our mid-term and long-term goals. For example, though Zero Net Carbon Buildings are not feasible at this time and more work needs to be done in this area, they will be necessary to achieve the 2050 target. To that end, work must begin now to review and evaluate research in this area, establish a planning horizon for targets, and identify implementation mechanisms. Concurrently, we must consider and implement policies that not only deliver critical reductions in 2030 and continue to help support the State's long-term climate objectives, but that also deliver other health, environmental and economic benefits. We should not just be planning to put 1.5 million ZEVs on the road by 2025 or 4.2 million on the road by 2030 – but rather, we should be comprehensively facilitating the market-wide transition to electric drive that we need to see materialize as soon as possible. This means that we need to be working towards making all fuels low carbon as quickly as possible, even as we incrementally ramp up volume requirements through the Low Carbon Fuel Standard. And it means that we need to support the broad array of actions and strategies identified in Chapter 4, and new ones that may emerge – to keep us on track to achieve deeper GHG reductions to protect the environment and our way of life. As with all investments, the approach taken must balance risk, reward, longevity, and timing.

Figure 5 illustrates the potential GHG reductions that are possible by making consistent progress between 2020 and 2050, versus an approach that begins with the 2030 target and then makes progress toward the 2050 level included in Executive Order S-3-05. Depending on our success in achieving the 2030 target, taking a consistent approach may be possible. It would achieve the 2050 target earlier, and together with similar actions globally, would have a greater chance of preventing global warming of 2°C. The strategy for achieving the 2050 target should leave open the possibility for both paths. Note that Figure 5 does not include emissions or sequestration potential from the natural and working lands sector or black carbon.

Figure 5: Plotting California's Path Forward



Intergovernmental Collaboration

Federal, state, Tribal, and local action can be complementary. We have seen federal action through the Clean Air Act, regulations for GHG emissions from passenger cars and trucks, development of the Clean Power Plan to limit GHGs from power plants, and the advancement of methane rules for oil and gas production. We have also seen recent federal efforts to delay or reverse some of these actions. As we have done in the past, California, working with other climate leaders, can take steps to advance more ambitious federal action and protect the ability of states to move forward to address climate change. Both collaboration and advocacy will mark the road ahead. However, to the extent that California cannot implement policies or measures included in the Scoping Plan because of the lack of federal action, we will develop alternative measures to achieve the reductions from the same sectors to ensure we meet our GHG reduction targets.

Regional, Tribal, and local governments and agencies are critical leaders in reducing emissions through actions that reduce demand for electricity, transportation fuels, and natural gas, and improved natural and working lands management. Many local governments already employ efforts to reduce GHG emissions beyond those required by the State. For example, many cities and counties improve their municipal operations by upgrading vehicle fleets, retrofitting government buildings and streetlights, purchasing greener products, and implementing waste-reduction policies. In addition, they may adopt more sustainable codes, standards, and general plan improvements to reduce their community's footprints and emissions. Many Tribes within and outside of California have engaged in consultations with CARB to develop robust carbon offset projects under California's Cap-and-Trade Program, in particular forest projects. In fact, Tribal forest projects represent a significant percentage of offset credits issued under the Program. These consultations and carbon sequestration projects are in addition to other Tribal climate-related efforts. The State will provide a supportive framework to advance these and other local efforts, while also recognizing the need to build on, and export, this success to other regional, Tribal, and local governments throughout California and beyond.

Local actions are critical for implementation of California's ambitious climate agenda. State policies, programs, and actions–such as many of those identified throughout this Scoping Plan–can help to support, incentivize, and accelerate local actions to achieve mutual goals for more sustainable and resilient communities. Local municipal code changes, zoning changes, or policy directions that apply broadly to the community within the general plan or climate action plan area can promote the deployment of renewable, zero emission, and low carbon technologies such as zero net energy buildings, renewable fuel production facilities, and zero emission charging stations. Local decision-making has an especially important role in achieving reductions of GHG emissions generated from transportation. Over the last 60 years, development patterns have led to sprawling suburban neighborhoods, a vast highway system, growth in automobile ownership, and under-prioritization of infrastructure for public transit and active transportation. Local decisions about these policies today can establish a more sustainable built environment for the future.

International Efforts

California is not alone in its efforts to address climate change at the international level to reduce global GHG emissions. The agreement reached in Paris by the 2015 Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC), aimed at keeping the global temperature rise below 2°C, is spurring worldwide action to reduce GHGs and support decarbonization across the global economy. In recent years, subnational governments have emerged to take on a prominent role. With the establishment of the Under 2 Memorandum of Understanding (MOU),[46,47] the Governors' Climate and Forests Task Force,[48] and the Western Climate Initiative,[49] among other partnership initiatives, subnational jurisdictions from the around the world are collaborating and leading on how best to address climate change.

46 Under 2 MOU website: *under2mou.org/*

47 One of the Brown Administration's priorities is to highlight California's climate leadership on the subnational level, and to ensure that subnational activity is recognized at the international level. In the year preceding the Paris negotiations, the Governor's Office recruited subnational jurisdictions to sign onto the Memorandum of Understanding on Subnational Global Climate Leadership (Under 2 MOU), which brings together states and regions willing to commit to reducing their GHG emissions by 80 to 95 percent, or to limit emissions to 2 metric tons CO_2-equivalent per capita, by 2050. The governor led a California delegation to the Paris negotiations to highlight our successful climate programs and to champion subnational action and international cooperation on meeting the challenge of reducing GHG emissions. As of October 2017, 188 jurisdictions representing more than 1.2 billion people and more than one-third of the global economy had joined California in the Under 2 MOU.

48 Governors' Climate and Forests Task Force website: *www.gcftaskforce.org/*

49 Western Climate Initiative website: *www.wci-inc.org/*

From its inception, AB 32 recognized the importance of California's climate leadership and engagement with other jurisdictions, and directed CARB to consult with the federal government and other nations to identify the most effective strategies and methods to reduce GHGs, manage GHG control programs, and facilitate the development of integrated and cost-effective regional, national, and international GHG reduction programs. California undertook a two-pronged approach: first, we assessed our State-specific circumstances to develop measures that would apply specifically in California; and second, we assessed which measures might lend themselves, through careful design and collaboration with other interested jurisdictions, toward linked or collaborative GHG reduction programs. Under the Clean Air Act, California has a special role as an innovator and leader in the area of motor vehicle emission regulations, which allows our State to adopt motor vehicle emission standards that are stricter than federal requirements. Partners around the country and the world emulate these motor vehicle standards, leading to widespread health benefits. Similarly, by enacting a comprehensive climate strategy that appeals to national and international partners, California can help lead the world in tackling climate change.

Today, the State's Cap-and-Trade Program is linked with Québec's program and scheduled to link with Ontario's emissions trading system on January 1, 2018. Low carbon fuel mandates similar to California's LCFS have been adopted by the United States Environmental Protection Agency (U.S. EPA) and by other jurisdictions including Oregon, British Columbia, the European Union, and the United Kingdom. Over two-dozen states have a renewables portfolio standard. California is a member of the Pacific Coast Collaborative with British Columbia, Oregon, and Washington, who collaborate on issues such as energy and sustainable resource management, among others.[50] California continues to discuss carbon pricing through a cap-and-trade program with international delegations. We have seen design features of the State's Cap-and-Trade Program incorporated into other emerging and existing programs, such as the European Union Emissions Trading System, the Regional Greenhouse Gas Initiative, China's emerging national trading program, and Mexico's emerging pilot emission trading program.

Recognizing the need to address the substantial GHG emissions caused by the deforestation and degradation of tropical and other forests, California worked with a group of subnational governments to form the Governors' Climate and Forests Task Force (GCF) in 2008.[51] The GCF is currently comprised of 38 different subnational jurisdictions– including states and provinces in Brazil, Colombia, Ecuador, Indonesia, Ivory Coast, Mexico, Nigeria, Peru, Spain, and the United States–that are contemplating or enacting programs for low-emissions rural development and reduced emissions from deforestation and land use. GCF members continue to engage in discussions to share information and experiences about the design of such programs and how the programs could potentially interact with carbon markets. Ongoing engagement between California and its GCF partners, as well as ongoing discussions with other stakeholders, continues to provide lessons on how such programs could complement California's climate programs.[52]

Further, California's High-Speed Rail is part of the International Union of Railways (UIC), and California has signed the Railway Climate Responsibility Pledge, which was commended by the Secretary of the UNFCCC as part of achieving the global 2050 targets. This initiative is to demonstrate that rail transport is part of the solution for sustainable and carbon free mobility.

California will continue to engage in multi-lateral forums that develop the policy foundation and technical infrastructure for GHG regulations in multiple jurisdictions through entities such as the International Carbon Action Partnership (ICAP), established by California and other partners in 2007. Members of the ICAP that have already implemented or are actively pursuing market-based GHG programs[53] share experiences and knowledge. California also participates in the Partnership for Market Readiness (PMR), a multilateral World Bank initiative that brings together more than 30 developed and developing countries to share experiences and build capacity for climate change mitigation efforts, particularly those implemented using market instruments.[54] In November 2014, CARB became a Technical Partner of the PMR, and CARB staff members have provided technical information on the design and implementation of the Cap-and-Trade Program at several PMR meetings.

50 Pacific Coast Collaborative website: *pacificcoastcollaborative.org/*

51 Governors' Climate and Forests Task Force Website: *www.gcftaskforce.org/*

52 Continued collaboration on efforts to reduce emissions from tropical deforestation and to evaluate sector-based offset programs, such as the jurisdictional program in Acre, Brazil, further demonstrates California's ongoing climate leadership and fosters partnerships on mutually beneficial low emissions development initiatives, including measures to encourage sustainable supply chain efforts by public and private entities.

53 International Carbon Action Partnership website: *icapcarbonaction.com/*

54 Partnership for Market Readiness website: *www.thepmr.org/*

Many foreign jurisdictions seek out California's expertise because of our history of success in addressing air pollution and climate change. California also benefits from these interactions. Expanding global action to fight air pollution and climate change expands markets for clean technology. This can bolster business for companies in California developing clean energy products and services and help to bring down the cost of those products globally and in California. Additionally, innovative policies and lessons learned from our partners' jurisdictions can help to inform future climate policies in California.

Governor Brown's focus on subnational collaborations on climate change and air quality has strengthened and deepened California's existing international relationships and forged new ones. These relationships are a critical component of reducing emissions of GHGs and other pollutants worldwide. As we move forward, CARB and other State agencies will continue to communicate and collaborate with international partners to find the most cost-effective ways to improve air quality, fight climate change, and share California's experience and expertise in reducing air pollution and GHGs while growing a strong economy. To highlight the State's resolve and support of other governments committed to action and tackling the threat of the global warming, on July 6, 2017, Governor Brown announced a major initiative to host world leaders at a Global Climate Action Summit planned for September 2018 in San Francisco.

Chapter 2

The Scoping Plan Scenario

This chapter describes the State strategy for meeting the 2030 GHG target (also called the Scoping Plan Scenario), along with a short description of the four alternative scenarios, which were evaluated but ultimately rejected when compared against statutory and policy criteria and priorities that the State's comprehensive climate action must deliver. All scenarios are set against the business-as-usual (BAU or Reference Scenario) scenario–what would GHG emissions look like if we did nothing beyond the existing policies that are required and already in place to achieve the 2020 limit. BAU includes the existing renewables requirements, advanced clean cars, the 10 percent reduction in carbon intensity Low Carbon Fuel Standard, and the SB 375 program for sustainable communities, among others. However, it does not include a range of new policies or measures that have been developed or put into statute over the past two years.

The Reference Scenario (BAU) shows continuing, but modest, reductions followed by a later rise of GHG emissions as the economy and population grow. The comprehensive analysis of all five alternatives indicates that the Scoping Plan Scenario–continuing the Cap-and-Trade Program–is the best choice to achieve the State's climate and clean air goals. It also protects public health, provides a solid foundation for continued economic growth, and supports California's quality of life.

All of the alternative scenarios briefly described in this chapter are the product of the Scoping Plan development process and were informed by public input, including that from EJAC, as well as Board and legislative direction over the course of two years. The scenarios all include a range of additional measures developed or required by legislation over the past two years with 2030 as their target date and include: extending the LCFS to an 18 percent reduction in carbon intensity beyond 2020, and the requirements of SB 350 to increase renewables to 50 percent and to double energy efficiency savings. They also all include the Mobile Source Strategy targets for more zero emission vehicles and much cleaner trucks and transit, the Sustainable Freight Action Plan to improve freight efficiency and transition to zero emission freight handling technologies, and the requirements under SB 1383 to reduce anthropogenic black carbon 50 percent and hydrofluorocarbon and methane emissions by 40 percent below 2013 levels by 2030. The recent adoption of AB 398 into State law on July 25, 2017, clarifies the role of the Cap-and-Trade Program through December 31, 2030.

Work is still underway on how to quantify the GHG emissions within the natural and working lands sector. As such, the analyses in this chapter do not include any estimates from this sector. Additional information on the current efforts to better understand GHG emissions fluxes and model the actions needed to support the goal of net carbon sequestration in natural and working lands can be found in Chapter 4. Even absent quantification data, the importance of this sector in achieving the State's climate goals should be considered in conjunction with any efforts to reduce GHG emissions in the energy and industrial sectors.

During the development of the Scoping Plan, stakeholders suggested alternative scenarios to achieve the 2030 target. While countless scenarios could potentially be developed and evaluated, the four below were considered, as they were most often included in comments by stakeholders and they bracket the range of potential scenarios. Several of these alternative scenarios were also evaluated in the Initial AB 32 Scoping Plan in 2008 (All Regulations, Carbon Tax).[55] Since the adoption of the Initial AB 32 Scoping Plan, some of the alternative scenarios have been implemented or contemplated by other jurisdictions, which has helped in the analysis and the development of this Scoping Plan. This section provides a brief description of the alternatives. A full description of the alternatives and staff's AB 197 and policy analyses are included in Appendix G.

55 CARB. 2009. Initial AB 32 Climate Change Scoping Plan Document. *www.arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm*

Scoping Plan Scenario: Ongoing and statutorily required programs and continuing the Cap-and-Trade Program. This scenario was modified from the January 2017 Proposed Scoping Plan to reflect AB 398, including removal of the 20 percent refinery measure.

Alternative 1: No Cap-and-Trade. Includes additional activities in a wide variety of sectors, such as specific required reductions for all large GHG sources, and more extensive requirements for renewable energy. Industrial sources would be regulated through command and control strategies.

Alternative 2: Carbon Tax. A carbon tax to put a price, but not limit, on carbon, instead of the Cap-and-Trade Program.

Alternative 3: All Cap-and-Trade. This alternative is the same as the Scoping Plan Scenario, while maintaining the LCFS at a 10 percent reduction in carbon intensity past 2020.

Alternative 4: Cap-and-Tax. This would place a declining cap on individual industrial facilities, and individual natural gas and fuel suppliers, while also requiring them to pay a tax on each metric ton of GHGs emitted.

Since the statutory direction on meeting a 2030 GHG target is clear, the issue of certainty of reductions is paramount. These alternatives vary greatly as to the certainty of meeting the target. The declining mass emissions cap under a cap-and-trade program provides certain and measurable reductions over time; a carbon tax, meanwhile, establishes some carbon price certainty, but does not provide an assurance on reductions and instead assumes that some degree of reductions will occur if costs are high enough to alter behavior.

There are also other considerations: to what extent does an alternative meet the target, but also deliver clean air benefits, prioritize reductions at large stationary sources, and allow for continued investment in disadvantaged communities? What is the cost of an alternative and what will be the impact on California consumers? Does an alternative allow for California to link with other jurisdictions, and support the Clean Power Plan[56] and other federal and international climate programs? Does an alternative provide for flexibility for regulated entities, and a cost-effective approach to reduce greenhouse gases?

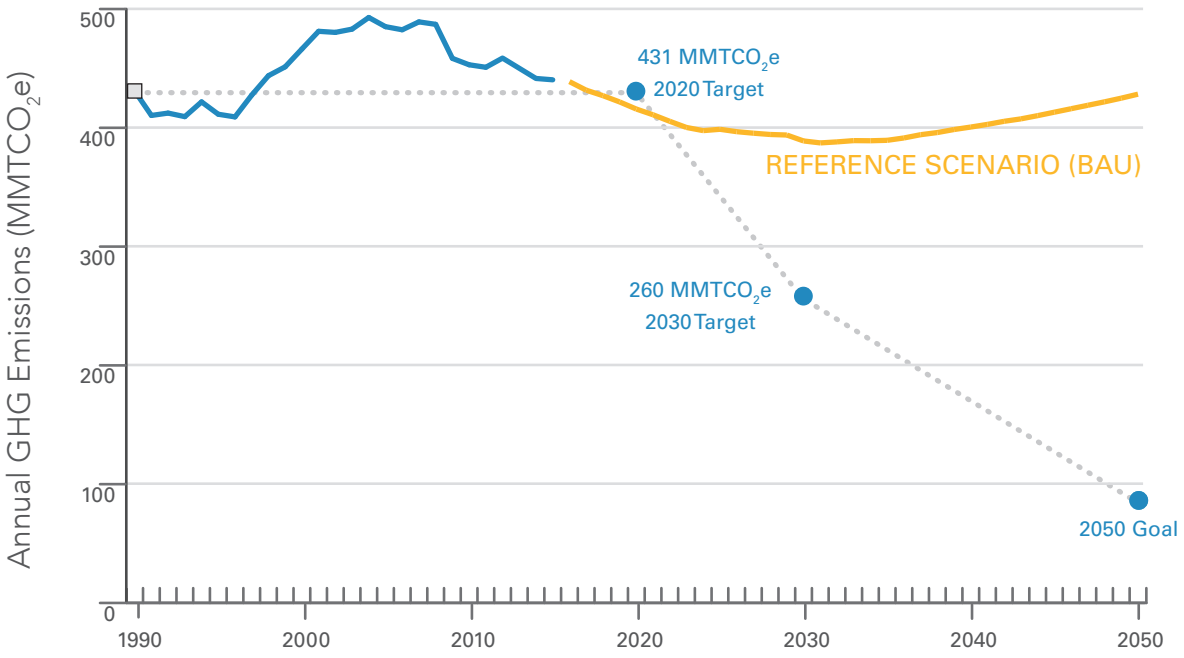
The Scoping Plan Scenario provides a portfolio of policies and measures that balances this combination of objectives, including the highest certainty to achieve the 2030 target, while protecting the California economy and consumers. A more detailed analyses of the alternatives is provided in Appendix G.

Scoping Plan Scenario

The development of the Scoping Plan began by first modeling a Reference Scenario (BAU). The Reference Scenario is the forecasted statewide GHG emissions through 2030 with existing policies and programs, but without any further action to reduce GHGs. Figure 6 provides the modeling results for a Reference Scenario for this Scoping Plan. The graph shows the State is expected to reduce emissions below the 2020 statewide GHG target, but additional effort will be needed to maintain and continue GHG reductions to meet the mid- (2030) and long-term (2050) targets. Figure 6 depicts a linear, straight-line path to the 2030 target. It should be noted that in any year, GHG emissions may be higher or lower than the straight line. That is to be expected as periods of economic recession or increased economic activity, annual variations in hydropower, and many other factors may influence a single or several years of GHG emissions in the State. CARB's annual GHG reporting and inventory will provide data on progress towards achieving the 2030 target. More details about the modeling for the Reference Scenario can be found in Appendix D.

56 Although the Clean Power Plan is being challenged in legal and administrative processes, its requirements reflect U.S. EPA's statutory obligation to regulate greenhouse gases from the power sector. Thus it, and other federal programs, are a key consideration for Scoping Plan development.

Figure 6: 2017 Scoping Plan Reference Scenario



The Scoping Plan Scenario is summarized in Table 1. As shown in the table, most of the measures are identified as "known commitments" (marked with "*"), meaning that they are existing programs or required by statute. These commitments are not part of the Reference Scenario (BAU) in Figure 6 since their passage and implementation is related to meeting the Governor's climate pillars, the 2030 climate target, or other long-term climate and air quality objectives. In addition to the known commitments, the Scoping Plan Scenario includes a post-2020 Cap-and-Trade Program.

Table 1: Scoping Plan Scenario

Policy	Primary Objective	Highlights	Implementation Time Frame
SB 350[57]*	Reduce GHG emissions in the electricity sector through the implementation of the 50 percent RPS, doubling of energy savings, and other actions as appropriate to achieve GHG emissions reductions planning targets in the Integrated Resource Plan (IRP) process.	• Load-serving entities file plans to achieve GHG emissions reductions planning targets while ensuring reliability and meeting the State's other policy goals cost-effectively. • 50 percent RPS. • Doubling of energy efficiency savings in natural gas and electricity end uses statewide.	2030
Low Carbon Fuel Standard (LCFS)*	Transition to cleaner/less-polluting fuels that have a lower carbon footprint.	• At least 18 percent reduction in carbon intensity, as included in the Mobile Source Strategy.	2030
Mobile Source Strategy (Cleaner Technology and Fuels [CTF] Scenario)[58]*	Reduce GHGs and other pollutants from the transportation sector through transition to zero-emission and low-emission vehicles, cleaner transit systems and reduction of vehicle miles traveled.	• 1.5 million zero emission vehicles (ZEV), including plug-in hybrid electric, battery-electric, and hydrogen fuel cell vehicles by 2025 and 4.2 million ZEVs by 2030. • Continue ramp up of GHG stringency for all light-duty vehicles beyond 2025. • Reductions in GHGs from medium-duty and heavy-duty vehicles via the Phase 2 Medium and Heavy-Duty GHG Standards. • Innovative Clean Transit: Transition to a suite of innovative clean transit options. Assumed 20 percent of new urban buses purchased beginning in 2018 will be zero emission buses with the penetration of zero-emission technology ramped up to 100 percent of new bus sales in 2030. Also, new natural gas buses, starting in 2018, and diesel buses, starting in 2020, meet the optional heavy-duty low-NO_X standard. • Last Mile Delivery: New regulation that would result in the use of low NO_X or cleaner engines and the deployment of increasing numbers of zero-emission trucks primarily for class 3-7 last mile delivery trucks in California. This measure assumes ZEVs comprise 2.5 percent of new Class 3–7 truck sales in local fleets starting in 2020, increasing to 10 percent in 2025. • Reduction in vehicle miles traveled (VMT), to be achieved in part by continued implementation of SB 375 and regional Sustainable Community Strategies; forthcoming statewide implementation of SB 743; and potential additional VMT reduction strategies not specified in the Mobile Source Strategy, but included in the document "Potential VMT Reduction Strategies for Discussion" in Appendix C.[59]	Various
SB 1383*	Approve and Implement Short-Lived Climate Pollutant strategy[60] to reduce highly potent GHGs	• 40 percent reduction in methane and hydrofluorocarbon (HFC) emissions below 2013 levels by 2030. • 50 percent reduction in anthropogenic black carbon emissions below 2013 levels by 2030.	2030
California Sustainable Freight Action Plan[61]*	Improve freight efficiency, transition to zero emission technologies, and increase competitiveness of California's freight system.	• Improve freight system efficiency by 25 percent by 2030. • Deploy over 100,000 freight vehicles and equipment capable of zero emission operation and maximize both zero and near-zero emission freight vehicles and equipment powered by renewable energy by 2030.	2030
Post-2020 Cap-and-Trade Program	Reduce GHGs across largest GHG emissions sources	• Continue the existing Cap-and-Trade Program with declining caps to ensure the State's 2030 target is achieved.	

* These measures and policies are referred to as "known commitments."

57 SB 350 Clean Energy and Pollution Reduction Act of 2015 (De León, Chapter 547, Statutes of 2015). *leginfo.legislature.ca.gov/faces/billNavClient.xhtml?billid=201520160SB350* This policy also includes increased demand response and PV.
58 CARB. 2016. 2016 Mobile Source Strategy. *www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf*
59 CARB. Potential State-Level Strategies to Advance Sustainable, Equitable Communities and Reduce Vehicle Miles of Travel (VMT)--for Discussion. *www.arb.ca.gov/cc/scopingplan/meetings/091316/Potential%20VMT%20Measures%20For%20Discussion_9.13.16.pdf*
60 CARB. 2016. Reducing Short-Lived Climate Pollutants in California. *www.arb.ca.gov/cc/shortlived/shortlived.htm*
61 State of California. California Sustainable Freight Action Plan website. *www.casustainablefreight.org/*

Table 2 summarizes the results of the modeling for the Reference Scenario and known commitments. Per SB 32, the 2030 limit is 260 $MMTCO_2e$. That is a limit on total GHG emissions in a single year. At approximately 389 $MMTCO_2e$, the Reference Scenario is expected to exceed the 2030 limit by about 129 $MMTCO_2e$.

Table 2 also compares the Reference Scenario 2030 emissions estimate of 389 $MMTCO_2e$ to the 2030 target of 260 $MMTCO_2e$ and the level of 2030 emissions with the known commitments, estimated to be 320 $MMTCO_2e$. And, in the context of a linear path to achieve the 2030 target, there is also a need to achieve cumulative emissions reductions of 621 $MMTCO_2e$ from 2021 to 2030 to reach the 2030 limit. While there is no statutory limit on cumulative emissions, the analysis considers and presents some results in cumulative form for several reasons. It should be recognized that policies and measures may perform differently over time. For example, in early years, a policy or measure may be slow to be deployed, but over time it has greater impact. If you were to look at its performance in 2021 versus 2030, you would see that it may not seem important and may not deliver significant reductions in the early years, but is critical for later years as it results in greater reductions over time. Further, once GHGs are emitted into the atmosphere, they can have long lifetimes that contribute to global warming for decades. Policies that reduce both cumulative GHG emissions and achieve the single-year 2030 target provide the most effective path to reducing climate change impacts. A cumulative construct provides a more complete way to evaluate the effectiveness of any measure over time, instead of just considering a snapshot for a single year.

Table 2: 2030 Modeling GHG Results for the Reference Scenario and Known Commitments

Modeling Scenario	2030 GHG Emissions ($MMTCO_2e$)	Cumulative GHG Reductions 2021–2030 ($MMTCO_2e$)	Cumulative Gap to 2030 Target ($MMTCO_2e$)
Reference Scenario (Business-as-Usual)	389	n/a	621
Known Commitments	320	385	236

As noted above, the known commitments are expected to result in emissions that are 60 $MMTCO_2e$ above the target in 2030, and have a cumulative emissions reduction gap of about 236 $MMTCO_2e$. This means the known commitments do not decline fast enough to achieve the 2030 target. The remaining 236 $MMTCO_2e$ of estimated GHG emissions reductions would not be achieved unless further action is taken to reduce GHGs. Consequently, for the Scoping Plan Scenario, the Post-2020 Cap-and-Trade Program would need to deliver 236 $MMTCO_2e$ cumulative GHG emissions reductions from 2021 through 2030. If the estimated GHG reductions from the known commitments are not realized due to delays in implementation or technology deployment, the post-2020 Cap-and-Trade Program would deliver the additional GHG reductions in the sectors it covers to ensure the 2030 target is achieved. Figure 7 illustrates the cumulative emissions reductions contributions of the known commitments and the Cap-and-Trade Program from 2021 to 2030.

Post-2020 Cap-and-Trade Program with Declining Caps

This measure would continue the Cap-and-Trade Program post-2020 pursuant to legislative direction in AB 398. The program is up and running and has a five-year-long record of auctions and successful compliance. In the face of a growing economy, dry winters, and the closing of a nuclear plant, it is delivering GHG reductions. This is not to say that California should continue on this road simply because the Cap-and-Trade Program is already in place. The analyses in this chapter, and the economic analysis in Chapter 3, clearly demonstrate that continuing the Cap-and-Trade Program through 2030 will provide the most secure, reliable, and feasible clean energy future for California–one that will continue to deliver crucial investments to improve the quality of life and the environment in disadvantaged communities.

Under this measure, funds would also continue to be deposited into the Greenhouse Gas Reduction Fund (GGRF) to support projects that fulfill the goals of AB 32, with AB 398 identifying a list of priorities for the Legislature to consider for future appropriations from GGRF. Investment of the Cap-and-Trade Program proceeds furthers the goals of AB 32 by reducing GHG emissions, providing net GHG sequestration, providing co-benefits, investing in disadvantaged communities and low-income communities, and supporting the long-term, transformative efforts needed to improve public and environmental health and

develop a clean energy economy. These investments support programs and projects that deliver major economic, environmental, and public health benefits for Californians. Importantly, prioritized investments in disadvantaged communities are providing a multitude of meaningful benefits to these communities some of which include increased affordable housing opportunities, reduced transit and transportation costs, access to cleaner vehicles, improved mobility options and air quality, job creation, energy cost savings, and greener and more vibrant communities.

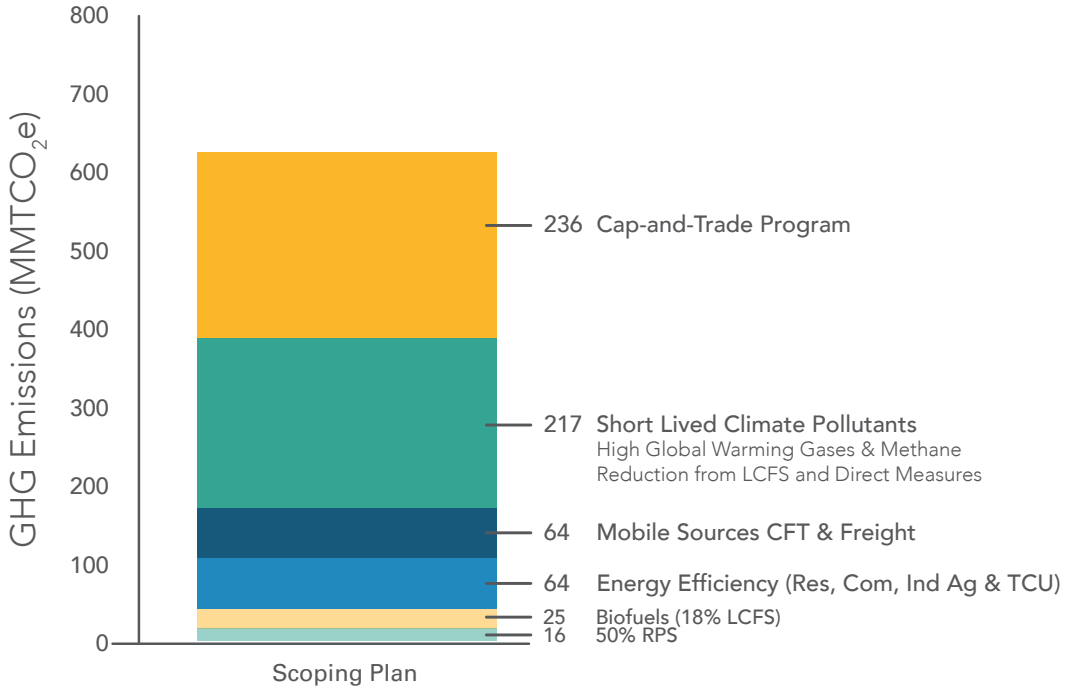
Further, the Cap-and-Trade Program is designed to protect electricity and natural gas residential ratepayers from higher energy prices. The program includes a mechanism for electricity and natural gas utilities to auction their freely allocated allowances, with the auction proceeds benefiting ratepayers. The Climate Credit is a twice-annual bill credit given to investor-owned utility electricity residential customers. The total value of the Climate Credit for vintage 2013 auction allowances alone was over $400 million. The first of these credits appeared on customer bills in April 2014.[62] Currently, natural gas utilities are permitted to use a portion of their freely allocated allowances to meet their own compliance obligations; however, over time, they must consign a larger percentage of allowances and continue to provide the value back to customers.

Additionally, under this measure, the State would preserve its current linkages with its Canadian partners and support future linkages with other jurisdictions, thus facilitating international action to address climate change. The high compliance rates with the Cap-and-Trade Program also demonstrate that the infrastructure and implementation features of the program are effective and understood by the regulated community. This measure also lends itself to integration with the Clean Power Plan requirements and is flexible to allow expansion to other sectors or regions.

In late 2017, CARB began evaluating changes to program design features for post-2020 in accordance with AB 398.[63] This includes changes to the offset usage limit, direction on allocation, two price containment points, and a price ceiling – which, if in the unlikely event were to be accessed, must result in GHG reductions by compensating for any GHG emissions above the cap, ensuring the environmental integrity of the program. Changes to conform to the requirements of AB 398 will be subject to a public process, coordinated with linked partners, and be part of a future rulemaking that would take effect by January 1, 2021.

62 *www.arb.ca.gov/cc/capandtrade/allowanceallocation/edu-v2013-allowance-value-report.pdf*
63 *www.arb.ca.gov/cc/capandtrade/meetings/20171012/ct_presentation_11oct2017.pdf*

Figure 7: Scoping Plan Scenario – Estimated Cumulative GHG Reductions by Measure (2021–2030)[64]



The Scoping Plan Scenario in Figure 7 represents an expected case where current and proposed GHG reduction policies and measures begin as expected and perform as expected, and technology is readily available and deployed on schedule. An Uncertainty Analysis was performed to examine the range of outcomes that could occur under the Scoping Plan policies and measures. The uncertainty in the following factors was characterized and evaluated:

- Economic growth through 2030;
- Emission intensity of the California economy;
- Cumulative emissions reductions (2021 to 2030) achieved by the prescriptive measures, including the known commitments; and
- Cumulative emissions reductions (2021 to 2030) that can be motivated by emission prices under the Cap-and-Trade Program.

The combined effects of these uncertainties are summarized in Figure 8. As shown in Figure 7, the Scoping Plan analysis estimates that the prescriptive measures will achieve cumulative emissions reductions of 385 $MMTCO_2e$, the Cap-and-Trade Program will achieve 236 $MMTCO_2e$, resulting in total cumulative emissions reductions of 621 $MMTCO_2e$. These values are again reflected in the bar on the left of Figure 8. The results of the Uncertainty Analysis are summarized in the three bars on the right of the figure as follows:

- The cumulative emissions reductions required to achieve the 2030 emission limit has the potential to be higher or lower than the Scoping Plan estimate. The uncertainty analysis simulates an average required emissions reductions of about 660 $MMTCO_2e$ with a range of +130 $MMTCO_2e$.[65] This estimate and the range are shown in Figure 8 as the bar on the right. Notably, the estimate of the average required emissions reductions is 40 $MMTCO_2e$ greater than the estimate in the Scoping Plan analysis.
- The prescriptive measures have the potential to underperform relative to expectations. Based on CARB staff assessments of the potential risk of underperformance of each measure, the average emissions reductions simulated to be achieved was 335 $MMTCO_2e$, or about 13 percent below the Scoping Plan estimate. The range for the performance of the measures was about +50 $MMTCO_2e$.

64 The whole number values displayed in Figure 7 do not mathematically sum to 621 $MMTCO_2e$, consistent with the modeling results summary in Table 2. This is a result of embedded significant figures and rounding for graphic display purposes. Please refer to the corresponding PATHWAYS modeling data spreadsheets for details.

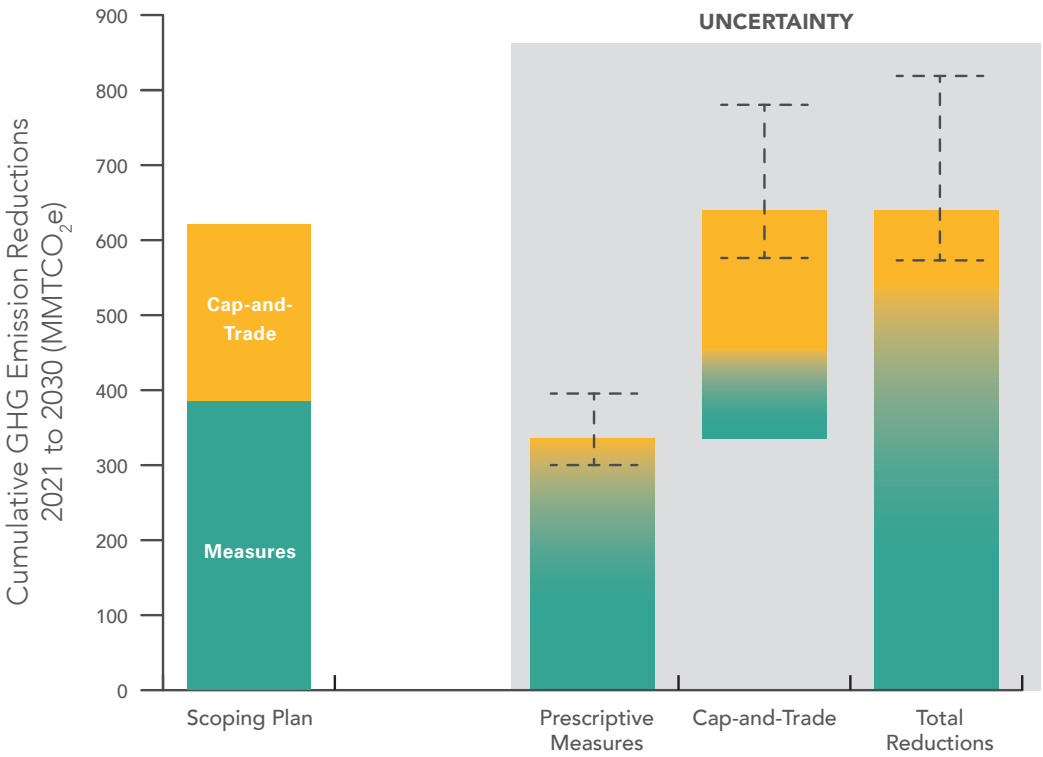
65 The ranges presented are the 5th and 95th percentile observations in the Uncertainty Analysis. See Appendix E for details.

These values for the potential reductions achieved by the measures are shown in the figure.

- The Cap-and-Trade program is designed to fill the gap in the required emissions reductions over and above what is achieved by the prescriptive measures. Because the total required emissions reductions are uncertain, and the emissions reductions achieved by the prescriptive measures are uncertain, the required emissions reductions from the Cap-and-Trade Program are also uncertain. The Uncertainty Analysis simulated the average emissions reductions achieved by the Cap-and-Trade Program at about 305 $MMTCO_2e$, or about 30 percent higher than the Scoping Plan estimate. The range was simulated to be about +120 $MMTCO_2e$. These values for the potential reductions achieved by the Cap-and-Trade Program are shown in the figure.

The Uncertainty Analysis provides insight into the range of potential emissions outcomes that may occur, and demonstrates that the Scoping Plan, with the Cap-and-Trade Program, is extremely effective in the face of uncertainty, assuring that the required emissions reductions are achieved (see Appendix E for more detail). The Uncertainty Analysis also indicates that the Cap-and-Trade Program could contribute a larger or smaller share of the total required cumulative emissions reductions than expected in the Scoping Plan analysis.

Figure 8: Uncertainty Analysis



While the modeling results provide estimates of the GHG reductions that could be achieved by the measures, the results also provide other insights and highlight the need to ensure successful implementation of each measure. The SLCP Strategy will provide significant reductions with a focus on methane and hydrofluorocarbon gases. To ensure the SLCP Strategy implementation is successful, it will be critical to ensure programs such as LCFS maintain incentives to finance the capture and use of methane as a transportation fuel–further reducing the State's dependence on fossil fuels. The modeling also shows that actions on energy efficiency could provide the same magnitude of GHG emissions reductions as the mobile source measures, but each effort will provide different magnitudes of air quality improvements and cost-effectiveness as discussed in Chapter 3.

Another way to look at this scenario is to understand the trajectory of GHG reductions over time, relative to the 2030 target. Figure 9 provides the trajectory of GHG emissions modeled for the Scoping Plan Scenario. Again, this depicts a straight-line path to the 2030 target for discussion purposes, but in reality GHG emissions may be above or below the line in any given year(s).

Figure 9: Scoping Plan Scenario GHG Reductions

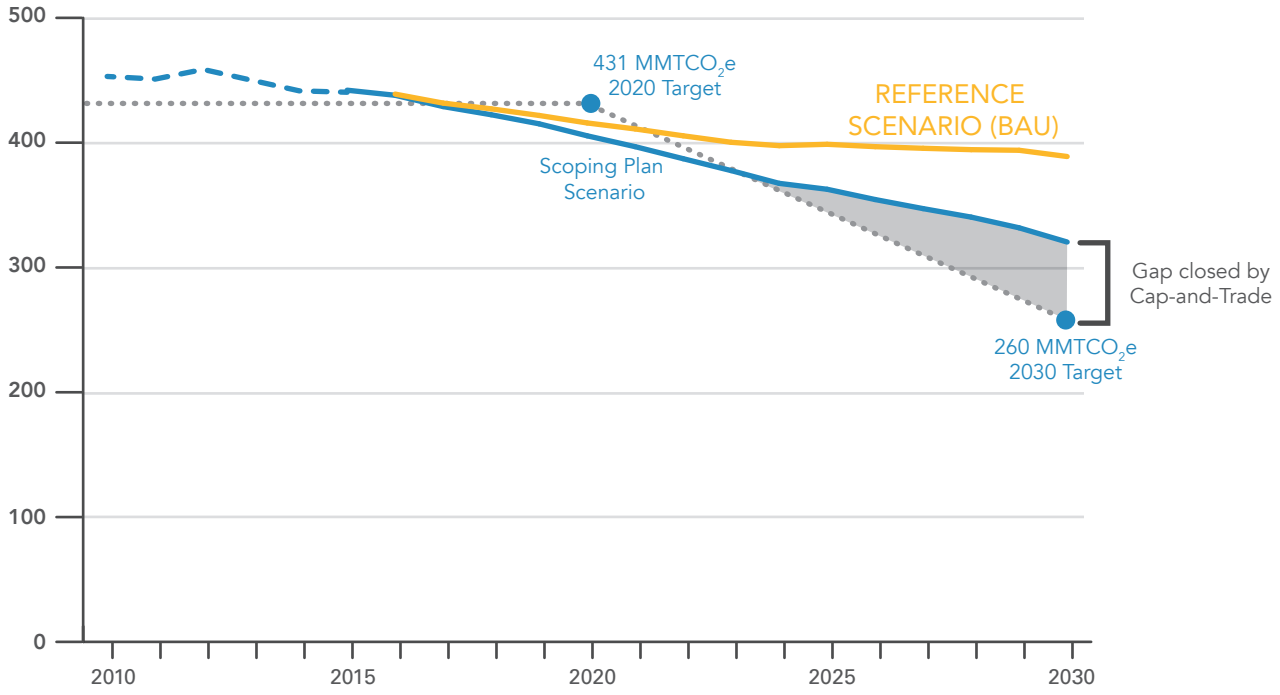


Figure 9 shows the Reference Scenario (yellow) and the version of the Scoping Plan Scenario that excludes the Cap-and-Trade Program (blue). Until 2023, the measures in the Scoping Plan Scenario constrain GHG emissions below the dotted straight line. After 2023, GHG emissions continue to fall, but at a slower rate than needed to meet the 2030 target. It is the Cap-and-Trade Program that will reduce emissions to the necessary levels to achieve the 2030 target. In this scenario, it is estimated that the known commitments will result in an emissions level of about 320 $MMTCO_2e$ in 2030. Thus, for the Scoping Plan Scenario, the Cap-and-Trade Program would deliver about 60 $MMTCO_2e$ in 2030 and ensure the 2030 target is achieved.

To understand how the Scoping Plan affects the main economic sectors, Table 3 provides estimated GHG emissions by sector, compared to 1990 levels, and the range of GHG emissions for each sector estimated for 2030. This comparison helps to illustrate which sectors are reducing emissions more than others and where to focus additional actions to reduce GHGs across the entire economy.

Table 3: Estimated Change in GHG Emissions by Sector ($MMTCO_2E$)

	1990	2030 Scoping Plan Ranges[6]	% change from 1990
Agriculture	26	24–25	-8 to -4
Residential and Commercial	44	38–40	-14 to -9
Electric Power	108	30–53[7]	-72 to -51
High GWP	3	8–11[8]	267 to 367
Industrial	98	83–90[9]	-15 to -8
Recycling and Waste	7	8–9[70]	14 to 29**
Transportation (Including TCU)	152	103–111	-32 to -27
Natural Working Lands Net Sink*	-7***	TBD	TBD
Sub Total	431	294–339	-32 to -21
Cap-and-Trade Program	n/a	34–79	n/a
Total	**431**	**260**	**-40**

* Work is underway through 2017 to estimate the range of potential sequestration benefits from the natural and working lands sector.

** The SLCP will reduce emissions in this sector by 40 percent from 2013 levels. However, the 2030 levels are still higher than the 1990 levels as emissions in this sector have grown between 1990 and 2013.

*** This number reflects net results and is different than the intervention targets discussed in Chapter 4.

The sector ranges may change in response to how the sectors respond to the Cap-and-Trade Program. While the known commitments will deliver some reductions in each sector, the Cap-and-Trade Program will deliver additional reductions in the sectors it covers. Annual GHG reporting and the GHG inventory will track annual changes in emissions, and those will provide ongoing assessments of how each sector is reducing emissions due to the full complement of known commitments and the Cap-and-Trade Program, as applicable.

Scenario Modeling

There are a variety of models that can be used to model GHG emissions. For this Plan, the State is using the PATHWAYS model.[70] PATHWAYS is structured to model GHG emissions while recognizing the integrated nature of the industrial economic and energy sectors. For example, if the transportation sector adds more electric vehicles, PATHWAYS responds to reflect an energy demand increase in the electricity sector. However, PATHWAYS does not reflect any change in transportation infrastructure and land use demand associated with additional ZEVs on the road. The ability to capture a subset of interactive effects of policies and measures helps to provide a representation of the interconnected nature of the system and impacts to GHGs.

66 Unless otherwise noted, the low end of the sector range is the estimated emissions from the Scoping Plan Scenario and the high end adjusts the expected emissions by a risk factor that represents sector underperformance.

67 The high end of the electric power sector range is represented by the Scoping Plan Scenario, and the low end by enhancements and additional electricity sector measures such as deployment of additional renewable power, greater behind-the-meter solar PV, and additional energy efficiency. The electric power sector range provided in Table 3 will be used to help inform CARB's setting of the SB 350 Integrated Resource Plan greenhouse gas emissions reduction planning targets for the sector. CARB, CPUC, and CEC will continue to coordinate on this effort before final IRP targets are established for the sector, load-serving entities, and publicly-owned utilities. State agencies will investigate the potential for and appropriateness of deeper electric sector reductions in light of the overall needs of the Scoping Plan to cost-effectively achieve the statewide GHG goals. Concurrently, CEC and CPUC are proceeding with their respective IRP processes using this range.

68 The sector emissions are anticipated to increase by 2030. As such, the high end of the sector range is the estimated emissions from the Scoping Plan Scenario and the low end adjusts the expected emissions by a risk factor that represents sector over performance.

69 This estimate does not account for the reductions expected in this sector from the Cap-and-Trade Program. The Cap-and-Trade line item includes reductions that will occur in the industrial sector.

70 CARB. 2016. AB 32 Scoping Plan Public Workshops. *www.arb.ca.gov/cc/scopingplan/meetings/meetings.htm*

At this time, PATHWAYS does not include a module for natural and working lands. As such, PATHWAYS cannot be used to model the natural and working lands sector, the interactive effects of polices aimed at the economic and energy sectors and their effect on land use or conditions, or the interactive effects of polices aimed at the natural environment and their impact on the economic and energy sectors. For this Plan, external inputs had to be developed for PATHWAYS to supply biofuel volumes. The natural and working lands sector is also being modeled separately as described in Chapter 4. Moving forward, CARB and other State agencies will work to integrate all the sectors into one model to fully capture interactive effects across both the natural and built environments.

Lastly, the PATHWAYS assumptions and results in this Plan show the significant action that the State must take to reach its GHG reduction goals. It is important to note that the modeling assumptions may differ from other models used by other State agencies. Modeling exercises undertaken in future regulatory proceedings may result in different measures, programs, and program results than those used in the modeling for this Scoping Plan. State agencies will engage on their specific policies and measure development processes separately from CARB Scoping Plan activities, in public forums to engage all stakeholders.

Uncertainty

Several types of uncertainty are important to understand in both forecasting future emissions and estimating the benefits of emissions reductions scenarios. In developing the Scoping Plan, we have forecast a Reference Scenario and estimated the GHG emissions outcome of the Scoping Plan using PATHWAYS. Inherent in the Reference Scenario modeling is the expectation that many of the existing programs will continue in their current form, and the expected drivers for GHG emissions such as energy demand, population growth, and economic growth will match our current projections. However, it is unlikely that the future will precisely match our projections, leading to uncertainty in the forecast. Thus, the single "reference" line should be understood to represent one possible future in a range of possible predictions. For the Scoping Plan Scenario, PATHWAYS utilized inputs that are assumptions external to the model. PATHWAYS was provided plausible inputs such as energy demand over time, the start years for specific policies, and the penetration rates of associated technologies. Each of the assumptions provided to PATHWAYS has some uncertainty, which is also reflected in the results. Thus, while the results presented in the Scoping Plan may seem precise due to the need for precision in model inputs, these results are estimates, and the use of ranges in some of the results is meant to capture that uncertainty.

Further, as noted in the November 7, 2016, 2030 Target Scoping Plan Workshop, "All policies have a degree of uncertainty associated with them."[71] As this Scoping Plan is meant to chart a path to achieving the 2030 target, additional work will be required to fully design and implement any policies identified in this Scoping Plan. During the subsequent development of policies, CARB and other State agencies will learn more about technologies, cost, and how each industry works as a more comprehensive evaluation is conducted in coordination with stakeholders. Given the uncertainty around assumptions used in modeling, and in performance once specific policies are fully designed and implemented, estimates associated with the Scoping Plan Scenario are likely to differ from what actually occurs when the Scoping Plan is implemented. One way to mitigate for this risk is to develop policies that can adapt and increase certainty in GHG emissions reductions. Periodic reviews of progress toward achieving the 2030 target and the performance of specific policies will also provide opportunities for the State to consider any changes to ensure we remain on course to achieve the 2030 target. The need for this periodic review process was anticipated in AB 32, as it calls for updates to the Scoping Plan at least once every five years. Additional information on the uncertainty analyses conducted in the development of this Scoping Plan is located in Appendix E.

71 Bushnell, James. Economic Modeling and Environmental Policy Choice. PowerPoint. Department of Economics, University of California, Davis. *www.arb.ca.gov/cc/scopingplan/meetings/110716/bushnellpresentation.pdf*

Policy Analysis of Scoping Plan Scenario

The following key criteria were considered while evaluating potential policies beyond the known commitments. The results of the economic analysis (presented in Chapter 3) were also important in the design of this Scoping Plan.

- **Ensure the State achieves the 2030 target.** The strategy must ensure that GHG emissions reductions occur and are sufficient to achieve the 2030 target.
- **Provide air quality co-benefits.** An important concern for environmental justice communities is for any Scoping Plan to provide air quality co-benefits.
- **Prioritize rules and regulations for direct GHG reductions.** AB 197 requires CARB in developing this Scoping Plan to prioritize emissions reductions rules and regulations that result in direct emissions reductions at large stationary sources of GHG emissions sources and direct emissions reductions from mobile sources.
- **Provide protection against emissions leakage.** Require any policies to achieve the statewide limits to minimize emissions leakage to the extent possible. Emissions leakage can occur when production moves out-of-state, so there appears to be a reduction in California's emissions, but the production and emissions have just moved elsewhere. This loss in production may be associated with loss in jobs and decreases in the State's gross domestic product (GDP) and could potentially increase global GHG emissions if the production moves to a less efficient facility outside of California.
- **Develop greenhouse gas reduction programs that can be readily exported to other jurisdictions.** Currently, California's Cap-and-Trade Program is linked with Québec's program and is scheduled to link with Ontario's cap-and-trade program beginning in 2018. At the same time, California's ambitious policies such as the RPS, LCFS, and Advanced Clean Cars have resulted in other regions adopting similar programs.
- **Minimize costs and increase investment in disadvantaged and low-income communities, and low-income households.** Currently, Cap-and-Trade auction proceeds from the sale of State-owned allowances are appropriated for a variety of programs to reduce GHGs, and provide other environmental, health and economic benefits including job creation and economic development. Under AB 1550, a minimum of 25 percent of the proceeds are to be invested in projects located in and benefiting disadvantaged communities, with an additional minimum 10 percent to projects in low-income communities, and low-income households. It is important to understand if the strategy will require or result in funding to support these GHG reductions and associated benefits.
- **Avoid or minimize the impacts of climate change on public health by continuing reductions in GHGs.** Climate change has the potential to significantly impact public health, including increases in heat illness and death, air pollution-related exacerbation of cardiovascular and respiratory diseases, injury and loss of life due to severe storms and flooding, increased vector-borne and water-borne diseases, and stress and mental trauma due to extreme weather-related catastrophes.
- **Provide compliance flexibility.** Flexibility is important as it allows each regulated entity the ability to pursue its own path toward compliance in a way that works best for its business model. Flexibility also acknowledges that regulatory agencies may not have a complete picture of all available low-cost compliance mechanisms or opportunities even across the same sector. In addition, under AB 32 and AB 197, the strategy to reduce GHGs requires consideration of cost-effectiveness, which compliance flexibility provides.
- **Support the Clean Power Plan and other federal climate programs.** California will continue to support aggressive federal action, as well as to defend existing programs like the Clean Power Plan, which is the most prominent federal climate regulation applicable to stationary sources. The U.S. Supreme Court has repeatedly confirmed that federal greenhouse gas regulation must move forward under the federal Clean Air Act, so it is important to ensure that California's programs can support federal compliance as well. Although continuing litigation has stayed certain Clean Power Plan deadlines in the near term, and U.S. EPA has proposed to reconsider aspects of the rule as issued, the Clean Power Plan remains the law of the land. California is vigorously defending this important program, and is continuing to support federal climate regulation as is required by law. U.S EPA also has a legal obligation to implement GHG controls for power plants, even if it proposes to alter the form of those controls in the future. Therefore, the Clean Power Plan and other federal efforts are important considerations for this Scoping Plan. With regard to the

Clean Power Plan, California power plants are expected to be within their limits as set forth by the State's compliance plan, which was approved by CARB on July 27, 2017. However, the State still needs a mechanism to ensure the emissions for the covered electricity generating plants do not exceed the federal limits. This mechanism must be federally enforceable with regard to the affected power plants, and limit their emissions in accordance with the federal limit.

Table 4 uses the criteria listed above to assess the Scoping Plan Scenario. This assessment is based on CARB staff evaluation as well as the analyses described in Chapter 3.

Table 4: Policy Assessment of the Scoping Plan

Criteria	Details
Ensure the State Achieves the 2030 Target	• Incorporates existing and new commitments to reduce emissions from all sectors • The Cap-and-Trade Program scales to ensure reductions are achieved, even if other policies do not achieve them. This is particularly critical given the uncertainty inherent in both CARB's emission forecast and its estimate of future regulations.
Provide Air Quality Co-Benefits	• Reduced fossil fuel use and increased electrification (including plug-in hybrid electric, battery-electric, and hydrogen fuel cell vehicles) from policies such as the Mobile Source Strategy, enhanced LCFS and RPS, energy efficiency, land conservation, and refinery measure will likely reduce criteria pollutants and toxic air contaminants. • The Cap-and-Trade Program will ensure GHG emissions reductions within California that may reduce criteria pollutants and toxic air contaminants.
Prioritize Rules and Regulations for Direct GHG Reductions	• Advanced Clean Cars regulations require reduction in the light-duty vehicle sector. • Enhanced LCFS requires reductions in light-duty and heavy-duty transportation. • SB 350, RPS, and energy efficiency will reduce the need for fossil power generation. • The Cap-and-Trade Program constrains and reduces emissions across approximately 80 percent of California GHG emissions. • SB 1383 and the Short-lived Climate Pollutant Reduction Strategy require reductions in the agricultural, commercial, residential, industrial, and energy sectors.
Protect Against Emissions Leakage	• Free allowance allocation to minimize leakage, where supported by research.
Develop GHG Reduction Programs that can be Readily Exported to Other Jurisdictions	• Supports existing and future linkages, allows for larger GHG emissions reductions worldwide through collaborative regional efforts. • Provides leadership on how to integrate short-lived climate pollutants into the broader climate mitigation program.
Minimize Costs and Invest in Disadvantaged and Low-Income Communities, and Low-Income Households	• Continue to fund programs and projects that reduce GHGs and meaningfully benefit disadvantaged and low-income communities and low-income households through the Greenhouse Gas Reduction Fund.
Avoid or Minimize the Impacts of Climate Change on Public Health	• Reduces GHGs and provides leadership nationally and internationally for climate action. • Provides funding for programs such as home weatherization focused on disadvantaged communities, to mitigate potential cost impacts.
Compliance Flexibility	• Regulated sources self-identify and implement some GHG emissions reductions actions, beyond those already required to comply with additional prescriptive measures.
Support the Clean Power Plan and other Federal Climate Programs	• Post-2020 Cap-and-Trade Program can be used to comply with the Clean Power Plan.

Chapter 3

Evaluations

Programs for Air Quality Improvement in California

For half a century, CARB has been a leader in measuring, evaluating, and reducing sources of air pollution that impact public health. Its air pollution programs have been adapted for national programs and emulated in other countries. Significant progress has been made in reducing diesel particulate matter (PM), which is a designated toxic air contaminant, and many other hazardous air pollutants. CARB partners with local air districts to address stationary source emissions and adopts and implements State-level regulations to address sources of criteria and toxic air pollution, including mobile sources. The key air quality strategies being implemented by CARB include the following:

- **State Implementation Plans (SIPs).**[72] These comprehensive plans describe how an area will attain national ambient air quality standards by deadlines established by the federal Clean Air Act. SIPs are a compilation of new and previously submitted plans, programs, air district rules, State regulations, and federal controls designed to achieve the emissions reductions needed from mobile sources, fuels, stationary sources, and consumer products. On March 23, 2017, CARB adopted the Revised Proposed 2016 State Strategy for the SIP, describing the commitments necessary to meet federal ozone and $PM_{2.5}$ standards over the next 15 years.
- **Diesel Risk Reduction Plan.**[73] The plan, adopted by CARB in September 2000, outlined 14 recommended control measures to reduce the risks associated with diesel PM and achieve a goal of 75 percent PM reduction by 2010 and 85 percent by 2020. Since 2000, CARB has adopted regulations to reduce smog-forming pollutants and diesel PM from mobile vehicles and equipment (e.g., trucks, buses, locomotives, tractors, cargo handling equipment, construction equipment, marine vessels, transport refrigeration units); stationary engines and portable equipment (e.g., emergency standby generators, prime generators, agricultural irrigation pumps, portable generators); and diesel fuels. Diesel PM accounts for approximately 60 percent of the current estimated inhalation cancer risk for background ambient air.[74] CARB staff continues to work to improve implementation and enforcement efforts and examine needed amendments to increase the community health benefits of these control measures.
- **Sustainable Freight Action Plan.**[75] This joint agency strategy was developed in response to Governor's Executive Order B-32-15 to improve freight efficiency, transition to zero emission technologies, and increase the competitiveness of California's freight system. The transition of the freight transport system is essential to support the State's economic development in the coming decades and reduce air pollution affecting many California communities.
- **AB 32 Scoping Plan.**[76] This comprehensive strategy is updated at least every five years and is designed to achieve the State's climate goals, which includes measures that achieve air pollutant reduction co-benefits.
- **AB 1807.**[77] AB 1807 (Tanner, 1983) created California's program to reduce exposure to air toxics. CARB uses a comprehensive process to prioritize the identification of substances that pose the greatest health threat and to develop airborne toxic control measures to reduce those exposures. CARB has reduced public exposure to toxic air contaminants (TACs) through control of motor vehicles, fuels, consumer products, and stationary sources, including adopting control measures for

72 CARB. 2016. California State Implementation Plans. *www.arb.ca.gov/planning/sip/sip.htm*
73 CARB. 2000. Final Diesel Risk Reduction Plan with Appendices. *www.arb.ca.gov/diesel/documents/rrpapp.htm*
74 CARB and California Air Pollution Control Officers Association. 2015. Risk Management Guidance for Stationary Sources of Air Toxics. July 23. *www.arb.ca.gov/toxics/rma/rmgssat.pdf*
75 CARB. 2016. Sustainable Freight Transport. *www.arb.ca.gov/gmp/sfti/sfti.htm*
76 CARB. 2016. AB 32 Scoping Plan. *www.arb.ca.gov/cc/scopingplan/scopingplan.htm*
77 CARB. 2014. California Air Toxics Program – Background. *www.arb.ca.gov/toxics/background.htm*

industrial sources (e.g., perchloroethylene in automotive products; hexavalent chromium from cooling towers, automotive coatings and plating; ethylene oxide from sterilizers and aerators; dioxins from medical waste incinerators; perchloroethylene from dry cleaners; cadmium from metal melting).

- **AB 2588 Air Toxics "Hot Spots" Program.**[78] The Hot Spots Program supplements the AB 1807 program by requiring a statewide air toxics inventory, identification of facilities having localized impacts, notification of nearby residents exposed to a significant health risk, and facility risk management plans to reduce those significant risks to acceptable levels.
- **AB 617 Community Air Protection Program.** Together with the extension of the Cap-and-Trade Program and in recognition of ongoing air quality challenges, California has committed to expand its criteria and toxic emissions reductions efforts through the pursuit of a multipronged approach to reduce localized air pollution and address community exposure, framed by recently-signed new legislation, AB 617 (C. Garcia, 2017). AB 617 outlines actions in five core areas, to be completed in the 2018 to 2020 timeframe, to reduce criteria and toxic emissions in the most heavily impacted areas of the State:
    - **Community-scale air monitoring.** Ambient air monitoring is needed to evaluate the status of the atmosphere compared to clean air standards and historical data. Monitoring helps identify and profile air pollution sources, assess emerging measurement methods, characterize the degree and extent of air pollution, and track progress of emissions reductions activities. AB 617 requires a statewide assessment of the current air monitoring network and identification of priority locations where community-level air monitoring will be deployed.
    - **Statewide Strategy to reduce air pollutants impacting communities.** CARB will identify locations with high cumulative exposure to criteria and toxic pollutants, the sources contributing to those exposures, and select locations that will be required to develop a community action plan to reduce pollutants to acceptable levels.
    - **Community Action Plans to reduce emissions in identified communities.** High priority locations identified in the Statewide Strategy will need to prepare a community action plan that includes emissions reductions targets, measures, and an implementation timeline. The plan will be submitted to CARB for review and approval.
    - **Accelerated retrofits and technology clearinghouse.** This effort will focus on stationary source equipment at Cap-and-Trade facilities that, as of 2007, have not been retrofitted with BARCT-level emission controls for nonattainment pollutants. In addition, creation of a statewide clearinghouse that identifies BACT and BARCT technologies and emission levels for criteria pollutants and TACs will be developed to assist the air districts with the BARCT evaluation and identify available emission controls for the Statewide Strategy.
    - **Direct reporting of facility emissions data to CARB.** An improved, standardized emission inventory promotes a better understanding of actual emissions and helps identify major emission sources, priorities for emissions reduction, and data gaps requiring further work. AB 617 requires CARB to establish a uniform emission inventory system for stationary sources of criteria pollutants and TACs. Data integration and transparency-related efforts are already required by AB 197 (E. Garcia, 2016) and underway at CARB, so this new task will build on these efforts. Moreover, it is clear that better data reporting is necessary to identify localized exposure risk to harmful criteria and toxic pollutants and actions to address any localized impacts must be taken as quickly as possible.

To support efforts to advance the State's toxics program, the Office of Environmental Health Hazard Assessment (OEHHA) finalized a new health risk assessment methodology, *Air Toxics Hot Spots Program Risk Assessment Guidelines: Guidance Manual for Preparation of Health Risk Assessments*, on March 6, 2015, which updates the previous version of the guidance manual and reflects advances in the field of risk assessment along with explicit consideration of infants and children.[79] Subsequently, CARB, in collaboration with the California Air Pollution Control Officers Association (CAPCOA), finalized a *Risk Management Guidance for Stationary Sources of Air Toxics* for the air districts to use to incorporate OEHHA's new health risk assessment methodology into their stationary source permitting and AB 2588 Air Toxics Hot Spots programs.[80]

Together, all of these efforts will reduce criteria and toxics emissions in the State, with a focus on the most burdened communities. In particular, AB 617 responds to environmental justice concerns that the Cap-and-

78 CARB. 2016. AB 2588 Air Toxics "Hot Spots" Program. *www.arb.ca.gov/ab2588/ab2588.htm*

79 OEHHA. 2015. Notice of Adoption of Air Toxics Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments 2015. *http://oehha.ca.gov/air/crnr/notice-adoption-air-toxics-hot-spots-program-guidance-manual-preparation-health-risk-0*

80 *www.arb.ca.gov/toxics/rma/rmgssat.pdf*

Trade Program does not force large GHG emitters to reduce air pollution which results in localized health impacts. Prior to the passage of AB 617, in February 2017, OEHHA published the first in a series of reports tasked with evaluating the impacts of California's climate change programs on disadvantaged communities. The initial report focused on the Cap-and-Trade Program.[81] Future reports will focus on the impacts of other climate programs on disadvantaged communities. The report confirms disadvantaged communities are frequently located close to large stationary and mobile sources of emissions. It also notes there are complexities in trying to correlate GHGs with criteria and toxics emissions across industry and within sectors, although preliminary data review shows there may be some poor to moderate correlations in specific instances. Lastly, the report noted, "…the emissions data available at this time do not allow for a conclusive analysis."

Two additional reports were released during this same period of time: a California Environmental Justice Alliance (CEJA) report focused on identifying equity issues for disadvantaged communities resulting from the implementation of the Cap-and-Trade Program[82] and a research paper examining the question of whether the Cap-and-Trade Program is causing more GHG emissions in disadvantaged communities when compared to other regions.[83] Both of these reports also confirmed that disadvantaged communities are disproportionately located close to large stationary and mobile sources of emissions. While the CEJA report noted, "Further research is needed before firm policy conclusions can be drawn from this preliminary analysis," the research paper, in reference to GHGs, states, "By and large, the annual change in emissions across disadvantaged and non-disadvantaged communities look similar."

While the reports do not provide evidence that implementation of the Cap-and-Trade Program is contributing to increased local air pollution, they do underscore the need to use all of the tools (e.g., enhanced enforcement, new regulations, tighter permit limits) available to the State and local agencies to achieve further emissions reductions of toxic and criteria pollutants that are impacting community health. Importantly, AB 617 provides a new framework and tools for CARB, in collaboration with local air districts, to deploy focused monitoring and ensure criteria and toxics emissions reductions at the State's largest GHG emitters.

AB 197 Measure Analyses

This section provides the required AB 197 estimates for the measures evaluated in this Scoping Plan. These estimates provide information on the relative impacts of the evaluated measures when compared to each other. To support the design of a suite of policies that result in GHG reductions, air quality co-benefits, and cost-effective measures, it is important to understand if a measure will increase or reduce criteria pollutants or toxic air contaminant emissions, or if increasing stringency at additional costs yields few additional GHG reductions. To this end, AB 197 (E. Garcia, Chapter 250, Statutes of 2016) requires the following for each potential reduction measure evaluated in any Scoping Plan update:

- The range of projected GHG emissions reductions that result from the measure.
- The range of projected air pollution reductions that result from the measure.
- The cost-effectiveness, including avoided social costs, of the measure.

As the Scoping Plan was developed, it was important to understand if any of the proposed policies or measures would increase criteria pollutant or toxic air contaminant emissions. Note the important caveats around some of the estimates; they must be considered when using the information in the tables below for purposes other than as intended.

Estimated Emissions Reductions for Evaluated Measures

For many of the existing programs with known commitments, such as the Mobile Source Strategy, previous analyses provide emission factors or other methods for estimating the impacts required by AB 197. Where available, these values were used. In some cases, estimates are based on data from other sources, such as the California Public Utilities Commission (CPUC) Renewables Portfolio Standard Calculator. For newly proposed measures, assumptions were required to estimate the values. Consequently, the estimates for the newly proposed measures have substantial uncertainty. The uncertainty in the impacts of these measures would be reduced as the measures are defined in greater detail during the regulatory processes that are undertaken to

81 *https://oehha.ca.gov/media/downloads/environmental-justice/report/oehhaab32report020217.pdf*
82 *http://dornsife.usc.edu/PERE/enviro-equity-CA-cap-trade*
83 *https://www.dropbox.com/s/se3ibxkv8t4at8g/Meng_CA_EJ.pdf?dl=1*

define and adopt the programs. For example, as a measure is developed in detail, ways to obtain additional co-pollutant reductions or avoid co-pollutant increases may be identified and evaluated.

Table 5 provides the estimates for the measures evaluated during the development of the Scoping Plan. Based on the estimates below, these measures are expected to provide air quality benefits. The table also provides important context, limitations, and caveats about the values. As shown, the table includes criteria pollutant and diesel PM estimates. As mentioned above, diesel PM accounts for 60 percent of the current estimated inhalation cancer risk for background ambient air. As we do not have direct modeling results for criteria and toxic pollutant estimates from PATHWAYS, we are estimating air quality benefits by using reductions in GHGs to assign similar reductions for criteria and toxic pollutants. By assigning an arbitrary 1:1 relationship in changes between GHGs and criteria and toxic pollutants, the air quality reductions likely overestimate the actual reductions from implementation of the measures. As noted in the OEHHA report, the exact relationship between GHGs and air pollutants is not clearly understood at this time. Moving forward, CARB will continue to assess the nature of the exact relationship between GHGs and criteria and toxics emissions. All estimates in Table 5 have some inherent uncertainty. The table allows for assessing measures against each other and should not be used for other purposes without understanding the limitations on the how the air quality values are derived.

Table 6 provides a summary of the total estimated emissions reductions for the Scoping Plan Scenario as outlined in Table 1. Table 6 was developed by adding the estimated emissions reductions for all of the measures included within the Scoping Plan Scenario in Table 1. More detail on the estimates for the Scoping Plan Scenario, as well as the specific measures included in each of the other four alternative scenarios can be found in Appendix G. In 2030, the Scoping Plan scenario and alternatives will provide comparable GHG and air quality reductions. When there is a range, the measure or policy should be designed to maximize the benefit to the extent possible.

Table 5: Ranges of Estimated Air Pollution Reductions by Policy or Measure in 2030

Measure	Range of NO_X Reductions (Tons/Day)	Range of VOC Reductions (Tons/Day)	Range of $PM_{2.5}$ Reductions (Tons/Day)	Range of Diesel PM Reductions (Tons/Day)
50 percent RPS	~0.5	<0.1	~0.4	< 0.01
Mobile Sources CTF and Freight	51–60	4.6–5.5	~1.1	~0.2
18 percent Carbon Intensity Reduction Target for LCFS - Liquid Biofuels*	3.5–4.4	0.5–0.6	0.4–0.6	~0.5
Short-Lived Climate Pollutant Strategy	–	–	–	–
2x additional achievable energy efficiency in the 2015 Integrated Energy Policy Report (IEPR)	0.4–0.5	0.5–0.7	< 0.1	< 0.01
Cap-and-Trade Program	A	A	A	4–9

* LCFS estimates include estimates of the NO_X and $PM_{2.5}$ tailpipe benefits limited to renewable diesel consumed in the off-road sector.

– CARB is evaluating how to best estimate these values. Criteria and toxic values are shown in tons per day, as they are episodic emissions events with residence times of a few hours to days, unlike GHGs, which have atmospheric residence times of decades.

A Due to the inherent flexibility of the Cap-and-Trade Program, as well as the overlay of other complementary GHG reduction measures, the mix of compliance strategies that individual facilities may use is not known. However, based on current law and policies that control industrial and electricity generating sources of air pollution, and expected compliance responses, CARB believes that emissions increases at the statewide, regional, or local level due to the regulation are not likely. A more stringent post-2020 Cap-and-Trade Program will provide an incentive for covered facilities to decrease GHG emissions and any related emissions of criteria and toxic pollutants. Please see CARB's Co-Pollutant Emissions Assessment for a more detailed evaluation of a cap-and-trade program and associated air emissions impacts: *www.arb.ca.gov/regact/2010/capandtrade10/capv6appp.pdf*

NO_X = nitrogen oxides; VOC = volatile organic compound

Important: These estimates assume a 1:1 relationship between changes in GHGs, criteria pollutants, and toxic air contaminant emissions, and it is unclear whether that is ever the case. The values should not be considered estimates of absolute changes for other analytical purposes and only allow for comparison across measures in the table. The values are estimates that represent current assumptions of how programs may be implemented; actual impacts may vary depending on the design, implementation, and performance of the policies and measures. The table does not show interactions between measures, such as the relationship with increased transportation

electrification and associated increase in energy demand for the electricity sector. The measures in the Scoping Plan Scenario are shown in bold font in the table below. Additional details, including GHG reductions, are available in Appendix G.

Table 6: Summary of Ranges of Estimated Air Pollution Reductions for the Scoping Plan Scenario in 2030

Scenario	Range of NO_X Reductions (Tons/Day)	Range of VOC Reductions (Tons/Day)	Range of $PM_{2.5}$ Reductions (Tons/Day)	Range of Diesel PM Reductions (Tons/Day)
Scoping Plan Scenario	48–73	5.1–7.3	1.4–2.4	5–10

The total estimates for air pollution reductions provided in this table for the Scoping Plan Scenario are estimated by adding the air pollution benefits for the subset of individual measures examined in Table 5 and included in the Scoping Plan Scenario described in Table 1, and scaled by a risk adjustment factor to capture interactive effects and risks of under/over achieving on air pollution reductions. Appendix G includes details of the specific measures in the Scoping Plan Scenario and Alternatives. **All caveats in Table 5 apply to air quality estimates in this table.**

Estimated Social Costs of Evaluated Measures

Consideration of the social costs of GHG emissions is a requirement in AB 197, including evaluation of the avoided social costs for measures within this Scoping Plan.[84] Social costs are generally defined as the cost of an action on people, the environment, or society and are widely used to evaluate the impact of regulatory actions. Social costs do not represent the cost of abatement or the cost of GHG reductions, rather social costs estimate the harm that is avoided by reducing GHGs.

Since 2008, federal agencies have been incorporating the social costs of GHGs, including carbon dioxide, methane, and nitrous oxide into the analysis of their regulatory actions. Agencies including the U.S. Environmental Protection Agency (U.S. EPA), Department of Transportation (DOT), and Department of Energy (DOE) are subject to Executive Order 12866, which directs agencies "to assess both the costs and benefits of the intended regulation…".[85] In 2007, the National Highway Transportation Safety Administration (NHTSA) was directed by the U.S. 9th Circuit Court of Appeals to include the social cost of carbon in a regulatory impact analysis for a vehicle fuel economy rule. The Court stated that "[w]hile the record shows that there is a range of values, the value of carbon emissions reduction is certainly not zero."[86]

In 2009, the Council of Economic Advisors and the Office of Management and Budget convened the Interagency Working Group on the Social Cost of Greenhouse Gases[87] (IWG) to develop a methodology for estimating the social cost of carbon (SC-CO_2). This methodology relied on a standardized range of assumptions and could be used consistently when estimating the benefits of regulations across agencies and around the world. The IWG, comprised of scientific and economic experts, recommended the use of SC-CO_2 values based on three integrated assessment models (IAMs) developed over decades of global peer-reviewed research.[88]

In this Scoping Plan, CARB utilizes the current IWG supported SC-CO_2 values to consider the social costs of actions to reduce GHG emissions. This approach is in line with Executive Orders including 12866 and the OMB Circular A-4 of September 17, 2003, and reflects the best available science in the estimation of the socio-economic impacts of carbon.[89] CARB is aware that the current federal administration has recently withdrawn certain social cost of carbon reports as no longer representative of federal governmental policy.[90] However, this determination does not call into question the validity and scientific integrity of federal social

84 AB 197 text available at: *https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160AB197*.
85 *https://www.reginfo.gov/public/jsp/Utilities/EO_12866.pdf*
86 Center for Biological Diversity v National Highway Traffic Safety Administration 06-71891 (9th Cir, November 15 2007)
87 Originally titled the Interagency Working Group on the Social Cost of Carbon, the IWG was renamed in 2016.
88 Additional technical detail on the IWG process is available in the Technical Updates of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866. Iterations of the Updates are available at: *https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf*, *https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf*, and *https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf*.
89 OMB circular A-4 is available at: *https://www.transportation.gov/sites/dot.gov/files/docs/OMB%20Circular%20No.%20A-4.pdf*.
90 See Presidential Executive Order, March 28, 2017, sec. 5(b).

cost of carbon work, or the merit of independent scientific work. Indeed, the IWG's work remains relevant, reliable, and appropriate for use for these purposes.

The IWG describes the social costs of carbon as follows:

> *The social cost of carbon (SC-CO_2) for a given year is an estimate, in dollars, of the present discounted value of the future damage caused by a 1-metric ton increase in carbon dioxide (CO_2) emissions into the atmosphere in that year, or equivalently, the benefits of reducing CO_2 emissions by the same amount in that year. The SC-CO_2 is intended to provide a comprehensive measure of the net damages – that is, the monetized value of the net impacts – from global climate change that result from an additional ton of CO_2.*
>
> *These damages include, but are not limited to, changes in net agricultural productivity, energy use, human health, property damage from increased flood risk, as well as nonmarket damages, such as the services that natural ecosystems provide to society. Many of these damages from CO_2 emissions today will affect economic outcomes throughout the next several centuries.*[91]

Table 7. presents the range of IWG SC-CO_2 values used in regulatory assessments including this Scoping Plan.[92]

Table 7: SC-CO_2, 2015-2030 (in 2007 $ per Metric Ton)

Year	5 Percent Discount Rate	3 Percent Discount Rate	2.5 Percent Discount Rate
2015	$11	$36	$56
2020	$12	$42	$62
2025	$14	$46	$68
2030	$16	$50	$73

The SC-CO_2 is year specific, that is, the IAMs estimate the environmental damages from a given year in the future and discount the value of the damages back to the present. For example, the SC-CO_2 for the year 2030 represents the value of climate change damages from a release of CO_2 in 2030 discounted back to today. The SC-CO_2 increases over time as systems become stressed from the aggregate impacts of climate change and future emissions cause incrementally larger damages. Table 7 presents the SC-CO_2 across a range of discount rates – or the value today of preventing environmental damages in the future. A higher discount rate decreases the value placed on future environmental damages. This Scoping Plan utilizes the IWG standardized range of discount rates, from 2.5 to 5 percent to represent varying valuation of future damages.

The SC-CO_2 is highly sensitive to the discount rate. Higher discount rates decrease the value today of future environmental damages. This Scoping Plan utilizes the IWG standardized range of discount rates, from 2.5 to 5 percent to represent varying valuation of future damages. The value today of environmental damages in 2030 is higher under the 2.5 percent discount rate compared to the 3 or 5 percent discount rate, reflecting the trade-off of consumption today and future damages. The IWG estimates the SC-CO_2 across a range of discount rates that encompass a variety of assumptions regarding the correlation between climate damages and consumption of goods and is consistent with OMB's Circular A-4 guidance.[93]

There is an active discussion within government and academia about the role of SC-CO_2 in assessing regulations, quantifying avoided climate damages, and the values themselves. In January 2017, the National Academies of Sciences, Engineering, and Medicine (NAS) released a report examining potential approaches for a comprehensive update to the SC-CO_2 methodology to ensure resulting cost estimates reflect the best available science. The NAS review did not modify the estimated values of the SC-CO_2, but evaluated the models, assumptions, handling of uncertainty, and discounting used in the estimating of the SC-CO_2. The report titled, "Valuating Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide," recommends near-term improvements to the existing IWG SC-CO_2 as well as a long-term strategy to more comprehensive updates.[94] The State will continue to follow updates to the IWG SC-CO_2, including changes

91 From The National Academies, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, 2017, available at: *http://www.nap.edu/24651*

92 The SC-CO_2 values as of July 2015 are available at: *https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf*

93 The National Academies, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, 2017, available at: *http://www.nap.edu/24651.*

94 The National Academies, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, 2017, available at:

outlined in the NAS report, and incorporate appropriate peer-reviewed modifications to estimates based on the latest available data and science.

It is important to note that the SC-CO_2, while intended to be a comprehensive estimate of the damages caused by carbon globally, does not represent the cumulative cost of climate change and air pollution to society. There are additional costs to society outside of the SC-CO_2, including costs associated with changes in co-pollutants, the social cost of other GHGs including methane and nitrous oxide, and costs that cannot be included due to modeling and data limitations. The IPCC has stated that the IWG SC-CO_2 estimates are likely underestimated due to the omission of significant impacts that cannot be accurately monetized, including important physical, ecological, and economic impacts.[95] CARB will continue engaging with experts to evaluate the comprehensive California-specific impacts of climate change and air pollution.

The Social Cost of GHG Emissions

Social costs for methane (SC-CH_4) and nitrous oxide (SC-N_2O) have also been developed using methodology consistent with that used in estimating the IWG SC-CO_2. These social costs have also been endorsed by the IWG and have been used in federal regulatory analyses.[96] Along with the SC-CO_2, the State also supports the use of the SC-CH_4 and SC-N_2O in monetizing the impacts of GHG emissions.

While the SC-CO_2, SC-CH_4, and SC-N_2O provide metrics to account for the social costs of climate change, California will continue to analyze ways to more comprehensively identify the costs of climate change and air pollution to all Californians. This will include following updates to the IWG methodology and social costs of GHGs and incorporating the SC-CO_2, SC-CH_4, and SC-N_2O into regulatory analyses.

Table 9 presents the estimated social cost for each policy or measure considered in the development of the Scoping Plan in 2030. For each measure or policy, Table 9 includes the range of the IWG SC-CO_2 values that result from the anticipated range of GHG reductions in 2030 presented in Appendix G. The SC-CO_2 range is obtained using the IWG SC-CO_2 values in 2030 at the 2.5, 3, and 5 percent discount rates. These values (of $16 using the 5 percent discount rate, $50 using the 3 percent discount rate, and $73 using the 2.5 percent discount rate) are translated into 2015 dollars and multiplied across the range of estimated reductions by measure in 2030 to estimate the value of avoided social costs from each measure in that year.[97]

Implementation of the SLCP Strategy will result in reduction of a variety of GHGs, including methane and HFCs, which reported in carbon dioxide equivalent (CO_2e). While there is no social cost of CO_2e, the avoided damages associated with the methane reductions outlined in the SLCP Strategy are estimated in Table 9 using the IWG SC-CH_4 as presented in Table 8.[98]

Table 8: SC-CH_4, 2015-2030 (in 2007$ per Metric Ton)

Year	5 Percent Discount Rate	3 Percent Discount Rate	2.5 Percent Discount Rate
2015	$450	$1000	$1400
2020	$540	$1200	$1600
2025	$650	$1400	$1800
2030	$760	$1600	$2000

The range of SC-CH_4 is obtained using the IWG SC-CH_4 values in 2030 at the 2.5, 3, and 5 percent discount rates. The SC-CH_4 values (e.g., $760 using the 5 percent discount rate, $1,600 using the 3 percent discount rate, and $2,000 using the 2.5 percent discount rate) are translated into 2015 dollars and multiplied across the range of estimated methane reductions in 2030 to estimate the value of climate benefits from the SLCP

http://www.nap.edu/24651

95 https://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch3s3-5-3-3.html

96 More information is available at: https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/august_2016_sc_ch4_sc_n2o_addendum_final_8_26_16.pdf

97 The IWG.SC-CO_2 values are in 2007 dollars. In 2015 dollars, $16, $50, and $73 in 2007 translates to about $18, $57, and $83, respectively, based on the Bureau of Labor Statistics GDP Series Table 1.1.4.

98 https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/august_2016_sc_ch4_sc_n2o_addendum_final_8_26_16.pdf

Strategy.[99] As the social cost associated with the SLCP Strategy does not include the impact associated with non-methane reductions, Table 9 underestimates the avoided social costs of this Scoping Plan as calculated using the IWG valuations.

As this Scoping Plan is a suite of policies developed to reduce GHGs to a specific level in 2030, any alternative scenario that also achieves the 2030 target (with the same proportion of carbon dioxide and methane reductions) will have the same avoided social cost, as estimated using the IWG social cost of GHGs, for the single year 2030. The social costs of alternatives could vary if the 2030 target is achieved with vastly different ratios of carbon dioxide to methane reductions. However, all alternatives in this Scoping Plan are anticipated to achieve the same proportion of carbon dioxide and methane reductions and will therefore all have the same estimated avoided social damage or social cost. This social cost, as estimated in 2030 using the IWG SC-CO_2 and SC-CH_4, ranges from $1.9 to $11.2 billion using the 2.5 to 5 percent discount rates, and is estimated at $5.0 to $7.8 billion using the 3 percent discount rate. For example, in Table 9 the CH_4 reductions for the SCLP strategy are about 1 MMTCH_4. That value is multiplied by the 2030 SC-CH_4 values in Table 8 for the 2030 values at the 2.5 and 5 percent discount rates to get a range of $860 to $2,260 in 2015 dollars.

99 The IWG.SC-CH_4 values are in 2007 dollars. In 2015 dollars, the range of SC-CH_4 translates to about $858, $1,807, and $2,259, for the 5 percent, 3 percent, and 2.5 percent discount rates, respectively. These values are based on the Bureau of Labor Statistics GDP Series Table 1.1.4.

Table 9: Estimated Social Cost (Avoided Economic Damages) of Policies or Measures Considered in the 2017 Scoping Plan Development#

Measure (Measures in bold are included in the Scoping Plan)	Range of Social Cost of Carbon $ million USD (2015 dollars)**
50 percent Renewables Portfolio Standard (RPS)	$55–$250
Mobile Sources CTF and Freight	$200–$1,080
18 percent Carbon Intensity Reduction Target for LCFS -Liquid Biofuels	$70–$330
Short-Lived Climate Pollutant Strategy	$860-$2,260 (SC-CH_4)
2x additional achievable energy efficiency in the 2015 IEPR	$125–$750
Cap-and-Trade Program	$610–$6,560
10 percent incremental RPS and additional 10 GW behind-the-meter solar PV*	$250–$1,160
25 percent Carbon Intensity Reduction Target for LCFS and a Low-Emission Diesel Standard - Liquid Biofuels*	$90–$415
20 percent Refinery	$55–$500
30 percent Refinery	$20–$250
25 percent Industry	$20–$415
25 percent Oil and Gas	$35–$330
5 percent Increased Utilization of RNG (core and non-core)	$35–$165
Mobile Source Strategy (CTF) with Increased ZEVs in South Coast and early retirement of LDVs with more efficient LDVs*	$55–$500
2.5x additional achievable energy efficiency in the 2015 IEPR, electrification of buildings (heat pumps and res. electric stoves) and early retirement of HVAC*	$70–$580
Carbon Tax	$775–$8,300
All Cap-and-Trade	$700–$6,890
Cap-and-Tax	$775–$8,300
Scoping Plan Scenario SC-CO_2 Scoping Plan Scenario SC-CH_4 **Scoping Plan Scenario (Total)**	$1,060–$8,970 $860–$2,260 **$1,920–$11,230**

Note: All values are rounded. The values for SC-CO_2 and SC-CH_4 in 2030 are presented in Tables 7 and 8.

* Where enhancements have been made to a measure or policy, the ranges in emissions reductions are incremental to the original measure. For example, the ranges for the 25 percent LCFS are incremental to the emissions ranges for the 18 percent LCFS.

\# Measures included in the Scoping Plan and the All Cap-and-Trade measure reflect emissions reductions from modeling changes after passage of AB 398. Emissions reductions from all other measures reflect modeling completed prior to passage of AB 398. See Appendix G for additional details.

** All values have been rounded to the nearest 0 or 5.

~ Some measures do not show a significant change in 2030 when there is an incremental increase in measure stringency or when modeling uncertainty was factored.

Social Costs of GHGs in Relation to Cost-Effectiveness

AB 32 includes a requirement that "rules and regulations achieve the maximum technologically feasible and cost-effective greenhouse gas emissions reductions."[100] Under AB 32, cost-effectiveness means the relative cost per metric ton of various GHG reduction strategies, which is the traditional cost metric associated with emission control. In contrast, the SC-CO_2, SC-CH_4, and SC-N_2O are estimates of the economic benefits, and not the cost of reducing GHG emissions.

There may be technologies or policies that do not appear to be cost-effective when compared to the SC-CO_2, SC-CH_4, and SC-N_2O associated with GHG reductions. However, these technologies or policies may result in other benefits that are not reflected in the IWG social costs. For instance, the evaluation of social costs might include health impacts due to changes in local air pollution that result from reductions in GHGs, diversification of the portfolio of transportation fuels (a goal outlined in the LCFS) and reductions in criteria pollutant emissions from power plants (as in the RPS).

Estimated Cost Per Metric Ton by Measure

AB 197 also requires an estimation of the cost-effectiveness of the potential measures evaluated for the Scoping Plan. The values provided in Table 10 are estimates of the cost per metric ton of estimated reductions for each measure in 2030. To capture the fuel and GHG impacts of investments made from 2021 through 2030 to meet the 2030 GHG goal, the table also includes an evaluation of the cost per metric ton based on the cumulative GHG emissions reductions and cumulative costs or savings for each potential measure from 2021 through 2030. While it is important to understand the relative cost effectiveness of measures, the economic analysis presented in Appendix E provides a more comprehensive analysis of how the Scoping Plan and alternative scenarios affect the State's economy and jobs.

The cost (or savings) per metric ton of CO_2e reduced for each of the measures is one metric for comparing the performance of the measures. Additional factors beyond the cost per metric ton that could be considered include continuity with existing laws and policies, implementation feasibility, contribution to fuel diversity and technology transformation goals, as well as health and other benefits to California. These considerations are not reflected in the cost per ton metric below.

Because many of the measures interact with each other, isolating the cost and GHG savings of an individual measures is analytically challenging. For example, the performance of the renewable electricity measure impacts the GHG savings and cost per ton associated with increasing the use of electric vehicles. Likewise, the increased use of electric vehicles may increase flexible loads on the electric system, enabling increased levels of renewable electricity to be achieved more cost effectively. Both the renewable electricity measure and the increased use of electric vehicles affect the cost of meeting the Low-Carbon Fuel Standard.

For most of the measures shown in Table 10, the 2030 cost per metric ton is isolated from the other measures by performing a series of sensitivity model runs in the California PATHWAYS model. This cost per metric ton is calculated as the difference in the 2030 annualized cost (or savings) with and without the measure. For the measures in the Scoping Plan Scenario, the analysis starts with the Scoping Plan Scenario PATHWAYS estimates, and then costs and emissions are recalculated with each measure removed individually. For measures included in the No Cap-and-Trade Scenario, the approach starts with the No Cap-and-Trade Scenario PATHWAYS estimates and then each measure is removed. Using this approach, the incremental impact on GHG emissions and costs for each measure is calculated. The incremental cost in 2030 is divided by the incremental GHG emission impact to calculate the cost per ton in 2030.

The same approach of removing each measure individually is used to estimate the incremental cost and emission impacts of each measure for the period 2021 to 2030. For each measure, its annual incremental costs from 2021 to 2030 are calculated and then discounted to 2021 using the discount rate used in PATHWAYS to levelize capital costs over the life of equipment. As a result, the discounted incremental cost of each measure is the total investment required from 2021 to 2030 to achieve each measure's emissions reductions from 2021 to 2030 (including both incremental capital costs and incremental fuel savings/expenditures). This discounted cost for each measure was divided by its cumulative emissions reductions from 2021 to 2030 to calculate a cost per ton for the measure for the period. A second calculation was also made that divides each measure's discounted cost by its discounted emissions reductions from 2021 to 2030. The

100 *www.arb.ca.gov/cc/docs/ab32text.pdf*

same discount rate is used to discount both incremental costs and emissions in this approach. The estimates are presented in the table below.

Costs that represent transfers within the state, such as incentive payments for early retirement of equipment, are not included in this California total cost metric. The cost ranges shown below represent some of the uncertainty inherent in estimating this metric. The details of how the ranges for each measure were estimated are described in the footnotes below. All cost estimates have been rounded representing further uncertainty in individual values.

It is important to note that this cost per metric ton does not represent an expected market price value for carbon mitigation associated with these measures. In addition, the single year (2030) values and the estimates that encompass 2021 to 2030 do not capture the fuel savings or GHG reductions associated with the full economic lifetime of measures that have been implemented by 2030, but whose impacts extend beyond 2030. The estimates also do not capture the climate or health benefits of the GHG mitigation measures. Table 10 also notes the measures for which sources other than the PATHWAYS model were used to develop estimates of the cost per metric ton. The estimates in the table indicate that the relative cost of the measures is reasonably consistent across the different measures of cost per metric ton. Measures that are relatively less costly using the 2030 cost per metric ton are also less costly using the cost per metric ton based on the period 2021 to 2030. However, for several measures the sign of the estimate differs, such that in 2030 the measure has a positive cost while there is a negative cost for the period 2021 to 2030. This difference in sign occurs because the measure includes increasingly costly investments toward the end of the period examined. By examining only 2030, the lower cost components of the measure that occur in earlier years are omitted, resulting in a higher cost estimate for 2030 alone.

Table 10: Estimated Cost Per Metric Ton of Measures Considered in the 2017 Scoping Plan Development and Averaged from 2021 through 2030

Important: As individual measures are designed and implemented they will be subject to further evaluation and refinement and public review, which may result in different findings than presented below. The ranges are estimates that represent current assumptions of how programs may be implemented and may vary greatly depending on the design, implementation, and performance of the policies and measures. Measures in bold text are included in the Scoping Plan.

Measure	Cost/metric ton in 2030*	Cost/metric ton 2021-2030**
50 percent Renewables Portfolio Standard (RPS) [a]	**$175**	**$100 to $200**
Mobile Sources CFT and Freight [b]	**<$50**	**<$50**
Liquid Biofuels (18 percent Carbon Intensity Reduction Target for LCFS) [c]	**$150**	**$100 to $200**
Short-Lived Climate Pollutant Strategy [d]	**$25**	**$25**
2x additional achievable energy efficiency in the 2015 IEPR [f]	**-$350**	**-$300 to -$200**
10 percent incremental RPS and additional 10 GW behind-the-meter solar PV [a]	$350	$250 to $450
Liquid Biofuels (25 percent Carbon Intensity Reduction Target for LCFS and a Low-Emission Diesel Standard) [b]	$900	$550 to $975
20 percent Refinery [d]	$100	$50 to $100
30 percent Refinery [d]	$300	$175 to $325
25 percent Industry [d]	$200	$150 to $275
25 percent Oil and Gas [d]	$125	$100 to $175
5 percent Increased Utilization of renewable natural gas - core and non-core [e]	$1500	$1350 to $3000
Mobile Source Strategy (CFT) with Increased ZEVs in South Coast & additional reductions in VMT and energy demand & early retirement of LDVs with more efficient LDVs [b]	$100	<$50
2.5x additional achievable energy efficiency in the 2015 IEPR, electrification of buildings (heat pumps & res. electric stoves) and early retirement of HVAC [f]	$75	-$120 to -$70

* Where enhancements have been made to a measure or policy, the cost per metric ton are incremental to the original measure. For example, the cost per metric ton for the 25 percent LCFS are incremental to the cost per metric ton for the 18 percent LCFS.

** The lower values use a cost discount rate of 10 percent and cumulative emissions for the period 2021 to 2030. The higher values discount both costs and emissions using a discount rate of 10 percent.

a Cost estimate is based on PATHWAYS sensitivity analysis as described in the main text.

b Cost estimate is based on PATHWAYS sensitivity analysis as described in the main text.

c Liquid biofuel values are calculated as the average unsubsidized cost of biofuels supplied above that of an equivalent volume of fossil fuels. These values do not reflect impacts from other biofuel policies, such as the Renewable Fuel Standard or production tax credits, that are partially supported by fuel purchasers/taxpayers outside of California. Therefore, these values do not represent LCFS program costs or potential LCFS credit prices.

d See Appendix D

e Cost estimate is based on PATHWAYS sensitivity analysis as described in the main text.

f Cost estimate is based on PATHWAYS sensitivity analysis as described in the main text. The cost per metric ton does not represent the results of the CPUC's or CEC's standard cost-effectiveness evaluation tests

Health Analyses

Climate mitigation will result in both environmental and health benefits. This section presents information about the potential health benefits of the Scoping Plan. The impacts are primarily from reduced particulate matter pollution, reduced toxics pollution (both diesel combustion particles and other toxic pollutants), and the health benefits of increased physical activity that will result from more active modes of transportation such as walking and biking in lieu of driving. CARB is using the AB 197 air quality estimates in Table 5 as a proxy to understand the potential health impacts from the Scoping Plan. There is uncertainty in the air quality estimates and that is carried through to the health impacts evaluation presented here. In the future, CARB will be working to explore how to better integrate health analysis and health considerations in the design and implementation of climate programs.

Because the health endpoints of each of these benefits is different (e.g., fewer incidences of premature mortality, lower cancer risk, and fewer incidences of heart disease), the methodologies for estimating the benefits differ. Further, the methodologies are statistical estimates of adverse health outcomes aggregated to the statewide level. Therefore, this information should only be used to understand the relative health benefits of the various strategies and should not be taken as an absolute estimate of the health outcomes of the Scoping Plan statewide, or within a specific community. The latter is a function of the unique exposure to air pollutants within each community and each individual's choice of more active transport modes that increase physical activity.

The estimates of health benefits in this section do not include any potential avoided adverse health impacts associated with a reduction in global climate change. While we recognize that mitigating climate change will, for example, prevent atmospheric temperature rise, thereby preventing increases in ozone in California, which will result in fewer breathing problems, the connection is difficult to estimate or model. Since it takes collective global action to mitigate climate change, the following analyses do not attempt to quantify the improved health outcomes from reducing or stopping the rise in global temperatures.

The estimated statewide health benefits of the Scoping Plan are dominated by reductions in particulate matter from mobile sources and wood burning and a switch to more active transport modes. In particular, the focus on the impacts of exposure to particulate matter from mobile sources is expected because this is a major cause of air pollution statewide. For this reason, the actions concerning mobile sources in the Scoping Plan were specifically developed with the goal of achieving health-based air quality standards by reducing criteria and toxics emissions as well as GHG emissions simultaneously. In addition, actions that support walkable communities not only result in reduced VMT and related GHG emissions, but promote active transport and increased physical activity that is strongly related to improved health.

Table 11 provides a summary of the total estimated health benefits from the relevant metrics for the Scoping Plan. The sections below summarize the methodologies used to estimate these benefits. More detail on how these estimates were calculated can be found in Appendix G. The air pollutant values used in estimating the health impacts are from Table 5 and all caveats in the estimation of the air quality impacts must be considered when reviewing the health impacts discussed below as the air pollutant values are likely overestimates based on assigned relationships to GHGs that may not be real.

Potential Health Impacts of Reductions in Particulate Matter Air Pollution

CARB relied on an U.S. EPA-approved methodology to estimate the health impacts of reducing air pollution by actions in the Scoping Plan. This methodology relies on an incidents-per-ton factor to quantify the health benefits of directly emitted (diesel particles and wood smoke) and secondary $PM_{2.5}$ formed from oxides of nitrogen from reductions due to regulatory controls. It is similar in concept to the methodology developed by the U.S. EPA for comparable estimations[101], but uses California air basin specific relationships between emissions and air quality. The basis of the methodology is an approximately linear relationship between changes in $PM_{2.5}$ emissions and estimated changes in health outcomes. In this methodology, the number of premature deaths is estimated by multiplying emissions by the incidents-per-ton scaling factor. The factors are derived from studies that correlate the number of incidents (premature deaths, hospitalizations, emergency room visits) associated with exposure to $PM_{2.5}$.

101 Fann, N., Fulcher, C.M, & Hubbell, B.J. (2009) The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution. (2009)Air Quality, Atmosphere & Health 2(3), 169–176

Potential Health Impacts of Reductions in Toxic Air Pollution

A number of factors complicate any attempt to evaluate the health benefits of reducing exposure to toxic air pollution. First, there are hundreds of individual chemicals of concern with widely varying health effects and potencies. Therefore, a single metric is of limited value in capturing the range of potential toxics benefits. Furthermore, unlike the criteria pollutants whose impacts are generally measured on regional scales, toxics pose concern for both near-source impacts and larger-scale photochemical transformations and transport. Finally, the accepted scientific understanding for cancer risk is that there is usually no safe threshold for exposures to carcinogens. Therefore, cancer risks are usually expressed as "chances per million" of contracting cancer over a (70-year) lifetime exposure (in Table 11 lifetime exposure is provided in the far right column).

In light of these complexities, CARB relied on the most recent National Air Toxics Assessment (NATA) conducted by the U.S. EPA.[102] The NATA 2011 models the potential risks from breathing emissions of approximately 180 toxic air pollutants across the country. Modeled cancer risk results are available by census tract. The NATA data cover industrial facilities, mobile sources (on-road and off-road), small area-wide sources, and more. CARB multiplied the NATA "cancer risk-per-million" values by census tract by the census tract's population, in order to estimate a population-weighted metric that could be aggregated to the statewide level. This statistic should not be construed as actual real-world cancers (due to the many uncertainties in estimating the real-world levels of risk). Next, CARB applied the percent reductions in emissions due to Scoping Plan actions, in order to obtain an estimate of the "avoided incidence" of statistical lifetime cancers attributable to implementation of the Scoping Plan. Again, the "avoided incidence" is a construct designed to provide a useful statistical metric for comparative purposes among scenarios. It should not be construed to be a real-world parameter.

Potential Health Impacts of Active Transportation

High levels of active transportation have been linked to improved health and reduced premature mortality by increasing daily physical activity, representing a major direct co-benefit of using active transportation as a strategy to reduce GHG emissions. The benefits of physical activity can be very large. Individuals who are active for approximately 12 minutes a day have a 20 percent lower risk of dying early than those who are active for just 5 minutes a day and those who are active an hour a day, have close to a 40 percent lower risk of premature death.103

The Scoping Plan includes reductions in VMT, which can be achieved in a number of ways, including increased active transportation. To estimate the potential health benefits of active transport, CARB staff reviewed work done by the California Department of Public Health (CDPH) concerning the potential health benefits associated with the Caltrans Strategic Management Plan. In this Management Plan, Caltrans set a target for increasing the adoption of active transportation, aiming for a doubling of walking and a tripling of bicycle trips by 2020 compared to 2010. While this plan itself is not part of the Scoping Plan, it helps provide a sense of the magnitude of health benefits associated with increased active transportation.

CDPH performed a risk assessment to compare the number of premature deaths due to physical inactivity and traffic injuries in the baseline year of 2010 to the year 2020, assuming that Caltrans' walking and bicycling mode share targets were met.[104] CPDH's methodology has been documented in a publicly available technical manual[105] and the model has appeared in many peer-reviewed research articles.[106] It has been in development

102 U.S. Environmental Protection Agency (2011), National Air Toxics Assessment (NATA) 2011, *https://www.epa.gov/national-air-toxics-assessment/2011-nata-assessment-results*

103 U.S. Department of Health and Human Services (2008) Physical Activity Guidelines Advisory Committee. Physical Activity Guidelines Advisory Committee Report, Washington, DC

104 Maizlish, N. (2016a) Increasing Walking, Cycling, and Transit: Improving Californians' Health, Saving costs, and Reducing Greenhouse Gases. Office of Health Equity, California Department of Public Health. *https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/Maizlish-2016-Increasing-Walking-Cycling-Transit-Technical-Report-rev8-17-ADA.pdf*

105 Maizlish, N. (2016b) Integrated Transport and Health Impact Model (ITHIM): A Guide to Operation, Calibration and Integration with Travel Demand Models. California Spreadsheet Version December 12, 2016.

106 Gotschi, T., Tainio, M., Maizlish, N., Schwanen, T., Goodman, A., & Woodcock, J. (2015). Contrasts in active transport behaviour across four countries: how do they translate into public health benefits? Preventative Medicine, 74, 42-48. doi:10.1016/j.ypmed.2015.02.009
Maizlish, N., Woodcock, J., Co, S., Ostro, B., Fanai, A., & Fairley, D. (2013). Health cobenefits and transportation-related reductions in greenhouse gas emissions in the San Francisco Bay area. American journal of public health, 103(4), 703-709. doi:10.2105/ajph.2012.300939
Whitfield, G. P., Meehan, L. A., Maizlish, N., & Wendel, A. M. (2016). The Integrated Transport and Health Impact Modeling

since 2009, and a California-specific version was released with a recent update in November 2016.[107]

CDPH estimated that 2,100 premature deaths annually would be avoided if Californians met the Management Plan's 2020 targets were met by Californians compared to 2010 travel patterns. A recent paper by Dr. Maizlish et al[108] quantified the health co-benefits of the preferred Sustainable Communities Strategies scenarios (compared to the 2010 baseline travel pattern) for the major Metropolitan Planning Organizations using the same methodology and found that 940 deaths annually would be avoided. For both analyses, there were significant reductions in cause-specific premature mortality due to increased physical activity, which was slightly counteracted by a much smaller increase in fatal traffic injuries due to the increased walking and bicycling. When taken together, the health benefit of increasing active transportation greatly outweighed the increased mortality from road traffic collisions. The Scoping Plan goals related to active transportation are more aggressive than those in both the Maizlish et al. 2017 publication and the analysis by CDPH for the Management Plan. Therefore, CARB staff used the CDPH estimate of approximately 2,100 fewer premature deaths from the Management Plan as a lower bound of what could be realized through implementation of the VMT reductions and active transport goals called for in the Scoping Plan Scenario.

Table 11: Summary of Ranges of Estimated Health Impacts for the Scoping Plan Scenario in 2030

	Fewer Premature Deaths	Fewer Hospitalizations (all)	Fewer ER visits	Fewer cancers *
Diesel PM	~60-91	~9-14	~25-38	
Secondary PM	~76-120	~11-17	~33-50	
Toxics				~21-61
Wood smoke	~1000	~ 148	~ 418	
Active Transport**	>2100			
Total	~3300	~180	~500	~21-61

* This metric should not be construed as actual real-world cancer cases. It is intended to be a comparative metric, based on the NATA estimates of lifetime cancer risk (chances-per-million over a 70 year life-time exposure) by census tract multiplied by the tract population.

** Reduction in premature death assumes meeting the CSMP 2020 mode shift target.

Note: The numbers in the table represent individual avoided incidences.

Tool in Nashville, Tennessee, USA: Implementation Steps and Lessons Learned. Journal of transport & health, 3. doi:10.1016/j.jth.2016.06.009

Woodcock, J. (2015). Integrated Transport and Health Impact Modelling Tool (ITHIM). Retrieved from *http://www.cedar.iph.cam.ac.uk/research/modelling/ithim/*

Woodcock, J., Edwards, P., Tonne, C., Armstrong, B. G., Ashiru, O., Banister, D., & Roberts, I. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. Lancet, 374(9705), 1930-1943. doi:10.1016/s0140-6736(09)61714-1

Woodcock, J., Givoni, M., & Morgan, A. S. (2013). Health impact modelling of active travel visions for England and Wales using an Integrated Transport and Health Impact Modelling Tool (ITHIM). PLoS One, 8(1), e51462. doi:10.1371/journal.pone.0051462

Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., & Goodman, A. (2014). Health effects of the London bicycle sharing system: health impact modelling study. BMJ (Clinical research ed.), 348, g425. doi:10.1136/bmj.g425

107 Woodcock, J. Maizlish, N. (2016). ITHIM: Integrated Transport & Health Impact Modelling, California Version, November 11, 2016. Original citation: Woodcock J, Givoni M, Morgan AS. Health Impact Modelling of Active Travel Visions for England and Wales Using an Integrated Transport and Health Impact Modelling Tool (ITHIM). PLoS One. 2013;8(1):e51462.

108 Maizlish N, Linesch N,& Woodcock J.(2017) Health and greenhouse gas mitigation benefits of ambitious expansion of cycling, walking, and transit in California. Journal of Transport and Health. ; doi: 10.1016/j.jth.2017.04.011

Future Health Activities

As Table 11 shows, the Scoping Plan measures would have significant potential positive health outcomes. The integrated nature of the strategies to reduce emissions of GHGs and criteria and toxics emissions could provide multiple benefits. Actions to reduce black carbon from wood smoke are reducing the same particles that lead to premature mortality. Reductions in fossil combustion will not only reduce GHG emissions, but also toxics emissions. Finally, reducing VMT with strategies that provide opportunities for people to switch to active transport modes can have very large health benefits resulting from increased physical activity.

In recognition of the potential for significant positive health benefits of the Scoping Plan, CARB is initiating a process to better understand how to integrate health analysis broadly into the design and implementation of our climate change programs with the goal of maximizing the health benefits. Although health impact assessments have been used to inform CARB's policymaking, these analyses have not been consistently integrated into the general up-front design of CARB programs. To begin the effort to increase health benefits from climate change mitigation policies, CARB will convene a public meeting in Spring 2018 to solicit input on how best to incorporate health analyses into our policy development. CARB staff will seek appropriate tools for these analyses and will assemble a team of academic advisors to provide input on the latest developments in methods and data sources.

Economic Analyses

The following section outlines the economic impact of the Scoping Plan relative to the business-as-usual Reference Scenario. Additional detail on the economic analysis, including modeling details and the estimated economic impact of alternative scenarios is presented in Appendix E.

The Scoping Plan outlines a path to achieve the SB 32 target that requires less reliance on fossil fuels and increased investment in low carbon fuels and clean energy technologies. Through this shift, California can lead the world in developing the technologies needed to reduce the global risks of climate change. This builds on California's current successes of reducing GHG emissions while also developing a cleaner, resilient economy that uses less energy and generates less pollution. Innovation in low-carbon technologies will continue to open growth opportunities for investors and businesses in California. As modeled, the analysis in this Scoping Plan suggests that the costs of transitioning to this lower carbon economy are small, even without counting the potential opportunities for new industries and innovation in California. Under the Scoping Plan, the California economy, employment, and personal income will continue to grow as California businesses and consumers make clean energy investments and improve efficiency and productivity to reduce energy costs.

In 2030, the California economy is projected to grow to $3.4 trillion, an average growth rate of 2.2 percent per year from 2021 to 2030. It is not anticipated that implementation of the Scoping Plan will change the growth of annual State Gross Domestic Product (GDP). Further, this growth in GDP will occur under the entire projected range of Cap-and-Trade Program allowance prices. Based on this analysis, in 2030 the California economy will take only three months longer to grow to the GDP estimated in the absence of the Scoping Plan–referred to as the Reference Scenario. The impact of the Scoping Plan on job growth is also negligible, with employment less than one half of one percent smaller in 2030 compared to the Reference Scenario.

Additionally, reducing GHG emissions 40 percent below 1990 levels under the Scoping Plan will lead to avoided social damages from climate change on the order of $1.9 to $11.2 billion, as estimated using the SC-CO_2 and SC-CH_4, as well as additional potential savings from reductions in air pollution and petroleum dependence. These impacts are not accounted for in this economic analysis. The estimated impact to California households is also modest in 2030. In 2030, the average annual household impact of the Scoping Plan ranges from $115 to $280, depending on the price of reductions under the Cap-and-Trade Program.[109] Estimated personal income in California is also relatively unchanged by the implementation of the Scoping Plan.

109 Household projections are obtained from the California Department of Finance and were access on March 16, 2017 at: *http://www.dof.ca.gov/Forecasting/Demographics/projections/*.

Overview of Economic Modeling

Two models are used to estimate the economic impact of the Scoping Plan and California's continued clean energy transition: (1) the California PATHWAYS model, and (2) the Regional Economic Models, Inc. (REMI) Policy Insight Plus model. The California PATHWAYS model estimates the direct costs and GHG emissions reductions of implementing the prescriptive (or non-Cap-and-Trade) measures in the Scoping Plan relative to the BAU scenario.[110] Direct costs are the sum of the incremental changes in capital expenditures and fuel expenditures, including fuel savings for reduced energy use from efficiency measures. In most cases, reducing GHG emissions requires the use of more expensive equipment that can be operated using less fuel. In the Scoping Plan, the prescriptive measures modeled in PATHWAYS account for a portion of the GHG reductions required to meet the 2030 target. The remaining reductions are delivered through the Cap-and-Trade Program. The direct costs associated with the Cap-and-Trade Program are calculated outside of PATHWAYS based on an assumed range of Cap-and-Trade allowance prices from 2021 through 2030.

To estimate the future costs of the Scoping Plan, this economic analysis necessarily creates a hypothetical future California that is essentially identical to today, adjusted for currently existing climate policy as well as projected economic and population growth through 2030. The analysis cannot predict the types of innovation that will create efficiencies nor can it fully account for the significant economic benefits associated with reducing emissions. Rather, the economic modeling is conducted by estimating incremental capital and clean fuel costs of measures and assigning those costs to certain sectors within this hypothetical future.

The macroeconomic impacts of the Scoping Plan on the California economy are modeled using the REMI model with output from California PATHWAYS and estimated Cap-and-Trade Program costs as inputs. Additional methodological detail is presented in Appendix E.[111]

Estimated Cost of Prescriptive Measures

As described above, the Scoping Plan combines new measures addressing legislative mandates and the extension of existing measures, including a comprehensive cap on overall GHG emissions from the State's largest sources of pollution. The PATHWAYS model calculates costs and GHG emissions reductions associated with the prescriptive measures in the Scoping Plan. Changes in energy use and capital investment are calculated in PATHWAYS and represent the estimated cost of achieving an estimated 50 to 70 percent of the cumulative GHG reductions required to reach the SB 32 target between 2021 and 2030. The Cap-and-Trade Program delivers any remaining reductions, as shown in Figure 8.

Table 12 outlines the cost of prescriptive measures by sector in 2030, compared to the Reference Scenario, as calculated in PATHWAYS. Estimated capital costs of equipment are levelized over the life of the equipment using a 10 percent discount rate and fuel costs are calculated on an annual basis.[112] The costs in Table 12 are disaggregated into capital costs and fuel costs, which includes the varying costs of gasoline, diesel, biofuels, natural gas, electricity and other fuels.[113] Table 12 assumes that all prescriptive measures deliver anticipated GHG reductions, and does not include any uncertainty in GHG reductions or cost.[114] The impact of uncertainty in GHG reductions is explored in more detail in Appendices E, which include additional detail on measure, cost, and Reference Scenario uncertainty.

The prescriptive measures result in incremental capital investments of $6.7 billion per year in 2030, but these annual capital costs are nearly offset by annual fuel savings of $6.6 billion in 2030. The incremental net cost of prescriptive measures in the Scoping Plan is estimated at $100 million in 2030, which represents 0.03 percent of the projected California economy in 2030. The residential and transportation sectors are anticipated to see net savings in 2030 as fuel savings for these areas vastly outweigh annual capital investment. Several sectors will see a net cost increase from implementation of the prescriptive measures. The industrial sector sees higher fuel costs relative to the Reference Scenario. In the agriculture sector, capital expenditures are due to investments in more efficient lighting and the mitigation of agricultural methane and nitrogen oxides. Agricultural fuel costs increase due to higher electricity and liquid biofuel costs.

110 The PATHWAYS modeling is described in Chapter 2, and additional detail is presented in Appendix D.

111 Additional modeling details are available at the REMI PI+ webpage: *http://www.remi.com/products/pi*.

112 PATHWAYS costs are calculated in real $2012. For this analysis, all costs are reported in $2015. The PATHWAYS costs are inflated using Bureau of Economic Analysis (BEA) data available at: *https://www.bea.gov/iTable/iTable.cfm?ReqID=9#reqid=9&step=1&isuri=1&903=4*.

113 Additional information on the fuels included in PATHWAYS is available at: *www.arb.ca.gov/cc/scopingplan/meetings/1142016/e3pathways.pdf*.

114 More information on the inputs to the California PATHWAYS model is available at: *www.arb.ca.gov/cc/scopingplan/scoping_plan_scenario_description2016-12-01.pdf*.

Table 12: Change in PATHWAYS Sector Costs in 2030 Relative to the Reference Scenario (Billion $2015)[115]

End Use Sector[116]	Levelized Capital Cost	Fuel Cost	Total Annual Cost
Residential	$0.1	-$1.2	-$1.1
Commercial	$1.8	-$1.8	$0.1
Transportation	$3.5	-$3.8	-$0.3
Industrial	$0.8	$0.3	$0.5
Oil and Gas Extraction	$0.0	$0.0	$0.1
Petroleum Refining	$0.0	$0.0	$0.0
Agriculture	$0.3	$0.2	$0.5
TCU (Transportation Communications and Utilities)	$0.1	$0.1	$0.2
Total	$6.7	-$6.6	$0.1

Note: Table values may not add due to rounding.

Estimated Cost of the Cap-and-Trade Program

The direct cost of achieving GHG reductions through the Cap-and-Trade Program is estimated outside of PATHWAYS. The Cap-and-Trade Program sets an economy-wide GHG emissions cap and gives firms the flexibility to choose the lowest-cost approach to reduce emissions. As with the prescriptive measures, the direct costs of any single specific GHG reduction activity under the Cap-and-Trade Program is subject to a large degree of uncertainty. However, as Cap-and-Trade allows covered entities to pursue the reduction options that emerge as the most efficient, overall abatement costs can be bounded by the allowance price. Covered entities should pursue reduction actions with costs less than or equal to the allowance price. An upper bound on the compliance costs under the Cap-and-Trade Program can therefore be estimated by multiplying the range of anticipated allowance prices by the anticipated GHG reductions needed (in conjunction with the reductions achieved through the prescriptive measures) to achieve the SB 32 target.

A large number of factors influence the allowance price, including the ease of substituting lower carbon production methods, consumer price response, the pace of technological progress, and impacts to the price of fuel. Other policy factors that also affect the allowance price include the use of auction proceeds from the sale of State-owned allowances and linkage with other jurisdictions.

Flexibility allows the Cap-and-Trade allowance price to adjust to changes in supply and demand while a firm cap ensures GHG reductions are achieved. This analysis includes a range of allowance prices bounded at the low end by the Cap-and-Trade auction floor price (C+T Floor Price) which represents the minimum sales price for allowances sold at auction and the Allowance Price Containment Reserve Price (C+T Reserve Price), which represents the price at which an additional pool of allowances will be made available to ensure entities can comply with the Cap-and-Trade Program and is the highest anticipated price under the Program. Table 13 outlines the projected allowance prices used in this analysis.[117]

115 PATHWAYS costs reported in $2012 are inflated to $2015 using the Bureau of Economic Analysis (BEA) data available at: *https://www.bea.gov/iTable/iTable.cfm?ReqID=9#reqid=9&step=1&isuri=1&903=4*.

116 Information on the end use sectors are available in the California PATHWAYS documentation available at: *www.arb.ca.gov/cc/scopingplan/scopingplan.htm*.

117 The Cap-and-Trade allowance price range is based on the Cap-and-Trade Regulation approved by the Office of Administrative

Table 13: Estimated Range of Cap-and-Trade Allowance Price 2021–2030*

($2015)	2021	2025	2030
C+T Floor Price	$16.2	$19.7	$25.2
C+T Reserve Price	$72.9	$76.4	$81.9

* Based on current regulation in effect October 1, 2017

Uncertainty in the GHG reduction potential of prescriptive measures in the Scoping Plan can affect the cost of achieving the 2030 target. The aggregate emissions cap of the Cap-and-Trade Program ensures that the 2030 target will be met–irrespective of the GHG emissions realized through prescriptive measures. If GHG reductions anticipated under prescriptive measures do not materialize, the Cap-and-Trade Program will be responsible for a larger share of emissions reductions. Under that scenario, the demand for Cap-and-Trade allowances may rise, resulting in an increase in allowance price. While the Cap-and-Trade allowance price may rise, it is highly unlikely that it will rise above the C+T Reserve price, given the program design. If prescriptive measures deliver anticipated GHG reductions, demand for allowances will be low, depressing the price of allowances. However, the C+T Floor Price represents the lowest price at which allowances can be sold at auction.

Table 14 presents the estimated direct cost estimates for GHG reductions achieved through the Cap-and-Trade Program in 2030. These costs represent the lower and upper bounds of the cost of reducing GHG emissions to achieve the SB 32 target under the Scoping Plan. The estimated direct costs range from $1.6 to $5.1 billion dollars (in $2015), depending on the allowance price in 2030. This range highlights the allowance price uncertainty that is a trade-off to the GHG reduction certainty provided by the Cap-and-Trade Program. The estimated cost of GHG reductions is calculated by multiplying the allowance price by the GHG emissions reductions required to achieve the SB 32 target.

Sensitivity Analysis

In addition to uncertainty in the Cap-and-Trade allowance price and uncertainty in the GHG reductions achieved through the prescriptive measures, there is uncertainty in the GHG emissions that will occur under the Reference Scenario, as presented in Figure 6. There is also uncertainty in costs embedded within the Reference Scenario including the price of oil, other energy costs, and technology costs.

The PATHWAYS incremental cost results are also sensitive to the fossil fuel price assumptions. Altering the fuel price trajectory in the Reference Scenario directly impacts the incremental cost of achieving GHG reductions in the Scoping Plan, as the costs of the Scoping Plan are relative to the Reference Scenario.[118]

The PATHWAYS scenarios use fossil fuel price projections from the Annual Energy Outlook (AEO) 2015 reference case.[119] To estimate the impact of changes in future fuel prices on the estimated incremental cost of the Scoping Plan two sensitivities were conducted. In the low fuel price sensitivity, the AEO low oil and natural gas price case is used to project the future cost of fuels in the Reference Scenario. The cost of the Scoping Plan, relative to the Reference Scenario, increases under these conditions, since fuel savings are less valuable when fuel prices are low. A second sensitivity shows that high future oil and natural gas prices (as projected in the AEO high oil price case) reduce the net cost of the Scoping Plan, relative to the Reference Scenario. This is because avoided fuel savings are more valuable when fuel prices are high. Table 14 outlines the costs and savings from the Scoping Plan (both prescriptive measures and cap-and-trade) under the high and low fuel price sensitivities.

The price of oil and natural gas affects the value of fuel savings (as presented in Table 12), which are estimated to be significant using AEO reference oil and natural gas prices. Under the low fuel price sensitivity,

Law on September 18, 2017. Documentation is available at: *www.arb.ca.gov/regact/2016/capandtrade16/capandtrade16.htm*

118 In addition to the fuel cost sensitivities presented in this section, Appendix E includes an uncertainty analysis of the Scoping Plan Scenario and alternatives. This analysis addresses uncertainty in the Reference Scenario emissions, GHG reductions from each measure, as well as capital and fuel costs.

119 The high and low fuel price sensitivity ranges are derived from differences between the AEO 2016 High Oil Price or Low Oil Price forecast and the AEO 2016 reference case, and are applied as ratios to the base case fuel price assumptions (which are based on the AEO 2015 report). The AEO 2015 report is available at: *http://www.eia.gov/outlooks/aeo/pdf/0383(2015).pdf* and the AEO 2016 report is available for download at: *http://www.eia.gov/outlooks/aeo/pdf/0383(2016).pdf*.

the net incremental cost of prescriptive measures is $2.9 billion in 2030. Under the high fuel price sensitivity, the prescriptive measures result in net *savings of* $4.9 billion in 2030. Table 14 also shows that these price uncertainties are captured within the analyzed range of allowance prices. As described above, changes in fuel prices may affect the price of Cap-and-Trade allowances, but the price is highly unlikely to go outside the range of prices bounded by the C+T Floor Price and C+T Reserve Price. The final column in Table 14 presents the estimated direct cost of the Scoping Plan, including both the prescriptive measures and a range of estimated costs to achieve GHG reductions under the Cap-and-Trade Program for varying projections of future fuel prices. The total cost, reflecting fuel and allowance price uncertainty, ranges from an annual savings to California of $3.3 billion to an annual cost of $8.0 billion in 2030. The net climate benefits, as estimated by the SC-CO_2 and SC-CH_4, outweigh these direct costs.[120]

Table 14: Estimates of Direct Cost and Climate Benefits in 2030 Relative to the Reference Scenario and Including Fuel Price Sensitivity (Billion $2015)

Scenario	Prescriptive Measures	C+T Floor Price	C+T Reserve Price	2030 Total Cost
Scoping Plan	$0.1	$1.6	$5.1	$1.7 to $5.2
Low Fuel Price Sensitivity	$2.9	$1.6	$5.1	$4.5 to $8.0
High Fuel Price Sensitivity	-$4.9	$1.6	$5.1	-$3.3 to -$0.2

Fuel price sensitivity is directly modeled in PATHWAYS, resulting in a range of impacts from prescriptive measures. The range of costs labeled "2030 Total Cost" includes the cost of prescriptive measures estimated in PATHWAYS and the impact of the Cap and-Trade Program calculated at the C+T Floor Price (the lower bounds) and the C+T Reserve Price (the upper bounds).
The social cost of GHGs estimated range in 2030 is $1.9 to $11.2 billion.

Macroeconomic Impacts

The macroeconomic impacts of the Scoping Plan are estimated using the REMI model. Annual capital and fuel costs (for example, the costs in Table 12) are estimated using PATHWAYS and input into the REMI model to estimate the impact of the Scoping Plan on the California economy each year relative to GDP, which is often used as a proxy for economic growth, as well as employment, personal income, and changes in output by sector and consumer spending. Table 15 presents key macroeconomic impacts of implementing the Scoping Plan, based on the range of anticipated allowance prices. In 2030, under the Scoping Plan, growth across the indicators is about one-half of one percent less than the Reference Scenario. The results in Table 15 include not only the estimated direct cost of the Cap-and-Trade Program, but also distribution of allowance value from the auction of Cap-and-Trade allowances to California and consumers. See Appendix E for more detail on the modeling of the return of allowance value under the Cap-and-Trade Program in REMI.

The Cap-and-Trade Program is modeled in REMI as an increase in production cost to sectors based on estimated future GHG emissions and anticipated free allowance allocation. If a sector is expected to receive free allocation of allowances, the value of those free allowances is not modeled as a cost in REMI. The analysis does include the estimated benefit to sectors due to the proceeds from the auction of cap-and-trade allowances and assumes that each year $2 billion of proceeds from the auction of State-owned cap-and-trade allowances are distributed to the economic sectors currently receiving GGRF appropriations. These funds work to achieve further GHG reductions in California, lower the cost to businesses of reducing GHG emissions and protect disadvantaged communities. Any auction proceeds remaining after the distribution of $2 billion through GGRF sectors are distributed evenly to consumers in California as a dividend. The estimated costs in Table 15 include the cost of the GHG reductions to sectors, as well as the benefit to those sectors when allowance proceeds are returned through the GGRF and as a dividend to consumers, as detailed in Appendix E.

120 Climate benefits are estimated using the Social Cost of Carbon in 2030 across the range of discount rates from 2.5 to 5 percent. All values are reported in $2015. Additional information on the Social Cost of Carbon is available from the National Academies of Sciences, Engineering, and Medicine at: *https://www.nap.edu/catalog/24651/valuing-climate-damages-updating-estimation-of-the-social-cost-of*.

Table 15: Macroeconomic Indicators in 2030 Under Base Fuel Price Assumptions

	Reference Scenario (2030)	Scoping Plan (2030)	Percentage Change Relative to Reference Scenario
California GDP (Billion $2015)	$3,439	$3,430 to $3,420	-0.3 percent to -0.6 percent
Employment (Thousand Jobs)	23,522	23,478 to 23,441	-0.2 percent to -0.3 percent
Personal Income (Billion $2015)	$3,010	$3,006 to $3,008	-0.1 percent to -0.1 percent

Table 15 was estimated using the REMI model. The range of costs for the Scoping Plan represents the impact of achieving the SB 32 target through prescriptive measures and the Cap-and-Trade Program at the C+T Floor Price (the lower bounds) and the C+T Reserve Price (the upper bounds).

It is important to put the results of Table 15 into context of the growing $3.4 trillion California economy in 2030. As noted earlier, the economic analysis does not include avoided social damages and other potential savings from reductions in air pollution and petroleum dependency.

Determining employment changes as a result of policies is challenging to model, due to a range of uncertainties and global trends that will influence the California economy, regardless of implementation of the Scoping Plan. The global economy is seeing a shift toward automation and mechanization, which may lead to slowing of employment across some industries globally, irrespective of California's energy and low carbon investments. In California, employment is projected to reach 23.5 million jobs in 2030. In this analysis, implementing the Scoping Plan would slow the growth of employment by less than one-half of one percent in 2030.

Estimated personal income in California is relatively unchanged under the Scoping Plan relative to the Reference Scenario. Considering the uncertainty in the modeling, modest changes in the growth of personal income are not different from zero, which suggests that meeting the SB 32 target will not change the growth of personal income relative to the Reference Scenario.

When analyzing the estimated macroeconomic impacts, it is important to remember that a major substitution of electricity and capital away from fossil fuels is anticipated to have a very small effect on California GDP, employment, and personal income–less than one percent relative to the Reference Scenario in 2030. The economic impacts indicate that shifting money and investment away from fossil fuels and to clean energy is likely to have a negligible effect on the California economy. Additionally, it is certain that innovation will continue as new technologies are developed and implemented. While this analysis projects the costs and GHG reductions of current technologies over time, it does not capture the impact of new technologies that may shift the economy and California in unanticipated ways or benefits related to changes in air pollution and improvements to human health, avoided environmental damages, and positive impacts to natural and working lands. Thus, the results of this analysis very likely underestimate the benefits of shifting to a clean energy economy.

Consumer spending also shifts in response to implementation of the Scoping Plan relative to the Reference Scenario. As presented in Table 15, there is a negligible impact to consumer income, but small changes in income can alter the distribution of consumer spending among categories. In 2030, consumer spending is lower under the Scoping Plan than in the Reference Scenario across all analyzed allowance prices. Consumers spend less on fuels, electricity, natural gas, and capital as a result of measures in the Scoping Plan that reduce demand, increase efficiency, and drive technological innovations. The estimated impact to California households is also modest in 2030. The estimated cost to California households in 2030 ranges from $115 to $280, depending on the price of reductions under the Cap-and-Trade Program.[121]

The household impact is estimated using the per-household change in personal income as modeled in REMI and utilizing household estimates from the California Department of Finance. The household impact does not account for benefits from reduced climate impacts, health savings from reduced air pollution impacts, or lower petroleum dependence costs that might impact households. Additional details are presented in Appendix E.

As modeled, the household impact of the Scoping Plan comprises approximately one percent of average household expenditures in 2030. To ensure that vulnerable populations and low-income households are not

121 Household projections are obtained from the California Department of Finance and are available at: *http://www.dof.ca.gov/Forecasting/Demographics/projections/*.

disproportionately affected by California's climate policy, CARB is taking steps to better quantify localized economic impacts and ensure that low-income households see tangible benefits from the Scoping Plan. Researchers at the University of California, Los Angeles (UCLA) are currently working on a retrospective analysis that will estimate the impacts across California communities of the implementation of AB 32, which will help identify areas of focus as 2030 measures are developed. The Cap-and-Trade Program will also continue to provide benefit to disadvantaged communities through the disbursement of GGRF funds.

The investments made in implementing the Scoping Plan will have long-term benefits and present significant opportunities for California investors and businesses, as upfront capital investments will result in long-term fuel and energy efficiency savings, the benefits of which will continue into the future. The California economy will continue to grow under the Scoping Plan, but it will grow more resilient, more sustainable, and will be well positioned to reap the long-term benefits of lower carbon investments.

Economic Modeling of Health Impacts

Health benefits associated with reductions in diesel particulate matter (DPM) and nitrogen oxides (NO_X) are monetized for inclusion in the macroeconomic modeling. The health benefits are estimated by quantifying the harmful future health effects that will be avoided by reducing human exposure to DPM and NO_X, as detailed in Appendix G, and monetized by estimating a health effect's economic value to society. As previously noted the health impacts are based on air quality benefits estimated in Table 6, which have important limitations and likely overestimate the impacts of the Scoping Plan. Additional detail on the economic modeling of health impacts, including the monetization methodology and modeling results for all Scoping Plan scenarios, is presented in Appendix E. Including the monetized health impacts in the REMI modeling has no discernible impact on the overall results. The impact of including the monetized health impacts is indiscernible relative to the impact of the Scoping Plan.

Estimating the Economic Impact on Disadvantaged Communities (DACs)

Implementing the Scoping Plan is estimated to have a small impact on the Statewide California economy through 2030. However, shifting from fossil fuels can disproportionately affect specific geographic regions whose local economies rely on fossil fuel intensive industries. These regions can also include vulnerable populations and disadvantaged communities who may be disproportionately impacted by poor air quality and climate.

The regional impacts of the Scoping Plan, including the impact to disadvantaged communities, are estimated using the REMI California County model, which represents the 58 counties and 160 sectors of the California economy. Utilizing the same inputs used for modeling the statewide impact of the Scoping Plan relative to the Reference Scenario, the California County model estimates how measures will affect employment, value added, and other economic indicators at the county level across the state.

The county-level REMI output is also used to estimate impacts on disadvantaged communities affected by the Scoping Plan by allocating county impacts proportional to their share of economic indicators unique to each census tract.[122] These indicators include industry output, industry consumption by fuel category, personal consumption, and population. The overall impact on employment across regions is not significant and there is no discernible difference in the impact to employment in disadvantaged communities. There is also no discernible impact to wages in disadvantaged communities across regions in California. Additional details on the regional modeling, including the results for the Scoping Plan and alternatives, is presented in Appendix E.

In addition to the regional modeling conducted in this analysis, there are currently three research contracts underway at CARB to quantify the impact of California's climate policy on regions and disadvantaged communities throughout California. As mentioned above, researchers from UCLA are estimating the improvements in health outcomes associated with AB 32, with a focus on disadvantaged communities. This research will be informed by input from technical advisory committees including a group focused on environmental justice.

122 Census tracts are small geographic areas within greater metropolitan areas that usually have a population between 2,500 and 8,000 persons. More information on the composition of census tracts available here: *https://www.census.gov/geo/reference/gtc/gtc_ct.html*. Disadvantaged census tracts are identified using CalEnviroScreen 2.0. Additional information is available at: *https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-version-20*.

There are also two studies currently underway to quantify the impact of GGRF funds. A UCLA contract focuses on quantifying jobs supported by GGRF funds in California, while a University of California, Berkeley contract is constructing methodologies to assess the co-benefits of GGRF projects across California. These research efforts will provide a regional analysis of the impact of and benefits to specific communities and sectors to ensure that all Californians see economic benefits, in addition to clean air benefits, from the implementing the Scoping Plan.

Public Health

Many measures to reduce GHG emissions also have significant health co-benefits that can address climate change *and* improve the health and well-being of all populations across the State. Climate change is already affecting the health of communities.[123] Climate-related health impacts can include increased heat illness and death, increases in air pollution-related exacerbation of cardiovascular and respiratory diseases, injury and loss of life due to severe storms and flooding, increased vector-borne and water-borne diseases, and stress and mental trauma due to extreme weather-related catastrophes.[124] The urgency of action to address the impacts already being felt from a changing climate and the threats in coming decades provides a unique opportunity for California's leadership in climate action to reduce GHG emissions and create healthy, equitable, and resilient communities where all people thrive. This section discusses the link between climate change and public health. It does not analyze the specific measures included in the strategy but provides context for assessing the potential measures and scenarios.

Achieving Health Equity through Climate Action

Many populations in California face *health inequities,* or unfair and unjust health differences between population groups that are systemic and avoidable.[125] Differences in environmental and socioeconomic determinants of health result in these health inequities. Those facing the greatest health inequities include low-income individuals and households, the very young and the very old, communities of color, and those who have been marginalized or discriminated against based on gender or race/ethnicity.[126] It is these very same populations, along with those suffering existing health conditions and certain populations of workers (e.g., outdoor workers), that climate change will most disproportionately impact.[127] The inequitable distribution of social, political, and economic power results in health inequities, while perpetuating systems (e.g., economic, transportation, land use, etc.) that drive GHG emissions. As a result, communities face inequitable living conditions. For example, low-income communities of color tend to live in more polluted areas and face climate change impacts that can compound and exacerbate existing sensitivities and vulnerabilities.[128,129] Fair and healthy climate action requires that the inequities creating and intensifying community vulnerabilities be addressed. Living conditions and the forces that shape them, such as income, education, housing, transportation, environmental quality, and access to services, significantly drive the capacity for climate resilience. Thus, strategies such as alleviating poverty, increasing access to opportunity, improving living conditions, and reducing health and social inequities will result in more climate-resilient communities. In fact, there are already many "no-regret" climate mitigation and adaptation measures available (discussed below) that can reduce health burdens, increase community resilience, and address social inequities.[130] Focusing efforts to achieve health equity can thus lead to significant progress in addressing human-caused climate change.

123 USGCRP. 2016. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins, A., J. Balbus, J. L. Gamble, C. B. Beard, J. E. Bell, D. Dodgen, R. J. Eisen, N. Fann, M. D. Hawkins, S. C. Herring, L. Jantarasami, D. M. Mills, S. Saha, M. C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, D.C., 312 pp.

124 Ibid.

125 Whitehead, M. 1992. "The concepts and principles of equity and health." International Journal of Health Services 22(3), 429–445.

126 California Department of Public Health (CDPH). 2015. The Portrait of Promise: The California Statewide Plan to Promote Health and Mental Health Equity. A Report to the Legislature and the People of California by the Office of Health Equity. Sacramento, CA: California Department of Public Health, Office of Health Equity.

127 Shonkoff, S., R. Morello-Frosch, M. Pastor, and J. Sadd. 2011. "The climate gap: Environmental health and equity implications of climate change and mitigation policies in California–a review of the literature." Climatic Change 109 (Suppl 1):S485–S503.

128 Ibid.

129 Rudolph, L. and S. Gould. 2015. "Climate change and health inequities: A framework for action." Annals of Global Health 81:3, 432–444.

130 Watts N, Adger WN, Agnolucci P, et al. 2015. Health and climate change: policy responses to protect public health. Lancet: 386, 1861-1914

Potential Health Impacts of Climate Change Mitigation Measures

Socioeconomic Factors: Income, Poverty, and Wealth

Economic factors, such as income, poverty, and wealth, are collectively one of the largest determinants of health. As such, climate mitigation measures that yield economic benefits can improve population health significantly, especially if the economic benefits are directed to those most vulnerable and disadvantaged (including those living in poverty) who often face the most health challenges. From the poorest to richest ends of the income spectrum, higher income is associated with greater longevity in the United States.[131,132,133] The gap in life expectancy between the richest 1 percent and poorest 1 percent of Americans was almost 15 years for men in 2014, and about 10 years for women.[134] Early death among those living in poverty is not a result of those with higher incomes having better access to quality health care.[135] Only about 10-20 percent of a person's health status is accounted for by health care (and 20-30 percent attributed to genetics), while the remainder is attributed to the social determinants of health. These include environmental quality, social and economic circumstances, and the social, media, policy, economic, retail, and built environments– all of which in turn shape stress levels and behaviors, including smoking, diet, and exercise.[136,137,138,139,140,141,142,143,144,145,146] In fact, where people live, work, learn, and play is often a stronger predictor of life expectancy than their genetic and biological makeup.[147] The World Health Organization's Commission on the Social Determinants of Health concluded that the poor health of poor people, and the social gradient in health, are caused by the unequal distribution of power, income, goods, and services resulting from poor social policies and programs, unfair economic arrangements, and bad politics.[148] Thus, improving the conditions of daily life and tackling the inequitable distribution of power, money, and resources can remedy inequitable health outcomes.[149] Simply put, the more evenly distributed the wealth, the healthier a society is.[150]

The wealth-health gradient has significant implications for this Scoping Plan. State climate legislation and policies require prioritizing GHG reduction strategies that serve vulnerable populations and improve well-being for disadvantaged communities. As such, strategies that improve the financial security of communities facing disadvantages while reducing GHG emissions are win-win strategies. These include providing funds or services for GHG reduction programs (e.g., weatherization, energy efficiency, renewable energy, ZEVs, transit, housing, and others) to low-income individuals and households to help them reduce costs. Among the poorest 25 percent of people, per capita government expenditures are strongly associated with longer

131 Chetty, R., M. Stepner, S. Abraham, et al. 2016. "The Association Between Income and Life Expectancy in the United States, 2001–2014." JAMA Published online April 10, 2016. doi:10.1001/jama.2016.4226.
132 Marmot, M., S. Friel, R. Bell, et al. 2008. "Closing the gap in a generation: Health equity through action on the social determinants of health." The Lancet 372, 9650: 1661–1669.
133 Woolf, S. H., and P. Braveman. 2011. "Where health disparities begin: The role of social and economic determinants–and why current policies may make matters worse." Health Affairs (Millwood) 30(10), 1852–1859.
134 Chetty R, Stepner M, Abraham S, et al. 2016. The Association between Income and Life Expectancy in the United States, 2001-2014. JAMA. Published online April 10, 2016. doi:10.1001/jama.2016.4226
135 Ibid.
136 DHHS, Public Health Service. 1980. Ten leading causes of death in the United States. Atlanta, GA: Bureau of State Services.
137 McGinnis, J., and W. Foege. 1993. "Actual causes of death in the United States." JAMA 270(18), 2207–2212.
138 Lantz, P. et al. 1998. "Socioeconomic factors, health behaviors, and mortality: Results from a nationally representative prospective study of US adults." JAMA 279(21), 1703–1708.
139 McGinnis, J. et al. 2002. "The case for more active policy attention to health promotion." Health Affairs 21(2), 78–93.
140 Mokdad, A. et al. 2004. "Actual causes of death in the United States, 2000." JAMA 291(10), 1238–1245.
141 Danaei, G. et al. 2009. "The preventable causes of death in the United States: Comparative risk assessment of dietary, lifestyle, and metabolic risk factors." PLoS Medicine 6(4), e1000058.
142 World Health Organization (WHO). 2009. Global health risks: Mortality and burden of disease attributable to selected major risks. Geneva: WHO.
143 Booske, B. et al. 2010. Different perspectives for assigning weights to determinants of health. County Health Rankings Working Paper. Madison, WI: University of Wisconsin Population Health Institute.
144 Stringhini, S. et al. 2010. "Association of socioeconomic position with health behaviors and mortality." JAMA 303(12), 1159–1166.
145 Thoits, P. 2010. "Stress and health: Major findings and policy implications." *Journal of Health and Social Behavior* 51 Suppl, S41–53.
146 McGovern, L., G. Miller and P. Highes-Cromwick. 2014. "Health policy brief: The relative contribution of multiple determinants to health outcomes." Health Affairs
147 Iton, A. 2006. Tackling the root causes of health disparities through community capacity building. In: Hofrichter R, ed. Tackling Health Inequities Through Public Health Practice: A Handbook for Action. Washington, D.C., and Lansing, MI: National Association of County and City Health Officials and Ingham County Health Department; 116–136.
148 Marmot M, Friel S, Bell R, et al. 2008. Closing the gap in a generation: health equity through action on the social determinants of health. The Lancet , Volume 372 , Issue 9650, 1661 – 1669
149 Ibid.
150 Smith, R. 1996. "The big idea." British Medical Journal 312:April 20th, Editor's choice.

life spans.[151] Successful strategies California has already implemented to assure the poor do not pay higher costs for societal GHG reductions include low-income energy discount programs, in combination with direct climate credits, and policies and programs that help Californians reduce electricity, natural gas, and gasoline consumption.[152] More such strategies could be pursued. To tackle the inequitable distribution of power that leads to disparate health outcomes, agencies can first assure their hearing and decision-making processes provide opportunities for civic engagement so people facing health inequities can themselves participate in decision-making about solutions. Whether it is absolute poverty or relative deprivation that leads to poor health, investments and policies that both lift up the poor and reduce wealth disparities will address the multiple problems of climate change mitigation, adaptation, and health inequities.

Employment

Employment status impacts human health in many ways. Poor health outcomes of unemployment include premature death, self-rated ill-health (a strong predictor of poor health outcomes), and mental illness.[153,154,155,156] Economic strain related to unemployment can impact mental health and trigger stress that is linked to other health conditions.[157,158] Populations of color are overrepresented in the unemployment and under-employment ranks, which likely contributes to racial health inequities. In 2014, 14.7 percent of African-Americans, 12.1 percent of American Indians and Alaska Natives, and 9.8 percent of Latinos were unemployed, compared to 7.9 percent of Whites.[159] In addition to providing income, the work experience has health consequences. There is a *work status–health gradient* similar to the wealth–health gradient. Workers with lower occupational status have a higher risk of death,[160] increased blood pressure,[161] and more heart attacks.[162,163] Higher status workers often have a greater sense of autonomy, control over their work, and predictability, compared to lower status workers, whose lack of control and predictability translates to stress that shortens their lives.[164] Nonstandard working arrangements such as part-time, seasonal, shift, contract, or informal sector work have been linked to greater psychological distress and poorer physical health.[165,166] Women are heavily overrepresented in nonstandard work, as are people of color and people with low levels of education.[167,168]

The implementation of California's climate change goals provides great opportunity to not only improve the habitability of the planet, but also to increase economic vitality, employ historically disadvantaged people

151 Chetty R, Stepner M, Abraham S, et al. 2016. The Association between Income and Life Expectancy in the United States, 2001-2014. JAMA. Published online April 10, 2016. doi:10.1001/jama.2016.4226
152 Gattaciecca, J., C. Callahan, and J. R. DeShazo. 2016. Protecting the most vulnerable: A financial analysis of Cap-and-Trade's impact on households in disadvantaged communities across California. UCLA Luskin School of Public Affairs: Los Angeles, CA. *http://innovation.luskin.ucla.edu/content/protecting-most-vulnerable*. Accessed April 22, 2016.
153 Krueger, P., and S. Burgard. 2011. Income, occupations and work. In: Rogers R, Crimmins E, eds. International Handbook of Adult Mortality. New York: Springer: 263–288.
154 Rogers, R., R. Hummer, and C. Nam. 2000. Living and Dying in the USA. Behavioral, health, and social differentials of adult mortality. New York, NY: Academic.
155 Ross, C. and J. Mirowsky. 1995. "Does employment affect health?" Journal of Health and Social Behavior 36(3):230–243.
156 Burgard, S., and K. Lin. 2013. "Bad jobs, bad health? How work and working conditions contribute to health disparities." Am Behav Sci 57(8).
157 Price, R., D. Friedland, J. Choi, and R. Caplan. 1998. Job-loss and work transitions in a time of global economic change.
158 Price, R., J. Choi, and A. Vinokur. 2002. "Links in the chain of adversity following job loss: How financial strain and loss of personal control lead to depression, impaired functioning, and poor health." Journal of Occupational Health Psychology 7(4), 302.
159 U.S. Census Bureau. 2014. American Community Survey 1-Year Estimates. *http://www2.census.gov/programs-surveys/acs/summary_file/2014/data/*. Last updated August 31, 2015. Accessed April 20, 2016.
160 Rogers R, Hummer R, and Nam C. 2000. Living and Dying in the USA. Behavioral, health, and social differentials of adult mortality. New York, NY: Academic
161 Colhoun, H., H. Hemingway, and N. Poulter. 1998. "Socio-economic status and blood pressure: An overview analysis." Journal of Human Hypertension 12(2).
162 Möller, J., T. Theorell, U. De Faire, A. Ahlbom, and J. Hallqvist. 2005. "Work related stressful life events and the risk of myocardial infarction. Case-control and case-crossover analyses within the Stockholm heart epidemiology programme (SHEEP)." Journal of Epidemiology and Community Health 59(1), 23–30.
163 Burgard S, Lin K. 2013. Bad jobs, bad health? How work and working conditions contribute to health disparities. Am Behav Sci: 57(8).
164 Marmot, M., G. Rose, M. Shipley, and P. Hamilton. 1978. "Employment grade and coronary heart disease in British civil servants." Journal of Epidemiology and Community Health 32(4), 244–249.
165 Dooley, D., and J. Prause. 2004. Settling down: Psychological depression and underemployment. The social costs of underemployment, 134-157. In: Dooley, D. and J. Prause. The Social Costs of Underemployment: Inadequate Employment as Disguised Unemployment.
166 Virtanen, M., M. Kivimäki, M. Joensuu, P. Virtanen, M. Elovainio, and J. Vahtera. 2005. "Temporary employment and health: A review." International Journal of Epidemiology 34(3): 610–622.
167 Nollen, S. 1996. "Negative aspects of temporary employment." Journal of Labor Research 17(4): 567–582.
168 Burgard S, Lin K. 2013. Bad jobs, bad health? How work and working conditions contribute to health disparities. Am Behav Sci: 57(8)

in secure jobs, and improve the health of the population. Measures in the Scoping Plan that aim to reduce GHGs can simultaneously improve health and social equity by prioritizing or requiring that: (1) infrastructure projects using public funds pay living wages, provide quality benefits to all employees, and minimize nonstandard work; (2) locals are hired as much as is feasible; (3) preference is given for women-owned and minority-owned businesses; (4) employers receiving public funds assess and reduce work stress and lack of workplace control; (5) projects benefiting from State climate investments prioritize hiring from historically hard-to-employ groups, such as youth (especially youth of color), formerly incarcerated people, and people with physical or mental illness; and (6) training is provided to these same groups to work in jobs in sectors that will support a sustainable economy.

Communications Supporting Climate Change Behaviors and Policies

California's leadership on GHG reductions is exceptional. However, climate mitigation goals are often treated independently by sector, and the public does not see a unified message that changes must take place on every level in every sector to preserve human health and well-being. Climate strategy could be supported by public communications campaigns that link sectors and present a message of the need for bold action, along with the benefits that action can yield. Mass media communications and social marketing campaigns can help shift social and cultural norms toward sustainable and healthy practices. Messaging about the co-benefits of climate change policies in improving health and well-being can lead to increased community and decision-maker support among vulnerable groups for policies and measures outlined in the Scoping Plan.

Community Engagement Leads to Robust, Lasting, and Effective Climate Policies

For California's climate change policies to be supported by the public and be implemented with enthusiasm, they must be developed through ample, genuine opportunities for community members to discuss and provide input. Californians' contributions to the policy arena strengthen the end products and assist in their implementation and enforcement.

Efforts to mitigate climate change through policy, environmental, and systems change present considerable opportunities to promote sustainable, healthy, resilient, and equitable communities. The measures in the Scoping Plan, and the way they are implemented, can help create living conditions that facilitate physical activity; encourage public transit use; provide access to affordable, fresh, and nutritious foods; protect the natural systems on which human health depends; spur economic development; provide safe, affordable, and energy-efficient housing; enable access to jobs; and increase social cohesion and civic engagement. These climate change mitigation measures can improve overall population health, as well as material conditions, access to opportunity, and health and well-being in communities facing health inequities. Approaching the policy solutions outlined in the Scoping Plan with a health and equity lens can ultimately help lead to a California in which all current and future generations of Californians can benefit and thrive.

Environmental Analysis

CARB, as the lead agency, prepared a Draft Environmental Analysis (Draft EA) in accordance with the requirements of the California Environmental Quality Act (CEQA) and CARB's regulatory program (CARB's program has been certified as complying with CEQA by the Secretary of Natural Resources; see California Code of Regulation, title 17, sections 60006-60008; California Code of Regulation, title 14, section 15251, subdivision (d)). The resource areas from the CEQA Guidelines Environmental Checklist were used as a framework for a programmatic environmental analysis of the reasonably foreseeable compliance responses resulting from implementation of the measures proposed in the Scoping Plan to achieve the 2030 target. Following circulation of the Draft EA for an 80-day public review and comment period (January 20, 2017 through April 10, 2017), CARB prepared the Final Environmental Analysis Prepared for the Proposed Strategy for Achieving California's 2030 Greenhouse Gas Target (Final EA), which includes minor revisions to the Draft EA, and the Response to Comments on the Draft Environmental Analysis prepared for the Proposed Strategy for Achieving California's 2030 Greenhouse Gas Target (RTC). The Final EA is included as Appendix F to the 2017 Scoping Plan. The Final EA and RTC were posted on CARB's Scoping Plan webpage before the Board hearing in December 2017.

The Final EA provides a programmatic level of analysis of the adverse environmental impacts that are reasonably foreseeable as resulting from implementation of the proposed Scoping Plan measures; feasible mitigation measures; a cumulative impacts analysis and an alternatives analysis.

Collectively, the Final EA concluded that implementation of these actions could result in the following short-term and long-term beneficial and adverse environmental impacts:

- Beneficial long-term impacts to air quality, energy demand and greenhouse gas emissions.
- Less than significant impacts to energy demand, resources related to land use planning, mineral resources, population and housing, public services, and recreational services.
- Potentially significant and unavoidable adverse impacts to aesthetics, agriculture and forest resources, air quality, biological resources, cultural resources, geology and soils, hazards and hazardous materials, hydrology and water quality, resources related to land use planning, noise, recreational services, transportation/traffic, and utilities and service systems.

The potentially significant and unavoidable adverse impacts are disclosed for both short-term construction-related activities and long-term operational activities, which explains why some resource areas are identified above as having both less-than-significant impacts and potentially significant impacts. For a summary of impacts, please refer to the table in Attachment B to the Final EA.

Chapter 4

Key Sectors

Climate change mitigation policies must be considered in the context of the sector's contribution to the State's total GHGs, while also considering any co-benefits for criteria pollutant and toxic air contaminant reductions. The transportation, electricity (in-state and imported), and industrial sectors are the largest contributors to the GHG inventory and present the largest opportunities for GHG reductions. However, to ensure decarbonization across the entire economy and to meet our 2030 GHG target, policies must be considered for all sectors. Policies that support energy efficiency, alternative fuels, and renewable power also can provide co-benefits for both criteria and toxic air pollutants.

The specific policies identified in this Scoping Plan are subject to additional analytical and public processes to refine the requirements and methods of implementation. For example, a change in the LCFS Carbon Intensity (CI) target would only take effect after a subsequent rulemaking for that regulation, which would include its own public process and environmental, economic, and public health analyses. As described in Chapter 2, many policies for reducing emissions toward the 2030 target are already known. This Scoping Plan identifies these and additional policies or program enhancements needed to achieve the remaining GHG reductions in a complementary, flexible, and cost-effective manner to meet the 2030 target. These policies should continue to encourage reductions beyond 2030 to keep us on track to stabilize the climate. Policies that ensure economy-wide investment decisions that incorporate consideration of GHG emissions are particularly important.

As we pursue GHG reduction targets, we must acknowledge the integrated nature of our built and natural environments, and cross-sector impacts of policy choices. The State's Green Buildings Strategy is one such example of this type of integrated approach. Buildings have tremendous cross-sector interactions that influence our health and well-being and affect land use and transportation patterns, energy use, water use, communities, and the indoor and outdoor environment. Green building regulations and programs offer complementary opportunities to address the direct and indirect effects of buildings on the environment by incorporating strategies to minimize overall energy use, water use, waste generation, and transportation impacts. The Governor's Green Buildings Executive Order B-18-12 for State buildings and the California Green Building Standards (CALGreen) Code[169] are key state initiatives supporting emissions reductions associated with buildings. Local governments are taking action by adopting "beyond code" green building standards. Additional efforts to maintain and operate existing buildings as third-party certified green buildings provides a significant opportunity to reduce GHG emissions associated with buildings. These foundational regulations and programs for reducing building-related emissions are described in more detail in Appendix H. Looking forward, there is a need to establish a path toward transitioning to zero net carbon buildings[170], which will be the next generation of buildings that can contribute significantly to achieving long-term climate goals. A discussion of how the green buildings strategy can support GHG reductions to help meet the 2030 target is provided in Appendix I. Recent research activities have provided results to better quantify GHG emissions reductions of green buildings, and additional research activities need to continue to expand their focus to support technical feasibility evaluations and implementation. Research needs related to green buildings are included in Appendix I.

Further, each of the policies directed at the built environment must be considered in the broader context of the high-level goals for other sectors, including the natural and working lands sector. For example, policies that support natural and working lands can reduce emissions and sequester carbon, while also providing ecosystem benefits such as better water quality, increased water yield, soil health, reduced erosion, and

169 The authority to update and implement the CALGreen Code is the responsibility of several State agencies identified in California Building Standards Law.

170 A zero carbon building generates zero or near zero GHG emissions over the course of a year from all GHG emission sources associated, directly and indirectly, with the use and occupancy of the building (initial definition included in the May 2014 *First Update to the Climate Change Scoping Plan*).

habitat connectivity. These policies and co-benefits will be considered as part of the integrated strategy outlined above. Table 16 provides examples of the cross-sector interactions between and among the main sectors analyzed for the Scoping Plan that are discussed in this chapter (Energy, Transportation, Industry, Water, Waste Management, and Natural and Working Lands, including agricultural lands).

This chapter recognizes these interactions and relates these broad strategic options to the specific additional programs recommended in Chapter 2 of this document. Accordingly, Chapter 4 provides an overview of each sector's contributions to the State's GHG emissions, a description of both ongoing and proposed programs and policies to meet the 2030 target, and additional climate policy or actions that could be considered in the future. The wide array of complementary and supporting measures being contemplated or undertaken across State government are detailed here. The broad view of State action described in this chapter thus provides context for the narrower set of measures discussed in detail in Chapter 2 of this Scoping Plan. It is these measures in Chapter 2 that CARB staff has identified as specific actions to meet the 2030 target in SB 32.

The following phrases have specific meanings in this discussion of the policy landscape: "Ongoing and Proposed Measures" refers to programs and policies that are either ongoing existing efforts, or efforts required by statute, or which are otherwise underway or about to begin. These measures include, but are not limited to, those identified as necessary specific actions to meet the 2030 GHG target, and which are set apart and described in greater detail in Chapter 2. "Sector Measures" listed also include cross-cutting measures that affect many entities in the sector; some of these are also identified in Chapter 2. "Potential Additional Actions" are not being proposed as part of the specific strategy to achieve the 2030 target in this Scoping Plan. This Scoping Plan includes this broader, comprehensive, review of these measures because it aims to spur thinking and exploration of innovative new technologies and polices that may help the State achieve its long-term climate goals. Some of these items may not ever be formally proposed, but they are included here because CARB, other agencies, and stakeholders believe their potential should be explored with stakeholders in coming years.

Table 16: Cross-Sector Relationships

Sector	Example Interactions with Other Sectors
Energy	• Hydroelectric power, cooling, cleaning, waste water treatment plant (WWTP) bioenergy • Vehicle-to-grid power; electricity supply to vehicle charging infrastructure • Biomass feedstock for bioenergy, land for utility-scale renewable energy (solar, wind) • Agricultural waste and manure feedstocks for bioenergy/biofuels • Organic waste for bioenergy
Transportation	• Electric vehicles, natural gas vehicles, transit/rail; more compact development patterns that reduce vehicle miles traveled (VMT) also demand less energy per capita • More compact development patterns that reduce VMT also demand less water per capita and reduce conversion of natural and working lands • Reducing VMT also reduces energy demands necessary for producing and distributing fuels and vehicles and construction and maintenance of roads • Biomass feedstock for biofuels • Agricultural waste and manure feedstocks for biofuels • Organic waste for biofuels • Greenfield suburban development on natural and working lands leads to increased VMT
Industry	• Potential to electrify fossil natural gas equipment, substitution of fossil-based energy with renewable energy • Greenfield urban development impacts
Water	• Energy consumption for water pumping, treatment, heating; resource for cooling, cleaning; WWTP bioenergy • Use of compost to help with water retention / conservation / drought mitigation • Land conservation results in healthier watersheds by reducing polluted runoff, allowing groundwater recharge, and maintaining properly functioning ecosystems
Waste Management	• Composting, anaerobic digestion, and wastewater treatment plant capacity to help process organic waste diverted from landfills • Compost for carbon sequestration, erosion control in fire-ravaged lands, water conservation, and healthy soils • Replacing virgin materials with recycled materials associated with goods production; enhanced producer responsibility reduces energy impacts of consumption • Efficient packaging materials reduces energy consumption and transportation fuel use
Agriculture	• Crop production, manure management; WWTP biosolids for soil amendments • Agricultural waste and manure feedstocks for bioenergy • Compost production in support of Healthy Soils Initiative
Natural and Working Lands	• Healthy forestlands provide wood and other forest products • Restoring coastal and sub-tidal areas improves habitat for commercial and other fisheries • Sustainable management can provide biomass for electricity • Sustainable management can provide biomass for biofuels • Resilient natural and working lands provide habitat for species and functions to store water, recharge groundwater, naturally purify water, and moderate flooding. Forests are also a source of compost and other soil amendments. • Conservation and land protections help reduce VMT and increase stable carbon pools in soils and above-ground biomass

Low Carbon Energy

The energy sector in California is composed of electricity and natural gas infrastructure, which brings electricity and natural gas to homes, businesses, and industry. This vast system is critical to California's economy and public well-being, and pivotal to reducing its GHG emissions.

Historically, power plants generated electricity largely by combusting fossil fuels. In the 1970s and early 1980s, a significant portion of California's power supply came from coal and petroleum resources. To reduce air pollution and promote fuel diversity, the State has shifted away from these resources to natural gas, renewable energy, and energy efficiency programs, resulting in significant GHG emissions reductions. Emissions from the electricity sector are currently approximately 20 percent below 1990 levels and are well on their way to achieving deeper emissions cuts by 2030. Since 2008, renewable generation has almost doubled, coal generation has been reduced by more than half, and GHG emissions have been reduced by a quarter.

Carbon dioxide is the primary GHG associated with electricity and natural gas systems. The electricity sector, which is composed of in-State generation and imported power to serve California load, has made great strides to help California achieve its climate change objectives. Renewable energy has shown tremendous growth, with capacity from solar, wind, geothermal, small hydropower, and biomass power plants growing from 6,600 megawatts (MW) in 2010 to 27,500 MW as of June 2017.[171]

Renewable energy adoption in California has been promoted through the RPS and several funding mechanisms, such as the California Solar Initiative (CSI) programs, Self-Generation Incentive Program (SGIP), Net-Energy Metering (NEM), and federal tax credits. These mandates and incentives have spurred both utility-scale and small-scale customer-developed renewable energy projects. SB 350 increased the RPS requirement from 33 percent by 2020 to 50 percent by 2030.

SB 350 requires publicly-owned utilities under the jurisdiction of the California Energy Commission (CEC) and all load-serving entities under the jurisdiction of the California Public Utilities Commission (CPUC) to file integrated resource plans (IRPs) with the CEC and CPUC, respectively. Through their IRPs, filing entities will demonstrate how they will plan to meet the electricity sector's share of the State's 2030 GHG reduction target while ensuring reliability in a cost-effective manner. The CEC and CPUC have developed the guidelines that publicly-owned utilities and load-serving entities will follow to prepare and submit IRPs, and CARB is working collaboratively with CEC and CPUC to set the sector and utility and load-serving entity planning targets. The Scoping Plan provides information to help establish the range of GHG reductions required for the electricity sector, and those numbers will be translated into planning target ranges in the IRP process. The IRP processes as currently proposed by CEC and CPUC staff will grant publicly-owned utilities flexibility to determine the optimal way to reduce GHG emissions, and load serving entities some flexibility to achieve the electricity sector's share of the 2030 goal. The CPUC has developed a Reference System Plan to help guide investment, resource acquisition, and programmatic decisions to reach the State's policy goals, in addition to informing the development of individual load serving entities' IRPs.

Energy efficiency is another key component to reducing energy sector GHG emissions, and is another consideration in each agency's IRP process. Utilities have been offering energy efficiency programs, such as incentives, to California customers for decades, and CEC has continually updated building and appliance standards. In the context of IRPs, utility-ratepayer-funded energy efficiency programs will likely continue to play an important role in reducing GHG emissions in the electricity sector.

SB 350 requires CEC and CPUC to establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a cumulative doubling of statewide energy efficiency savings in electricity and natural gas end uses by 2030. These targets can be achieved through appliance and building energy efficiency standards; utility incentive, rebate, and technical assistance programs; third-party delivered energy efficiency programs; and other programs. Achieving greater efficiency savings in existing buildings, as directed by Governor Brown in his 2015 inaugural speech, will be essential to meet the goal of doubling energy efficiency savings. In September 2015, CEC adopted the Existing Buildings Energy Efficiency Action Draft Plan, which is designed to provide foundational support and strategies to enable scaling of energy efficiency in the built environment. Pursuant to SB 350, CEC published an updated Existing Buildings Energy Efficiency Action Plan prior to January 2017. More than $10 billion in private capital investment will be needed

171 California Energy Commission. August, 2017. Tracking Progress. Renewable Energy – Overview. *http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf*

to double statewide efficiency savings in California.[172] Energy efficiency programs are one part of the broader green buildings strategy, which incorporates additional measures to minimize water use, waste generation, and transportation impacts. The green buildings strategy is described in further detail in Appendix I.

Heating fuels used for activities such as space and water heating in the residential, commercial, and industrial sectors represent a significant source of GHG emissions. Transitioning to cleaner heating fuels is part of the solution of achieving greater efficiency savings in existing buildings and has significant GHG emissions reductions potential. Examples of this transition can include use of renewable gas and solar thermal, as well as electrification of end uses in residential, commercial, and industrial sectors. However, achieving significant GHG emissions reductions can only be achieved by decarbonizing the electricity sector – switching from natural gas end uses to electricity generated by burning natural gas would not be effective. Electrification can complement renewables and energy storage if implemented in an integrated, optimized manner. Other hurdles that will have to be overcome include electric equipment performance across all California climate regions, seasonal variations of renewable generation, cost-effectiveness, and consumer acceptance of different heating fuel options.

Fossil-fuel-based natural gas is a significant fuel source for both in-State electricity generation and electricity imported into California. It is also used in transportation applications and in residential, commercial, industrial, and agricultural sector end uses. Greenhouse gas emissions from combustion of fossil natural gas decreased from 134.71 $MMTCO_2e$ in 2000 to 126.98 $MMTCO_2e$ in 2015, while natural gas pipeline fugitive emissions were estimated to be 4.0 $MMTCO_2e$ in 2015 and have been nearly unchanged since 2000.[173] Greenhouse gas-reduction strategies should focus on efficiency, reducing leakage from wells and pipelines, implementing the SLCP strategy, and studying the potential for renewable gas fuel switching (e.g., renewable hydrogen blended with methane or biomethane).

Moving forward, reducing use of fossil natural gas wherever possible will be critical to achieving the State's long-term climate goals. For end uses that must continue to rely on natural gas, renewable natural gas could play an important role. Renewable natural gas volume has been increasing from approximately 1.5 million diesel gallon equivalent (dge) in 2011 to more than 68.5 million dge in 2015, and continued substitution of renewable gas for fossil natural gas would help California reduce its dependence on fossil fuels. In addition, renewable gas can be sourced by in-vessel waste digestion (e.g., anaerobic digestion of food and other organics) and recovering methane from landfills, livestock operations, and wastewater treatment facilities through the use of existing technologies, thereby also reducing methane emissions. The capture and productive use of renewable methane from these and other sources is consistent with requirements of SB 1383.

Collectively, renewable energy and energy efficiency measures can result in significant public health and climate benefits by displacing air pollution and GHG emissions from fossil-fuel based energy sources, as well as by reducing the health and environmental risks associated with the drilling, extraction, transportation, and storage of fossil fuels, especially for communities living near fossil-fuel based energy operations.

As the energy sector continues to evolve and decarbonize, both the behavior of individual facilities and the design of the grid itself will change, with important distributional effects. Some power plants may operate more flexibly to balance renewables, emerging technologies (examples include storage, smart inverters, renewably-fueled fuel cells, and others) will become more prevalent, and aging facilities may retire and be replaced. In turn, this may shift patterns of criteria pollutant emissions at these facilities. Because many existing power plants are in, or near, disadvantaged communities, it is of particular importance to ensure that this transition to a cleaner grid does not result in unintended negative impacts to these communities.

Appendix H highlights the more significant existing policies, programs, measures, regulations, and initiatives that provide a framework for helping achieve GHG emissions reductions in this sector.

172 California Energy Commission. 2016. Existing Building Energy Efficiency Action Plan. page 61. Available at: *http://docketpublic.energy.ca.gov/PublicDocuments/16-EBP-01/TN214801_20161214T155117_Existing_Building_Energy_Efficency_Plan_Update_Deceber_2016_Thi.pdf*

173 CARB. 2017. CARB's Emission Inventory Activities. *www.arb.ca.gov/ei/ei.htm*

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Electricity Goals

- Achieve sector-wide, publicly-owned utility, and load-serving entity specific GHG reduction planning targets set by the State through Integrated Resource Planning.
- Reduce fossil fuel use.
- Reduce energy demand.

Natural Gas Goals

- Ensure safety of the natural gas system.
- Decrease fugitive methane emissions.
- Reduce dependence on fossil natural gas.

Cross-Sector Interactions

The energy sector interacts with nearly all sectors of the economy. Siting of power plants (including solar and wind facilities) and transmission and distribution lines have impacts on land use in California–be it conversion of agricultural or natural and working lands, impacts to sensitive species and habitats, or implications to disadvantaged, vulnerable, and environmental justice communities. Additionally, more compact development patterns reduce per capita energy demands, while less-compact sprawl increases them. Further, efforts to reduce GHG emissions in the transportation sector include electrification, such as PHEVs, BEVs, and FCEVs. Some industrial sources also use electricity as a primary or auxiliary source of power for manufacturing. In the future, industrial facilities may electrify their systems instead of relying on natural gas. These activities will increase demand in this sector. In addition, water is used in various applications in the energy sector, ranging in intensity from cooling of turbines and other equipment at power plants to cleaning solar photovoltaic panels. Given California's recent historic drought, water use for the electricity sector is an important consideration for operation, maintenance, and construction activities.

Continued planning and coordination with federal, State, and local agencies, governments, Tribes, and stakeholders will be crucial to minimizing environmental and health impacts from the energy sector, deploying new technologies, and identifying feedstocks.

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for this sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit.

Ongoing and Proposed Measures – Electricity

- Per SB 350, with respect to Integrated Resource Plans, establish GHG planning targets for the electricity sector, publicly-owned utilities, and load-serving entities.
- Per SB 350, ensure meaningful GHG emissions reductions by publicly-owned utilities and load-serving entities through Integrated Resource Planning.
- Per AB 197, prioritize direct reductions at large stationary sources, including power-generating facilities.
- Per SB 350, increase the RPS to 50 percent of retail sales by 2030 and ensure grid reliability.
- Per Governor Brown's Clean Energy Jobs Plan, AB 327 (Perea, Chapter 611, Statutes of 2013), and AB 693 (Eggman, Chapter 582, Statutes of 2015), increase development of distributed renewable generation, including for low income households.
- Continue to increase use of distributed renewable generation at State facilities where space allows.
- Increase retail customers' use of renewable energy through optional utility 100 percent renewable energy tariffs.
- Continue GHG reductions through participation in the California Independent System Operator (CAISO) Energy Imbalance Market.

- Per SB 350, efforts to evaluate, develop, and deploy regionalization of the grid and integration of renewables via regionalization of the CAISO should continue while maintaining the accounting accuracy and rigor of California's GHG policies.
- Per SB 350, establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a cumulative doubling of statewide energy efficiency savings in electricity and natural gas end uses by 2030.
- Per SB 350, implement the recommendations of the Barriers Study for increasing access to renewable energy generation for low-income customers, energy efficiency and weatherization investments for low-income customers, and contracting opportunities for local small business in disadvantaged communities.[174] And, track progress towards these actions over time to ensure disadvantaged communities are getting equal access and benefits relative to other parts of the State.
- Continue implementation of the Regulations Establishing and Implementing a Greenhouse Gases Emission Performance Standard for Local Publicly Owned Electric Utilities as required by SB 1368 (Perata, Chapter 598, Statutes of 2006), which effectively prohibits electric utilities from making new long-term investments in high-GHG emitting resources such as coal power.
- Per AB 802 (Williams, Chapter 590, Statutes of 2015), adopt the forthcoming CEC regulations governing building energy use data access, benchmarking, and public disclosure.
- Per AB 2868 (Gatto, Chapter 681, Statutes of 2016), encourage development of additional energy storage capacity on the transmission and distribution system.
- Per AB 758 (Skinner, Chapter 470, Statutes of 2009),[175] implement recommendations under State jurisdiction included in the AB 758 Action Plan developed by CEC.

Ongoing and Proposed Measures – Natural Gas

- Implement the CARB Regulation for Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities to reduce fugitive methane emissions from storage and distribution infrastructure.
- Per SB 1371 (Leno, Chapter 525, Statutes of 2014), adopt improvements in investor-owned utility (IOU) natural gas systems to address methane leaks.
- Implement the SLCP Strategy to reduce natural gas leaks from oil and gas wells, pipelines, valves, and pumps to improve safety, avoid energy losses, and reduce methane emissions associated with natural gas use.
- Per SB 1383, CEC will develop recommendations for the development and use of renewable gas as part of its 2017 Integrated Energy Policy Report (IEPR).
- Per SB 1383, adopt regulations to reduce methane emissions from livestock manure and dairy manure management operations by up to 40 percent below the dairy sector's and livestock sector's 2013 levels by 2030, including establishing energy infrastructure development and procurement policies needed to encourage dairy biomethane projects. The regulations will take effect on or after January 1, 2024.
- Per SB 1383, reduce methane emissions at landfills by reducing landfill disposal of organic waste 75 percent below 2014 levels by 2025, including establishing energy infrastructure development and procurement policies needed to encourage in-vessel digestion projects and increase the production and use of renewable gas.
- Per SB 887 (Pavley, Chapter 673, Statutes of 2016), initiate continuous monitoring at natural gas storage facilities and (by January 1, 2018) mechanical integrity testing regimes at gas storage wells, develop regulations for leak reporting, and require risk assessments of potential leaks for proposed new underground gas storage facilities.
- Per Public Utilities (PU) Code 454.56, CPUC, in consultation with CEC, (1) identifies all potentially achievable cost-effective natural gas efficiency savings and establishes gas efficiency targets for the gas corporation to achieve, and (2) requires gas corporations to first meet unmet resource needs through available natural gas efficiency and demand reduction resources that are cost-effective, reliable, and feasible (PU Codes 890–

174 CEC. 2016. Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities. *http://docketpublic.energy.ca.gov/PublicDocuments/16-OIR-02/TN214830_20161215T184655_SB_350_LowIncome_Barriers_Study_Part_A__Commission_Final_Report.pdf*

175 AB 758 requires CEC, in collaboration with CPUC, to develop a comprehensive program to achieve greater energy efficiency in the State's existing buildings.

900 provide public goods charge funding authorization for these programs).
- Per SB 185 (De Leon, Chapter 605, Statutes of 2015), implement the requirement for the California Public Employees' Retirement System (CalPERS) and the California State Teachers' Retirement System (CalSTRS) to sell their holdings in coal-producing companies by June 1, 2017, and explore extending divestiture requirements for additional fossil-fuel assets.

Sector Measures

- Implement the post-2020 Cap-and-Trade Program.

Potential Additional Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals. It is anticipated that there will be workshops and other stakeholder forums in the years following finalization of the Scoping Plan to explore these potential actions.

- Further deploy fuel cells that use renewable fuels or those that generate electricity that is less carbon intensive than the grid.
- Increase use of renewable energy through long-term agreements between customers and utilities (such as Sacramento Municipal Utility District Solar Shares).
- Develop rules needed for the development of electricity storage technologies.
- Adopt a zero net energy (ZNE) standard for residential buildings by 2018/2019, and for commercial buildings by 2030.
- Through a public process, evaluate and set targets for the electrification of space and water heating in residential and commercial buildings and cleaner heating fuels that will result in GHG reductions, and identify actions that can be taken to spur market transformation in the 2021-2030 period.
- Expand the State Low-Income Weatherization Program (LIWP) to continue to improve energy efficiency and weatherize existing residential buildings, particularly for low-income individuals and households.
- Decrease usage of fossil natural gas through a combination of energy efficiency programs, fuel switching, and the development and use of renewable gas in the residential, commercial, and industrial sectors.
- Accelerate the deployment of heat pumps and the replacement of diesel generators.
- Consider enhanced energy efficiency (high efficiency air conditioners, light-emitting diode (LED) lamps, efficiency improvements in industrial process cooling and refrigeration, efficient street lighting).
- Promote programs to support third-party delivered energy efficiency projects.
- Per AB 33 (Quirk, Chapter 680, Statutes of 2016), consider large-scale electricity storage.
- Support more compact development patterns to promote reduced per capita energy demand (see the Transportation sector for specific policy recommendations).

Industry

California's robust economy, with the largest manufacturing sector in the United States, is supported by a variety of sub-industrial sectors, some of which include cement plants, refineries, food processors, paper products, wineries, steel plants, and industrial gas, entertainment, technology and software, aerospace, and defense companies. Together, industrial sources account for approximately 21 percent of the State's GHG emissions–almost equal to the amount of GHG emissions from the energy sector. Emissions in this sector are mainly due to fuel combustion and, in some industries, process-related emissions. Changes in this sector strongly correlate with changes in the overall economy. For example, housing and construction growth usually increases demand for cement. Moving toward a cleaner economy and ensuring we meet the statewide targets requires us to address GHG emissions in this sector, which has the potential to provide local co-benefits in criteria pollutant and toxic air contaminant reductions in immediate surrounding locations, especially in vulnerable communities. At the same time, we must ensure there is a smooth path to a cleaner future to support a resilient and robust economy with a strong job force, including training opportunities for workers in disadvantaged communities, while continuing to support economic growth in existing and new industries.

Greenhouse gas emissions in the Industrial sector have remained relatively flat for the last few years while the State's economy has continued to grow, meaning the GHG emissions to produce each dollar of gross standard product is decreasing. Manufacturing accounts for approximately 10 percent of the gross state product.[176] In 2016, California industry exported $163.6 billion in merchandise.[177]
Policies to address GHG emissions reductions must continue to balance the State's economic well-being with making progress toward achievement of the statewide limits.

As this sector is dominated by combustion-related emissions, policies and measures to supply cleaner fuels and more efficient technology are the key to reducing GHG emissions. Some sectors, such as cement and glass, also have significant process emissions, and it may be more challenging to address those process emissions, as they are related to chemical reactions and processes to meet safety, product-specific, or regulatory standards for the final products. Another important aspect for this sector is its role as the State transitions to a cleaner future. Infrastructure, including existing facilities and new facilities, can support the production of new technology to bolster the State's efforts to address GHGs. For example, existing refineries have an opportunity to move away from fossil fuel production and switch to the production of biofuels and clean technology. As the State works to double energy efficiency in existing buildings, there will be an increased demand for efficient lighting fixtures, building insulation, low-e[178] coatings for existing windows, or new windows–goods which could be produced in California. The predominant paths to reducing GHG emissions for the Industrial sector are: fuel switching, energy efficiency improvements, and process modifications. Carbon capture and sequestration also offers a potential new, long-term path for reducing GHGs for large stationary sources.

Relocation of production to outside the State would also reduce emissions, but this is disadvantageous for a couple of reasons and efforts are needed to avoid this outcome. First, AB 32 requires the State's climate policies to minimize emissions leakage, and relocation would shift GHG emissions outside of the State without the benefit of reducing pollutants that contribute to overall global warming impacts. Second, it could also reduce the availability of associated jobs and could impact a local tax base that supports local services such as public transportation, emergency response, and social services, as well as funding sources critical to protecting the natural environment and keeping it available for current and future generations.

Even while we continue to seek further GHG reductions in the sector, it is important to recognize the State has a long history of addressing health-based air pollutants in this sector. Many of the actions for addressing criteria pollutants and toxic air contaminants in the industrial sector are driven by California's local air district stationary source requirements to ensure progress toward achieving State and national ambient air quality standards. Some of those actions, such as use of Best Available Control Technology, have resulted in co-benefits in the form of GHG reductions. The State must continue to strengthen its existing criteria and toxic air pollutant programs and relationships with local air districts to ensure all Californians have healthy, clean air. This is especially true in disadvantaged communities.

AB 32 directed CARB to take several actions to address GHG emissions, such as early action measures, GHG reporting requirements for the largest GHG sources, and other measures. In response, the State adopted multiple measures and regulations, including regulations for high global warming potential (high-GWP) gases used in refrigeration systems and the semiconductor industry.[179] These regulations apply to specific GHGs and types of equipment that can be found across the economy. For example, high-GWP gases are found in refrigeration systems in large food processing plants and chemical and petrochemical facilities, among others.[180]

The State has also adopted the first in the world economy-wide cap-and-trade program that applies to all large industrial GHG emitters, imported electricity, and fuel and natural gas suppliers. As discussed in Chapters 2 and 3, the Cap-and-Trade Program is a key element of California's GHG reduction strategy. The

176 *http://www.investopedia.com/articles/investing/011416/californias-economy-9-industries-driving-gdp-growth.asp*
177 U.S. Department of Commerce. International Trade Administration. 2017. California Exports, Jobs, & Foreign Investment. *www.trade.gov/mas/ian/statereports/states/ca.pdf*
178 Low-e coatings reduce the emissivity, or heat transfer, from a window to improve its insulating properties.
179 CARB. Refrigerant Management Program. *www.arb.ca.gov/cc/rmp/rmp.htm*
180 The U.S. Environmental Protection Agency (U.S. EPA) has also enacted regulations to reduce hydrofluorocarbon (HFC) emissions by prohibiting high-GWP refrigerants in new retail food refrigeration equipment and in chillers used for large air-conditioning applications. On the international level, the European Union F-gas regulations went into effect January 1, 2015. Those regulations prohibit high-GWP HFCs in new equipment and require a gradual phasedown in the production and import of HFCs. A similar HFC phasedown that would take place globally was the subject of international negotiations during the Montreal Protocol meeting in Rwanda in October, 2016. Those negotiations resulted in an agreement that will phase down the use of HFCs and put the world on track to avoid nearly 0.5°C of warming by 2100.

Cap-and-Trade Program establishes a declining limit on major sources of GHG emissions, and it creates a powerful economic incentive for major investment in cleaner, more efficient technologies. The Cap-and-Trade Program applies to emissions that cover about 85 percent of the State's GHG emissions. CARB creates allowances equal to the total amount of permissible emissions (i.e., the "cap") over a given compliance period. One allowance equals one metric ton of GHG emissions. Fewer allowances are created each year, thus the annual cap declines and statewide emissions are reduced over time. An increasing annual auction reserve (or floor) price for allowances and the reduction in annual allowance budgets creates a steady and sustained pressure for covered entities to reduce their GHGs. All covered entities in the Cap-and-Trade Program are still subject to the air quality permit limits for criteria and toxic air pollutants.

The Cap-and-Trade Program is designed to achieve the most cost-effective statewide GHG emissions reductions; there are no individual or facility-specific GHG emissions reductions requirements. Each entity covered by the Cap-and-Trade Program has a compliance obligation that is set by its GHG emissions over a compliance period, and entities are required to meet that compliance obligation by acquiring and surrendering allowances in an amount equal to their compliance obligation. Companies can also meet a limited portion of their compliance obligation by acquiring and surrendering offset credits, which are compliance instruments that are based on rigorously verified emissions reductions that occur from projects outside the scope of the Cap-and-Trade Program. Like allowances, each offset credit is equal to one metric ton of GHG emissions. The program began in January 2013 and achieved a near 100 percent compliance rate for the first compliance period (2013–2014). Reported and verified emissions covered by the Cap-and-Trade Program have been below the cap throughout the first years of the Program.[181]

Allowances are issued by CARB and distributed by free allocation and by sale at auctions. CARB also provides for free allocation to some entities covered by the Program to address potential trade exposure due to the cost of compliance with the Program and address concerns of relocation of production out-of-state and resulting emissions leakage. Offset credits are issued by CARB to qualifying offset projects. Secondary markets exist where allowances and offset credits may be sold and traded among Cap-and-Trade Program participants. Facilities must submit allowances and offsets to match their annual GHG emissions. Facilities that emit more GHG emissions must surrender more allowances or offset credits, and facilities that can cut their emissions need to surrender fewer compliance instruments. Entities have flexibility to choose the lowest-cost approach to achieving program compliance; they may purchase allowances at auction, trade allowances and offset credits with others, take steps to reduce emissions at their own facilities, or utilize a combination of these approaches. Proceeds from the sale of State-owned allowances at auction are placed into the Greenhouse Gas Reduction Fund.

It is important to note that while the Cap-and-Trade Program is designed to reduce GHGs for the industrial sector, there are recommendations from the EJAC (or Committee) for the State to pursue more facility-specific GHG reduction measures to achieve potential local air quality co-benefits, and AB 197 directs CARB to prioritize direct reductions at large stationary sources. The Committee has expressed a strong preference to forgo the existing Cap-and-Trade Program and rely on prescriptive facility level regulations.

We agree with the EJAC that more can and should be done to reduce emissions of criteria pollutants and toxic air contaminants. These pollutants pose air quality and related health issues to the communities adjacent to the sources of industrial emissions. Further, many of these communities are already disadvantaged and burdened by a variety of other environmental stresses. As described in Chapter 3, however, there is not always a direct correlation between emissions of GHGs, criteria pollutants, and toxic air contaminants. Also, relationships between these pollutants are complex within and across industrial sectors. The solution, therefore, is not to do away with or change the regulation of GHGs through the Cap-and-Trade Program to address these legitimate concerns; instead, consistent with the direction in AB 197 and AB 617, State and local agencies must evaluate and implement additional measures that directly regulate and reduce emissions of criteria and toxic air pollutants through other programs.

181 CARB. 2016. Mandatory Greenhouse Gas Emissions Reporting. *www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep.htm*

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Goals

- Increase energy efficiency.
- Reduce fossil fuel use.
- Promote and support industry that provides products and clean technology needed to achieve the State's climate goals.
- Create market signals for low carbon intensity products.
- Maximize air quality co-benefits.
- Support a resilient low carbon economy and strong job force.
- Make California the epicenter for research, development, and deployment of technology needed to achieve a near-zero carbon future.
- Increase in-State recycling manufacturing.

Cross-Sector Interactions

There are clear, direct relationships between the industrial sector and other sectors that go beyond the economic support that a strong economy provides. For instance, this sector could increase its use of renewable fuels such as biomethane, which would be sourced from landfills or dairies. Additionally, some industries could shift from raw materials to recycled materials to reduce waste and reduce GHG emissions associated with processing of raw materials. Further, addressing energy efficiency could reduce onsite heating, water, and fuel demand. Moreover, supporting mass-transit or ride share programs for employees would reduce VMT. Finally, upgrading existing facilities or repurposing existing infrastructure instead of constructing new facilities or infrastructure would support land conservation and smart growth goals.

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for this sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit.

Ongoing and Proposed Measures

- At the October 2016 annual Montreal Protocol Meeting of Parties in Kigali, Rwanda, an international amendment to globally phase down HFC production was agreed upon by more than 150 countries. Depending on the level of future HFC emissions reductions expected for California from the Kigali Agreement, California may also: (1) consider placing restrictions on the sale or distribution of refrigerants with a GWP > 2,500, and (2) consider prohibiting refrigerants with a GWP >= 150 in new stationary refrigeration equipment and refrigerants with a GWP >= 750 for new stationary air-conditioning equipment. At the time the SLCP Strategy was finalized, U.S. EPA was expected to continue implementing certain HFC reductions under its Significant New Alternatives Policy (SNAP). Recent litigation may result in CARB implementing similar measures as state law instead.
- Develop a regulatory monitoring, reporting, verification, and implementation methodology for the implementation of carbon capture and sequestration projects.
- Implement the CARB Regulation for Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities to reduce fugitive methane emissions from storage and distribution infrastructure.

Sector Measures

- Implement the post-2020 Cap-and-Trade Program.
- Continue and strategically expand research and development efforts to identify, evaluate, and help deploy innovative strategies that reduce GHG emissions in the industrial sector.
- Promote procurement policies that prioritize low carbon production to delivery options, including at the State and local government levels.
- Identify and remove barriers to existing grant funding for onsite clean technology or efficiency upgrades.

Potential Additional Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals. It is anticipated that there will be workshops and other stakeholder forums in the years following finalization of the Scoping Plan to explore these potential actions.

- Further deploy fuel cells that use renewable fuels or those that generate electricity that is less carbon intensive than the grid.
- Decrease usage of fossil natural gas through a combination of efficiency, fuel switching, and the development and use of renewable gas.
- Partner with California's local air districts to effectively use BARCT to achieve air quality and GHG reduction co-benefits at large industrial sources.
- Evaluate the potential for and promote electrification for industrial stationary sources whose main emissions are onsite natural gas combustion.
- Identify new funding for grants and tariff opportunities for onsite clean technology, efficiency upgrades, diesel generator replacement, or recycling manufacturing technology.
- Develop an incentive program to install low-GWP refrigeration systems in retail food stores.
- Evaluate and design additional mechanisms to further minimize emissions leakage in the Cap-and-Trade Program (e.g., border carbon adjustment).

Transportation Sustainability

California's population is projected to grow to 50 million people by 2050. How and where the State grows will have important implications for all sectors of the economy, especially the transportation sector. Supporting this growth while continuing to protect the environment, developing livable and vibrant communities, and growing the economy is dependent on transitioning the State's transportation system to one powered by ZEVs (including PHEVs, BEVs, and FCEVs) and low carbon fuels. It must also offer other attractive and convenient low carbon transportation choices, including safe walking and bicycling, as well as quality public transportation. Investments should consider California's diverse communities and provide accessible and clean travel options to all while drastically reducing reliance on light-duty combustion vehicles.

The transportation system in California moves people between home, work, school, shopping, recreation, and other destinations, and connects ports, industry, residential communities, commercial centers, educational facilities, and natural wonders.[182] California's vast transportation system includes roads and highways totaling more than 175,000 miles and valued at approximately $1.2 trillion, 500 transit agencies, 245 public-use airports, 12 major ports, and the nation's first high-speed rail system, now under construction.[183] Transportation infrastructure also includes sidewalks, bicycle paths, parking, transit stations and shelters, street trees and landscaping, signage, lighting, and other elements that affect the convenience, safety, and accessibility of transportation choices. Increasingly, technologies such as real-time, web- and mobile-enabled trip planning and ride-sourcing services are changing how people travel. In the near future, automated and connected vehicles, and unmanned aerial systems (e.g., drones) are expected to be part of our transportation landscape and to transform the way that people and freight are transported. Responsibility for the transportation system is spread across State, regional, and local levels.

Through effective policy design, the State has an opportunity to guide technology transformation and influence investment decisions with a view to mitigate climate and environmental impacts while promoting economic opportunities and community health and safety. The network of transportation technology and infrastructure, in turn, shapes and is shaped by development and land use patterns that can either support or detract from a more sustainable, low carbon, multi-modal transportation future. Strategies to reduce GHG emissions from the transportation sector, therefore, must actively address not only infrastructure and technology, but also coordinated strategies to achieve development, conservation, and land use patterns that align with the State's GHG and other policy goals.

Transportation also enables the movement of freight such as food, building materials, and other consumable products, as well as waste and recyclables. The California freight system includes myriad equipment and

182 Caltrans. California Transportation Plan 2040, February 2016.
183 Ibid.

facilities,[184] and is the most extensive, complex, and interconnected system in the country, with approximately 1.5 billion tons of freight valued at $2.8 trillion shipped in 2015 to, through, and within California.[185] Freight-dependent industries accounted for over $740 billion of California's GDP and over 5 million California jobs in 2014.[186, 187]

Transportation has a profound and varied impact on individuals and communities, including benefits such as economic growth, greater accessibility, and transport-related physical activity, and adverse consequences such as GHG emissions, smog-forming and toxic air pollutants, traffic congestion, and sedentary behaviors. The sector is the largest emitter of GHG emissions in California. Air pollution from tailpipe emissions contributes to respiratory ailments, cardiovascular disease, and early death, with disproportionate impacts on vulnerable populations such as children, the elderly, those with existing health conditions (e.g., chronic obstructive pulmonary disease, or COPD), low-income communities, and communities of color.[188, 189, 190, 191, 192] Importantly, transportation costs are also a major portion of most Californian's household budgets.[193] Additionally, dependence on cars has a direct impact on levels of physical activity, which is closely linked to multiple adverse health outcomes.

Fortunately, many measures that reduce transportation sector GHG emissions simultaneously present opportunities to bolster the economy, enhance public health, revitalize disadvantaged communities, strengthen resilience to disasters and changing climate, and improve Californians' ability to conveniently access daily destinations and nature. These opportunities are particularly important for those who are not able to, or cannot afford to, drive. In addition, a growing market demand for walkable, bikeable, and transit-accessible communities presents a significant opportunity to shift California's transportation systems toward a lower-carbon future while realizing significant public health benefits through increased levels of physical activity (e.g., walking and bicycling). In fact, transport-related physical activity could result in reducing risks from chronic diseases such as cardiovascular disease, diabetes, certain cancers, and more, to such an extent that it would rank among the top public health accomplishments in modern history, and help to reduce the billions of dollars California spends each year to treat chronic diseases. Just as California was the first to mitigate the contribution of cars and trucks to urban smog, it is leading the way toward a clean, low carbon, healthy, interconnected, and equitable transportation system.

Continuing to advance the significant progress already underway in the areas of vehicle and fuel technology is critical to the transportation sector strategy and to reducing GHG emissions in the transportation sector. The rapid technological and behavioral changes underway with automated and connected vehicles, unmanned aerial systems, and ride-sourcing services are redefining the transportation sector, and should be part of the solution for a lower carbon transportation sector. It is critical to support and accelerate progress on transitioning to a zero carbon transportation system, while ensuring VMT reductions are still achieved. The growing severity of climate impacts, persistent public health impacts and costs from air pollution,[194] and rapid technology progress that supports the expectation that cost parity between some ZEVs and comparable internal combustion vehicles will be attained in a few years, underscores the need for further

184 The freight system includes trucks, ocean-going vessels, locomotives, aircraft, transport refrigeration units, commercial harborcraft and cargo handling, industrial and ground service equipment used to move freight at seaports, airports, border crossings, railyards, warehouses, and distribution centers.

185 U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration. Freight Analysis Framework, V 4.1, 2016.

186 U.S. Department of Commerce, Bureau of Economic Analysis. Regional Economic Accounts. Available at: *www.bea.gov/regional/index.htm*, accessed March 11, 2016.

187 State of California Employment Development Department. Labor Market Information by California Geographic Areas. Available at: *www.labormarketinfo.edd.ca.gov/geography/lmi-by-geography.html*, accessed March 21, 2016.

188 CARB. May 2016. Mobile Source Strategy. Available at: *www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf*

189 Hoek, G., Krishnan, R. M., Beelen, R., Peters, A., Ostro, B., Brunekreef, B., and Kaufman, J. D. 2013. Long-term air pollution exposure and cardio-respiratory mortality: a review. Environmental Health, 12(1), 1.

190 Friedman, M. S., K. E. Powell, L. Hutwagner, L. M. Graham, and W. G. Teague. 2001. "Impact of changes in transportation and commuting behaviors during the 1996 Summer Olympic Games in Atlanta on air quality and childhood asthma." JAMA 285(7), 897–905.

191 Bell, M. L., and K. Ebisu. 2012. "Environmental inequality in exposures to airborne particulate matter components in the United States." Environmental Health Perspectives 120(12), 1699.

192 Morello-Frosch, R., M. Zuk, M. Jerrett, B. Shamasunder, and A. D. Kyle. 2011. "Understanding the cumulative impacts of inequalities in environmental health: implications for policy." Health Affairs 30(5), 879–887.

193 H + T® Index website. *htaindex.cnt.org/*

194 For example, a recent report by the American Lung Association estimates the costs of climate and air pollution from passenger vehicles in California to be $15 billion annually. Holmes-Gen, B. and W. Barrett. 2016. Clean Air Future – Health and Climate Benefits of Zero Emission Vehicles. American Lung Association in California, October.

action on ZEVs. Therefore, CARB is signaling the need for additional policy and technical support on strategies to move toward a goal of achieving 100 percent ZEV sales in the light-duty vehicle sector. Austria, Germany, India, Netherlands, and Norway are all taking steps to, or have indicated a desire to, move to 100 percent ZEV sales in the 2020–2030 time frame.

In addition, policies that maximize the integration of electrified rail and transit to improve reliability and travel times, increase active transportation such as walking and bicycling, encourage use of streets for multiple modes of transportation, improve freight efficiency and infrastructure development, and shift demand to low carbon modes will need to play a greater role as California strives to achieve its 2030 and 2050 climate targets.[195]

The State's rail modernization program has identified critical elements of the rail network where improvements, either in timing of service or infrastructure, provide benefits across the entire statewide network, furthering the attractiveness of rail for a range of trip distances.[196] The State also uses the Transit and Intercity Rail Capital Program (TIRCP) and Low Carbon Transit Operations Program (LCTOP) to provide grants from GGRF to fund transformative improvements modernizing California's intercity, commuter, and urban rail systems, as well as bus and ferry transit systems, to reduce emissions of GHGs by reducing congestion and VMT throughout California. As the backbone of an electrified mass-transportation network for the State, the high-speed rail system catalyzes and relies on focused, compact, and walkable development well-served by local transit to funnel riders onto the system and provide alternative options to airplanes and automobiles for interregional travel. Concentrated development, such as that incentivized by the Affordable Housing and Sustainable Communities (AHSC) grant program, can improve ridership and revenue for the system while providing vibrant communities for all.

At the same time, more needs to be done to fully exploit synergies with emerging mobility solutions like ride-sourcing and more effective infrastructure planning to anticipate and guide the necessary changes in travel behavior, especially among millennials. Uniquely, high-speed rail affects air-miles traveled, diverting, at minimum, 30 percent of the intrastate air travel market in 2040.[197]

While most of the GHG reductions from the transportation sector in this Scoping Plan will come from technologies and low carbon fuels, a reduction in the growth of VMT is also needed. VMT reductions are necessary to achieve the 2030 target and must be part of any strategy evaluated in this Plan. Stronger SB 375 GHG reduction targets will enable the State to make significant progress toward this goal, but alone will not provide all of the VMT growth reductions that will be needed. There is a gap between what SB 375 can provide and what is needed to meet the State's 2030 and 2050 goals.

At the time of this writing, adoption of the first round of SCSs by MPOs is complete, and the second round of SCS planning is underway. Three MPO regions are in the very early stages of developing their third SCSs. To date, CARB staff reviewed the final determinations of 16 MPOs, and concluded that all 16 of those SCSs would achieve their targets, if implemented, with many of the MPOs indicating that they expect to exceed their targets. CARB staff recognizes the very strong performance in this first round of SCSs as a major success. Currently adopted sustainable communities strategies achieve, in aggregate, a 17 percent reduction in statewide per capita GHG emissions relative to 2005 by 2035.

Since 2014, CARB has been working with MPOs and other stakeholders to update regional SB 375 targets. At the same time, CARB has also conducted analysis for development of the Mobile Source Strategy and Scoping Plan that identifies the need for statewide per capita greenhouse gas emissions reductions on the order of 25 percent by 2035, to meet our climate goals. Many MPOs have identified challenges to incorporating additional strategies and reducing emissions further in their plans, principally tied to the need for additional and more flexible revenue sources. MPOs have submitted target update recommendations to CARB that in aggregate maintains a 17 percent reduction statewide, which includes commitments of 18 percent reduction by 2035 from each of the four largest MPOs in the State.

CARB is currently reviewing each MPOs target update recommendations alongside new State policies. State agencies have been working on new State-level VMT-related Policies and Measures (see Table 17) as part of this Scoping Plan intended to provide the State, MPOs, and local agencies with additional funding resources and tools to successfully meet the State's climate goals. CARB's preliminary review indicates that new State-level policies and measures will help support updated SB 375 targets that achieve up to 20 percent of the

195 Morello-Frosch, R., M. Zuk, M. Jerrett, B. Shamasunder, and A. D. Kyle. 2011. "Understanding the cumulative impacts of inequalities in environmental health: Implications for policy." Health Affairs 30(5), 879–887.

196 California State Transportation Agency. 2016. 2018 California State Rail Plan factsheet and TIRCP fact sheet.

197 California High-Speed Rail Authority. 2016. 2016 Business Plan. Ridership and Revenue Forecast.

needed statewide reduction, as well as help bridge the remaining VMT growth reduction gap.

Discussions among a broad suite of stakeholders from transportation, the building community, financial institutions, housing advocates, environmental organizations, and community groups are needed to begin the process to pursue and develop the needed set of strategies to ensure that we can achieve necessary VMT reductions, and that the associated benefits are shared by all Californians. Appendix C further details potential actions for discussion that can be taken by State government, regional planning agencies, and local governments, to achieve a broad, statewide vision for more sustainable land use and close the VMT gap.[198]

At the State level, a number of important policies are being developed. Governor Brown signed Senate Bill 743 (Steinberg, Chapter 386, Statutes of 2013), which called for an update to the metric of transportation impact in CEQA. That update to the CEQA Guidelines is currently underway. Employing VMT as the metric of transportation impact statewide will help to ensure GHG reductions planned under SB 375 will be achieved through on-the-ground development, and will also play an important role in creating the additional GHG reductions needed beyond SB 375 across the State. Implementation of this change will rely, in part, on local land use decisions to reduce GHG emissions associated with the transportation sector, both at the project level, and in long-term plans (including general plans, climate action plans, specific plans, and transportation plans) and supporting sustainable community strategies developed under SB 375. The State can provide guidance and tools to assist local governments in achieving those objectives.

Appendix H highlights the more significant existing policies, programs, measures, regulations, and initiatives that provide a framework for helping achieve GHG emissions reductions in this sector.

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Vibrant Communities and Landscapes / VMT Reduction Goals

- Implement and support the use of VMT as the metric for determining transportation impacts under CEQA, in place of level of service (LOS).
- Promote all feasible policies to reduce VMT, including:
  - Land use and community design that reduce VMT,
  - Transit oriented development,
  - Complete street design policies that prioritize transit, biking, and walking, and
  - Increasing low carbon mobility choices, including improved access to viable and affordable public transportation and active transportation opportunities.
- Complete the construction of high-speed rail integrated with enhanced rail and transit systems throughout the State.
- Promote transportation fuel system infrastructure for electric, fuel-cell, and other emerging clean technologies that is accessible to the public where possible, and especially in underserved communities, including environmental justice communities.
- Increase the number, safety, connectivity, and attractiveness of biking and walking facilities to increase use.
- Promote potential efficiency gains from automated transportation systems and identify policy priorities to maximize sustainable outcomes from automated and connected vehicles (preferably ZEVs), including VMT reduction, coordination with transit, and shared mobility, and minimize any increase in VMT, fossil fuel use, and emissions from using automated transportation systems.
- Promote shared-use mobility, such as bike sharing, car sharing and ride-sourcing services to bridge the "first mile, last mile" gap between commuters' transit stops and their destinations.
- Continue research and development on transportation system infrastructure, including:
  - Integrate frameworks for lifecycle analysis of GHG emissions with life-cycle costs for pavement and large infrastructure projects, and
  - Health benefits and costs savings from shifting from driving to walking, bicycling, and transit use.
- Quadruple the proportion of trips taken by foot by 2030 (from a baseline

198 CARB. Potential State - Level Strategies to Advance Sustainable, Equitable Communities and Reduce Vehicle Miles of Travel (VMT) -- for Discussion. *www.arb.ca.gov/cc/scopingplan/meetings/091316/Potential%20VMT%20Measures%20For%20Discussion_9.13.16.pdf*

of the 2010–2012 California Household Travel Survey).
- Strive for a nine-fold increase in the proportion of trips taken by bicycle by 2030 (from a baseline of the 2010–2012 California Household Travel Survey).
- Strive, in passenger rail hubs, for a transit mode share of between 10 percent and 50 percent, and for a walk and bike mode share of between 10 percent and 15 percent.

Vehicle Technology Goals

- Through a strong set of complementary policies–including reliable incentives, significant infrastructure investment, broad education and outreach, and potential regulation–aim to reach 100 percent ZEV sales in the light-duty sector (PHEVs, BEVs, and FCEVs) by 2050.
- Make significant progress in ZEV penetrations in non-light-duty sectors.
- Deploy low-emission and electrified rail vehicles.

Clean Fuels Goals

- Electrify the transportation sector using both electricity and hydrogen.
- Promote research development and deployment of low carbon fuels such as renewable gas, including renewable hydrogen.
- Rapidly reduce carbon intensity of existing liquid and gaseous transportation fuels.

Sustainable Freight Goals

- Increase freight system efficiency of freight operations at specific facilities and along freight corridors such that more cargo can be moved with fewer emissions.
- Accelerate use of clean vehicle and equipment technologies and fuels of freight through targeted introduction of zero emission or near-zero emission (ZE/NZE) technologies, and continued development of renewable fuels.
- Encourage State and federal incentive programs to continue supporting zero and near-zero pilot and demonstration projects in the freight sector.
- Accelerate use of clean vehicle, equipment, and fuels in freight sector through targeted introduction of ZE/NZE technologies, and continued development of renewable fuels. This includes developing policy options that encourage ZE/NZE vehicles on primary freight corridors (e.g., Interstate-710); examples of such policy options include a separated ZE/NZE freight lane, employing market mechanisms such as favorable road pricing for ZE/NZE vehicles, and developing fuel storage and distribution infrastructure along those corridors.

Cross-Sector Interactions

The transportation sector has considerable influence on other sectors and industries in the State. California's transportation sector is still primarily powered by petroleum, and to reduce statewide emissions, California must reduce demand for driving; continue to reduce its gasoline and diesel fuel consumption; diversify its transportation fuel sources by increasing the adoption of low- and zero-carbon fuels; increase the ease and integration of the rail and transit networks to shift travel mode; and deploy ZE/NZE vehicles.

As California's population continues to increase, land use patterns will directly impact GHG emissions from the transportation sector, as well as those associated with the conversion and development of previously undeveloped land. Specifically, where and how the State population grows will have implications on distances traveled and tailpipe emissions; as well as on secondary emissions from the transportation sector, including emissions from vehicle manufacturing and distribution, fuel refining and distribution, demand for new infrastructure (including roads, transit, and active transportation infrastructure), demand for maintenance and upkeep of existing infrastructure. Conversion of natural and working lands further affects emissions, with the attendant impacts to food security, watershed health, and ecosystems. Less dense development also demands higher energy and water use. With the exception of VMT reductions, none of these secondary emissions are currently accounted for in the GHG models used in this Scoping Plan, but are nonetheless important considerations. Additionally, compact, lower-VMT future development patterns are essential to achieving public health, equity, economic, and conservation goals, which are also not modeled but are important co-benefits of the overall transportation sector strategy. For example, high-speed rail station locations were identified in downtown areas to reinforce existing city centers.

Achieving LCFS targets and shifting from petroleum dependence toward greater reliance on low carbon fuels also has the potential to affect land use in multiple ways. For example, increased demand for conventional biofuels could require greater use of land and water for purpose-grown crops, which includes interactions with the agricultural and natural and working lands sectors. On the other hand, continuing growth in fuels from urban organic waste, as well as waste biomass such as composting residues, by-processing residues and agricultural waste and excess forest biomass acts to alleviate the pressure on croplands to meet the need for food, feed, and fuel. Likewise, captured methane from in-vessel digestion, landfills or dairy farms for use in vehicles requires close interaction with the waste and farming sectors.

Also, as more electric vehicles and charging stations are deployed, drivers' charging behavior will affect the extent to which additional electric generation capacity and ancillary services are needed to maintain a reliable grid and accommodate a portfolio of 50 percent renewable electricity by 2030. Charging control and optimization technologies will determine how well integrated the electric and transportation sectors can become, including, for instance, the widespread use of electric vehicles as storage for excess renewable generation, vehicle to grid, smart charging, and/or smart grid. The GHG emissions intensity of electricity affects the GHG savings of fuel switching from petroleum-based fuels to electricity; the cleaner the electric grid, the greater the benefits of switching to electricity as a fuel. Similar to electric vehicles, hydrogen fuel cell electric vehicles have zero-tailpipe emissions and can mitigate GHGs and criteria pollutants. Greenhouse gas emissions could be further reduced with the use of renewable hydrogen, which can be produced using renewable electricity or renewable natural gas.

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for the transportation sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit.

Ongoing and Proposed Measures – Vibrant Communities and Landscapes / VMT Reduction Goals

- Mobile Source Strategy – 15 percent reduction in total light-duty VMT from the BAU in 2050 (with measures to achieve this goal not specified; potential measures identified in Appendix C).
- Work with regions to update SB 375 Sustainable Communities Strategies targets for 2035 to better align with the 2030 GHG target and take advantage of State rail investments.
- Stronger SB 375 GHG reduction targets will enable the State to make significant progress toward the goal of reducing total light-duty VMT by 15 percent from expected levels in 2050, but alone will not provide all of the VMT reductions that will be needed. The gap between what SB 375 can provide and what is needed to meet the State's 2030 and 2050 goals needs to be addressed through additional VMT reduction measures such as those mentioned in Appendix C.
- Implement and support the adoption and use of VMT as the CEQA metric of transportation impact, such that it promotes GHG reduction, the development of multimodal transportation networks, and a diversity of land uses.
- Continue to develop and explore pathways to implement State-level VMT reduction strategies, such as those outlined in the document "Potential State-Level Strategies to Advance Sustainable, Equitable Communities and Reduce Vehicle Miles of Travel (VMT) – for Discussion"[199] – included in Appendix C – through a transparent and inclusive interagency policy development process to evaluate and identify implementation pathways for additional policies to reduce VMT and promote sustainable communities, with a focus on:
    - Accelerating equitable and affordable transit-oriented and infill development through new and enhanced financing and policy incentives and mechanisms,
    - Promoting stronger boundaries to suburban growth through enhanced support for sprawl containment mechanisms such as urban growth boundaries and transfer of development rights programs,
    - Identifying performance criteria for transportation and other infrastructure investments

199 Refers to the document discussed at the September 2016 Public Workshop on the Transportation Sector to Inform Development of the 2030 Target Scoping Plan Update, also available at: *www.arb.ca.gov/cc/scopingplan/meetings/091316/Potential%20VMT%20Measures%20For%20Discussion_9.13.16.pdf*

to ensure alignment with GHG reduction goals and other State policy priorities and expand access to transit, shared mobility, and active transportation choices,
    - Promoting efficient development patterns that maximize protection of natural and working lands,
    - Developing pricing mechanisms such as road user/VMT-based pricing, congestion pricing, and parking pricing strategies,
    - Reducing congestion and related GHG emissions through commute trip reduction strategies, and
    - Programs to maximize the use of alternatives to single-occupant vehicles, including bicycling, walking, transit use, and shared mobility options.
- Finalize analysis of the results of the pilot road usage charge program, implemented pursuant to SB 1077 (DeSaulnier, Chapter 835, Statues of 2014), and evaluate deployment of a statewide program.
- Continue promoting active transportation pursuant to SB 99 (Committee on Budget and Fiscal Review, Chapter 359, Statutes of 2013) – The Active Transportation Program and beyond.
- Continue to build high-speed rail and broader statewide rail modernization pursuant to the funding program in SB 862 (Committee on Budget and Fiscal Review, Chapter 36, Statutes of 2014) and other sources.
- Encourage use of streets for multiple modes of transportation (including public transit and active transportation, such as walking and bicycling), and for all users, including the elderly, young, and less able bodied, pursuant to AB 1358 (Leno, Chapter 657, Statutes of 2008) – Complete Streets policies.
- Support and assist local and regional governments, through technical assistance, and grant and other local assistance programs, to develop and implement plans that are consistent with the goals and concepts in The Second Investment Plan for Fiscal Years 2016-2017 through 2018-2019[200] and its subsequent updates, and Appendix C: Vibrant Communities and Landscapes, including the following:
    - California Climate Investment programs such as Transformative Climate Communities Program, ensuring promotion of GHG reductions from neighborhood-level community plans in disadvantaged communities.
    - AB 2087 (Levine, Chapter 455, Statutes of 2016) – Help local and State agencies apply core investment principles when planning conservation or mitigation projects.
    - High speed rail station area plans.
    - Implementation of updated General Plan Guidelines.
- Per SB 350, implement the recommendations identified in the Barriers Study to accessing ZE/NZE transportation options for low-income customers and recommendations on how to increase access.[201] And, track progress towards these actions over time to ensure disadvantaged communities are getting equal access and benefits relative to other parts of the State.
- Take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in State infrastructure, as required under Executive Order B-30-15.

Ongoing and Proposed Measures – Vehicle Technology

- Implement the Cleaner Technology and Fuels Scenario of CARB's Mobile Source Strategy, which includes:
    - An expansion of the Advanced Clean Cars program, which further increases the stringency of GHG emissions for all light-duty vehicles, and 4.2 million zero emission and plug-in hybrid light-duty electric vehicles by 2030,
    - Phase 1 and 2 GHG regulations for medium- and heavy-duty trucks,
    - An Advanced Clean Cars program, and
    - Innovative Clean Transit.
- Periodically assess and promote cleaner fleet standards.
- Deploy ZEVs across all vehicle classes, including rail vehicles, along with the necessary charging infrastructure.
- Encourage State and federal incentive programs to continue supporting zero and near-zero pilot and demonstration projects.
- Collaborate with the U.S. Environmental Protection Agency to promulgate more

200 CARB. January 2016. Cap-and-Trade Auction Proceeds Second Investment Plan: Fiscal Years 2016-17 through 2018-19. Available at: *www.arb.ca.gov/cc/capandtrade/auctionproceeds/16-17-updated-final-second-investment-planii.pdf*

201 CARB. 2017. Low-Income Barriers Study, Part B: Overcoming Barriers to Clean Transportation Access for Low Income Residents. *www.arb.ca.gov/msprog/transoptions/draft_sb350_clean_transportation_access_guidance_document.pdf*

stringent locomotives requirements,[202] work with California seaports, ocean carriers, and other stakeholders to develop the criteria to incentivize introduction of Super-Low Emission Efficient Ships, and investigate potential energy efficiency improvements for transport refrigeration units and insulated truck and trailer cargo vans.
- Promote research, development, and deployment of new technology to reduce GHGs, criteria pollutants, and toxics.
- Implement a process for intra-state agency and regional and local transportation coordination on automated vehicles to ensure shared policy goals in achieving safe, energy efficient, and low carbon autonomous vehicle deployment that also contribute to VMT reductions.

Ongoing and Proposed Measures – Clean Fuels

- Continue LCFS activities, with increasing stringency of at least 18 percent reduction in carbon intensity (CI).
- Continue to develop and commercialize clean transportation fuels through renewable energy integration goals, tax incentives, research investments, support for project demonstration, public outreach, setting procurement standards, including updating State and local procurement contracts.
- Per SB 1383 and the SLCP Strategy, adopt regulations to reduce and recover methane from landfills, wastewater treatment facilities, and manure at dairies; use the methane as a source of renewable gas to fuel vehicles and generate electricity; and establish infrastructure development and procurement policies to deliver renewable gas to the market.
- Accelerate deployment of alternative fueling infrastructure pursuant to the following:
  - SB 350 – CPUC to accelerate widespread transportation electrification.
  - Executive Order B-16-2012 and 2016 ZEV Action Plan – call for infrastructure to support 1 million ZEVs by 2020.
  - CEC's Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP).
  - CPUC's NRG settlement.
  - CALGreen Code provisions mandate installation of PEV charging infrastructure in new residential and commercial buildings.[203]
  - IOU electric vehicle charging infrastructure pilot programs.

Ongoing and Proposed Measures – Sustainable Freight

- Implement the California Sustainable Freight Action Plan:
  - 25 percent improvement of freight system efficiency by 2030.
  - Deployment of over 100,000 freight vehicles and equipment capable of zero emission operation, and maximize near-zero emission freight vehicles and equipment powered by renewable energy by 2030.

Ongoing and Proposed Measures – California and Transportation Plan

- Update every five years and implement California Transportation Plan.

Sector Measures

- Implement the post-2020 Cap-and-Trade Program

Potential Additional Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals.

- Develop a set of complementary policies to make light-duty ZEVs clear market winners, with a goal of reaching 100 percent light-duty ZEV sales. This could include the following:
  - Reliable purchase/trade-in incentives for at least 10 years.
  - Dealer incentives for ZEV sales.
  - Policies to ensure operating cost savings for ZEVs relative to internal

202 *www.arb.ca.gov/railyard/docs/final_locomotive_petition_and_cover_letter_4_13_17.pdf*
203 Such as raceway and panel capacity to support future installation of electrical vehicle charging stations.

combustion engines, including low cost electricity.
    - Additional investments in charging and ZEV refueling infrastructure.
    - A broad and effective marketing and outreach campaign.
    - Collaborations with cities to develop complementary incentive and use policies for ZEVs.
    - Targeted policies to support ZEV sales and use in low income and disadvantaged communities.
- Develop a Low-Emission Diesel Standard to diversify the fuel pool by incentivizing increased production of low-emission diesel fuels. This standard is anticipated to both displace consumption of conventional diesel with increased use of low-emission diesel fuels, and to reduce emissions from conventional fuels.
- Continue to develop and explore pathways to implement State-level VMT reduction strategies, such as those outlined in Appendix C through a transparent and inclusive interagency policy development process to evaluate and identify implementation pathways for additional policies to reduce VMT and promote sustainable communities, with a focus on the following:
    - Accelerating equitable and affordable transit-oriented and infill development through new and enhanced financing and policy incentives and mechanisms.
    - Promote infrastructure necessary for residential development in existing communities, and ensure any urban growth boundaries are paired with significant infill promotion strategies and removal of infill development barriers.
    - Identifying performance criteria for transportation and other infrastructure investments, to ensure alignment with GHG reduction goals and other State policy priorities, and improve proximity, expanded access to transit, shared mobility, and active transportation choices.
    - Promoting efficient development patterns that maximize protection of natural and working lands.
    - Developing pricing mechanisms such as road user/VMT-based pricing, congestion pricing, and parking pricing strategies.
    - Reducing congestion and related GHG emissions through programs to maximize the use of alternatives to single-occupant vehicles, including bicycling, walking, transit use, and shared mobility options for commute trips.
- Continue to promote research and standards for new and existing technologies to reduce GHGs, including but not limited to:
    - Low rolling resistance tires in the replacement tire market, subject to certification standards that identify tires as low rolling resistance tires or verify emissions reductions and potential fuel savings.
    - Impacts on VMT of car sharing, ride-sourcing, and other emerging mobility options.
    - Driving behaviors that reduce GHG emissions, such as ecodriving training and real-time feedback mechanisms.

Natural and Working Lands Including Agricultural Lands

In his 2015 State of the State address, Governor Brown established 2030 targets for GHG emissions reductions and called for policies and actions to reduce GHG emissions from natural and working lands, including forests, rangelands, farms, wetlands, and soils. The passage of SB 1386 (Wolk, Chapter 535, Statutes of 2015-16) codified this policy and emphasized the important role natural and working lands play in the State's climate strategy. This Scoping Plan focuses renewed attention on California's natural and working lands and the contribution they make to meet the State's goals for carbon sequestration, GHG reduction, and climate change adaptation.

California's natural and working lands encompass a range of land types and uses, including farms, ranches, forests, grasslands, deserts, wetlands, riparian areas, coastal areas and the ocean-- as well as the green spaces in urban and built environments. These resources can be both a source and sink for GHG emissions. Policy in this sector must balance GHG emissions reductions and carbon sequestration with other co-benefits, such as clean air, wildlife and pollinator habitat, strong economies, food, fiber and renewable energy production, and water supply.[204]

Recent trends indicate that significant pools of carbon from these landscapes risk reversal: over the period 2001–2010 disturbance caused an estimated 150 MMT C loss, with the majority– approximately 120 MMT C–

204 *www.sierranevada.ca.gov/our-region/ca-primary-watershed*

lost through wildland fire.[205] At the same time, energy use, methane, and N_2O emissions from the agricultural sector accounts for eight percent of the emissions in the statewide GHG inventory.

California's climate objective for natural and working lands is to maintain them as a carbon sink (i.e., net zero or negative GHG emissions) and, where appropriate, minimize the net GHG and black carbon emissions associated with management, biomass utilization, and wildfire events. In order to achieve this objective, this Plan directs the continued development of the broad and growing understanding of carbon dynamics on California's landscapes, statewide emission trends, and their responses to different land management scenarios. Further, in order to build a programmatic framework for achieving this long-term objective to maintain California's natural and working lands as a carbon sink, this Plan directs the State to quantify the carbon impacts of both publicly funded (e.g., bonds, special taxes, general fund) climate intervention activities on California's natural and working lands made through existing programs as well as potential regulatory actions on land management. This Plan proposes an intervention based reduction goal of at least 15-20 million metric tons by 2030 as a reasonable beginning point for further discussion and development based on the State's current preliminary understanding of what might be feasible. This Plan recognizes that achieving an initial statewide goal of sequestering and avoiding emissions in this sector by at least 15-20 million metric tons by 2030 through existing pathways and new incentives would provide a crucial complement to the measures described in this Scoping Plan and will inform the development of longer-term natural and working lands goals. Achieving this ambitious climate goal will require collaboration and support from State and local agencies, which must improve their capacity to participate and benefit from State climate programs, and set the path for natural and working lands to help the State meet its long-range climate goals.

Looking to the Future

This section outlines how the State will achieve California's climate objectives to: (1) maintain them as a resilient carbon sink (i.e., net zero or negative GHG emissions), and (2) minimize the net GHG and black carbon emissions associated with management, biomass disposal, and wildfire events to 2030 and beyond.

Implementation will include policy and program pathways, with activities related to land protection; enhanced carbon sequestration; and innovative biomass utilization. The framework for this section is to:

- **Protect** land from conversion to more intensified uses by increasing conservation opportunities and pursuing local planning processes in urban and infrastructure development patterns that avoid greenfield development.
- **Enhance** the resilience of and potential for carbon sequestration on lands through management and restoration, and reduce GHG and black carbon emissions from wildfire and management activities. This enhancement includes expansion and management of green space in urban areas.
- **Innovate** biomass utilization such that harvested wood and excess agricultural and forest biomass can be used to advance statewide objectives for renewable energy and fuels, wood product manufacturing, agricultural markets, and soil health, resulting in avoided GHG emissions relative to traditional utilization pathways. Associated activities should increase the resilience of rural communities and economies.

To accomplish these objectives, the State, led by California Natural Resources Agency (CNRA), California Department of Food and Agriculture (CDFA), California Environmental Protection Agency (CalEPA) and CARB will complete a Natural and Working Lands (NWL) Climate Change Implementation Plan (Implementation Plan) in 2018 to evaluate a range of implementation scenarios for natural and working lands and identify long-term (2050 or 2100) sequestration goals that can be incorporated into future climate policy. The Implementation Plan will:

- Include a projection of statewide emissions under business-as-usual land use and management conditions and alternative scenarios, as well as a listing and quantitative assessment of conservation and management activities the state may pursue to achieve the NWL climate objectives and the statewide goals of at least 15-20 $MMTCO_2e$ emissions sequestering and avoidance from the NWL sector by 2030;
- Identify state departments, boards, conservancies, and CNRA and CDFA programs responsible for meeting the 15-20 $MMTCO_2e$ goal by 2030; and
- Identify methodologies to be used by State programs to account for the

205 *www.arb.ca.gov/cc/inventory/sectors/forest/forest.htm*

GHG impacts of prior state funded land use and management interventions, and to be used to estimate the GHG impacts of future interventions.

While growing trees and other vegetation, as well as soil carbon sequestration, reduce some of the carbon losses measured, climate change itself further stresses many of these systems and affects the ability of California's landscapes to maintain its carbon sink. The State will continue to rely on best available science to support actions and incentives to slow and reverse these trends, in concert with other production and ecological objectives of land use. The Forest Climate Action Team, Healthy Soils Initiative, State Coastal Conservancy's Climate Ready Program, various California Climate Investment programs, and CARB's compliance offset program already undertake portions of this work. As we move towards and maximize the ability of our land base to serve as a carbon sink, it will also be important to strengthen these individual activities through the coordination and aggregation of ecoregional plans that inform these interventions. These and future additional efforts can not only protect California's natural carbon stocks, they can also improve quality of life in urban and rural communities alike and increase the climate resilience of agricultural, forestry, and recreational industries and the rural communities they support; the State's water supply; biodiversity; and the safety and environmental health of all who call California home.

Research and Policy Needs

Research is ongoing across agencies to advance the state of the science on NWL carbon dynamics, including a number of projects within the Fourth Climate Change Assessment, and a compendium of climate research being managed by the CNRA that will be completed in 2018. Additionally, California needs a well-defined reference case, or "business as usual" scenario to set a comprehensive and strategic path forward for California's lands and ocean environments to contribute to the State's climate goals. Finally, efforts must increase to gather, interpret, and unify best available science on the GHG and carbon sequestration impacts of land use and management practices applied across forests, cultivated agricultural lands, rangelands and grasslands, wetlands, coastal and ocean systems, desert ecosystems, and urban and other settled lands.

The Implementation Plan, as summarized above, will utilize the Protect-Enhance-Innovate framework and employ projections for carbon sequestration and GHG emissions from California's land base under reference case and increased management scenarios. The quantitative outputs of these projections, expressed as carbon dioxide equivalents will drive acreage needs for implementation using CO_2e/acre results from multiple modeling efforts. The Implementation Plan will also identify GHG emissions quantification within and across programs and agencies and describe implementation monitoring and emissions inventories.

Natural and Working Lands Inventory

In order to understand how carbon is released and sequestered by natural and working landscapes, CARB has worked extensively with other State agencies, academic researchers and the public to develop a Natural and Working Lands inventory that will guide this process. As with other sectors, the CARB Natural and Working Lands inventory represents a snapshot of emissions in recent years, using a combination of reported and measured data. A time lag exists between the last year of available data and the completion of the inventory to allow time for reporting and processing the data. For emission sources that are hard to individually measure, the CARB inventory estimates emissions based on "surrogates," such as the typical amount of travel on unpaved roads to estimate particulate matter emissions at the county level. The most recent inventory can also be "forecast" to project prevailing conditions in a future year based on rules and programs currently in place – known as a "business as usual projection" - along with scenarios to explore the benefits of further strategies to reduce emissions. Forecasts of business-as-usual and policy scenarios guide planning efforts.

As discussed below, ongoing research into forecasting emissions from Natural and Working Lands includes a project at Lawrence Berkeley National Laboratory funded by CNRA. CARB is monitoring this and other research activities and will incorporate results into a proposed inventory and forecasting methodology for Natural and Working Lands. CARB will solicit public feedback and review on the resulting product prior to completing the first full Natural and Working Lands Inventory by the end of 2018, as called for in SB 859. The Natural and Working Lands Inventory is spatially-resolved, so it can be segmented by county, watershed, or other regional planning areas. This spatial resolution allows local governments and regional organizations to use the inventory, along with more granular location-specific information, to track progress from projects in their jurisdictions.

CARB plans to update the forest component of the Natural and Working Lands inventory to include 2012 GHG emissions estimates, followed by emissions estimates for soil carbon, urban forestry, and croplands by mid-2018. Work currently in progress applies airborne and space-based technologies to monitor forest health and quantify emissions associated with land-based carbon. California and federal agencies are working with researchers and funding studies to enhance our understanding of the roles of forests and other lands in climate change using rapidly advancing remote sensing technology.[206, 207]

CALAND Carbon Emissions Model

CNRA is managing the development of a CALAND model through Lawrence Berkeley National Laboratory, which will include a projection of business-as-usual emissions as well as a listing and quantitative assessment of conservation and management activities the State may pursue to achieve at least 15-20 MMT sequestration and GHG avoided emissions from the NWL sector by 2030.

CNRA, along with CARB and CDFA, will establish a formal public engagement process to gather external scientific expertise to inform development and finalization of the CALAND model for use in the Implementation Plan. Development of the Implementation Plan itself will also include a formal public process.

Cross-Sector Interactions

Strategies that reduce GHG emissions or increase sequestration in the natural and working lands sector often overlap and result in synergies with other sectors, most notably at intersections with land use, biomass and waste utilization, energy and water. It will be important for the sector to make critical linkages to other sectors, including energy, transportation fuels, and waste, and develop plans to integrate the natural and working lands sector into existing models, such as PATHWAYS and REMI.

Landowner, local, and regional decisions affect land use development patterns and natural and working land conversion rates; conversely, conservation activities can support infill-oriented regional development and related transportation needs. As discussed earlier in the Transportation Sustainability section, under SB 375, Sustainable Communities Strategies (SCSs) aim to link transportation, housing, and climate policy to reduce per capita GHG emissions while providing a range of other important benefits for Californians. Some SCSs include policies, objectives or implementation measures relating to conservation and land protections, and to urban greening.[208] Protecting natural and working lands that are under threat of conversion can promote infill development, reduce VMT, limit infrastructure expansion, and curb associated GHG emissions. An integrated vision for community development, land conservation and management, and transportation is a key component of meeting our transportation and natural and working lands goals.[209]

Agricultural and commercial forestry operations produce biomass as both an objective (i.e., food and fiber production) and a waste by-product. How this material is utilized can either increase or decrease emissions associated with management and restoration activities, turn waste into usable products, displace fossil fuels used in energy and transportation, and increase carbon stored in durable wood products in the built environment. Finding productive ways to use this material offers new opportunities to reduce GHG emissions, promote carbon sequestration, and generate economic resources for forest, agricultural, and waste sectors and communities. California is investigating ways to transform how organic waste from the agricultural and municipal sectors is managed to meet SLCP emissions reductions targets required by SB 1383,[210] and to protect public health. Cross-sector synergies and complete waste inter-cycles, discussed further in the Waste Management section, result from conscientious treatment of these resources, including opportunities to improve soil health, increase renewable energy generation, and enhance market support for non-commercial products and waste. Productive utilization of dead and dying trees is a significant focus of the Governor's Tree Mortality Task Force, and efforts to resolve the current shortfall in utilization capacity is addressed in that State of Emergency Declaration as well as in SB 859.

Natural and working lands stewardship is essential to securing the State's water supply along the entire

206 Asner, G. et al. (2015) Progressive forest canopy water loss during the 2012–2015 California drought. PNAS 113.2: E249-E255

207 Battles, J. et al. (in progress) Innovations in measuring and managing forest carbon stocks in California. Project 2C: 4th California Climate Change Assessment. Natural Resources Agency. resources.ca.gov/climate/fourth/

208 Livingston, Adam. Sustainable Communities Strategies and Conservation. January 2016. Available at: *www.nature.org/ourinitiatives/regions/northamerica/unitedstates/california/sustainable-communities-strategies-and-conservation.pdf*

209 *www.arb.ca.gov/cc/scopingplan/meetings/meetings.htm*

210 SB1383 (Lara, Chapter 396, Statutes of 2016) requires a 50 percent reduction in anthropogenic black carbon emissions by 2030.

supply chain, from protection and management of the forested headwaters to preserving the ability of mountain meadows to retain and filter water ensuring flows and habitat in the Delta and its tributaries, end use efficiencies in agricultural and urban uses, and groundwater infiltration and utilization statewide. For example, more efficient water and energy use in farming operations could support GHG emissions reductions goals in the energy sectors. And improving forest health in the Sierra Nevada, Cascades, and other headwaters protects water quality and availability, in alignment with the California Water Action Plan.

Potential Actions to Enhance Carbon Sequestration and Reduce Greenhouse Gases in NWL

While agricultural and forest lands comprise the greatest acreage of NWL statewide, representing significant opportunity for achieving the State's NWL climate goals, actions on all NWL remain critical. The land management strategies and targets included in these sections are illustrative of the types of actions that will be necessary to maintain all of California's NWL and urban green space as a net sink of carbon, and are being used to aid in development of scenario modeling. The Implementation Plan will use this scenario modeling to scope the scale of action needed to ensure resilient future landscapes and identify key areas for advancement.

Agriculture's Role in Emissions Reductions and Carbon Sequestration

In 2030 and 2050, the agricultural sector must remain vibrant and strong. California's agricultural production is critical to global food security. It is also vulnerable to climate change. A study[211] by the University of California concluded that the drought in 2015 cost the state economy $2.7 billion and 21,000 full time jobs. These losses are expected to ripple through rural communities for another several years. This illustrates the importance of strengthening agriculture while protecting resources and mitigating climate change.

As the State works to meet emissions reductions goals, the agricultural sector can reduce emissions from production, sequester carbon and build soil carbon stocks, and play a role in cross-sectoral efforts to maximize the benefits of natural and working lands.

Climate-smart agriculture is an integrated approach to achieving GHG reductions while also ensuring food security and promoting agricultural adaptation in the face of climate change. Conserving agricultural land, sequestering carbon in agricultural soils, employing a variety of techniques to manage manure on dairies, and increasing the efficiency of on-farm water and energy use are examples of practices that can achieve climate and food production goals across diverse agricultural systems. Climate-smart agriculture can support the Protect, Enhance, and Innovate goals.

Approximately 60 percent of agricultural emissions are methane emissions from the dairy and livestock sectors. Emissions come from the animals themselves, through enteric fermentation, as well as from manure management–especially at dairies. SB 1383 and the resultant SLCP Strategy identify a mix of voluntary, incentive-based, and potential regulatory actions to achieve significant emissions reductions from these sources. A variety of techniques can attain the best results for each specific farming operation; effectively implementing a broad mix of strategies will reduce the GHG emissions from the agricultural sector significantly. CARB and CDFA and other agencies are working together to solicit input from industry, environmental, and community groups to encourage early and meaningful action to reduce emissions from the livestock sector.

Over the last several years, farms have begun to optimize fertilizer applications to protect water quality, maintain high yields, and reduce emissions of N_2O, a greenhouse gas. Farmers are required through the Irrigated Lands Regulatory Program to manage nitrogen fertilizers to protect water quality through the use of nitrogen management plans. Nitrogen management plans are a tool designed to prevent over-applications of nitrogen through an approach that accounts for the nitrogen inputs from water, soil amendments and other sources, and also accounts for nitrogen removed from the field. CDFA's Fertilizer Research and Education Program, in coordination with university researchers and others, has developed fertilization guidelines to optimize the rate, timing and placement of fertilizers for crops that represent more than half of the irrigated agriculture in California. Similarly, innovations in water management and the expansion of high efficiency irrigation methods also are contributing to N_2O reductions.

211 Howitt, Richard E., Duncan MacEwan, Josué Medellín-Azuara, Jay R. Lund, Daniel A. Sumner. 2015. Economic Analysis of the 2015 Drought for California. Davis, CA: Center for Watershed Sciences, University of California – Davis.

California's farms and ranches have the ability to remove carbon from the atmosphere through management practices that build and retain soil organic matter. Adequate soil organic matter ensures the continued soil capacity to function as a vital living ecosystem with multiple benefits, producing food for plants, animals, and humans. The Healthy Soils Initiative, announced by Governor Brown in 2015, offers an opportunity to incentivize the management of farmland for increased carbon sequestration in soil, also augmenting co-benefits including improved plant health and yields, increased water infiltration and retention, reduced sediment erosion and dust, improved water and air quality, and improved biological diversity and wildlife habitat.

SB 859, signed into law in 2016, establishes the Healthy Soils Program at CDFA to provide incentives to farmers. It enables financial support for on-farm demonstration projects that "result in greenhouse gas benefits across all farming types with the intent to establish or promote healthy soils". It defines healthy soils as "soils that enhance their continuing capacity to function as a biological system, increase soil organic matter, improve soil structure and water-and nutrient-holding capacity, and result in net long-term greenhouse gas benefits."

As noted in the Cross-Sector Interactions section, State and local efforts to manage land for carbon sequestration must work in conjunction with existing plans, incentives, and programs protecting California's water supply, agricultural lands, and wildlife habitat. This Scoping Plan fits within a wide range of ongoing planning efforts throughout the State to advance economic and environmental priorities associated with natural and working lands.

The Role of Forests in Emissions Reductions and Carbon Sequestration

Decades of fire exclusion, coupled with an extended drought and the impacts of climate change, have increased the size and intensity of wildfires and bark beetle infestations; exposed millions of urban and rural residents to unhealthy smoke-laden air from wildfires; and threatened progress toward meeting the state's long-term climate goals. Managing forests in California to be healthy, resilient net sinks of carbon is a vital part of California's climate change policy.

More than 100 million trees are dead, and recent wildfires have been among the most destructive and expensive in state history. As many as 15 million acres of California forests are estimated to be unhealthy and in need of some form of restoration, including more than 9 million acres managed by federal land management agencies and 6 million acres of State and privately managed forests.

California's urban forests also face multiple challenges, including drought and invasive exotic insects. Urban forests require maintenance to preserve the multiple values they provide and merit expansion to sequester carbon and secure other benefits to urban dwellers and the State.

The California Forest Carbon Plan (FCP), being developed by the Forest Climate Action Team (FCAT), seeks to establish California's forests as a more resilient and reliable long-term carbon sink, rather than a GHG and black carbon emission source, and confer additional ecosystem benefits through a range of management strategies.[212] The FCP emphasizes working collaboratively at the watershed or landscape scale to restore resilience to all forestlands in the state.

The current draft of the FCP places carbon sequestration and reducing black carbon and GHG emissions as one set of management objectives in the broader context of forest health and a range of other important forest co-benefits. California will manage for carbon alongside wildlife habitat, watershed protection, recreational access, traditional tribal uses, public health and safety, forest products, and local and regional economic development.

212 *http://www.fire.ca.gov/fcat/*

Federally managed lands play an important role in the achievement of the California climate goals established in AB 32 and subsequent related legislation and plans. Over half of the forestland in California is managed by the federal government, primarily by the USDA Forest Service Pacific Southwest Region, and these lands comprise the largest potential forest carbon sink under one ownership in the state. Several regulatory, policy, and financial challenges have hindered the ability of the Forest Service and Department of Interior agencies (Bureau of Land Management and National Park Service) to increase the pace and scale of restoration needed, such as the current budget structure to fund wildland fire suppression and the procedural requirements of a number of federal environmental and planning statutes. The State of California must continue to work closely and in parallel to the federal government's efforts to resolve these obstacles and achieve forest health and resilience on the lands that federal agencies manage.

Protection of Land and Land Use

California will continue to pursue development and new infrastructure construction patterns that avoid greenfield development, limit conflicts with neighboring land uses, and increase conservation opportunities for NWL to reduce conversion to intensified uses. Success will depend on working through local and regional land use planning and permitting, as well as developing incentives for participation by local governments and individual landowners.

Enhance Carbon Sequestration and Resilience through Management and Restoration

California will increase efforts to manage and restore land to secure and increase carbon storage and minimize GHG and black carbon emissions in a sustainable manner so that the carbon bank is resilient and provides other benefits such as water quality, habitat and recreation.

One tool to demonstrate the potential for greater management and restoration on NWL is the CALAND model. As detailed in the Discussion Draft[213] and discussed above, it considers a variety of management and restoration activities employed across the State. Version 1 of the CALAND model considered two potential scenarios, a "low" and a "high" rate of implementation to 2030, with resulting carbon sequestration outcomes to 2050. The acreages given in the "low" scenario all represent feasible implementation on public and private lands beyond current rates for the listed activity, given availability of additional funding and other supporting resources. The "high" scenario represents a more ambitious approach, requiring new programs and policies, including collaboration with federal partners, to support implementation.

The activities presented in the Discussion Draft and Version 2 of CALAND are not inclusive of all activities under this strategy. Modeling will continue beyond finalization of the Scoping Plan. Agencies and modelers will continue to identify and analyze land management and restoration activities to advance the State's climate goals and improvements in modeling projections or other quantification protocols.

Management and restoration activities under consideration to help reduce GHG emissions beyond those identified in initial modeling include, but are not limited to the following:

- Forest fuel reduction treatments, reforestation, other restoration activities, prescribed fire and managed ignition.
- Restoration of mountain meadows, managed wetlands in the Sacramento San Joaquin Delta, coastal wetlands and desert habitat.
- Increasing the extent of eelgrass beds.
- Creation and management of parks and other greenspace in urban areas, including expansion of the existing urban tree canopy.
- Implementation of U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) management practices suitable for California agriculture including those practices identified in the Healthy Soils Incentive Program.
- Compost application to irrigated cropland.

Additional potential tools to encourage these activities include working with the federal government to fund more management on federal lands, mitigating for land conversion (as modeled by the High Speed Rail Authority), and revisiting the Forest Practices Act to enhance carbon sequestration benefits associated with timber production activities.

213 *www.arb.ca.gov/cc/scopingplan/2030target_sp_dd120216.pdf*

Innovate NWL Waste Utilization Pathways

Excess materials generated by commercial agricultural and forestry operations, biomass and wood harvested through forest health and restoration treatments, and material that is generated in response to Tree Mortality Emergency activities, should be used in a manner that minimizes GHG and black carbon emissions and promotes public and environmental health. The Legislature and Governor Brown set an ambitious goal of 75 percent recycling, composting or source reduction of solid waste in landfills by 2020. The State and stakeholders must develop targeted policies or incentives to support durable markets for all of this diverted material. Market opportunities include production of renewable electricity and biofuels, durable wood products, compost and other soil amendments, animal feed and bedding, and other uses. Research, development, and implementation activities in energy, wood products, waste, and soil amendment fields should be spatially-scaled to better link waste generation with infrastructure development.

The goals of this sector, with the potential to reduce GHGs and complement the measures and policies identified in Chapter 2, are described in Looking to the Future. The development of the Implementation Plan will spur thinking and exploration of innovation that may help the State achieve its long-term climate goals.

Waste Management

The Waste Management sector covers all aspects of solid waste[214] and materials management including reduction/reuse; recycling, and remanufacturing of recovered material; composting and in-vessel (anaerobic and aerobic) digestion; biomass management (chip and grind, composting, biomass conversion); municipal solid waste transformation; and landfilling. This sector also includes market development programs, such as the State's recycled-content product procurement program and a range of grant and loan programs. Data from CalRecycle's report, *2014 Disposal Facility-Based Characterization of Solid Waste in California*, shows that materials, such as organics, that decompose in landfills and generate methane comprise a significant portion of the waste stream. Methane is a potent SLCP with a global warming potential 25 times greater than that of carbon dioxide on a 100-year time horizon and more than 70 times greater than that of carbon dioxide on a 20-year time horizon.[215]

Within CARB's greenhouse gas inventory, emissions from the waste management sector consist of methane and nitrous oxide emissions from landfills and from commercial-scale composting, with methane being the primary contributor to the sector's emissions. The sector emitted 8.85 $MMTCO_2e$ in 2014, comprising approximately 2 percent of the State's GHG emissions.

Emissions from recycling and waste have grown by 19 percent since 2000. The majority of those emissions are attributed to landfills, despite the majority of landfills having gas collection systems in place.[216] Landfill emissions account for 94 percent of the emissions in this sector, while compost production facilities make up a small fraction of emissions.[217] The annual amount of solid waste deposited in California landfills grew from 37 million tons in 2000 to its peak of 46 million tons in 2005, followed by a declining trend until 2009 when landfilled solid waste stabilized to relatively constant levels. Landfill emissions are driven by the total waste-in-place, rather than year-to-year fluctuation in annual deposition of solid waste, as the rate and volume of gas produced during decomposition depends on the characteristics of the waste and a number of environmental factors. As a result, waste disposed in a given year contributes to emissions that year and in subsequent years.

In addition to direct emissions, the reduction, reuse, and recycling of waste materials decreases upstream GHG emissions associated with the extraction and processing of virgin materials and their use in production and transport of products. Although many of these upstream GHG emissions happen outside of California, California's waste policies can reduce both local and global GHG emissions and create jobs within the State.

214 In general, the term solid waste refers to garbage, refuse, sludges, and other discarded solid materials resulting from residential activities, and industrial and commercial operations. This term generally does not include solids or dissolved material in domestic sewage or other significant pollutants in water such as silt, dissolved or suspended solids in industrial wastewater effluents, dissolved materials in irrigation return flows or other common water pollutants.

215 Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: Working Group I: The Physical Science Basis. 2.10.2 Direct Global Warming Potentials. Fourth Assessment Report. *www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html*

216 CARB. 2013. California Greenhouse Gas Inventory for 2000–2013 – by Category as Defined in the 2008 Scoping Draft Plan (based upon IPCC Fourth Assessment Report's Global Warming Potentials).

217 CARB. 2016. 2016 Edition California GHG Emission Inventory. California Greenhouse Gas Emission Inventory: 2000–2014. Version June 17, 2016.

While landfills are an effective and relatively safe way to manage some waste, disposal-centric activities result in squandering valuable resources and generate landfill gases as well as other risks. A large fraction of the organics in the waste stream can be diverted from landfills to composting or digestion facilities to produce beneficial products. Moreover, food waste is the largest component of organics disposed in landfills; a portion of this is edible and should be captured at its source and, for example, provided to food banks to feed people in need. A State waste management sector "loading order" should focus more attention on reducing how much waste we generate and recovering and recycling whatever resources we can, using landfills as a last resort.

Landmark initiatives like the Integrated Waste Management Act of 1989 (AB 939) demonstrate California's efforts to build communities that consume less, recycle more, and take resource conservation to higher and higher levels. Statewide, Californians achieved a 49 percent recycling rate in 2014, and recycling programs support an estimated 75,000 to 115,000 green jobs in California. If California were to achieve a 75 percent statewide solid waste recycling rate by 2020–a goal set out by the Legislature in AB 341 (Chesboro, Chapter 476, Statutes of 2011)–by recycling and remanufacturing at in-state facilities, the State could potentially generate an additional 100,000 green jobs.[218] In addition to employment contributions, diversion of organic waste from landfills can generate positive environmental impacts. Compost from organic matter provides soil amendments to revitalize farmland, reduces irrigation and landscaping water demands, contributes to erosion control in fire-ravaged landscapes, and potentially increase long-term carbon storage in rangelands. Production and use of bioenergy in the form of biofuels and renewable natural gas has the potential to reduce dependency on fossil fuels for the transportation sector. For the energy sector, however, renewable natural gas faces safety, feasibility, and cost issues.

The State has a robust waste management system in place, with established programs that reduce air emissions through activities such as gas collection systems from landfills[219] and stringent recycling mandates. AB 939 required cities and counties to reduce the amount of waste going to landfills by 50 percent in 2000, and municipalities have nearly universally met this mandate. Californians dispose about 30 million tons of solid waste in landfills each year. To further reduce landfilled solid waste, the Legislature adopted AB 341 to achieve more significant waste reductions by setting a goal that 75 percent of solid waste generated be reduced, recycled, or composted by 2020, and by mandating commercial recycling. AB 1826 (Chesboro, Chapter 727, Statutes of 2014) added requirements regarding mandatory commercial organics recycling.

Although solid waste management has evolved over the last 27 years and diversion rates (which include more than recycling) have increased more than six-fold since 1989, if no further changes in policy are made, the State's growing population and economy will lead to higher amounts of overall disposal along with associated increases in GHG emissions. The pathway to reducing disposal and associated GHG emissions will require significant expansion of the composting, anaerobic digestion, and recycling manufacturing infrastructure in the State.

To help reduce GHG emissions by 40 percent below 1990 levels by 2030 and meet California's waste reduction goals, California's waste management sector strives to achieve in-state processing and management of waste generated in California. To carry out this vision, we must work with residents and producers to reduce the volume of waste generated overall and capitalize on technology and social changes that might enable waste reduction. Packaging comprises approximately 8 million tons of waste landfilled in California annually, or about one quarter of the State's total disposal stream. To reduce the climate change footprint of packaging, the State is promoting the inclusion of source reduction principles in packaging and product design; fostering recycling and recyclability as a front end design parameter for packaging and products that cannot be reduced; and encouraging recycling markets and market development for recycled-content products and packaging. CalRecycle is developing a packaging policy model containing components necessary for a mandatory comprehensive, statewide packaging program in California; this would need to be legislatively enacted to achieve a packaging reduction goal, such as 50 percent by 2030. CalRecycle is also continuing to work with stakeholder organizations and industry to explore complementary voluntary activities that have the potential to significantly decrease packaging disposal in California. In addition, large-scale shifts in materials management will be necessary, including steps to maximize recycling and diversion from landfills

218 CalRecycle. 2013. AB 341's 75 Percent Goal and Potential New Recycling Jobs in California by 2020. July. *www.calrecycle.ca.gov/Publications/Documents/1463/20131463.pdf*

219 CARB approved a regulation to reduce methane from municipal solid waste landfills as a discrete early action measure under AB 32. The regulation became effective June 17, 2010. Additional information is available at: *www.arb.ca.gov/regact/2009/landfills09/landfillfinalfro.pdf*

and build the necessary infrastructure to support a sustainable, low carbon waste management system within California. Working together, State and local agencies will identify ways to increase the use of waste diversion alternatives and expand potential markets, obtain funds and incentives for building the infrastructure and strengthening markets, and evaluate the need for additional research to achieve California's GHG reduction and waste management goals.

Additional legislation codified since the First Scoping Plan Update outlines new opportunities and requirements to reduce GHG emissions from the waste sector, with a focus on reducing organic waste sent to landfills. SB 605 (Lara, Chapter 523, Statutes of 2014) requires that CARB develop a strategy to reduce SLCPs and SB 1383 requires the strategy to be implemented by January 1, 2018. CARB's recently adopted SLCP Reduction Strategy includes organic waste diversion targets for 2020 and 2025 consistent with SB 1383 to reduce methane emissions from landfills. It requires CalRecycle, in consultation with CARB, to adopt regulations to achieve statewide disposal targets to reduce landfilling of organic waste by: (1) 50 percent from the 2014 level by 2020, and (2) 75 percent from the 2014 level by 2025. Under SB 1383, of the edible food destined for the organic waste stream, not less than 20 percent is to be recovered to feed people in need by 2025. The regulations are to take effect on or after January 1, 2022, and CalRecycle, in consultation with CARB, must analyze the progress that the waste management sector, State government, and local government have made in achieving the 2020 and 2025 goals by July 1, 2020. It is estimated that the combined effect of the food waste prevention and rescue programs and organics diversion from landfills will reduce 4 $MMTCO_2e$ of methane in 2030 (using a 20-year GWP), but one year of waste diversion in 2030 is expected to result in a reduction of 14 $MMTCO_2e$ of emissions over the lifetime of waste decomposition.

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Goals

- Take full ownership of the waste generated in California.
- View waste as a resource and convert waste from all sectors to beneficial uses.
- Develop a sustainable, low carbon waste management system that processes collected waste within California and generates jobs, especially in disadvantaged communities.
- Maximize recycling and diversion from landfills.
- Reduce direct emissions from composting and digestion operations through improved technologies.
- Build the infrastructure needed to support a sustainable, low carbon waste management system within California.
- Increase organics markets which complement and support other sectors.[220]
- Capture edible food before it enters the waste stream and provide to people in need.
- Increase production of renewable transportation fuels from anaerobic digestion of waste.
- Recognize the co-benefits of compost application.

Cross-Sector Interactions

The waste management sector interacts with all of the other sectors of the State's economy. Reducing waste, including food waste, is key to reducing the State's overall carbon footprint. Additionally, replacing virgin materials with recycled materials reduces the energy and GHGs associated with the goods we produce and consume.

California leads the United States in agricultural production in terms of value and crop diversity. Soil carbon is the main source of energy for important soil microbes and is key for making nutrients available to plants. Waste-derived compost and other organic soil amendments support the State's Healthy Soils Initiative being implemented by CDFA. In addition, the use of compost to increase soil organic matter in the agricultural sector provides other benefits, including reduced GHG emissions, conserved water, reduced synthetic (petroleum-based) fertilizer and herbicide use, and sequestered carbon.

220 Examples may include renewable energy (biogas to renewable transportation fuels or electricity); soils (application of organics to agricultural soils for building soil organic matter and conserving water; application of organics to mulch for erosion control; application of organics to rangelands for increased carbon sequestration); and forests (support use of forest residues for erosion control; stabilization of fire-ravaged lands).

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for this sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit. In addition, to move forward with the goals of the waste management sector and achieve the 2030 target, certain actions are recommended to help set the groundwork. These actions affect several broad areas and are necessary for reducing the challenges facing this sector, and they are listed below as supporting actions.

Ongoing and Proposed Measures

- Continue implementation of the Landfill Methane Control Measure.
- Continue implementation of the Mandatory Commercial Recycling Regulation and the Mandatory Commercial Organics Recycling requirements.
- As required by SB 1383:
  - By 2018, CARB will implement the SLCP Strategy.
  - CalRecycle will develop regulations to require 50 percent organic waste diversion from landfills from 2014 levels by 2020 and 75 percent by 2025, including programs to achieve an edible food waste recovery goal of 20 percent below 2016 levels by 2025. The regulations shall take effect on or after January 1, 2022. By July 1, 2020, analyze the progress that the waste sector, State government, and local governments have made in achieving these goals.
  - CEC will develop recommendations for the development and use of renewable gas as part of the 2017 Integrated Energy Policy Report. Based on these recommendations, adopt policies and incentives to significantly increase sustainable production and use of renewable gas.

Potential Additional or Supporting Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals.

- Establishing a sustainable State funding source (such as an increased landfill tip fee and new generator charge) for development of waste management infrastructure, programs, and incentives.
- Working with residents and producers to reduce the volume of waste generated overall and capitalize on technology and social changes that might enable waste reduction.
- Increasing organics diversion from landfills, building on established mandates (AB 341's 75 percent by 2020 solid waste diversion goal, AB 1594,[221] AB 1826,[222] AB 876[223]) and new short-lived climate pollutant targets for 2025 (SB 605, SB 1383) to be accomplished via prevention (including food rescue), recycling, composting/digestion, and biomass options.
- Addressing challenges and issues associated with significant expansion and construction of organics and recycling infrastructure in California that is needed to achieve recycling and diversion goals. Challenges and issues include permitting, grid/pipeline connection, funding, local siting, markets, and research.
- Developing programmatic Environmental Impact Reports (EIRs) and model permit and guidance documents to assist in environmental review and CEQA for new facilities.
- Providing incentives for expanded and new facilities to handle organics and recyclables to meet 2020 and 2030 goals.
- Providing incentives to develop and expand food rescue programs to reduce the amount of edible food being sent to landfills.
- Further quantifying co-benefits of compost products and addressing regulatory barriers that do not provide for consideration of co-benefits.
- Supporting existing and new clean technologies and markets for excess woody biomass from urban areas, forests, and agriculture.
- Supporting the development of transportation fuel production at digestion facilities to generate renewable transportation fuels.

221 Assembly Bill 1594, Waste Management (Williams, Chapter 719, Statutes of 2014).
222 Assembly Bill 1826, Solid Waste: Organic Waste (Chesbro, Chapter 727, Statutes of 2014).
223 Assembly Bill 876, Compostable Organics (McCarty, Chapter 593, Statutes of 2015).

- Resolving issues of pipeline injection and grid connection to make renewable energy projects competitive.
- Supporting the use of available capacity at wastewater treatment plants that have digesters to process food waste.
- Working with local entities to provide a supportive framework to advance community-wide efforts that are consistent with, or exceed, statewide goals.
- Supporting research and development and pathways to market for dairy and codigestion digesters, including pipeline injection and interconnection.
- Supporting research on digestate characterization and end products.

Water

Water is essential to all life, and is vital to our overall health and well-being. A reliable, clean, and abundant supply of water is also a critical component of California's economy and has particularly important connections to energy, food, and the environment. 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. This elaborate network of storage and delivery systems enables the State to prosper and support populations, amidst wide variability in annual precipitation rates and concentration of rain north of Sacramento, through storing and moving water when and where it is needed.

Local water agencies play an important role in delivering water to communities, farms, and businesses. Some purchase water from the major State and federal projects, treat the water as needed, and deliver it to their customers; others act as wholesale agencies that buy or import water and sell it to retail water suppliers. Some agencies operate their own local water supply systems, including reservoirs and canals that store and move water as needed. Many agencies rely on groundwater exclusively, and operate local wells and distribution systems. In recent decades, local agencies have developed more diversified sources of water supplies. Many agencies use a combination of imported surface water and local groundwater, and also produce or purchase recycled water for end uses such as landscape irrigation.[224]

The State's developed surface and groundwater resources support a variety of residential, commercial, industrial, and agricultural activities. California's rapidly growing population–estimated to reach 44 million by 2030[225] – is putting mounting pressure on the water supply system. In the future, the ability to meet most new demand for water will come from a combination of increased conservation and water use efficiency, improved coordination of management of surface and groundwater, recycled water, new technologies in drinking water treatment, groundwater remediation, and brackish and seawater desalination.[226]

One of the State's largest uses of energy is attributed to several aspects of the water life cycle, including end uses such as heating and cooling, and water treatment and conveyance. Ten percent of the State's energy use is associated with water-related end uses, while water and wastewater systems account for 2 percent of the State's energy use.[227] Therefore, as water demand grows, energy demand may increase concurrently. Population growth drives demand for both water and energy resources, so both grow at about the same rates and in many of the same geographic areas.[228] This dynamic is further exacerbated by the precipitation-population mismatch between Northern and Southern California. Since the greatest energy consumption related to water is from delivery to end uses, the potential for energy savings also resides with water end users, where water conservation and efficiency play an important role.

The principal source of GHG emissions from the water sector comes from the fossil fuel-based energy consumed for water end uses (e.g., heating, cooling, pressurizing, and industrial processes), and the fossil fuel-based energy used to "produce" water (e.g., pump, convey, treat). Therefore, emissions reductions strategies are primarily associated with reducing the energy intensity of the water sector. Energy intensity is a measure of the amount of energy required to take a unit of water from its origin (such as a river or aquifer)

224 California Department of Water Resources. Regional Energy Intensity of Water Supplies. *www.water.ca.gov/climatechange/RegionalEnergyIntensity.cfm*

225 *http://www.dof.ca.gov/Forecasting/Demographics/projections/*

226 California Natural Resources Agency, California Department of Food and Agriculture, and California Environmental Protection Agency. California Water Action Plan.

227 California Department of Water Resources. Water-Energy Nexus: Statewide. Web page accessed November 2016 at: *www.water.ca.gov/climatechange/WaterEnergyStatewide.cfm*.

228 Ibid

and extract and convey it to its end use.[229] Within California, the energy intensity of water varies greatly depending on the geography, water source, and end use. The California Department of Water Resources (DWR) subdivides the State into 10 regions corresponding to the State's major drainage basins. An interactive map on the DWR website allows users to see a summary of the energy intensity of regional water supplies, ignoring end-use factors.[230] As the energy sector is decarbonized through measures such as increased renewable energy and improved efficiency, energy intensities will also be reduced. It is also important to note that end user actions to reduce water consumption or replace fresh water with recycled water do not automatically translate into GHG reductions. The integrated nature of the water supply system means that a reduction by one end user can be offset by an increase in consumption by another user. Likewise, use of recycled water has the potential to reduce GHGs if it replaces, and not merely serves as an alternative to, an existing, higher-carbon water supply.

The State is currently implementing several targeted, agricultural, urban, and industrial-based water conservation, recycling, and water use efficiency programs as part of an integrated water management effort that will help achieve GHG reductions through reduced energy demand within the water sector. Appendix H highlights the more significant existing policies, programs, measures, regulations, and initiatives that provide a framework for helping achieve GHG emissions reductions in this sector.

While it is important for every sector to contribute to the State's climate goals, ensuring universal access to clean water as outlined in AB 685 (Eng, Chapter 524, Statutes of 2012), also known as the "human right to water" bill, should take precedence over achieving GHG emissions reductions from water sector activities where a potential conflict exists. AB 685 states that it is the policy of the State that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes." As described in this section, water supplies vary in energy intensity and resulting GHGs, depending on the source of the water, treatment requirements, and location of the end user.

Looking to the Future

This section outlines the high-level objectives and goals to reduce GHGs in this sector.

Goals

- Develop and support more reliable water supplies for people, agriculture, and the environment, provided by a more resilient, diversified, sustainably managed water resources system with a focus on actions that provide direct GHG reductions.
- Make conservation a California way of life by using and reusing water more efficiently through greater water conservation, drought tolerant landscaping, stormwater capture, water recycling, and reuse to help meet future water demands and adapt to climate change.
- Develop and support programs and projects that increase water sector energy efficiency and reduce GHG emissions through reduced water and energy use.
- Increase the use of renewable energy to pump, convey, treat, and utilize water.
- Reduce the carbon footprint of water systems and water uses for both surface and groundwater supplies through integrated strategies that reduce GHG emissions while meeting the needs of a growing population, improving public safety, fostering environmental stewardship, aiding in adaptation to climate change, and supporting a stable economy.

Cross-Sector Interactions

Water, energy, food, and ecosystems are inextricably linked, and meeting future climate challenges will require an integrated approach to managing the resources in these sectors.

Water is used in various applications in the energy sector, ranging in intensity from cooling of turbines and other equipment at power plants to cleaning solar photovoltaic panels. In 2003, CEC adopted a water conservation policy for power plants to limit the use of freshwater for power plant cooling, and has since encouraged project

229 A broader definition of energy intensity could consider the "downstream" energy (i.e., wastewater treatment) as well as the upstream components. More robust data are needed, and the State is working to better quantify these upstream and downstream emissions.

230 California Department of Water Resources. Regional Energy Intensity of Water Supplies. *www.water.ca.gov/climatechange/RegionalEnergyIntensity.cfm*

owners proposing to build new power plants in California to reduce water consumption with water-efficiency technologies such as dry cooling and to conserve fresh water by using recycled water. Likewise, energy is used in multiple ways and at multiple steps in water delivery and treatment systems, including energy for heating and chilling water; treating and delivering drinking water; conveying water; extracting groundwater; desalination; pressurizing water for irrigation; and wastewater collection, treatment, and disposal.

Although GHG reduction strategies for the water sector have the closest ties to energy, the water sector also interacts with the natural and working lands, agricultural, waste management, and transportation sectors. Water flows from mountains to downstream regions through natural and working lands, which provide habitat for many species and function to store water, recharge groundwater, naturally purify water, and moderate flooding. Protection of key lands from conversion results in healthier watersheds by reducing polluted runoff and maintaining a properly functioning ecosystem. California is the United States' leading agricultural production state in terms of value and crop diversity. Approximately nine million acres of farmland in California are irrigated.[231] In addition, water use is associated with livestock watering, feedlots, dairy operations, and other on-farm needs. Altogether, agriculture uses about 40 percent of the State's managed water supply.[232] In the end, agricultural products produced in California are consumed by humans throughout the world as food, fiber, and fuel. Wastewater treatment plants provide a complementary opportunity for the waste management sector to help process organic waste diversion from landfills. Treatment plants with spare capacity can potentially accommodate organic waste for anaerobic co-digestion of materials such as food waste and fats, oil, and grease from residential, commercial, or industrial facilities to create useful by-products such as electricity, hydrogen, biofuels, and soil amendments.[233] The water sector is also essential to our community health and long-term well-being, and measures must ensure that we continue to have access to clean and reliable sources of drinking water. Climate change threatens to impact our water supplies, for example, with long-term droughts leading to wells and other sources of water running dry. This can have devastating consequences, especially on communities already vulnerable and sensitive to changes in their water supply and natural hydrological systems, including rural communities who have limited options for water supplies. Water conservation and management strategies that are energy efficient can also ensure a continued supply of water for our health and well-being.

Efforts to Reduce Greenhouse Gases

The measures below include some required and new potential measures to help achieve the State's 2030 target and to support the high-level objectives for this sector. Some measures may be designed to directly address GHG reductions, while others may result in GHG reductions as a co-benefit. In addition, several recommended actions are identified to help the water sector move forward with the identified goals and measures to achieve the 2030 target; these are listed as supporting actions.

Ongoing and Proposed Measures

- As directed by Governor Brown's Executive Order B-37-16, DWR and State Water Resources Control Board (SWRCB) will develop and implement new water use targets to generate more statewide water conservation than existing targets (the existing State law requires a 20 percent reduction in urban per capita water use by 2020 [SBx7-7, Steinberg, Chapter 4, Statutes of 2009]). The new water use targets will be based on strengthened standards for indoor use, outdoor irrigation, commercial, industrial, and institutional water use.
- SWRCB will develop long-term water conservation regulation, and permanently prohibit practices that waste potable water.
- DWR and SWRCB will develop and implement actions to minimize water system leaks, and to set performance standards for water loss, as required by SB 555 (Wolk, Chapter 679, Statutes of 2015).
- DWR and CDFA will update existing requirements for agricultural water management plans to increase water system efficiency.

231 Hanson, Blaine. No date. Irrigation of Agricultural Crops in California. PowerPoint. Department of Land, Air and Water Resources University of California, Davis. *www.arb.ca.gov/fuels/lcfs/workgroups/lcfssustain/hanson.pdf*

232 Applied water use is the official terminology used by DWR. "Applied water refers to the total amount of water that is diverted from any source to meet the demands of water users without adjusting for water that is used up, returned to the developed supply, or considered irrecoverable."

233 An example of a resource recovering project that can help achieve methane reductions includes fuel cells that are integrated into wastewater treatment plants for both onsite heat and power generation and the production of renewable hydrogen.

- CEC will certify innovative technologies for water conservation and water loss detection and control.
- CEC will continue to update the State's Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601–1608) for appliances offered for sale in California to establish standards that reduce energy consumption for devices that use electricity, gas, and/or water.
- California Environmental Protection Agency (CalEPA) will oversee development of a voluntary registry for GHG emissions resulting from the water-energy nexus, as required by SB 1425 (Pavley, Chapter 596, Statutes of 2016).
- The State Water Project has entered long-term contracts to procure renewable electricity from 140 MW solar installations in California.
- As described in its Climate Action Plan, DWR will continue to increase the use of renewable energy to operate the State Water Project.

Overall, these actions will contribute to the broader energy efficiency goals discussed in the Low Carbon Energy section of this chapter.

Potential Additional or Supporting Actions

The actions below have the potential to reduce GHGs and complement the measures and policies identified in Chapter 2. These are included to spur thinking and exploration of innovation that may help the State achieve its long-term climate goals.

- Where technically feasible and cost-effective, local water and wastewater utilities should adopt a long-term goal to reduce GHGs by 80 percent below 1990 levels by 2050 (consistent with DWR's Climate Action Plan), and thereafter move toward low carbon or net-zero carbon water management systems.
- Local water and wastewater utilities should develop distributed renewable energy where feasible, using the expanded Local Government Renewable Energy Bill Credit (RES-BCT) tariff and new Net Energy Metering (which allow for installation without system size limit).
- In support of the Short-Lived Climate Pollutant Strategy, encourage resource recovering wastewater treatment projects to help achieve the goal of reducing fugitive methane by 40 percent by 2030, to include:
  - Determining opportunities to support co-digestion of food-related waste streams at wastewater treatment plants.
  - Incentivizing methane capture systems at wastewater treatment plants to produce renewable electricity, transportation fuel, or pipeline biomethane.
- Support compact development and land use patterns, and associated conservation and management strategies for natural and working lands that reduce per capita water consumption through more water-efficient built environments.

Chapter 5

Achieving Success

Meeting, and exceeding, our mandated GHG reduction goals in 2020 and through 2030 requires building on California's decade of success in implementing effective climate policies. State agencies are increasingly coordinating planning activities to align with overarching climate, clean air, social equity, and broader economic objectives.

However, to definitely tip the scales in favor of rapidly declining emissions, we also need to reach beyond State policy-making and engage all Californians. Further progress can be made by supporting innovative actions at the local level–among governments, small businesses, schools, and individual households. Ultimately, success depends on a mix of regulatory program development, incentives, institutional support, and education and outreach to ensure that clean energy and other climate strategies are clear, winning alternatives in the marketplace–to drive business development and consumer adoption.

Ongoing Engagement with Environmental Justice Communities

CARB continues seek ways to improve implementation of AB 32 and the unique set of impacts facing environmental justice communities. However, CARB's environmental justice efforts reach far beyond climate change. In 2001, the Board approved CARB's "Policies and Actions for Environmental Action,"[234] which expresses a broad commitment to environmental justice and makes it integral to all of CARB's programs, consistent with State directives at the time. Though over the years CARB has taken on a wide array of activities aimed at reducing environmental burdens on environmental justice communities, it has not knitted its various efforts together in a coherent narrative or maximized the impact of these activities by leveraging them off of each other.

This year, CARB appointed its first executive-level environmental justice liaison. Under her leadership, CARB will lay a roadmap for better serving California's environmental justice communities in the design and implementation of its programs, and identifying new actions CARB can take to advance environmental justice and social equity in all of its functions.

The extensive legislative framework addressing climate change, air quality, and environmental justice that has emerged since the passage of AB 32 has prompted CARB to step up its environmental justice efforts and articulate a vision that reflects the current context. CARB will initiate a public process, seeking advice and input from environmental justice advocates and other key stakeholders to inform the development of a new strategic plan for further institutionalizing environmental justice and social equity.

CARB understands that in addition to our programs to address climate change and reduce emissions of GHGs, more needs to be done to reduce exposure to toxic air and criteria pollutants and improve the quality of life in communities surrounding our largest emissions sources. To this end, and consistent with AB 617, AB 197, AB 1071, SB 535 and AB 1550, we will actively engage EJ advocates, communities, and relevant air districts in the development of programs that improve air quality and quantify the burdens placed on air quality in local communities. Measuring and monitoring air quality conditions over time and ongoing community engagement are integral to the success of CARB's efforts. This engagement will include substantive discussions with EJ stakeholders, gathering their input and providing adequate time for review before matters are taken to the Board for decision.

234 *www.arb.ca.gov/ch/programs/ej/ejpolicies.pdf*

CARB's approach to environmental justice will be grounded in five primary pillars: transparency, integration, monitoring, research, and enforcement.

- **Transparency:** CARB must improve communication and engagement with environmental justice stakeholders and deepen partnerships with local communities impacted by air pollution. CARB will continue to prioritize transparency in its decision-making processes and provide better access to the air quality, toxics, and GHG data CARB collects and stewards.
- **Integration:** Besides integrating environmental justice throughout all of CARB's programs, those programs must complement each other. To that end, CARB will endeavor to break down programmatic silos so that it is able to leverage its work and achieve more effective and timely results. Focused resources in individual communities can accelerate reduction in emissions, proliferation of clean vehicles and creation of jobs in the clean energy economy, while concurrently improving public health.
- **Monitoring:** Communities should be engaged in CARB's monitoring work. They can play a critical role in collecting their own data and adding to the coverage of other air monitoring efforts (e.g., CARB, local air districts). CARB has already invested in research on low-cost monitors that are accessible by communities, and it will continue to evaluate how community monitoring can make CARB more nimble in identifying and addressing "hotspots." Mobile monitoring projects similarly will allow CARB to better serve and protect residents of disadvantaged communities. CARB will continue to build partnerships with local communities and help build local capacity through funding and technical assistance.
- **Research:** CARB's research agenda is core to achieving its mission. To ensure that the research done by CARB responds to environmental justice concerns and has the greatest potential to improve air quality and public health in disadvantaged communities, CARB will engage communities groups early in the development of its research agenda and the projects that flow out from that agenda.
- **Enforcement:** Disadvantaged communities are often impacted by many sources of pollution. In order to improve air quality and protect public health, CARB will prioritize compliance with legal requirements, including enforcement actions if necessary, in environmental justice communities to ensure emissions of toxic and criteria pollutants in these communities are as low as possible.

Our inclusive approaches to further environmental justice in California's local communities may include an array of direct regulation, funding, and community capacity-building. CARB will continue to actively implement the provisions of AB 617, AB 197, AB 1071, SB 535, AB 1550, and other laws to better ensure that environmental justice communities see additional benefits from our clean air and climate policies. Our inclusive approaches to further environmental justice in California's local communities may include an array of direct regulation, funding, and community capacity-building.

Enabling Local Action

Local governments are essential partners in achieving California's goals to reduce GHG emissions. Local governments can implement GHG emissions reduction strategies to address local conditions and issues and can effectively engage citizens at the local level. Local governments also have broad jurisdiction, and sometimes unique authorities, through their community-scale planning and permitting processes, discretionary actions, local codes and ordinances, outreach and education efforts, and municipal operations. Further, local jurisdictions can develop new and innovative approaches to reduce GHG emissions that can then be adopted elsewhere. For example, local governments can develop land use plans with more efficient development patterns that bring people and destinations closer together in more mixed-use, compact communities that facilitate walking, biking, and use of transit. Local governments can also incentivize locally generated renewable energy and infrastructure for alternative fuels and electric vehicles, implement water efficiency measures, and develop waste-to-energy and waste-to-fuel projects. These local actions complement statewide measures and are critical to supporting the State's efforts to reduce emissions. Local efforts can deliver substantial additional GHG and criteria emissions reductions beyond what State policy can alone, and these efforts will sometimes be more cost-effective and provide more cobenefits than relying exclusively on top-down statewide regulations to achieve the State's climate stabilization goals. To ensure local and regional engagement, it is also recommended local jurisdictions make readily available information regarding ongoing and proposed actions to reduce GHGs within their region.

Many cities and counties are already setting GHG reduction targets, developing local plans, and making progress toward reducing emissions. The Statewide Energy Efficiency Collaborative recently released a report, *The State of Local Climate Action: California 2016*,[235] which highlights local government efforts, including:

- In California, 60 percent of cities and over 70 percent of counties have completed a GHG inventory, and 42 percent of local governments have completed a climate, energy, or sustainability plan that directly addresses GHG emissions. Many other community-scale local plans, such as general plans, have emissions reduction measures incorporated as well (see Governor's Office of Planning and Research [OPR] Survey questions 23 and 24).[236]
- Over one hundred California local governments have developed emissions reduction targets that, if achieved, would result in annual reductions that total 45 $MMTCO_2e$ by 2020 and 83 $MMTCO_2e$ by 2050.[237]

Local air quality management and air pollution control districts also play a key role in reducing regional and local sources of GHG emissions by actively integrating climate protection into air quality programs. Air districts also support local climate protection programs by providing technical assistance and data, quantification tools, and even funding.[238] Local metropolitan planning organizations (MPOs) also support the State's climate action goals via sustainable communities strategies (SCSs), required by the Sustainable Communities and Climate Protection Act of 2008 (SB 375, Chapter 728, Statutes of 2008). Under SB 375, MPOs must prepare SCSs as part of their regional transportation plan to meet regional GHG reduction targets set by CARB for passenger vehicles in 2020 and 2035. The SCSs contain land use, housing, and transportation strategies that allow regions to meet their GHG emissions reductions targets.

To engage communities in efforts to reduce GHG emissions, CARB has partnered with Energy Upgrade California on the CoolCalifornia Challenge. It is a competition among California cities to reduce their carbon footprints and build more vibrant and sustainable communities. Three challenges have been completed. Most recently, the 2015–2016 Challenge included 22 cities and engaged nearly 3,200 households, each of which took actions to reduce energy use and carbon GHG emissions. In total, the participants reported savings of 5,638 MTCO2 from completed actions, equivalent to emissions from more than 1,000 cars or from electricity used by more than 2,500 California homes in a year.

State agencies support these local government actions in several ways:

- *CoolCalifornia.org* is an informational website that provides resources that assist local governments, small businesses, schools, and households to reduce GHG emissions. The local government webpage includes carbon calculators, a climate planning resource guide, a Funding Wizard that outlines grant and loan programs, and success stories. It also features ClearPath California, a no-cost GHG inventory, climate action plan development, and tracking tool developed through the Statewide Energy Efficiency Collaborative in coordination with CARB and the Governor's Office of Planning and Research (OPR).
- Chapter 8 of OPR's General Plan Guidelines[239] provides guidance for climate action plans and

235 Statewide Energy Efficiency Collaborative. 2016. State of Local Climate Action: California 2016. *californiaseec.org/wp-content/uploads/2016/10/State-of-Local-Climate-Action-California-2016_Screen.pdf*

236 Governor's Office of Planning and Research. 2016. 2016 Annual Planning Survey Results. November. *www.opr.ca.gov/docs/2016_APS_final.pdf*

237 These reductions include reductions from both state and local measures.

238 Examples include: (1) Bay Area Air Quality Management District (BAAQMD). 2016 Clean Air Plan and Regional Climate Protection Strategy. Available at: *www.baaqmd.gov/plans-and-climate/air-quality-plans/plans-under-development*; (2) California Air Pollution Control Officers Association. California Emissions Estimator Model (CalEEMod). Available at: *www.caleemod.com/*; (3) San Joaquin Valley Air Pollution Control District. Grants and Incentives. Available at: *valleyair.org/grants/*; (4) BAAQMD. Grant Funding. Available at: *www.baaqmd.gov/grant-funding*; (5) South Coast Air Quality Management District. Funding. Available at: *www.aqmd.gov/grants-bids/funding*; (6) Sacramento Metropolitan Air Quality Management District. Incentive Programs. Available at: *www.airquality.org/Residents/Incentive-Programs*.

239 *http://opr.ca.gov/planning/general-plan/*

other plans linked to general plans, which address the community scale approach outlined in CEQA Guidelines Section 15183.5(b), Plans for the Reduction of Greenhouse Gas Emissions.

- OPR hosts the Integrated Climate Adaptation and Resiliency Program, which is developing resources and case studies that outline the co-benefits of implementing emissions reduction strategies and addressing the impacts of climate change.
- CARB is developing a centralized database and interactive map that will display the current statewide status of local government climate action planning. Users can view and compare the details of emission inventories, planned GHG reduction targets and strategies, and other climate action details specific to each local government. This information will help jurisdictions around California identify what climate action strategies are working in other, similar jurisdictions across the State, and will facilitate collaboration among local governments pursuing GHG reduction strategies and goals. This database and map will be featured on the *CoolCalifornia.org* website and are anticipated to be available in 2017.
- Additional information on local government activities is available on Cal-Adapt (*www.cal-adapt.org*) and OPR (*www.opr.ca.gov*)

Further, a significant portion of the $3.4 billion in cap-and-trade expenditures has either directly or indirectly supported local government efforts to reduce emissions, including, for example, the Affordable Housing and Sustainable Communities (AHSC) program and approximately $142 million for project implementation and planning grants awarded under the Transformative Climate Communities program.

Climate Action through Local Planning and Permitting

Local government efforts to reduce emissions within their jurisdiction are critical to achieving the State's long-term GHG goals, and can also provide important co-benefits, such as improved air quality, local economic benefits, more sustainable communities, and an improved quality of life. To support local governments in their efforts to reduce GHG emissions, the following guidance is provided. This guidance should be used in coordination with OPR's General Plan Guidelines guidance in Chapter 8, Climate Change.[240] While this guidance is provided out of the recognition that local policy makers are critical in reducing the carbon footprint of cities and counties, the decision to follow this guidance is voluntary and should not be interpreted as a directive or mandate to local governments.

Recommended Local Plan-Level Greenhouse Gas Emissions Reduction Goals

CARB recommends statewide targets of no more than six metric tons CO_2e per capita by 2030 and no more than two metric tons CO_2e per capita by 2050.[241] The statewide per capita targets account for all emissions sectors in the State, statewide population forecasts, and the statewide reductions necessary to achieve the 2030 statewide target under SB 32 and the longer term State emissions reduction goal of 80 percent below 1990 levels by 2050.[242] The statewide per capita targets are also consistent with Executive Order S-3-05, B-30-15, and the Under 2 MOU that California originated with Baden-Württemberg and has now been signed or endorsed by 188 jurisdictions representing 39 countries and six continents.[243,244] Central to the Under 2 MOU is that all signatories agree to reduce their GHG emissions to two metric tons CO_2e per capita by 2050. This limit represents California's and these other governments' recognition of their "fair share" to reduce GHG emissions to the scientifically based levels to limit global warming below two degrees Celsius. This limit is also consistent with the Paris Agreement, which sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to below 2°C.[245]

CARB recommends that local governments evaluate and adopt robust and quantitative locally-appropriate

240 *http://opr.ca.gov/planning/general-plan/* .

241 These goals are appropriate for the plan level (city, county, subregional, or regional level, as appropriate), but not for specific individual projects because they include all emissions sectors in the State.

242 This number represents the 2030 and 2050 targets divided by total population projections from California Department of Finance.

243 *http://under2mou.org/* California signed the Under 2 MOU on May 19, 2015. See *under2mou.org/wp-content/uploads/2015/05/California-appendix-English.pdf* and *under2mou.org/wp-content/uploads/2015/05/California-Signature-Page.pdf*.

244 The Under 2 MOU signatories include jurisdictions ranging from cities to countries to multiple-country partnerships. Therefore, like the goals set forth above for local and regional climate planning, the Under 2 MOU is scalable to various types of jurisdictions.

245 UNFCCC. The Paris Agreement. *unfccc.int/paris_agreement/items/9485.php*

goals that align with the statewide per capita targets and the State's sustainable development objectives and develop plans to achieve the local goals. The statewide per capita goals were developed by applying the percent reductions necessary to reach the 2030 and 2050 climate goals (i.e., 40 percent and 80 percent, respectively) to the State's 1990 emissions limit established under AB 32.

Numerous local governments in California have already adopted GHG emissions reduction goals for year 2020 consistent with AB 32. CARB advises that local governments also develop community-wide GHG emissions reduction goals necessary to reach 2030 and 2050 climate goals. Emissions inventories and reduction goals should be expressed in mass emissions, per capita emissions, and service population emissions. To do this, local governments can start by developing a community-wide GHG emissions target consistent with the accepted protocols as outlined in OPR's General Plan Guidelines Chapter 8: Climate Change. They can then calculate GHG emissions thresholds by applying the percent reductions necessary to reach 2030 and 2050 climate goals (i.e., 40 percent and 80 percent, respectively) to their community-wide GHG emissions target. Since the statewide per capita targets are based on the statewide GHG emissions inventory that includes all emissions sectors in the State, it is appropriate for local jurisdictions to derive evidence-based local per capita[246] goals based on local emissions sectors and population projections that are consistent with the framework used to develop the statewide per capita targets. The resulting GHG emissions trajectory should show a downward trend consistent with the statewide objectives. The recommendation for a community-wide goal expands upon the reduction of 15 percent from "current" (2005-2008) levels by 2020 as recommended in the 2008 Scoping Plan.[247]

In developing local plans, local governments should refer to "The U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions,"[248] (community protocol) which provides detailed guidance on completing a GHG emissions inventory at the community scale in the United States – including emissions from businesses, residents, and transportation. Quantification tools such as ClearPath California, which was developed with California agencies, also support the analysis of community-scale GHG emissions. Per the community protocol, these plans should disclose all emissions within the defined geographical boundary, even those over which the local government has no regulatory authority to control, and then focus the strategies on those emissions that the jurisdiction controls. For emissions from transportation, the community protocol recommends including emissions from trips that extend beyond the community's boundaries. Local plans should also include the carbon sequestration values associated with natural and working lands, and the importance of jurisdictional lands for water, habitat, agricultural, and recreational resources. Strategies developed to achieve the local goals should prioritize mandatory measures that support the Governor's "Five Pillars" and other key state climate action goals.[249] Examples of plan-level GHG reduction actions that could be implemented by local governments are listed in Appendix B. Additional information and tools on how to develop GHG emissions inventories and reduction plans tied to general plans can be found in OPR's General Plan Guidelines and at *CoolCalifornia.org*.

These local government recommendations are based on the recognition that California must accommodate population and economic growth in a far more sustainable manner than in the past. While state-level investments, policies, and actions play an important role in shaping growth and development patterns, regional and local governments and agencies are uniquely positioned to influence the future of the built environment and its associated GHG emissions. Greenhouse gas emissions reduction strategies in Climate Action Plans (CAPs) and other local plans can also lead to important co-benefits, such as improved air quality, local economic benefits such as green jobs, more mobility choices, improved public health and quality of life, protection of locally, statewide, and globally important natural resources, and more equitable sharing of these benefits across communities.

Contributions from policies and programs, such as renewable energy and energy efficiency, are helping to achieve the near-term 2020 target, but longer-term targets cannot be achieved without land use decisions that allow more efficient use and management of land and infrastructure. Local governments have primary authority to plan, zone, approve, and permit how and where land is developed to accommodate population growth, economic growth, and the changing needs of their jurisdictions. Land use decisions affect GHG emissions associated with transportation, water use, wastewater treatment, waste generation and treatment, energy consumption, and conversion of natural and working lands. Local land use decisions play a particularly

246 Or some other metric that the local jurisdiction deems appropriate (e.g., mass emissions, per service population)
247 2008 Scoping Plan, page 27, *www.arb.ca.gov/cc/scopingplan/document/scopingplandocument.htm*
248 *http://icleiusa.org/publications/us-community-protocol/*
249 *www.arb.ca.gov/cc/pillars/pillars.htm*

critical role in reducing GHG emissions associated with the transportation sector, both at the project level, and in long-term plans, including general plans, local and regional climate action plans, specific plans, transportation plans, and supporting sustainable community strategies developed under SB 375.

While the State can do more to accelerate and incentivize these local decisions, local actions that reduce VMT are also necessary to meet transportation sector-specific goals and achieve the 2030 target under SB 32. Through developing the Scoping Plan, CARB staff is more convinced than ever that, in addition to achieving GHG reductions from cleaner fuels and vehicles, California must also reduce VMT. Stronger SB 375 GHG reduction targets will enable the State to make significant progress toward needed reductions, but alone will not provide the VMT growth reductions needed; there is a gap between what SB 375 can provide and what is needed to meet the State's 2030 and 2050 goals. In its evaluation of the role of the transportation system in meeting the statewide emissions targets, CARB determined that VMT reductions of 7 percent below projected VMT levels in 2030 (which includes currently adopted SB 375 SCSs) are necessary. In 2050, reductions of 15 percent below projected VMT levels are needed. A 7 percent VMT reduction translates to a reduction, on average, of 1.5 miles/person/day from projected levels in 2030. It is recommended that local governments consider policies to reduce VMT to help achieve these reductions, including: land use and community design that reduces VMT; transit oriented development; street design policies that prioritize transit, biking, and walking; and increasing low carbon mobility choices, including improved access to viable and affordable public transportation and active transportation opportunities. It is important that VMT reducing strategies are implemented early because more time is necessary to achieve the full climate, health, social, equity, and economic benefits from these strategies.

Once adopted, the plans and policies designed to achieve a locally-set GHG goal can serve as a performance metric for later projects. Sufficiently detailed and adequately supported GHG reduction plans (including CAPs) also provide local governments with a valuable tool for streamlining project-level environmental review. Under CEQA, individual projects that comply with the strategies and actions within an adequate local CAP can streamline the project-specific GHG analysis.[250] The California Supreme Court recently called out this provision in CEQA as allowing tiering from a geographically specific GHG reduction plan.[251] The Court also recognized that GHG determinations in CEQA should be consistent with the statewide Scoping Plan goals, and that CEQA documents taking a goal-consistency approach may soon need to consider a project's effects on meeting the State's longer term post-2020 goals.[252] The recommendation above that local governments develop local goals tied to the statewide per capita goals of six metric tons CO_2e by 2030 and no more than two metric tons CO_2e per capita by 2050 provides guidance on CARB's view on what would be consistent with the 2017 Scoping Plan and the State's long-term goals.

Production based inventories and emissions reduction programs are appropriate for local communities wanting to mitigate their emissions pursuant to CEQA Section 15183.5(b). Consumption based inventories are complementary to production based inventories and are appropriate as a background setting, disclosure, and as an outreach tool to show how personal decisions may change a person's or household's contribution to climate change. For additional information, see the OPR General Plan Guidelines.[253]

Project-Level Greenhouse Gas Emissions Reduction Actions and Thresholds

Beyond plan-level goals and actions, local governments can also support climate action when considering discretionary approvals and entitlements of individual projects through CEQA. Absent conformity with an adequate geographically-specific GHG reduction plan as described in the preceding section above, CARB recommends that projects incorporate design features and GHG reduction measures, to the degree feasible, to minimize GHG emissions. Achieving no net additional increase in GHG emissions, resulting in no contribution to GHG impacts, is an appropriate overall objective for new development. There are recent examples of land use development projects in California that have demonstrated that it is feasible to design projects that achieve zero net additional GHG emissions. Several projects have received certification from the Governor under AB 900, the Jobs and Economic Improvement through Environmental Leadership Act (Buchanan, Chapter 354, Statutes of 2011), demonstrating an ability to design economically viable projects that create jobs while contributing no net additional GHG emissions. [254] Another example is the Newhall

250 CEQA Guidelines, § 15183.5, sub. (b).
251 Center for Biological Diversity v. California Dept. of Fish and Wildlife (2015) 62 Cal.4th 204, 229–230.
252 Id. at pp. 223–224.
253 *http://opr.ca.gov/planning/general-plan/*.
254 Governor's Office of Planning and Research. California Jobs. *http://www.opr.ca.gov/ceqa/california-jobs.html*

Ranch Resource Management and Development Plan and Spineflower Conservation Plan,[255] in which the applicant, Newhall Land and Farming Company, proposed a commitment to achieve net zero GHG emissions for a very large-scale residential and commercial specific planned development in Santa Clarita Valley.

Achieving net zero increases in GHG emissions, resulting in no contribution to GHG impacts, may not be feasible or appropriate for every project, however, and the inability of a project to mitigate its GHG emissions to net zero does not imply the project results in a substantial contribution to the cumulatively significant environmental impact of climate change under CEQA. Lead agencies have the discretion to develop evidence-based numeric thresholds (mass emissions, per capita, or per service population) consistent with this Scoping Plan, the State's long-term GHG goals, and climate change science.[256]

To the degree a project relies on GHG mitigation measures, CARB recommends that lead agencies prioritize on-site design features that reduce emissions, especially from VMT, and direct investments in GHG reductions within the project's region that contribute potential air quality, health, and economic co-benefits locally. For example, on-site design features to be considered at the planning stage include land use and community design options that reduce VMT, promote transit oriented development, promote street design policies that prioritize transit, biking, and walking, and increase low carbon mobility choices, including improved access to viable and affordable public transportation, and active transportation opportunities. Regionally, additional GHG reductions can be achieved through direct investment in local building retrofit programs that can pay for cool roofs, solar panels, solar water heaters, smart meters, energy efficient lighting, energy efficient appliances, energy efficient windows, insulation, and water conservation measures for homes within the geographic area of the project. These investments generate real demand side benefits and local jobs, while creating the market signals for energy efficient products, some of which are produced in California. Other examples of local direct investments include financing installation of regional electric vehicle (EV) charging stations, paying for electrification of public school buses, and investing in local urban forests.

Local direct investments in actions to reduce GHG emissions should be supported by quantification methodologies that show the reductions are real, verifiable, quantifiable, permanent, and enforceable. Where further project design or regional investments are infeasible or not proven to be effective, it may be appropriate and feasible to mitigate project emissions through purchasing and retiring carbon credits. CAPCOA has developed the GHG Reduction Exchange (GHG Rx) for CEQA mitigation, which could provide credits to achieve additional reductions. It may also be appropriate to utilize credits issued by a recognized and reputable voluntary carbon registry. Appendix B includes examples of on-site project design features, mitigation measures, and direct regional investments that may be feasible to minimize GHG emissions from land use development projects.

California's future climate strategy will require increased focus on integrated land use planning to support livable, transit-connected communities, and conservation of agricultural and other lands. Accommodating population and economic growth through travel- and energy-efficient land use provides GHG-efficient growth, reducing GHGs from both transportation and building energy use.[257] GHGs can be further reduced at the project level through implementing energy-efficient construction and travel demand management approaches.[258] Further, the State's understanding of transportation impacts continues to evolve. The CEQA Guidelines are being updated to focus the analysis of transportation impacts on VMT. OPR's Technical Advisory includes methods of analysis of transportation impacts, approaches to setting significance thresholds, and includes examples of VMT mitigation under CEQA.[259]

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255 *https://nrm.dfg.ca.gov/documents/ContextDocs.aspx?cat=NewhallRanchFinal*

256 CARB provided some guidance on development project thresholds in a paper issued in October 2008, which included a concept utilizing a bright-line mass numeric threshold based on capturing approximately 90 percent of emissions in that sector and a concept of minimum performance based standards. Some districts built upon that work to develop thresholds. For example, Santa Barbara County adopted a bright-line numeric threshold of 1,000 $MTCO_2e$/yr for industrial stationary-source projects, and Sacramento Metropolitan Air Quality Management District adopted a 10,000 $MTCO_2e$/yr threshold for stationary source projects and a 1,100 $MTCO_2e$/yr threshold for construction activities and land development projects in their operational phase. CARB is not endorsing any one of these approaches, but noting them for informational purposes.

257 Robert Cervero, Jim Murakami; Effects of Built Environment on Vehicle Miles Traveled: Evidence from 370 US Urbanized Areas. Environment and Planning A, Vol 42, Issue 2, pp. 400-418, February-01-2010; Ewing, R., & Rong, F. (2008). The impact of urban form on U.S. residential energy use. Housing Policy Debagte, 19 (1), 1-30.).

258 CAPCOA, Quantifying Greenhouse Gas Mitigation Measures: A Resource for Local Government to Assess Emission Reductions from Greenhouse Gas Mitigation Measures, August, 2010.

259 *http://www.opr.ca.gov/ceqa/updates/sb-743/*

Implementing the Scoping Plan

This Scoping Plan outlines the regulations, programs, and other mechanisms needed to reduce GHG emissions in California. CARB and other State agencies will work closely with State and local agencies, stakeholders, Tribes, and the public to develop regulatory measures and other programs to implement the Scoping Plan. CARB and other State agencies will develop regulations in accordance with established rulemaking guidelines. Per Executive Order B-30-15, as these regulatory measures and other programs are developed, building programs for climate resiliency must also be a consideration. Additionally, agencies will further collaborate and work to provide the institutional support needed to overcome barriers that may currently hinder certain efforts to reduce GHG emissions and to support the goals, actions, and measures identified for key sectors in Chapter 4. Table 17 provides a high-level summary of the Climate Change Policies and Measures discussed in the Scoping Plan, including, but not limited to, those identified specifically to achieve the 2030 target.

Table 17: Climate Change Policies and Measures

Recommended Action	Lead Agency
Implement SB 350 by 2030: • Increase the Renewables Portfolio Standard to 50 percent of retail sales by 2030 and ensure grid reliability. • Establish annual targets for statewide energy efficiency savings and demand reduction that will achieve a cumulative doubling of statewide energy efficiency savings in electricity and natural gas end uses by 2030. • Reduce GHG emissions in the electricity sector through the implementation of the above measures and other actions as modeled in IRPs to meet GHG emissions reductions planning targets in the IRP process. Load-serving entities and publicly-owned utilities meet GHG emissions reductions planning targets through a combination of measures as described in IRPs.	CPUC, CEC, CARB
Implement Mobile Source Strategy (Cleaner Technology and Fuels): • At least 1.5 million zero emission and plug-in hybrid light-duty electric vehicles by 2025. • At least 4.2 million zero emission and plug-in hybrid light-duty electric vehicles by 2030. • Further increase GHG stringency on all light-duty vehicles beyond existing Advanced Clean Cars regulations. • Medium- and heavy-duty GHG Phase 2. • Innovative Clean Transit: Transition to a suite of to-be-determined innovative clean transit options. Assumed 20 percent of new urban buses purchased beginning in 2018 will be zero emission buses with the penetration of zero-emission technology ramped up to 100 percent of new sales in 2030. Also, new natural gas buses, starting in 2018, and diesel buses, starting in 2020, meet the optional heavy-duty low-NO_X standard. • Last Mile Delivery: New regulation that would result in the use of low NO_X or cleaner engines and the deployment of increasing numbers of zero-emission trucks primarily for class 3-7 last mile delivery trucks in California. This measure assumes ZEVs comprise 2.5 percent of new Class 3–7 truck sales in local fleets starting in 2020, increasing to 10 percent in 2025 and remaining flat through 2030. • Further reduce VMT through continued implementation of SB 375 and regional Sustainable Communities Strategies; forthcoming statewide implementation of SB 743; and potential additional VMT reduction strategies not specified in the Mobile Source Strategy but included in the document "Potential VMT Reduction Strategies for Discussion."	CARB, CalSTA, SGC, CalTrans CEC, OPR, Local agencies
Increase stringency of SB 375 Sustainable Communities Strategy (2035 targets).	CARB
By 2019, adjust performance measures used to select and design transportation facilities. • Harmonize project performance with emissions reductions, and increase competitiveness of transit and active transportation modes (e.g. via guideline documents, funding programs, project selection, etc.).	CalSTA and SGC, OPR, CARB, GoBiz, IBank, DOF, CTC, Caltrans
By 2019, develop pricing policies to support low-GHG transportation (e.g. low-emission vehicle zones for heavy duty, road user, parking pricing, transit discounts).	CalSTA, Caltrans, CTC, OPR/SGC, CARB

Recommended Action	Lead Agency
Implement California Sustainable Freight Action Plan: • Improve freight system efficiency. • Deploy over 100,000 freight vehicles and equipment capable of zero emission operation and maximize both zero and near-zero emission freight vehicles and equipment powered by renewable energy by 2030.	CalSTA, CalEPA, CNRA, CARB, CalTrans, CEC, GoBiz
Adopt a Low Carbon Fuel Standard with a CI reduction of 18 percent.	CARB
Implement the Short-Lived Climate Pollutant Strategy by 2030: • 40 percent reduction in methane and hydrofluorocarbon emissions below 2013 levels. • 50 percent reduction in black carbon emissions below 2013 levels.	CARB, CalRecycle, CDFA, SWRCB, Local air districts
By 2019, develop regulations and programs to support organic waste landfill reduction goals in the SLCP and SB 1383.	CARB, CalRecycle, CDFA, SWRCB, Local air districts
Implement the post-2020 Cap-and-Trade Program with declining annual caps.	CARB
By 2018, develop Integrated Natural and Working Lands Implementation Plan to secure California's land base as a net carbon sink: • Protect land from conversion through conservation easements and other incentives. • Increase the long-term resilience of carbon storage in the land base and enhance sequestration capacity • Utilize wood and agricultural products to increase the amount of carbon stored in the natural and built environments • Establish scenario projections to serve as the foundation for the Implementation Plan	CNRA and departments within, CDFA, CalEPA, CARB
Establish a carbon accounting framework for natural and working lands as described in SB 859 by 2018	CARB
Implement Forest Carbon Plan	CNRA, CAL FIRE, CalEPA and departments within
Identify and expand funding and financing mechanisms to support GHG reductions across all sectors.	State Agencies & Local Agencies

A Comprehensive Approach to Support Climate Action

Ultimately, successfully tipping the scales in the fight against climate change relies on our ability to incentivize clean technologies in the marketplace and to make other climate strategies clearly understood and easily accessible. We must support and guide our businesses as they continue to innovate and make clean technologies ever more attractive to ever more savvy consumers. Until the point that clean technologies become the best and lowest cost option–which is clearly on the horizon for many technologies, including renewable energy and electric cars–we must continue to support emerging markets through incentives and outreach efforts. More than just coordinating among agencies and providing institutional support as described above, we will succeed if we tackle climate change from all angles–through regulatory and policy development, targeted incentives, and education and outreach.

Regulations and Programmatic Development

Our decade of climate leadership has demonstrated that developing mitigation strategies through a public process, where all stakeholders have a voice, leads to effective actions that address climate change and yield a series of additional economic and environmental co-benefits to the State. As we implement this Scoping Plan, State agencies will continue to develop and implement new and existing programs, as described herein. During any rulemaking process, there are many opportunities for both informal interaction with technical staff in meetings and workshops, and formal interaction at Board meetings, Commission business meetings, monthly public meetings, and others. Each State agency will consider all information and stakeholder input during the rulemaking process. Based on this information, the agency may modify proposed measures to reflect the status of technological development, the cost of the measure, the cost-effectiveness of the measures, and other factors before presenting them for consideration and adoption.

Further, to achieve cost-effective GHG reductions, California State agencies must consider the environmental impact of small businesses and provide mechanisms to assist businesses as GHG reduction measures are

implemented. CARB provides resources and tips for small businesses to prevent pollution, minimize waste, and save energy and water on *CoolCalifornia.org*. California's small businesses and their employees represent a valuable economic resource in the State and "greening" existing businesses is not only achievable, but sets an example for new businesses which will prove significant as California transitions to a low carbon state.

State agencies conduct environmental and environmental justice assessments of our regulatory actions. Many of the requirements in AB 32 overlap with traditional agency evaluations. In adopting regulations to implement the measures recommended in the Scoping Plan, or including in the regulations the use of market-based compliance mechanisms to comply with the regulations, agencies will ensure that the measures have undergone the aforementioned screenings and meet the requirements established in California Health and Safety Code Section 38562(b)(1-9) and Section 38570(b)(1-3).

Incentive Programs

Financial incentives and direct funding are critical components of the State's climate framework. In particular, incentives and funding are necessary to support GHG emissions reductions strategies for priority sectors, sources, and technologies. Although California has a number of existing incentive programs, available funding is limited. It is critical to target public investments efficiently and in ways that encourage integrated, system wide solutions to produce deep and lasting public benefits. Significant investments of private capital, supported by targeted, priority investments of public funding, are necessary to scale deployment and to maximize benefits. Public investments, including through decisions related to State pension fund portfolios, can help incentivize early action to accelerate market transition to cleaner technologies and cleaner practices, which can also be supported by regulatory measures.

Many existing State funding programs work in tandem to reduce emissions from GHGs, criteria pollutants, and toxic air contaminants, and are helping to foster the transition to a clean energy economy and protect and manage land for carbon sequestration. State law, including Senate Bill 535 (De León, Chapter 830, Statutes of 2012) and Assembly Bill 1550 (Gomez, Chapter 369, Statutes of 2016) also requires focused investment in low income and disadvantaged communities.

The State will need to continue to coordinate and utilize funding sources, such as the Greenhouse Gas Reduction Fund (cap-and-trade auction proceeds), the Alternative and Renewable Fuel and Vehicle Technology Program (AB 118), Electric Program Investment Charge (EPIC) Program, Carl Moyer Program, Air Quality Improvement Program, and Proposition 39 to expand clean energy investments in California and further reduce GHG and criteria emissions. Additionally, programs including the Bioenergy Feed-In Tariff, created by Senate Bill 1122 (Rubio, Chapter 612, Statutes of 2012), Low Carbon Fuel Standard, Cap-and-Trade, Self-Generation Incentive Program, Federal Renewable Fuel Standard, utility incentives pursuant to Assembly Bill 1900 (Gatto, Chapter 602, Statutes of 2012), and others provide important market signals and potential revenue streams to support projects to reduce GHG emissions.

These programs represent just a portion of the opportunities that exist at the federal, State, and local levels to incentivize GHG emissions reductions. The availability of dedicated and long-lasting funding sources is critical to help meet the State's climate objectives and help provide certainty and additional partnership opportunities at the national, State, Tribal, regional, and local levels for further investing in projects that have the potential to expand investments in California's clean economy and further reductions in GHG emissions.

Public Education and Outreach Efforts

California State agencies are committed to meaningful opportunities for public input and effective engagement with stakeholders and the public through the development of the Scoping Plan, and as measures are implemented through workshops, other meetings, and through the formal rulemaking process. Additionally, the State has broad public education and outreach campaigns to support markets for key technologies, like ZEVs and energy efficiency, as well as resources to support local and voluntary actions, such as *CoolCalifornia.org*.

In developing this Scoping Plan, there has been extensive outreach with environmental justice organizations and disadvantaged communities. The EJAC launched a community engagement process starting in July 2016, conducting 19 community meetings throughout the State and collecting hundreds of individual comments. To enhance the engagement opportunity, CARB coordinated with local government agencies and sister State agencies to hold collaborative discussions with local residents about specific climate issues that impact their

lives. This effort was well received and attended by local community residents and initiated a new community engagement endeavor for CARB. Recognizing the value of the input received and the opportunity to present California's climate strategy to communities across the State, CARB intends to continue this community involvement to generate awareness about California's climate strategy and be responsive to specific community needs as climate programs are implemented.

Education and Environment Initiative

The California Environmental Protection Agency (CalEPA), the California Department of Education, and the California Natural Resources Agency have developed an environmental curriculum that is being taught in more than half of California's school districts. The Education and Environment Initiative (EEI) provides California's teachers with tools to educate students about the natural environment and how everyday choices can improve our planet and save money.

Conclusion

This Scoping Plan continues more than a half-century of California's nation-leading efforts to clean our air, our water and improve the environment. But, climate change poses a challenge of unprecedented proportions that will, in one way or another, impact all Californians whether they are city dwellers in Los Angeles, San Diego or San Francisco, farmers in Salinas or the Central Valley, or the millions of Californians who live in the Sierra or in the desert areas.

This is the State's climate action plan, and in a very real sense it belongs to all those Californians who are feeling, and will continue to feel, the impacts of climate change. Californians want to see continued effective action that addresses climate change and benefits California – this Plan responds to both of these goals. The Plan was developed by the coordinated consensus of State agencies, but it is really California's Plan, because over the coming decades the approaches in this document will be carried out by all of us.

In this Scoping Plan, every sector in our thriving economy plays a crucial role. Tribes, cities, and local governments are already rising to the challenge, and will play increasingly important roles with everything from low-carbon and cleaner transit, to more walkable streets and the development of vibrant urban communities.

We will see a remarkable transformation of how we move throughout the state, away from cars that burn fossil fuels to cleaner, electric cars that will, in some cases, even drive themselves. Freight will be moved around the state by trucks that are vastly cleaner than those on the road now, with our ports moving towards zero- and near-zero emissions technologies. The heavily traveled Los Angeles-San Francisco corridor will be serviced by comfortable, clean and affordable high speed rail.

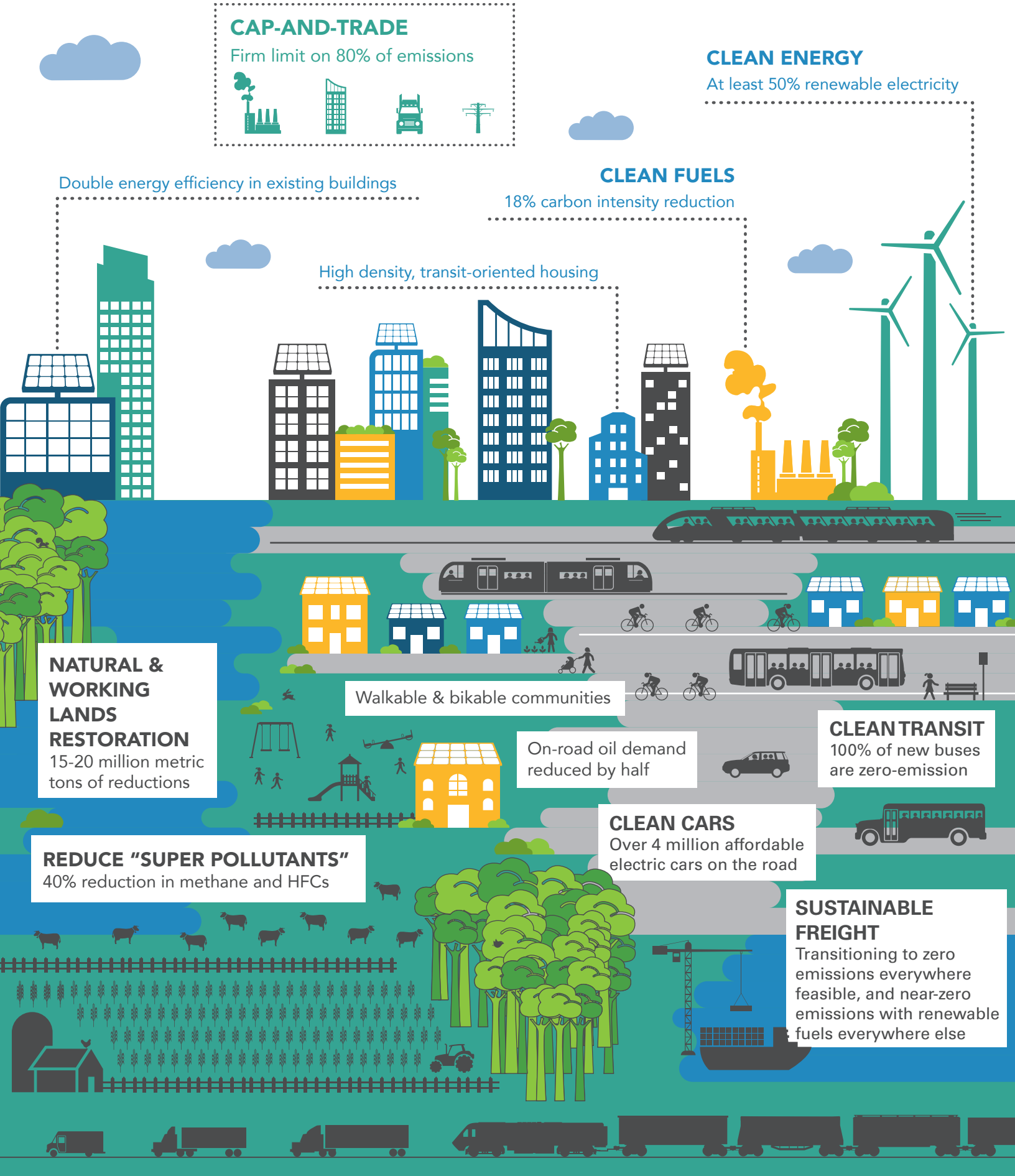
In addition to reducing GHGs, these efforts will slash pollution now created from using gasoline and diesel fuel statewide, with the greatest benefits going to the disadvantaged communities of our state which are so often located adjacent to ports, railyards, freight distribution centers and freeways. And, thanks to the continued investment of proceeds from the Cap-and-Trade Program in these same communities, we can continue to work on bringing the benefits of clean technology – whether electric cars or solar roofs – to those in our state who need them the most.

Climate change presents 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." The last ten years proved to ourselves, and the world, that Californians recognize the danger of climate change. It has also demonstrated that developing mitigation strategies through a public process where all stakeholders have a voice leads to effective actions that address climate change while yielding a series of co-benefits to the state. This Scoping Plan builds on those early steps and moves into a new chapter that will deliver a thriving economy and a clean environment to our children and grandchildren. It is a commitment to the future, but it begins today by moving forward with the policies in this Plan.

Abbreviations

AB	Assembly Bill
AC	air conditioning
AEO	Annual Energy Outlook
AHSC	Affordable Housing and Sustainable Communities
ARFVTP	Alternative and Renewable Fuel and Vehicle Technology Program
BARCT	best available retrofit control technology
BAU	business-as-usual
BC	British Columbia
BEV	Battery-electric vehicle
CARB	California Air Resources Board
CAISO	California Independent System Operator
CalEPA	California Environmental Protection Agency
CALGreen	California Green Building Standards
CalPERS	California Public Employees' Retirement System
CalSTA	California State Transportation Agency
CalSTRS	California State Teachers' Retirement System
CAP	Climate Action Plan
CARE	California Alternate Rates for Energy Program
CDFA	California Department of Food and Agriculture
CDPH	California Department of Public Health
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CFT	Clean Fuels and Technology
CH_4	Methane
CI	carbon intensity
CNRA	California Natural Resources Agency
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COPD	chronic obstructive pulmonary disease
CPUC	California Public Utilities Commission
CSI	California Solar Initiative
dge	diesel gallon equivalent
DWR	California Department of Water Resources
EA	Environmental Analysis
EEI	Education and Environment Initiative
EIR	Environmental Impact Report
EJAC	Environmental Justice Advisory Committee

EO	Executive Order
EPIC	Electric Program Investment Charge Program
F-gases	fluorinated gases
FCEV	Fuel-cell electric vehicle
FERA	Family Electric Rate Assistance
GCF	Governors' Climate and Forests Task Force
GDP	gross domestic product
GGRF	Greenhouse Gas Reduction Fund
GHG	greenhouse gas
GoBiz	Governor's Office of Business and Economic Development
GWP	global warming potential
HCD	California Department of Housing and Community Development
HFC	Hydrofluorocarbon
HVAC	heating, ventilation and air conditioning
ICAP	International Carbon Action Partnership
IEPR	Integrated Energy Policy Report
IOU	investor-owned utility
IPCC	United Nations Intergovernmental Panel on Climate Change
IRP	integrated resource plan
LCFS	Low Carbon Fuel Standard
LCTOP	Low Carbon Transit Operations Program
LDV	light-duty vehicle
LED	light-emitting diode
LIWP	Low-Income Weatherization Program
LOS	level of service
$MMTCO_2e$	million metric tons of carbon dioxide equivalent
MOU	memorandum of understanding
MPO	metropolitan planning organization
MRR	Regulation for the Mandatory Reporting of GHG Emissions
$MTCO_2$	metric tons of carbon dioxide
MW	Megawatt
N_2O	nitrous oxide
NAICS	North American Industry Classification System
NEM	Net-Energy Metering
NF_3	nitrogen trifluoride
NO_X	nitrogen oxide
NZE	near-zero emission
OEHHA	Office of Environmental Health Hazard Assessment
OPR	Governor's Office of Planning and Research
PEV	plug-in electric vehicle

PHEV	Plug-in hybrid electric vehicle
PFC	Perfluorocarbon
PM	particulate matter
$PM_{2.5}$	fine particulate matter
PMR	Partnership for Market Readiness
REMI	Regional Economic Models, Inc.
RES-BCT	Renewable Energy Bill Credit
RNG	renewable natural gas
RPS	renewable portfolio standard
RTP	regional transportation plan
SB	Senate bill
SCS	Sustainable Communities Strategies
SF_6	sulfur hexafluoride
SGC	Strategic Growth Council
SGIP	Self-Generation Incentive Program
SLCP	Short-lived climate pollutant
SWRCB	State Water Resources Control Board
TBD	to be determined
TCU	Transportation Communications and Utilities
TIRCP	Transit and Intercity Rail Capital Program
UCLA	University of California, Los Angeles
UHI	urban heat island
UIC	International Union of Railways
UNFCCC	United Nations Framework Convention on Climate Change
USDA	U.S. Department of Agriculture
U.S. EPA	United States Environmental Protection Agency
VMT	vehicle miles traveled
WWTP	waste water treatment plant
ZE	zero emission
ZEV	zero emission vehicles

California's 2030 Vision