SOUTHERN CALIFORNIA EDISON®
Energy for What's Ahead℠

THE CLEAN POWER AND ELECTRIFICATION PATHWAY

Realizing California's Environmental Goals

November 2017

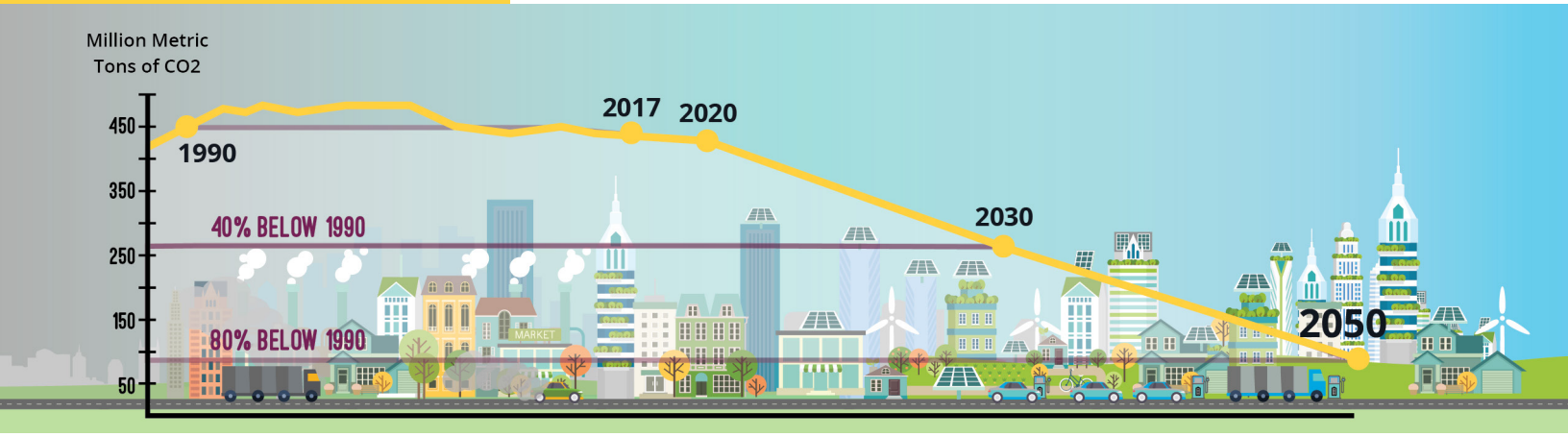

Figure 1: Meeting California's GHG Reduction Goals *(Source: California Air Resources Board [CARB])*

This paper presents Southern California Edison's integrated blueprint for California to reduce greenhouse gas emissions and air pollutants. Realizing the blueprint will reduce the threat of climate change and improve public health related to air quality. It is a systematic approach and each measure is integrated with — and depends upon — the success of the others. To be successful, California must approach implementation as an integrated package, applying resources across the board where most effective.

EXECUTIVE SUMMARY

Climate change and air pollution pose serious threats. Climate change effects, such as sea level rise and longer, more intense heat waves, are now occurring. In California, while significant progress has been made, too many communities continue to experience asthma and other air-quality-related health issues.

California continues its leadership in addressing climate change and air pollution. The state's greenhouse gas (GHG) goals call for a 40 percent reduction in GHG emissions from 1990 levels by 2030 and an 80 percent reduction by 2050 (Figure 1). Air quality goals include a 90 percent reduction in emissions of nitrogen oxides from 2010 levels in some of the state's most polluted areas by 2032. Meeting these ambitious clean energy and clean air goals requires fundamental changes over the next 12 years and beyond.

The electric sector is at the forefront of the fight against climate change in California and today accounts for only 19 percent of the state's GHG emissions. The transportation sector (including fuel refining) and fossil fuels used in space and water heating now produce almost three times as many GHG emissions as the electric sector and more than 80 percent of the air pollution in California.

The Clean Power and Electrification Pathway is an integrated approach to reduce GHG emissions and air pollution by taking action in three California economic sectors: electricity, transportation and buildings. It builds on existing state policies and uses a combination of measures to produce the most cost-effective and feasible path forward among the options studied.

The Pathway will help California achieve its climate goals and significantly reduce today's health-harming air pollution in local communities. It also has strong potential to create highly-skilled, middle-income jobs.

By 2030, it calls for:

- an electric grid supplied by 80 percent carbon-free energy;
- more than 7 million electric vehicles on California roads; and
- using electricity to power nearly one-third of space and water heaters, in increasingly energy-efficient buildings.

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(Continued - Executive Summary)

These electrified technologies will use zero-emission resources like solar and wind to provide most of their power, and can in turn support the electric grid by balancing electricity demand with supply.

The private and public sectors must work together to support customer adoption, while ensuring electricity remains reliable and affordable, and that end-use technologies are increasingly energy efficient. Public policy can enable the Clean Power and Electrification Pathway through comprehensive integrated resource planning that includes consideration of end uses of fossil fuels, through investing cap-and-trade revenues thoughtfully, and through supporting electrification in transportation, homes and businesses.

Southern California Edison is proud to be a long-standing partner with the state, customers and our communities on important climate change and air quality efforts. We look forward to continuing this broad-based partnership to pursue practical, cost-effective approaches to achieving a bold, clean energy future.

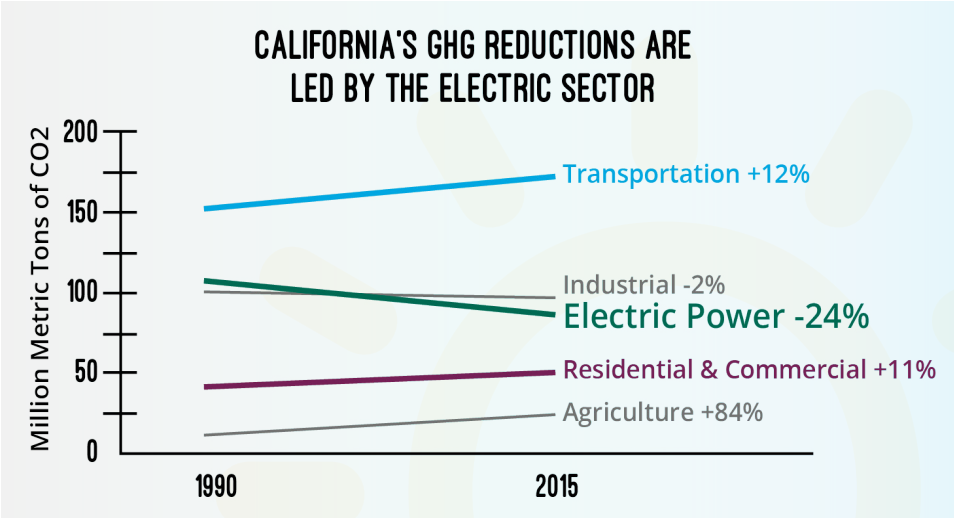

Figure 2: Change in California GHG Emissions *(Source: CARB)*

Successive California policies supporting GHG emissions reductions[1]

1. **SB 1078 (2002), SB 107 (2006), and SB X1-2 (2011)** established a Renewables Portfolio Standard (RPS), 20% by 2010 and then 33% by 2020.
2. **Executive Order S-3-05 (2005)** established a target of reducing GHG emissions 80% below 1990 levels by 2050.
3. **AB 32 (2006)** codified a GHG emissions target of 1990 levels by 2020 and created an economy-wide cap-and-trade program.
4. **SB 350 (2015)** established an RPS of 50% by 2030 and added new requirements for doubling energy efficiency and for wide scale transportation electrification deployment.
5. **SB 32 (2016)** codified a GHG target of reducing emissions 40% below 1990 levels by 2030.
6. **AB 398 (2017)** extended cap-and-trade program to 2030 and defined new offset levels.
7. **CARB Proposed Scoping Plan (2017)** identifies policies and tools to achieve the 2030 GHG target.

Additional major policy measures include the Low Carbon Fuel Standard, the Zero Emission Vehicle Program and Sustainable Community Planning.

A systematic approach that integrates these programs and market activities provides the best chance of achieving shared goals at the lowest cost to customers and the economy.

INTRODUCTION

California is committed to reducing its greenhouse gas (GHG) emissions, improving local air quality and supporting continued economic growth. The state set goals to reduce GHG emissions by 40 percent from 1990 levels by 2030 and 80 percent from the same baseline by 2050 (Figure 1).[2] State and local air quality plans call for substantial improvements, such as reducing smog-causing nitrogen oxides (NOx) 90 percent below 2010 levels by 2032 in the most polluted areas of the state.[3] Meeting environmental goals of this magnitude will require fundamental changes to infrastructure and transportation and, at the same time, can help the California economy by creating jobs. These policy goals cannot be achieved by the electric sector alone.[4]

The Urgency of Meeting Climate Change and Air Quality Goals

Meeting California's pressing 2030 climate and air quality goals requires timely, proactive decision-making by policymakers and leaders throughout the state. Stakeholders must quickly align on the near-term programs and market transformation activities required to meet this ambitious schedule. A systematic approach that integrates these programs and market activities provides the best chance of achieving shared goals at the lowest cost to customers and the economy.

The electric sector has provided the majority of emissions reductions in California (Figure 2) through energy efficiency, the phasing out of coal, and integration of new renewable resources. We are ahead of pace to reach a 50 percent renewables portfolio standard (RPS) by 2030.[5]

For California to meet its 2030 GHG target, significant emission reductions will be required from consumers of liquid and gas fuels — primarily in the transportation and building sectors. The transportation sector contributes nearly 40 percent of California's GHG emissions (approximately 45 percent when oil refining is included) and 80 percent of California's smog-forming NOx emissions.[6] The residential, commercial, and industrial sectors combined contribute approximately 30 percent of the state's GHG emissions (Figure 3). These emissions, as opposed to the emissions from the electric sector, have risen by more than 10 percent since 1990.[7]

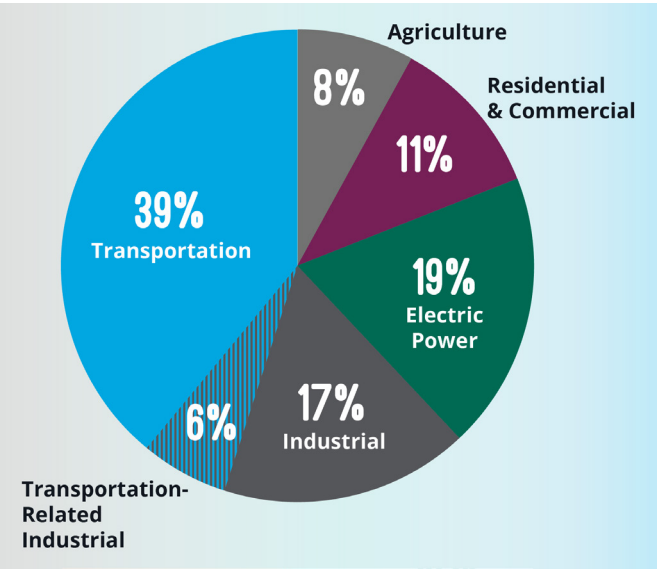

Figure 3: California GHG Emissions by Sector in 2015 *(Source: CARB)*

CLEAN POWER AND ELECTRIFICATION PATHWAY

California has taken concrete steps to move toward a clean energy future. Market-based policies such as the GHG cap-and-trade program and the low-carbon fuel standard provide a solid foundation by putting a price on carbon to encourage the most cost-effective actions to reduce or avoid GHGs. There are multiple pathways to meet California's 2030 climate goals, with varying levels of difficulty and costs. Some pathways are better than others in positioning the state to achieve 2050's deeper carbon reduction goals. SCE explored three alternatives (Table 1) and found that a clean power and electrification path is the most affordable and feasible approach to reaching California's climate and air quality goals. This pathway also will contribute to a strong state economy and can be an engine for creating highly-skilled, middle-income jobs.[8]

Table 1: Comparing 2030 Decarbonization Pathways *(Source: SCE Internal Analysis using E3 Pathways Model. Available at sce.com/pathwayto2030)*

PREFERRED PATHWAY		
CLEAN POWER AND ELECTRIFICATION	**RENEWABLE NATURAL GAS (RNG)**	**HYDROGEN (H2)**
• **80%** carbon-free electricity supported by energy storage • At least **24%** of light-duty vehicles are EVs (7MM) • **15%** of medium-duty and **6%** of heavy-duty vehicles are electrified • **Up to 30%** efficient electrification of commercial and residential space and water heating	• **60%** carbon-free electricity • **24%** of light-duty vehicles are EVs (7MM) • **12%** of medium- and heavy-duty vehicles use compressed natural gas • **42%** of natural gas replaced by RNG	• **80%** carbon-free electricity • **22%** zero-emission light-duty vehicles (4MM H2, 2MM EV) • **4%** of heavy-duty vehicles use H2 • **7%** natural gas replaced by hydrogen
• Dependent on broad adoption of electrified technologies • Most feasible pathway because technology already exists	• Power-to-gas not yet commercially available • A large biogas market requires expensive imports	• Most expensive pathway • Requires significant H2 adoption outside of CA • Lack of sufficient delivery infrastructure
Incremental abatement cost (last 36 MMT)* $79/ton	**Incremental abatement cost (last 36 MMT) $137/ton**	**Incremental abatement cost (last 36 MMT) $262/ton**

*The pathways analyzed include measures to achieve the full 2030 GHG abatement (180 MMT), such as existing state policies and programs included in CARB's Proposed Scoping Plan and additional measures. 36 MMT represents the last 20 percent of GHG abatement needed to meet the 2030 target after offsets are used. This incremental abatement is incentivized by the cap-and-trade market.

The Clean Power and Electrification Pathway…builds on existing state programs and policies to achieve California's climate and air quality goals…

THE VISION FOR CLEAN POWER AND ELECTRIFICATION

The Clean Power and Electrification Pathway is an integrated approach that builds on existing state programs and policies to achieve California's climate and air quality goals, while ensuring that an economy-wide transformation happens in an efficient and — importantly — affordable way. Using existing technologies, the Pathway calls for an electric grid with more carbon-free energy, which is used to clean other sectors of the economy. As the electric supply becomes cleaner, every electric vehicle and electric space or water heater becomes cleaner over its lifespan.

The Clean Power and Electrification Pathway to 2030 is defined by three measures. Each measure is integrated with — and depends upon — the success of the other and should be pursued in concert:

1. **Continue carbon reduction in the electric sector:** increase energy efficiency, provide 80 percent carbon-free energy through large-scale resources and use distributed solar.
2. **Accelerate electrification of the transportation sector**, including placing at least 7 million light-duty passenger vehicles on the roads and supporting a transition to zero-emission trucks and transit.
3. **Increase electrification of buildings:** electrify nearly one-third of residential and commercial space and water heaters.

Continue Carbon Reduction in the Electric Sector

Electric sector measures, including providing 80 percent carbon-free energy from large-scale resources, and leveraging energy efficiency and distributed solar will lower GHG emissions from 84 to 28 million metric tons (MMT)/year (Figure 4). This represents 31 percent of the 2030 GHG reduction goal and aligns with California's pillars for carbon reduction and decades of state energy policy.[9]

Large-scale renewable energy is likely to be the most significant and affordable means of decarbonizing the electric supply. The transmission grid can provide 80 percent carbon-free energy from a combination of renewable resources including wind, solar and large hydroelectric

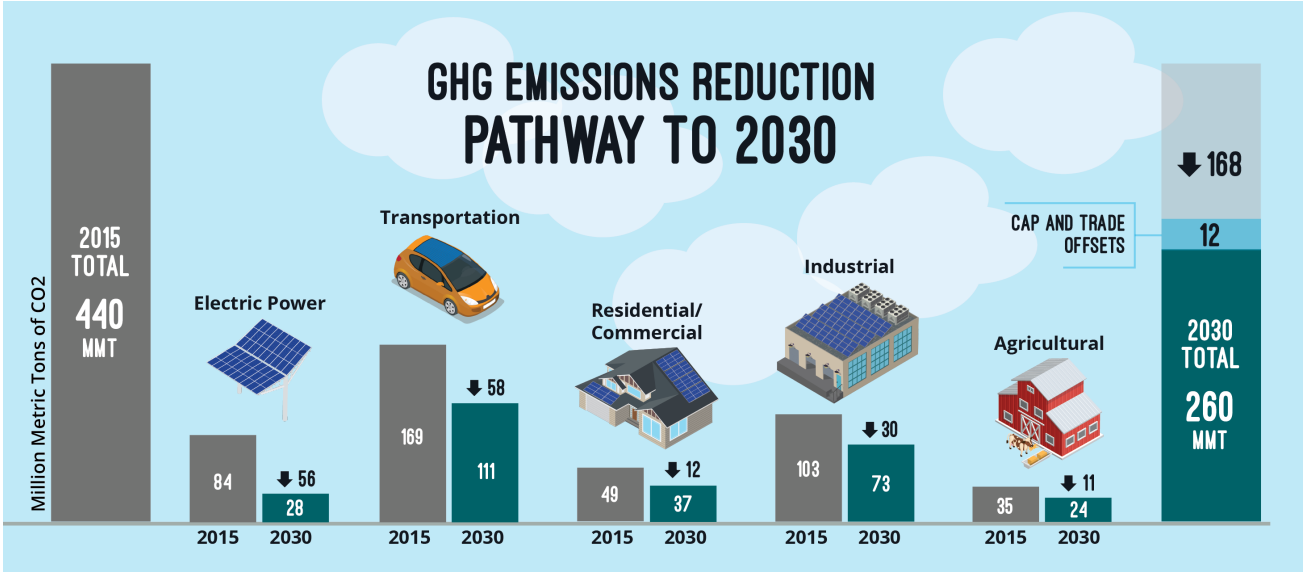

Figure 4: GHG Reductions Across Sectors to Reach 2030 Goals

generators. This will require the development of up to 30 gigawatts (GW) of additional renewable capacity.

California's electric system can incorporate a high penetration of large-scale renewable resources by having a renewables portfolio that is diverse in geography and resource availability, increasing transmission capacity, and enhancing integration across the western grid.

Using a system that relies so heavily on variable resources like wind and solar will require up to 10 additional GW of energy storage from fixed and mobile sources to even out hourly, daily and seasonal energy imbalances (the differences between energy supply and usage).

Even at today's levels of renewables, these energy imbalances can result in California's infamous "duck curve" — the timing imbalance that exists between solar generation and daily peak load.[10] This creates two significant problems for today's electric grid:

- the excess supply of solar at midday, which can lead to shutting down large-scale renewable resources or paying other states to take our power; and
- the significant fast ramp-up in generation to reliably cover the late afternoon and evening electricity need as the sun sets, solar generation fades and customer energy demands peak.

The extremes of the duck curve can be mitigated by the addition of energy storage at scale. Flexible electric vehicle charging could also provide beneficial load shifting — effectively a form of mobile energy storage — that could make electric fueling more affordable. Nonetheless, the magnitude of the duck curve issues is expected to increase as more renewables are added to the system, and some amount of gas-fired generation will be needed for service reliability.

Reducing or avoiding carbon in the electric sector also requires advances to integrate the clean energy resources that customers are adopting. These resources on the distribution grid are expected to include increased energy efficiency (consistent with SB350's mandate to double energy efficiency), rooftop and community solar, and electric vehicles. Modernizing the distribution grid with available and evolving technologies will allow these distributed energy resources to be better integrated and optimized, will improve system reliability and safety, and will support our customers' desire to participate in the clean energy future by making their own energy choices.

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Accelerate Electrification of the Transportation Sector

The GHG reduction potential of the Clean Power and Electrification Pathway hinges on aggressive electrification of light-duty vehicles, i.e., the passenger cars, SUVs and pickup trucks that currently contribute one-quarter of California's GHG emissions.[11] The Pathway calls for at least 24 percent of these vehicles — 7 million — to be electrified by 2030. EVs charging from an increasingly clean electric grid can help reduce transportation sector GHG emissions from 169 to 111 MMT/year, one-third of the 2030 goal. Reduced gasoline demand will also provide the benefit of reducing industrial emissions from refineries.

Electrification of the transportation sector will greatly improve local air quality — an urgent community need across California and particularly

Expanding transportation electrification will require sustainable policies and collaboration between vehicle manufacturers, charging companies, policymakers and electric utilities on issues such as charging standards and consumer awareness.

in Southern California. Many communities, particularly DACs*, are situated near heavily traveled freight corridors, where the concentration of air pollutants often exceeds health-based standards.†

Medium- and heavy-duty vehicles contribute to GHG emissions and are the largest mobile source of smog-forming emissions across the state. The Pathway calls for electrifying 15 percent of medium-duty and 6 percent of heavy-duty vehicles in the state by 2030, supporting needed GHG reductions and improvements in air quality. This will help California position itself for the 2050 GHG goal, which will require the elimination of virtually all vehicle emissions from fossil fuels.[12]

While these vehicle growth targets are ambitious, they are not far outside forecasts of rapid growth in the EV market.[13] Growing customer interest, increasing availability and variety of EV models (Figure 5), and the favorable economics of using EVs for ridesharing and autonomous vehicles have made a high-EV future more plausible than ever. Nations such as the United Kingdom, France, Norway, India and China have announced plans to phase out internal combustion vehicles within coming decades. Manufacturers are responding; GM recently indicated that it expects the company's entire model lineup to run on electricity in the future, and Volvo committed to eliminating traditional internal combustion engines in favor of an electric and hybrid fleet as early as 2019.[14]

Expanding transportation electrification will require sustainable policies and collaboration between vehicle manufacturers, charging companies, policymakers and electric utilities on issues such as charging standards and consumer awareness.[15]

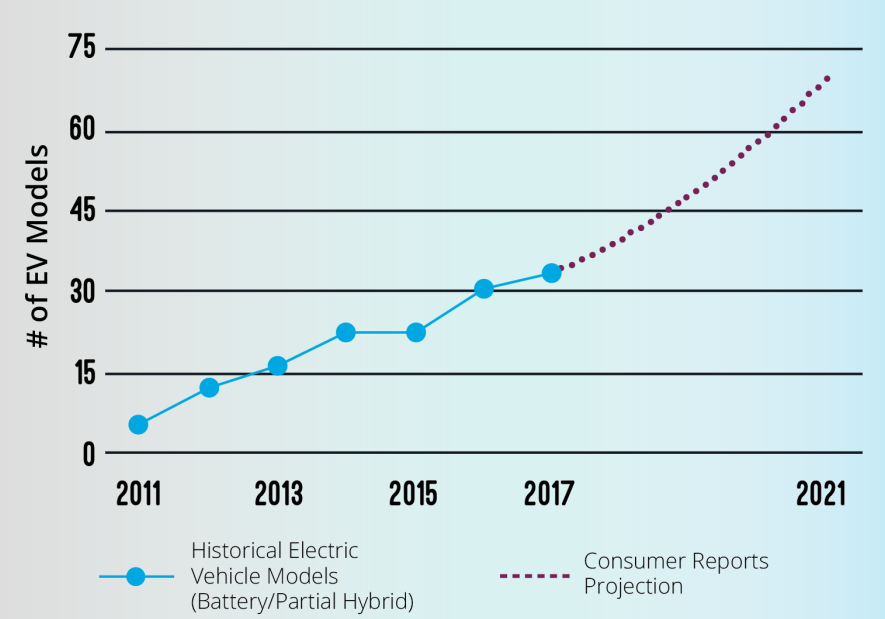


Figure 5: Battery/Partial Hybrid Electric Vehicle Models
(Sources: U.S. Department of Energy/Consumer Reports)

*CalEPA uses the designation Disadvantaged Community (DAC); DACs represent the 25% highest scoring census tracts in CalEnviroScreen 3.0, along with other areas with high amounts of pollution and low-income populations.
†Electrification in areas such as the I-710 corridor between Long Beach and Los Angeles promotes environmental justice by insuring that climate investments provide near-term air quality benefits to a broad set of communities.

Current codes and standards are based on the 20th century power-generation supply framework dominated by fossil fuels.

Continued price incentives, funded by the cap-and-trade and low carbon fuel standard programs, help to lower up-front purchase costs and will help drive additional adoption, as will increased selection and EV availability.

In order to support at least 7 million electric cars by 2030, California will need to have over one million away-from-home charging ports.[16] The state's investor-owned and public utilities have initiated charging infrastructure pilots*[17], but these pilots alone will not meet the expected scale of light-duty EV adoption. Funding will be needed to enable utilities and charging companies to rapidly deploy more infrastructure and chargers.

For medium- and heavy-duty vehicles in urban areas with lower daily mileage, such as buses, delivery vehicles and intermodal freight trucks, electrification is already being deployed and can significantly reduce GHG emissions and improve air quality. Larger plug-in electric and plug-in hybrid electric trucks are in development[18] and will play a greater role in achieving California's 2050 climate and air quality goals. Early deployments must coincide with the development of adequate charging infrastructure to support this critical clean-transportation opportunity.

Increase Electrification of Buildings

Space and water heating currently contributes more than two-thirds of total residential and commercial building GHG emissions. Electrifying nearly one-third of residential and commercial space and water heaters, in addition to increased energy efficiency and strong building codes and standards, could reduce GHG emissions from this sector from 49 to 37 MMT/year, or 7 percent of the 2030 goal.

Expanding electrification of residential and commercial buildings will require new policies and support. Collaboration between manufacturers, repair service providers and policymakers is needed to raise awareness and increase availability of clean, efficient options for electric space and water heating in new building construction and retrofits. Current building codes and standards are based on the 20th-century framework of power generation supply dominated by fossil fuels. This framework should be updated to account for an increasingly decarbonized electric grid.

Updated codes and standards can advance the use of clean electric appliances in new buildings, and incentives can encourage adoption of clean technologies through appliance replacement. For instance, controllable electric space and water heating, which draws from carbon-free electricity powered by solar in the middle of the day, could be an evolution of the Zero Net Energy (ZNE) framework toward more carbon-focused principles for new home construction.[19]

REACHING OUR GOALS WITHIN 12 YEARS

While the Clean Energy and Electrification Pathway is feasible, meeting the 2030 climate goal and also achieving significant improvements in air quality is an urgent challenge, requiring focused efforts and purposeful actions across multiple sectors of the economy (Figure 6). Many of the needed approvals, programs, and market transformations require compromise and consensus among stakeholders with diverse agendas and priorities. Customer adoption is also key to success — and that adoption requires that electricity remains an affordable alternative to fossil fuels.

*For instance, SCE's Charge Ready program is a $22 million pilot to increase charging infrastructure throughout the SCE service territory. The program provides the electrical infrastructure necessary for EV charging, as well as rebates to help pay for charging stations.

SCE's Clean Power and Electrification Pathway calls for integrated actions, programs and policies across all sectors of the economy and strongly links grid decarbonization with electrification right from the start. Planning for 2030 reduction targets now provides a starting point for important, necessary policies, programs and actions needed to meet the even more transformational 2050 climate goals.

Putting millions of electric vehicles on California's roads requires overcoming current barriers, such as vehicle affordability, customer awareness and EV charging accessibility. Durable, predictable incentives that lower EV purchase prices will encourage buyers to choose plug-in models at the end of their gasoline-powered vehicles' 11- year life cycles. Healthier incentives will also be needed to encourage commercial enterprises to switch to electricity as a fuel for buses and delivery and intermodal trucks with 18-year average life spans. In addition, charging station networks will need to expand rapidly to ensure availability at workplaces, multifamily units and along heavily traveled corridors.

An electric system upgrade can take as long as a decade to site, license, build and commission. Planning often involves a consensus-driven process that rarely results in a quick decision. Given this timeline, for the majority of electric power in California to come from renewable and distributed energy resources by 2030, the planning process for additional transmission capacity, new renewable energy development projects, grid modernization and large-scale energy storage investments must start now.

California's Building Energy Efficiency Standards are updated every three years, at the culmination of a multi-year planning process. Development of the 2019 standards is nearing completion, and planning for 2022 standards is an opportunity for strategic discussions. Waiting until the 2025 cycle could cost California the opportunity to decarbonize hundreds of thousands of new homes through electrified space and water heating, at a lower cost than later retrofits.

SUPPORTING THE PATHWAY THROUGH CALIFORNIA POLICY

Integrated Resource Planning

California has begun integrated resource planning — a comprehensive planning process to meet forecasted electricity needs and GHG targets for the electricity sector. Planning a decarbonized grid in a cost-effective manner requires strong coordination and balanced trade-offs for the good of the overall system. Provided that its scope includes consideration of

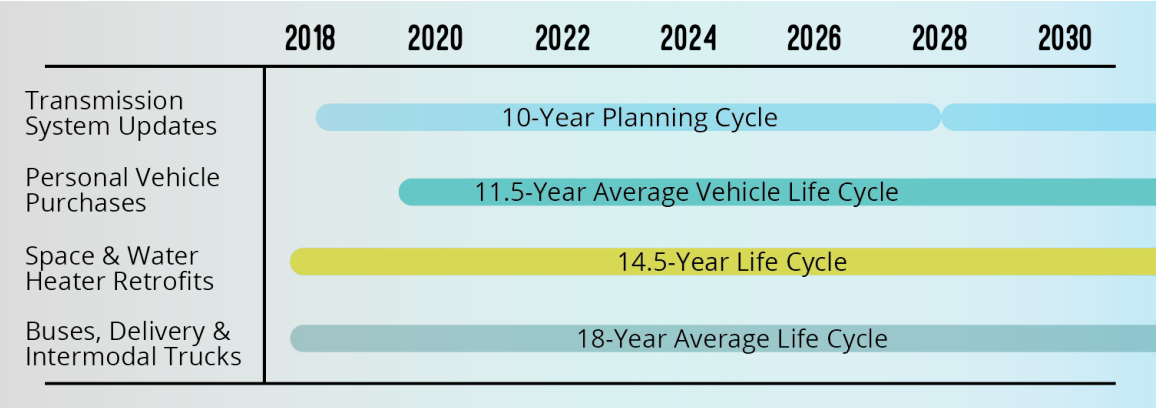


Figure 6: Planning and Life Cycle Timeline *(Source: SCE Internal Analysis)*

Planning a decarbonized grid in a cost-effective manner requires strong central coordination and balanced trade-offs across many parties for the good of the overall system.

the end uses of fossil fuels, this new process has the potential for more efficient planning decisions across economic sectors and electric sector technologies. This kind of planning would include large-scale and customer-sited renewable resources, energy efficiency, electric vehicles, energy storage and more.

GHG Cap-and-Trade
California's market-based, GHG cap-and-trade program is a critical enabler of the Clean Power and Electrification Pathway. Setting a price on GHG emissions with limited offsets creates opportunities to optimize spending in areas that most cost-effectively reduce or avoid GHG emissions. The continued, direct allocation of emissions allowances to utilities helps ensure electricity remains affordable and competitive with fossil fuels during the transition to the clean energy future.

Market-based programs could be bolstered by new flexible policy tools and significant funding to spur customer choice for clean electrification. California policymakers should allocate additional cap-and-trade revenues to programs that encourage consumers to adopt transportation and building electrification.

Transportation Electrification
New or refreshed policies could be enacted to smooth the pathway to broad customer adoption of electric vehicles. These policies could include support for continued and expanded consumer education, continued incentives for EV purchases, adequate charging infrastructure, and pricing that keeps electric fueling costs competitive with gasoline and diesel. Efforts are also needed to ensure the affordability of, and access to EVs for mid- and low-income Californians.

Building Electrification
California's 2022 Building Energy Efficiency Standards could include establishing new building standards to promote the clean electrification of space and water heating in homes and businesses, as well as to require collecting more data on fossil fuel end uses. In addition, energy efficiency programs could be optimized to include a focus on their ability to support GHG emissions reductions.

Keeping Clean Electricity Affordable
A key consideration for many consumers is, and will remain, the cost of electricity. The success of the Clean Power and Electrification Pathway rests on implementing an integrated package of measures that contribute to a strong California economy and maintain affordable electricity for all customers.

The price of electricity and who pays the costs must reflect the services provided to customers. All users of the electric grid must pay their share to support a reliable and increasingly clean electric system. Policies that ensure this fairness will help to keep electricity affordable, which will support customer adoption of the electrified solutions in the transportation and building sectors.

Creating Jobs That Support the Clean Energy Economy
A clean energy future benefits the California economy. Many studies suggest that the clean energy and electrification measures described in the Pathway will lead to higher statewide gross product, real output, state revenue and employment.[20] Highly skilled, middle-income jobs will be created to introduce and service new technologies. The Clean Power and Electrification Pathway can be a double win — both more prosperous and healthier — for California's residents.

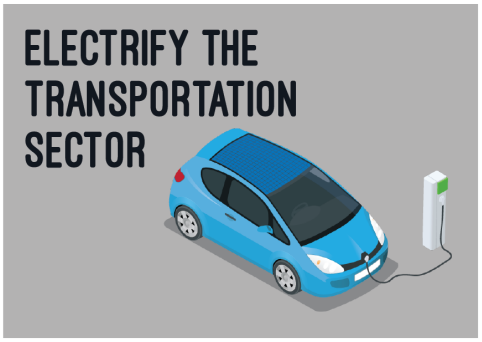
CONCLUSION

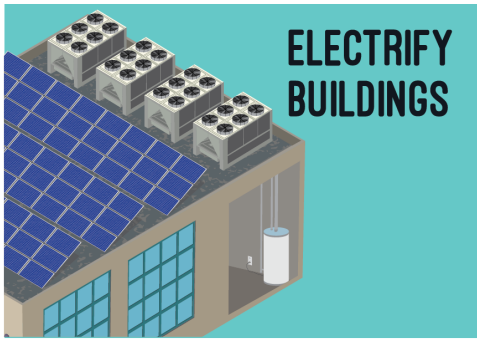
Broad decarbonization and electrification of the economy requires comprehensive policy to guide the transformations across our economy — not just in the electric sector.

Because of California's size and economic complexity, it will be a major undertaking for the state to meet its GHG goal in just 12 years. It is similarly difficult to meet our air quality targets. As the world's sixth largest economy, California has a unique opportunity to create a blueprint that others can follow for an affordable clean energy economy that improves air quality for our communities and mitigates impacts of climate change through greenhouse gas reductions across all energy sectors: electricity, fuels and gases.

Electric utilities are uniquely positioned to facilitate the transformation to a clean energy economy. They have the size, scope and infrastructure assets to deliver clean energy and support electrification for all customers. They also have the capacity to finance prudent investments to maintain and modernize the grid, with regulatory approval. But, they cannot do it alone. Broad decarbonization and electrification of the economy require comprehensive policy to guide the transformations across our economy — not just in the electric sector.

Everyone who lives, works, drives or invests in California is a stakeholder in this effort. The results will be a new energy paradigm that will address the enormous challenge of global climate change through the reduction of GHG emissions, improved air quality and human health — providing access to clean energy for all consumers.





ACRONYMS

AB	Assembly bill (California State Assembly)
BEV	battery-powered electric vehicle
CAISO	California Independent System Operator
CARB	California Air Resources Board
CNG	compressed natural gas
EV	electric vehicle
GHG	greenhouse gas
GW	gigawatt
H2	hydrogen
HDV	heavy-duty vehicle
MDV	medium-duty vehicle
MM	million
MMT	million metric tons
NOx	nitrogen oxide
PHEV	plug-in hybrid electric vehicle
RNG	renewable natural gas
RPS	Renewables Portfolio Standard
SB	Senate bill (California State Senate)
SCE	Southern California Edison
ZNE	zero net energy

REFERENCES

1. For more information on these policies, see Appendix at sce.com/pathwayto2030
2. Edmund G. Brown, Matt Rodriquez, Mary D. Nichols and Richard W. Corey, "First Update to the Climate Change Scoping Plan: Building on the Framework Pursuant to AB 32, The California Global Warming Solution of 2006," California Air Resources Board, last modified May, 2014, accessed Sept 13, 2017. https://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf
3. "Vision for Clean Air: A Framework for Air Quality and Climate Planning - Public Review Draft June 27, 2012," p. 10, California Air Resources Board, last modified June 27, 2012, accessed Oct 12, 2017. https://www.arb.ca.gov/planning/vision/docs/vision_for_clean_air_public_review_draft.pdf
4. "California Greenhouse Gas Inventory for 2000-2015 - by Sector and Activity," California Air Resources Board, last modified June 6, 2017, accessed Sept 13, 2017. https://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_sector_sum_2000-15.pdf
5. "California Renewables Portfolio Standard (RPS): Current Renewable Procurement Status," California Public Utilities Commission, accessed Oct 6, 2017. http://www.cpuc.ca.gov/RPS_Homepage/
6. California Greenhouse Gas Inventory

- "Mobile Source Strategy," p. 5, California Air Resources Board, last modified May, 2016, accessed Sept 25, 2017. https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf

7. California Greenhouse Gas Inventory
8. For more information on job creation, see Appendix at sce.com/pathwayto2030
9. The Governor's Climate Change Pillars: 2030 Greenhouse Gas Reduction Goals, California Air Resources Board, last modified Sept 20, 2016, accessed Sept 13, 2017. https://www.arb.ca.gov/cc/pillars/pillars.htm
10. "What the duck curve tells us about managing a green grid," California Independent System Operator, last modified 2016, accessed Sept 20, 2017. https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf
11. California Greenhouse Gas Emission Inventory - 2017 Edition: Data Links - Download the Entire Inventory - Economic Sector Categorization [Excel-496 KB], California Air Resources Board, accessed Sept 13, 2017. https://www.arb.ca.gov/cc/inventory/data/data.htm
12. James H. Williams, Benjamin Haley, Fredrich Kahrl, Jack Moore, Andrew D. Jones, Margaret S. Torn and Haewon McJeon, "US 2050 Report: pathways to deep decarbonization in the United States," Sustainable Development Solutions Network - A Global Institute for the United Nations, last modified Nov, 2014, accessed Sept 28, 2017. http://unsdsn.org/wp-content/uploads/2014/09/US-Deep-Decarbonization-Report.pdf
13. Adam Cooper and Kellen Schefer, "Plug-in Electric Vehicles Sales Forecast Through 2025 and the Charging Infrastructure Required," The Edison Foundation - Institute for Electric Innovation, last modified June, 2017, accessed Sept 27, 2017. http://www.edisonfoundation.net/iei/publications/Documents/IEI_EEI%20PEV%20Sales%20and%20Infrastructure%20thru%202025_FINAL%20%282%29.pdf
14. Jack Ewing, "Volvo, Betting on Electric, Moves to Phase Out Conventional Engines," nytimes.com, last modified July 5, 2017, accessed Sept 13, 2017. https://www.nytimes.com/2017/07/05/business/energy-environment/volvo-hybrid-electric-car.html

- "GM Outlines All-Electric Path to Zero Emissions," General Motor Co., last modified Oct 2, 2017, accessed Oct 12, 2017. http://www.gm.com/mol/m-2017-oct-1002-electric.html

15. "Transportation Electrification: Reducing Emissions, Driving Innovation," pp. 8-9, Southern California Edison, last modified Jan 2017, accessed Oct 12, 2017. https://www.edison.com/content/dam/eix/documents/our-perspective/201701-transportation-electrification-reducing-emissions-driving%20-innovation.pdf
16. Marc Melaina, Brian Bush, Joshua Eichman, Eric Wood, Dana Stringht, Venkat Krishnan, David Keyser, Trieu Mai, and Joyce McLaren, "National Economic Value Assessment of Plug-In Electric Vehicles Volume I," National Renewable Energy Laboratory, last modified Dec 2016, accessed Oct 12, 2017. https://www.nrel.gov/docs/fy17osti/66980.pdf
17. "Zero-Emission Vehicles," California Public Utilities Commission, accessed Oct 5, 2017. http://www.cpuc.ca.gov/General.aspx?id=5597
18. Marc Vartabedian, "Exclusive: Tesla's 'long-haul' electric truck aims for 200 to 300 miles on a charge," reuters.com, last modified Aug 24, 2017, accessed Oct 12, 2017. http://www.reuters.com/article/us-tesla-trucking-exclusive/exclusive-teslas-long-haul-electric-truck-aims-for-200-to-300-miles-on-a-charge-idUSKCN1B42GC

- "VW to develop electric trucks in $1.7 billion technology drive," reuters.com, last modified Oct 11, 2017, accessed Oct 12, 2017. https://www.reuters.com/article/us-autos-trucks-volkswagen-electric/vw-to-develop-electric-trucks-in-1-7-billion-technology-drive-idUSKBN1CG1VF

19. "New Residential Zero Net Energy Action Plan Vision Framework," 2020 Planning and Information for California ZNE Homes, accessed Oct 6, 2017. http://www.californiaznehomes.com/framework
20. For more information on job creation, see Appendix at sce.com/pathwayto2030

Electronic copies of this white paper and its appendices are available at sce.com/pathwayto2030