SPUR REGIONAL STRATEGY

SPUR REPORT
SEPTEMBER 2016

FOSSIL-FREE BAY AREA

A cleaner future for the region's energy

This report is a component of the SPUR Regional Strategy, a vision for the future of the San Francisco Bay Area
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Fossil-Free Bay Area

A cleaner future for the region's energy

The SPUR Executive Board adopted this report as official policy on August 1, 2016.

Executive Summary

Fossil fuel use is causing runaway global climate change, threatening people, cities and ecosystems with a dangerous future of flooding, extreme heat, fires and superstorms. But we still have time to reverse course if the world can transition to renewable sources for almost all energy purposes within the next few decades. The sooner we do this, the sooner we will improve public health, build resilience and foster a clean-energy economy — and the less we will have to pay toward the high cost of climate adaptation.

California has the most ambitious climate policy framework in the world, and the San Francisco Bay Area has the resources, political temperament and innovative spirit to demonstrate how to work toward eliminating fossil fuel use. This means ending our dependence on petroleum and natural gas and powering our buildings and transportation system with renewables like solar and wind. We can prototype ways to become fossil-free, modeling them for cities and urban regions around the world, and we can take important, relevant climate actions that confer benefits at the local level. If we succeed, this model can be exported throughout California and beyond.

In this report, SPUR addresses the question: *What can the Bay Area do to end our fossil fuel dependency?* Our goal is to create a policy agenda to accelerate the transition toward a high-efficiency energy system and away from carbon-based fuels, to create a model for other urban regions to do so and to become more climate resilient in the process.

We propose three big ideas and nine strategies for action by local government, regional agencies, utilities and the private sector to:

1. **Consume less fossil fuel** by eliminating unnecessary energy waste and improving energy efficiency of buildings, land use and the transportation system. Strategies we propose:
   - Increase the energy performance of new buildings and improve code enforcement
   - Require systematic energy retrofits of existing buildings
   - Control sprawl by protecting open space, supporting infill development and increasing density in places served by transit
   - Make communities more walkable, bikeable and transit accessible
   - Use policy and pricing tools to make less carbon-intensive modes of travel easier, safer and cheaper than driving
2. **Electrify most energy uses**, to convert buildings and vehicles that currently burn natural gas or gasoline to instead use the electricity grid, which will increasingly provide renewable energy, thanks to continuously advancing policy. Strategies we propose:
   - Electrify passenger vehicles and scale up infrastructure that supports them
   - Electrify fossil fuel uses in buildings
3. **Generate renewable electricity** to replace fossil fuel uses and meet almost all energy needs with 100 percent renewable sources like wind and solar. Strategies we propose:
   - Allow new renewable power facilities to be built quickly, by expediting permitting and reviews, offering incentives, setting requirements and leading by example
   - Decarbonize fuel sources that will be hard to electrify within the next 20 years

flickr user Steve Boland

Our recommendations provide the necessary background and a framework for local government, in partnership with regional agencies and state and federal governments, to influence some of the millions of private-sector and personal decisions that get made around energy every day, in support of a fossil-free future. This framework recognizes that energy technologies are constantly evolving and that public policy should aim to speed adoption without making implementation exorbitantly expensive. It also implores us to recognize that cities and regions have unique control over how people travel and commute compared to other levels of government, and that the transportation system's use of fossil fuels, particularly for passenger cars and trucks, is far greater than any other single source of emissions in the Bay Area and across the state.

These three big ideas — reduce, electrify, decarbonize — will allow the Bay Area to significantly reduce fossil fuel use, reduce our contributions to global climate change and improve our climate resilience. They will help us enjoy cleaner air, better economic opportunity and more transportation choices — and give us the opportunity to demonstrate a model of true urban sustainability that can be applied around the world.

See pages 58–63 for a plan of action identifying the parties who can implement our recommendations.

The Case for Going Fossil-Free

The Problem and Opportunity

Fossil fuel use is the single largest contributor to human-caused climate change. The ongoing burning of coal, oil and gas is bringing us nearer and nearer to the brink of dangerous climate disruption and ecological collapse. Humanity's reliance on fossil fuels is a disaster that worsens every day and particularly threatens future generations. Finding a way to stop fossil-fueled greenhouse gas emissions as quickly as possible is perhaps the greatest challenge world civilizations have ever faced together. With the Paris Agreement of 2015, we finally have unanimous global agreement to curtail emissions to limit global warming to 2 degrees Celsius. But the path to get there must still be built, and urgently. It will take policy and action at all levels — local, state, national and international — to lay the groundwork and lift up the best ideas for widespread implementation.

It has been said that people alive today are the first who will feel climate change's effects, and the last who can do something about it. This report is an effort to spur the San Francisco Bay Area to go fossil-free, create a model for other urban regions to follow and build climate resilience in the process.

What Climate Change Could Look Like Here

More severe storms, drought, heat waves, larger wildfires, species loss, ocean acidification, coastal erosion and sea level rise are all expected impacts of climate change. These consequences are already being felt, and all of them could significantly impact California and the Bay Area. Globally, 2015 was the hottest year on record, bringing deadly heat waves to Asia and Europe and the worst drought in history to California. Between 2012 and 2014 the state experienced its hottest, driest three-year period on record.[1]

Without action on climate change, the consequences will compound. Within a decade, the world's oceans may absorb enough carbon dioxide to trigger irreversible ecological effects, including the disappearance of coral reefs.[2] By 2050, unabated warming will leave one-fourth of earth's species at risk of extinction and island nations fleeing for safety. More than $20 billion of property in California alone will be subject to high-tide inundation. By 2100, a tripling of days over 95 degrees is likely to cause an additional 7,000 annual heat-related deaths in California. A 60 to 90 percent decline in days below freezing, and changes in the timing and type of precipitation, could have devastating consequences for water supplies, hydropower availability, agriculture and winter tourism.[3] The impacts of extreme heat and flood risk will disproportionately affect the poor, elderly, disabled, and unhealthy, who have the fewest resources and least ability to cope.

Our 2011 report *Climate Change Hits Home* described in depth the potential impacts of unabated climate change on the Bay Area by 2100, which include 5 to 7 degrees of temperature increase, 36 to 55 inches of sea level rise and the paradox of more extreme severe flooding alongside less reliable, less available water.[4] Within the last few years, institutions and leaders within the Bay Area have increasingly grown alarmed, recognizing the need for adaptation and resilience. Many projects and planning studies are currently underway, especially to address vulnerabilities related to sea level rise and flooding on the San Francisco Bay shoreline.[5]

Why the Bay Area Must Take Action

The cheapest and best way to avoid severe consequences of climate change is to do everything in our power to slow it down. While the Bay Area on its own cannot significantly slow global warming, local climate action can play two important roles in the worldwide fight against climate change: We can prototype the idea of a decarbonized urban place for cities around the world, and we can take important, relevant climate actions that can only be made at the local level.

Cities and regions, especially in California, are key players in the transition to a fossil-free energy system. Cities have direct control over land use, transportation and electricity decisions and investments, which can lock in energy use patterns for decades to come. They can test innovations and deploy "smart grid" investments and district-scale clean energy systems. They can plan

[1] http://www.water.ca.gov/waterconditions/docs/California_Signficant_Droughts_2015_small.pdf

[2] JP Gattuso, et al., Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios, Science 349, no. 6243 (July 2015), DOI: 10.1126/science.aac4722, and for a readable summary of recent research: http://www.rollingstone.com/politics/news/the-point-of-no-return-climate-change-nightmares-are-already-here-20150805?page=5

[3] http://riskybusiness.org/report/from-boom-to-bust-climate-risk-in-the-golden-state/

[4] http://www.spur.org/publications/spur-report/2011-05-02/climate-change-hits-home

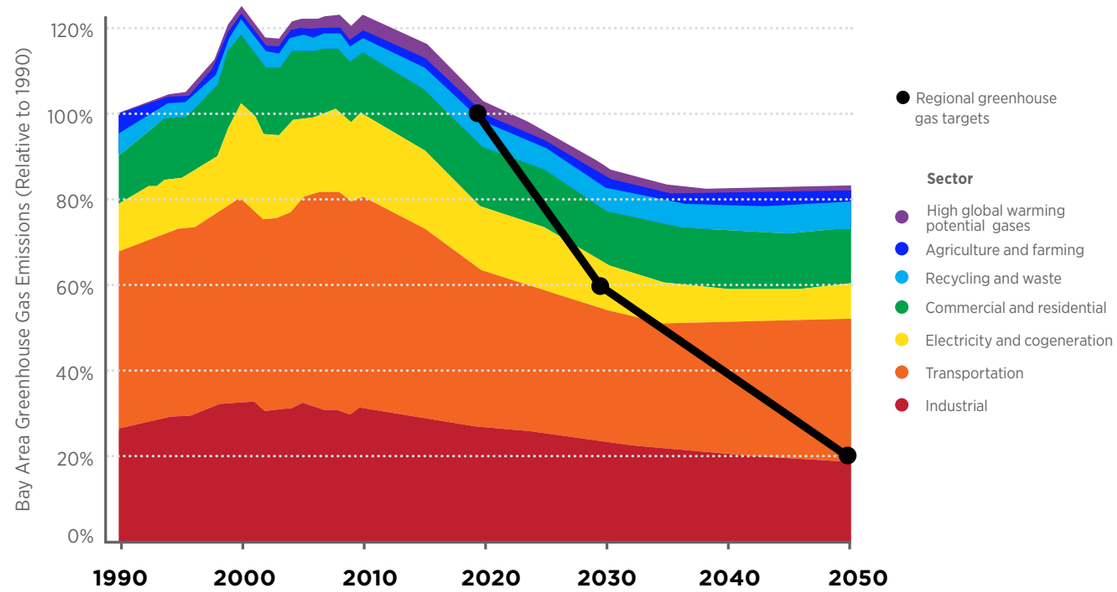
[5] For example, BCDC's Adapting to Rising Tides project, http://www.adaptingtorisingtides.org/project-location/local/ and other projects profiled by SPUR in 2014: http://www.spur.org/publications/article/2014-04-10/taking-action-sea-level-rise

FIGURE 1

Reaching the Bay Area's Emission Goals Requires New Policies and Programs

This chart shows actual greenhouse gas emissions between 1990 and 2010 and modeled emissions and projections (relative to 1990) through 2050. The projections account for the effect of existing climate and fuel policies, plus those widely expected to be adopted in the future. The black line shows the target the Air District has set for the region (80 percent below 1990 levels). The significant difference between this target and the projected emissions shows that more policies, programs, incentives, pricing and other tools must be invented and implemented for the Bay Area to achieve our emission reduction goals.

Source: BAAQMD, 2015 (Presentation to BOD, July 29, 2015), available at: http://www.baaqmd.gov/~/media/files/board-of-directors/2015/agenda_14_preliminary-climate-protection-program-update-pdf.pdf?la=en



walkable, bikeable streets that reduce the need for driving and gasoline consumption to meet the needs of daily life. Regions can direct transportation investments to support electrified infrastructure or other changes necessary for a low-carbon transportation system. There's a "sweet spot" at the regional scale on climate action: It's a scale that confers the ability to set goals and take action while still having a meaningful impact.[6]

The Bay Area has the resources and progressive ideals needed to demonstrate how to significantly lower our carbon footprint by eliminating fossil fuel use. Our state has the most ambitious climate policy framework in the world, aiming to reduce greenhouse gas emissions (or carbon-equivalent emissions) to a baseline of 1990 levels by 2020, 40 percent below that baseline by 2030 and 80 percent below the baseline by 2050. More than 55 cities and counties in the region — making up 80 percent of the Bay Area's population — have adopted their own climate action plans.[7] And the Bay Area Air Quality Management District has adopted a climate protection goal for the region of reducing greenhouse gas emissions 80 percent below 1990 levels by 2050. Under these conditions, the Bay Area can endeavor to offer the most carbon-efficient urban environment available anywhere in the world. If we succeed, this model can be exported throughout California and beyond.

The Local Benefits of Going Fossil-Free

Besides doing our part to stop climate change, there are even more immediate reasons to cut fossil fuel use in the Bay Area. When we burn fossil fuels, we release not only carbon dioxide but also nitrogen oxides, volatile organic compounds and particulate matter, which cause smog, respiratory illness, asthma and cancer. The adverse health effects are particularly concentrated among vulnerable populations and in urban areas. Powering buildings and vehicles with renewable energy would significantly improve air quality and health across the region, especially for vulnerable populations. This would not only improve quality of life for residents but also could save millions of dollars in avoided hospitalizations and sick days.

Through regulation, technological changes, using cleaner fuels and other means, the Bay Area has already seen significant improvements in overall air quality over the last 25 years. Days with high ozone pollution have dropped by more than 90 percent, the number of winter days exceeding fine particulate pollution

[6] Jane C.S. Long, presentation to the Bay Area Air Quality Management District, May 2014, http://www.baaqmd.gov/~/media/files/board-of-directors/advisory-council/2014/presentations/051414-ac-presentations.pdf?la=en

[7] BAAQMD, 2015, and Institute for Local Government, San Francisco Bay Area Climate Action Portal, http://www.ca-ilg.org/sf-bay-area-climate-portal

standards has dropped by half and residents' average lifetime cancer risk has dropped fourfold since 1990.[8] The Bay Area's air is cleaner than that of other urban areas of California like Los Angeles, Bakersfield and Fresno. But it ranks sixth most-polluted in the nation for short- and long-term particulate matter.[9] And some communities remain more impacted by air pollution's burdens than others, especially those near heavily trafficked freeways or industrial sources. (See Figure 2.)

These places, which are often home to low-income communities of color and populations of more-vulnerable people, have health disparities exceeding the region's average.[10] Some of them are among the region's most urbanized places and are where a significant portion of the Bay Area's expected growth of 2 million people by 2040 will end up living and working: eastern San Francisco, western Contra Costa and Alameda counties from San Pablo to Hayward, central Contra Costa County around Concord, eastern Contra Costa County around Pittsburg, Antioch and Vallejo, and central San Jose. For these places to grow healthfully, deeper cuts in pollution — and a halt to further air quality degradation — are necessary.

Besides reducing local pollution and creating a regional model for low-carbon growth, going fossil-free would bolster the Bay Area's growing green economy. The region is already a global leader in developing energy storage innovations and advanced transportation technologies — especially electric vehicles (EVs) and technology that improves the efficiency of transportation systems.[11] The region leads the nation in the adoption of electric vehicles.[12] California as a whole experienced a 153 percent increase in clean tech venture capital between 2013 and 2014, and the Bay Area received much more than half of this investment.[13] A progressive policy goal of becoming fossil fuel-free will increase the attractiveness of the Bay Area for this capital and leverage our culture of innovation, globally renowned universities and applied research institutions as well as our diversified information technology and advanced manufacturing sectors.

Investments we make today in powering our society with fossil fuel alternatives have potential to save money over the long run and to boost economic growth in our region and beyond. The price of wind, solar, geothermal and other renewable power is dropping as more renewable technologies are produced. Globally, the price of solar photovoltaic (PV) panels has fallen more than 75 percent since 2009, and the gap between the cost of conventional fuels and the cost of renewable sources such as geothermal, hydropower, wind and solar is expected to narrow in the future.[14] [15] The California Energy Commission expects that by 2024, large-scale solar PV could be near parity with natural gas generators when considering the cost of equipment and fuel over each technology's lifetime.[16] When considering the human health costs associated with burning fossil fuels, renewables become even more attractive. Federal, state and local policies have helped renewables become more competitive with fossil fuels, and their continued support is essential, especially beyond the electricity sector, in transportation and heating.[17]

Finally, if a Bay Area fossil-free strategy became widely replicated and succeeded in reducing world demand for natural gas and oil, this would reduce our contribution and exposure to a litany of other environmental, social, political and economic problems. These include fuel spills, fires and accidents at offshore platforms, ships, overland pipelines and mines — sometimes with tragic human consequences. Environmental impacts include hazardous air pollution, ocean pollution, wetland loss, habitat destruction, drinking water contamination and — more recently discovered — earthquakes caused by fracking for natural gas. Oil dependence requires spending billions of dollars annually on military resources to protect oil transit routes and infrastructure.[18] Oil price volatility has significant influence on the U.S. economy, and low-income communities are particularly vulnerable to price shocks.

California and the Bay Area's Energy System Today

Leading the Way in Energy Policy and Efficiency

California is a world leader in climate and energy policy. Over the last 40 years, the state has invested in and adopted a broad set of evolving and interlocking policies, regulations, laws, executive orders, building codes, consumer programs and incentives to reduce energy waste and greenhouse gas pollution. (See Figure 3 on page 8.) During this time, energy efficiency programs, appliance standards and building codes have saved Californians more than $90 billion, avoided the need to build more than 50 very large natural gas power plants and avoided the emissions of millions of tons of carbon and other air pollutants that contribute

[8] Bay Area Air Quality Management District (BAAQMD), Community Air Risk Evaluation Program Retrospective and Path Forward (2004-2013), 2014, http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/CARE%20Program/Documents/CARE_Retrospective_April2014.ashx?la=en

[9] American Lung Association, "State of the Air 2015," http://www.stateoftheair.org/2015/msas/san-jose-san-francisco-oakland-ca.html#pmann

[10] BAAQMD 2014, supra note 8

[11] Next 10, Bay To Market: Bay Area Innovations Leading Clean Technology Development, November 2014, http://next10.org/sites/next10.huang.radicaldesigns.org/files/Bay%20to%20Market%20-%20Bay%20Area%20Regional%20Report%20Nov.%202014.pdf

[12] Next 10, 2014, p. 7

[13] Next 10, 2015 California Green Innovation Index-International Edition, May 2015, http://next10.org/international

[14] International Renewable Energy Agency, Renewable Power Generation Costs in 2014, Executive Summary, http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Power_Costs_Summary.pdf

[15] International Energy Agency, Renewable Energy Medium-Term Market Report, 2014, http://www.iea.org/publications/freepublications/publication/medium-term-renewable-energy-market-report-2014.html

[16] California Energy Commission, Estimated Cost of New Renewable and Fossil Generation in California, May 2014, http://www.energy.ca.gov/2014publications/CEC-200-2014-003/CEC-200-2014-003-SD.pdf

[17] International Energy Agency, Renewable Energy Medium-Term Market Report, 2015, http://www.iea.org/bookshop/708-Medium-Term_Renewable_Energy_Market_Report_2015

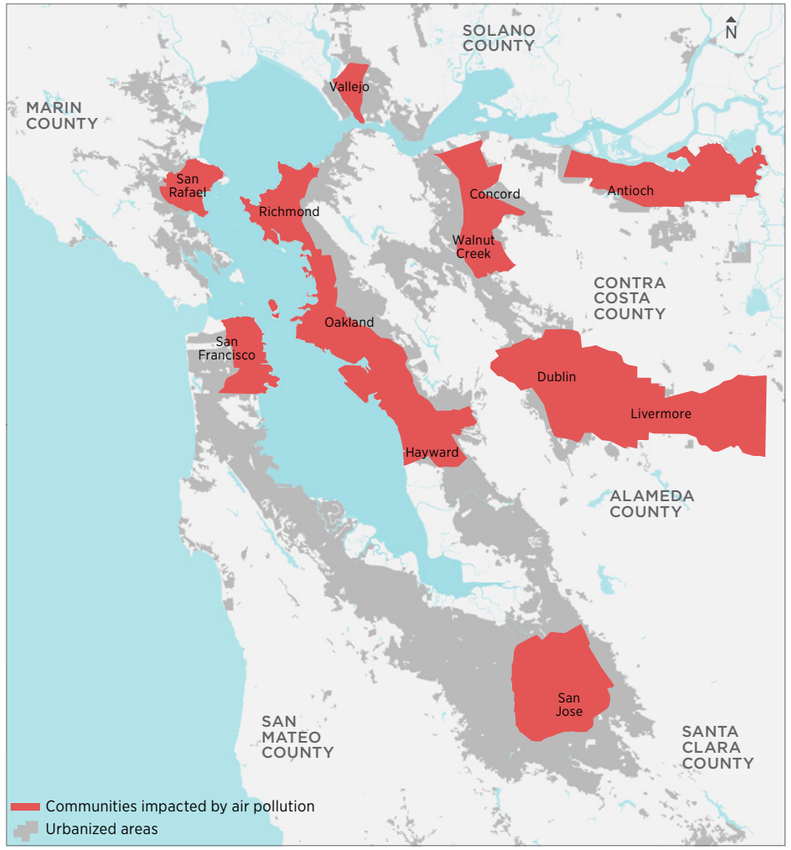
[18] Electrification Coalition, Electrification Roadmap: Revolutionizing Transportation and Achieving Energy Security, November 2009, http://www.electrificationcoalition.org/sites/default/files/SAF_1213_EC-Roadmap_v12_Online.pdf

FIGURE 2

Bay Area Communities Most Impacted by Air Pollution

The areas in red experience the greatest impacts from air pollution: they have relatively high levels of long-term exposure to toxic air pollution, fine particulate matter or ozone; they periodically exceed safe limits for fine particulate matter or ozone; and they have higher levels of air-quality-related adverse health outcomes. Even outside of these areas, residents may experience unhealthy air quality from localized sources of air pollution, such as high-traffic roads and highways.

Source: Bay Area Air Quality Management District, 2014



How to Measure Emissions

In this report, we use tons of carbon-equivalent emissions, or CO2e, as a way of comparing greenhouse gas impacts across categories of fossil fuel uses and understanding the relative impacts of policies on air quality and climate change targets. We wanted to use a common denominator that could be reported for all types of fossil fuel uses and that was legible to policymakers. CO2e is clearer than describing fuel use in terms of gallons, therms (used for measuring gas), kilowatt-hours or British thermal units (Btu). Metric tons of CO2e is a common way of measuring and reporting greenhouse gas impacts in everything from corporate sustainability reports to local climate action plans to state Assembly Bill 32. It is also a proxy for other kinds of air pollutant emissions associated with combustion of fossil fuels. The "e" represents a conversion factor that can be applied to any type of greenhouse gas emission to translate its global warming potential into the equivalent of one ton of carbon dioxide. For example, one ton of methane has 25 times the global warming potential of one ton of CO_2 over a 100-year time horizon, so its CO2e measurement would be 25 tons. Global warming potential can also be measured in terms of a 20-year time horizon, though this is less common. In this case, methane's potential is 86 times the equivalent of one ton of carbon dioxide.

FIGURE 3

Significant Climate Policies in California

These measures are key pieces of the policy and regulatory approach to decreasing fossil fuel energy use and greenhouse gas emissions in California through 2020 and beyond.

Measure	What It Does
AB 32 (2006) and SB 32 (2016)	AB 32 establishes a goal of reducing statewide greenhouse gas emissions from all sectors of the economy to 1990 levels by 2020. SB 32 expands that to 40% below 1990 levels by 2030.
Renewable Portfolio Standard (RPS)	Requires that electricity suppliers provide 33% of electricity from renewable sources by 2020 and 50% by 2030
Clean Car Standards	Requires passenger vehicle fleets in California to meet 42.5 mpg efficiency by 2020 by tightening efficiency standards for car model years 2012–2025
Title 24 standards / CALGreen	Creates energy efficiency and renewable energy requirements in the state building code, updated every three years; requires new low-rise residential and new commercial and multifamily buildings to be zero net energy by 2020 and 2030, respectively
Low Carbon Fuel Standard	Requires the carbon content of fuels to decrease 10% from 2010 levels by 2020
Cap and Trade	Sets a cap on statewide emissions equal to the target in AB 32 (to reduce emissions to 1990 levels by 2020). Large emitters across 85% of the state's economy surrender permits to meet their individual obligations, which they may buy and trade
SB 350	Requires doubling of energy efficiency in existing buildings by 2030 and codifies the 50% RPS goal by 2050
Sustainable Communities Strategies / SB 375	Requires metropolitan planning organizations to develop regional plans linking housing growth with transportation investments to reduce per-capita emissions from driving
AB 2021 (2006) Utility Energy Efficiency Goals	Requires the Energy Commission to set efficiency targets for investor-owned and publicly owned electricity utilities to reduce forecasted consumption 10% in 10 years

to asthma, cancer and other illnesses.[19] Where the rest of the country has increased per-capita electricity use by 50 percent since the 1970s, California's consumption has remained relatively flat, thanks in part to smart energy policies. In 2002, California enacted a renewable portfolio standard (RPS), aiming to increase the percentage of delivered renewable electricity to 20 percent by 2017,[20] a quota that the state readily surpassed. The RPS was subsequently expanded to require 33 percent renewable energy by 2020 and 50 percent by 2030. The Clean Car Standards that went into effect in 2009, along with land use policies adopted in 2008 to reduce the number of vehicle miles traveled each year, are expected to halve emissions from passenger transportation, as well as fuel costs for drivers, over the next 20 years.[21] Senate Bill 350, passed by the legislature in 2015, called for a doubling of energy efficiency in existing buildings by 2030.

Because of aggressive renewables policy in California, and proactive voluntary action taken beyond renewables policy, the market will increasingly build renewable energy, rather than fossil fuels, in the electricity sector. Despite this positive trend, we are still reliant upon oil for our gasoline and other transportation fuels and on natural gas for electricity production, the heating and cooling of our buildings, and many home appliances. (See Figure 4.) As we discuss throughout this report, the way forward is to transform the Bay Area's energy system to be entirely powered by renewable sources for all uses, including electricity, building and water heating, appliances and transportation. This transition won't happen for our natural gas and transportation fuel uses without additional policy and action.

Emissions and Fossil Fuel Use Are Increasing

The Bay Area is a leader within the state in terms of having a fuel-efficient economy. Between 1990 and 2011, per-capita emissions in the region increased overall by 5 percent (though today they are declining from a peak in the late 1990s). During this time, the greenhouse gas intensity of the region's economy — the emissions per unit of economic output — decreased by 27 percent.[22] Although this suggests that we are becoming more efficient, much of the region's economic growth in the last 25 years has occurred in the knowledge services sector, which does not have a high emissions intensity.

[19] NRDC and E2, "California's Golden Energy Efficiency Opportunity: Ramping Up Success to Save Billions and Meet Climate Goals," August 2015, http://switchboard.nrdc.org/blogs/lettenson/NRDC-E2_CA%20Golden%20EE%20Opportunity_082015.pdf

[20] http://www.energy.ca.gov/renewables/history.html

[21] http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf

[22] Bay Area Air Quality Management District, Bay Area Emissions Inventory Summary Report: Greenhouse Gases, 2015, http://www.baaqmd.gov/~/media/files/planning-and-research/emission-inventory/by2011_ghgsummary.pdf

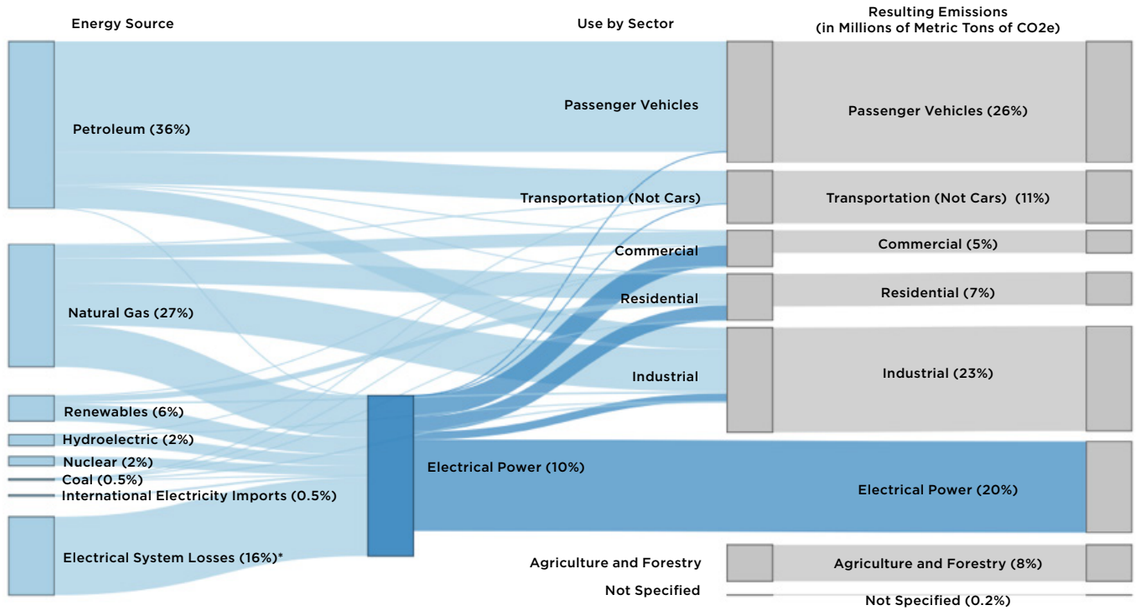
FIGURE 4

California Consumes More Petroleum Than Any Other Energy Source

This figure shows the consumption of fuels by sector and the resulting emissions. At the far left, the energy consumed in California is shown by percentage of the state's 9.346 trillion Btu total. This energy is consumed by intermediate or end-use sectors shown in the middle. At the far right, the greenhouse gas emissions from those sectors are the shown by percentage of the state's total 459.3 million metric tons of CO_2 equivalent. Electric power is unique in that it both consumes raw energy and provides energy to other sectors.

Sources: Energy Btus are from EIA's 2013 State Energy Consumption Estimates: http://www.eia.gov/state/seds/sep_use/notes/use_print.pdf; greenhouse gas emissions are from CARB's California Greenhouse Gas Inventory for 2000–2013—by Sector and Activity: http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_sector_all_2000-13_20150831.pdf

* Note: Electric system losses include the loss of energy through heat when fuels are burned to make electricity, as well as energy loss as electricity moves across transmission wires.



Notwithstanding the decrease in emissions per unit of economic output, the total demand for fossil fuel in the Bay Area is increasing, because of our population growth and economic growth. Between 1990 and 2014, total greenhouse gas emissions in the Bay Area increased 32 percent. (See Figure 1 on page 5.) Passenger cars and trucks are by far the largest single source of emissions, followed by natural gas combustion for commercial and residential use (heaters, boilers, chillers), oil refineries and, finally, electricity generation and imports. (See Figure 6 on page 11.)

As we saw in Figure 1, climate energy and fuel policies that will be implemented (or are widely expected to be adopted) in the future — for example, to reduce emissions, incentivize changes in the transportation system, regulate energy supplies and empower proactive action — will influence fuel use and emissions going forward. The Bay Area's total CO2e emissions are expected to decline through the period 2020–2030, but these savings will not be enough to meet the ambitious targets the state and region have set.

The Bay Area's Energy Uses

Looking at each of these sectors and fossil fuel uses more closely, we can identify three key energy-use trends and opportunities for the region:

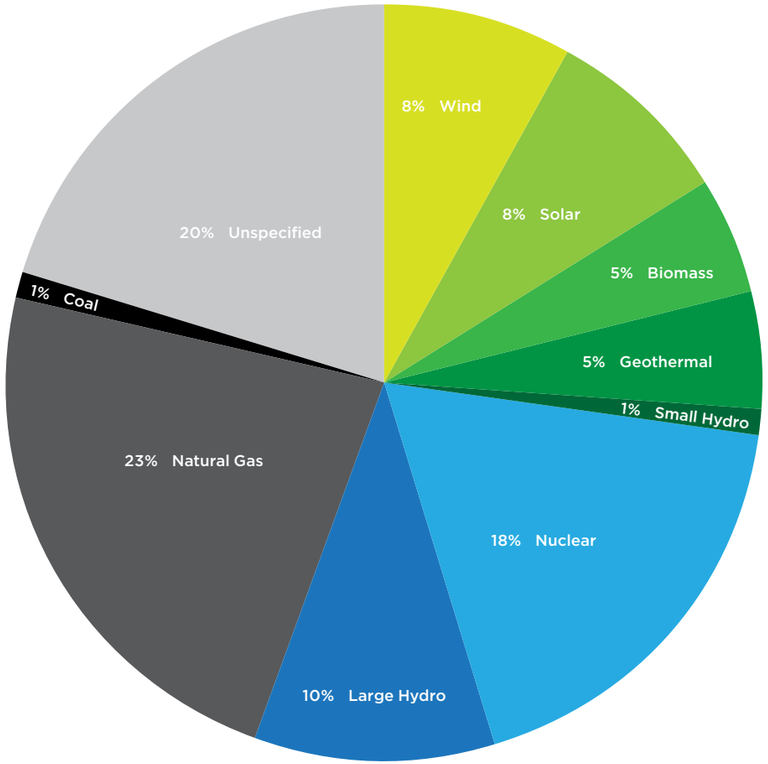
1. The Bay Area's electricity power portfolio is relatively clean, and getting cleaner. (See Figure 5 on page 10.) Bay Area residents and businesses currently receive nearly 30 percent of their electricity from state-eligible renewable sources, including small hydro, solar, wind, geothermal and biomass. This percentage will grow in the future, thanks to state requirements to increase renewable electricity to 50 percent by 2030. The Bay Area's electricity mix is even cleaner — only 24 percent fossil fuel-based — after counting the contributions of large hydroelectric and nuclear power sources, which are not considered renewable even though they are greenhouse gas-free. Growth in renewables is most likely to displace natural gas and nuclear as a fuel source. Expansion of energy efficiency and the growing adoption of rooftop solar (see Figure 7 on page 13) will also slow demand for new utility-provided electricity sources.

FIGURE 5

Where Our Electric Power Comes From

This chart shows the nine-county Bay Area's fuel mix, as of 2014, taken together across local municipal utilities, community choice aggregators and PG&E. The power is roughly split five ways between natural gas, large hydroelectricity, nuclear, renewables and "unspecified sources," which represents electricity sold on the wholesale market from an unverified combination of natural gas, coal and hydroelectricity.

Sources: SPUR analysis of 2014 California Energy Commission Power Content Labels for all Bay Area utilities and community choice aggregators: http://www.energy.ca.gov/pcl/labels/, and 2014 Energy Information Administration consumption tables: http://www.eia.gov/electricity/data.cfm



2. Natural gas is the Bay Area's second-largest source of emissions. Combined across the residential and commercial sectors, natural gas-fired boilers, heaters and chillers are the second-largest source of CO2e emissions in the region, but little is being done to shift demand to less greenhouse gas-intensive fuels (like biogas, gas produced by the breakdown of organic matter rather than from mining or hydraulic fracturing) or increasingly clean electricity. Natural gas burning in commercial and residential applications emits more greenhouse gases in the Bay Area than the region's five large oil refineries combined — not even accounting for leaks in the system. Outside of energy efficiency policies, incentives and appliance standards, there are no policies aimed at directly shifting natural gas uses to electricity, biofuels or another renewable source. The region's natural gas pipeline network is a legacy of the 1940s and is likely to persist without policy change and incentives to shift these uses to more renewable, non-fossil sources.

3. Transportation is our single greatest and fastest-growing fossil fuel use across all counties. Passenger cars and trucks are the largest single source of fossil fuel emissions in the region today. They are responsible for almost 80 percent of all transportation-related emissions, and their use grew 19 percent over the last 25 years.[23] These emission levels are expected to decrease slightly through the period 2020–2030 for two reasons: first, per-capita daily miles driven are expected to remain flat or only slightly increase, and second, vehicle emissions standards and clean fuel standards will significantly increase the fuel efficiency of miles driven. But the expected addition of 2 million people in the Bay Area by 2040 will increase the overall number of vehicle miles traveled, overwhelming the already highly congested transportation system. To achieve a fossil-free Bay Area, we will need to significantly reduce both the need for driving and the emissions per mile of travel.

[23] SPUR analysis of BAAQMD data, 2015.

Three Big Ideas for a Fossil-Free Region

To reduce and eventually eliminate fossil fuel use in the Bay Area, we propose a framework of three big ideas, each with a distinct set of policy recommendations and opportunities:

1. **Reduce consumption of fossil fuels** by eliminating unnecessary waste and improving resource efficiency without compromising utility or economic competitiveness. Actions include improving the energy efficiency of buildings (and the equipment within them) and reducing vehicle miles traveled by supporting walkability and transit and raising the prices of driving and parking.

2. **Electrify most of the remaining energy uses** to convert natural gas and gasoline burning to the electricity grid, which will increasingly provide renewable energy. This category of actions includes both building and vehicle electrification.

3. **Decarbonize the electricity grid** and remaining end uses to accelerate deployment of state, regional and local renewable energy goals and eventually supply all energy uses with 100 percent renewable energy. This category of actions includes scaling up renewable energy and energy storage and making changes to the grid itself to provide stability and reliability.

This framework is informed by energy modeling that found "deep decarbonization" for the entire United States — enough to reduce greenhouse gas emissions 80 percent by 2050 — is technically feasible.[24] The modeling also found that such emission reductions would not be cost prohibitive, as they account for less than 1 percent of U.S. gross domestic product, and could be achieved through existing technologies. It is essential to set forth on the pathway now, because investments made in infrastructure today affect how we use energy tomorrow. (See Figure 8 on page 13.)

We know the pathway to decarbonization is viable, and we believe that now is the time to seize the opportunity. This framework of actions — reduce, electrify, decarbonize — will allow the Bay Area to significantly reduce fossil fuel use, reduce our contributions to global climate change and improve our climate resilience. It will help us enjoy cleaner air, greater economic opportunity and more transportation choices — and give us the opportunity to demonstrate a model of true urban sustainability that can be copied around the world.

[24] J.H. Williams, B. Haley, F. Kahrl, J. Moore, A.D. Jones, M.S. Torn and H. McJeon, Pathways to deep decarbonization in the United States. Pathways to deep decarbonization in the United States, The U.S. report of the Deep Decarbonization Pathways Project of the Sustainable Development Solutions Network and the Institute for Sustainable Development and International Relations, Nov. 25, 2014. Available at: http://unsdsn.org/wp-content/uploads/2014/09/US_DDPP_Report_Final.pdf

FIGURE 6

The Bay Area's Biggest Sources of Emissions

Passenger vehicles are the largest single source of fossil fuel use in the Bay Area, followed by residential and commercial boilers, chillers and heaters powered by natural gas, the region's five large oil refineries, and electricity generation and imports.

Source: Data from BAAQMD (2015)

Source	Million Metric Tons of CO2e annually
Passenger cars and trucks	28.5
Oil refineries	14.2
Electricity generation and co-generation, including imports	12.1
Commercial natural gas boilers/ heaters	8.4
Residential natural gas	6.4
Refrigerants/ozone-depleting substances	4.7
Medium/heavy duty trucks and buses	4.3
Off-road transportation, including trains, ships, boats and all aviation	3.4
Waste management	1.6
Agriculture	1.3
Off-road equipment	1.3
Everything else combined	2.4
TOTAL	**88.6**

Courtesy GRID Alternatives

Growing Advanced Energy Jobs for Local Residents

California's policy commitment to carbon-free advanced energy systems has already affected our economy and workforce. In 2015, the state's 500,000 advanced energy jobs outnumbered those in agriculture, forestry and fishing combined and also those across Hollywood, TV and radio. Advanced energy jobs — including jobs in renewable energy generation, energy efficiency, smart metering and battery storage, and low-carbon vehicles and fuels — are also growing more quickly than the rest of the state's economy. Between 2014 and 2015, jobs in advanced energy grew by 18 percent, or six times faster than the rest of the state's economy.[25]

These jobs often offer equivalent salaries of other energy jobs and, depending on the industry, can fetch a pay premium.[26] Given this, it is important that Bay Area institutions prepare our workers to compete for advanced energy jobs and that all residents have equal opportunity to grow the necessary skills. A new collaboration between California Community Colleges and the electric vehicle industry — funded by the state's Industry-Driven Regional Collaborative — has the promise to do just that. Electric vehicle industry specialists are helping shape community college curriculum to train manufacturers, technicians and other specialists to work with the vehicles of the future. Such a curriculum advance has the potential to affect the Bay Area's 14 automotive training programs and help offer industry-tailored training throughout the region.[27]

In addition, the California Community Colleges system offers one of the most affordable higher educations in the country.[28] This is an important factor in a region with a high cost of living, especially for low-income residents and communities.

Numerous other programs and organizations exist across the Bay Area to empower job seekers with the skills and training to fill advanced energy jobs. GRID Alternatives (pictured) is worth noting for the free, equal opportunity solar panel installation training and experience if offers its volunteers. This training has helped volunteers secure jobs in the booming Bay Area solar industry.[29]

Collaborations to align open-entry education with industry needs are important in keeping California at the forefront of the innovative energy sector. They are also crucial in helping existing green-collar workers maintain a competitive edge and in extending opportunities to the future workers across our communities.

[25] Data and figures in this paragraph are from the Advanced Energy Economy Institute's 2016 Advanced Energy Employment Survey, Prepared by BW Research Partnership. Available: http://info.aee.net/advanced-energy-jobs-in-california-2016

[26] http://www.salary.com/how-much-cash-are-green-jobs-worth/

[27] See information presented by California Community College experts at Prospect Silicon Valley's 2016 Connected and Charged symposium: https://prospectsv.app.box.com/s/mod7ottocmj6pl6nxr4ptdh8in81mhun/1/8197184013

[28] https://trends.collegeboard.org/college-pricing/figures-tables/tuition-fees-sector-state-over-time

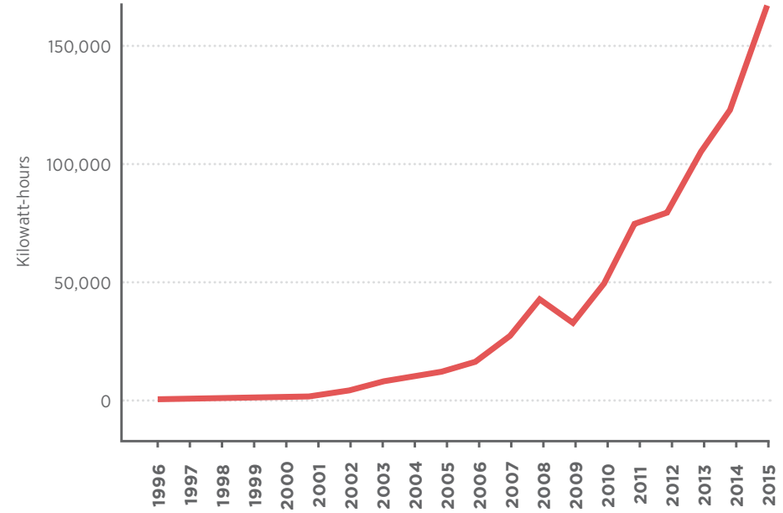
[29] http://www.thedailybeast.com/articles/2013/09/03/grid-alternatives-combats-poverty-by-installing-solar-arrays-on-roofs-of-low-income-households.html

FIGURE 7

Rooftop Solar Is Growing Exponentially

This chart shows new rooftop solar installed each year, expressed in total kilowatt-hours of energy produced. Every year, the nine-county Bay Area has added more and more solar panels, mostly on homes. Commercial, industrial, education and government applications are also growing.

Source: California Solar Initiative's Currently Interconnected Data Set: https://www.californiasolarstatistics.ca.gov/data_downloads/



Local Actions Matter: Learning from Near and Far

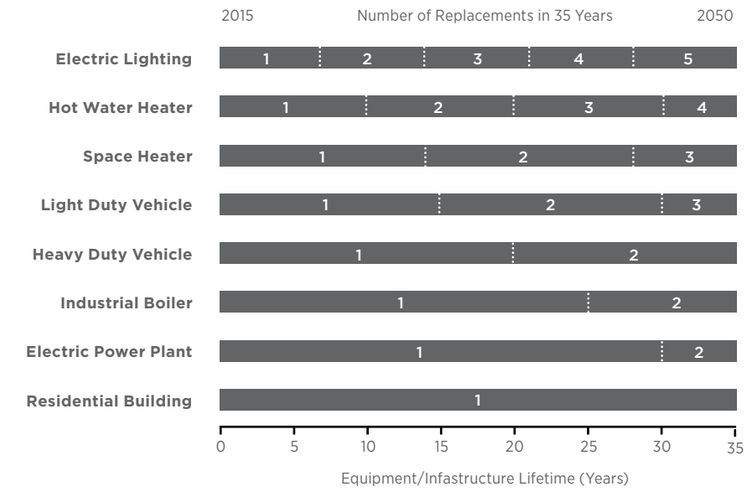
Throughout this report, sidebars highlight actions that have or will dramatically reduce fossil fuel use in the Bay Area and beyond. Although achieving success on stopping climate change and decarbonizing our energy systems may at times seem impossible, these stories attest that progress is attainable — sometimes in the very near term. In the 50-year arc of international and national environmental policies, significant changes have been made, with significant success, on problems that at first seemed insurmountable. We have dramatically reduced acid rain through a cap-and-trade program that began in the 1990s; we've banned lead, asbestos, ozone-destroying products, DDT and other pesticides from daily life; we've recovered numerous threatened or endangered species; and many cities provide municipal collection of recycling and compost — services totally unheard of 30 years ago. California's history of environmental progress is a model for the nation and the world: We were the first to establish air pollution control districts, the first to regulate vehicle fuel emissions, the first to establish a statewide recycling rule (which has increased waste diversion from 10 to 50 percent in just 25 years) and the first to regulate chemicals in consumer products. On climate change alone, California has world-leading policies on energy efficiency, renewable energy, vehicle fuel use, cap-and-trade and other areas of carbon policy (described in Figure 3) that should give us many reasons for optimism. Solving climate change is not the first, and likely not the last, environmental and cultural challenge we will face, but it is among the most urgent problems we need to address in our time.

FIGURE 8

Replacing Infrastructure to Get to Fossil-Free

Whenever energy-consuming lighting, vehicles, power plants or buildings reach the end of their useful lives, we have the opportunity to replace them with cleaner alternatives. We can ensure a continual shift to fossil-free investments if we do two things. First, we must make replacement investments with full consideration of lifecycle carbon emissions — emissions associated with any product through all stages of its life and usage. Second, we must remove barriers to adoption of cleaner technologies by reducing upfront costs, building supportive infrastructure and permitting them by code.

Source: Energy and Environmental Economics, Inc. (E3), LBNL, and PNNL, Pathways to deep decarbonization in the United States, November 2014, xvi.



Measuring the Region's Carbon Footprint

What's the carbon footprint of the average Bay Area household? The Bay Area Air Quality Management District, in collaboration with the CoolClimate Network at UC Berkeley, has developed a Consumption-Based Greenhouse Gas Emissions Inventory (CBEI) to identify potential policies for reducing greenhouse gas (GHG) emissions, assist cities' and counties' climate planning efforts, and educate residents about the size and makeup of their GHG footprint so they can take action to reduce their impact. While the Air District's traditional production-based emissions inventory measures greenhouse gases emitted within the Bay Area (see Figure 1 on page 5), the consumption-based inventory takes a more holistic approach by looking at the emissions associated with the production of goods and services consumed by Bay Area residents, no matter where they were made. The consumption-based inventory is intended to complement, not replace, the production-based model. Since our economy is globally integrated and a significant portion of the goods and services we use are made in other states or countries, this new outlook is key to fully comprehending our region's carbon footprint.

The CBEI examines emissions for several hundred categories of products consumed in the Bay Area. For each of the products studied within the sectors of transportation, housing, food, goods and services, the inventory takes into account its full lifecycle, from the emissions generated by the extraction of raw materials to the production, shipping, use and finally disposal of the product. The emissions for each category are then calculated by multiplying the average household expenditures for that category by the appropriate GHG emission factor. After calculating the emissions on a category-by-category basis, the CBEI adds them together to calculate the total GHG footprint for the average household within a given census block group.

Overall, the findings of the CBEI indicate that the GHG footprint of the average Bay Area household (44.3 metric tons per year) is smaller than that of the average American household (49.8 metric tons per year). This is primarily because residential electricity consumption in the Bay Area falls below the national average due to our moderate climate and because the electricity we consume is generated by cleaner sources. However, our lower total is somewhat offset by our higher levels of air travel and consumption of goods and services compared to national averages (likely due to our higher average incomes). Additionally, the CBEI notes that the GHG footprint in urban areas is smaller than that of suburban areas, suggesting that more compact development — which offers multifamily housing and the opportunity for people to walk, bike or take transit instead of drive — is a key decarbonization strategy for our region.

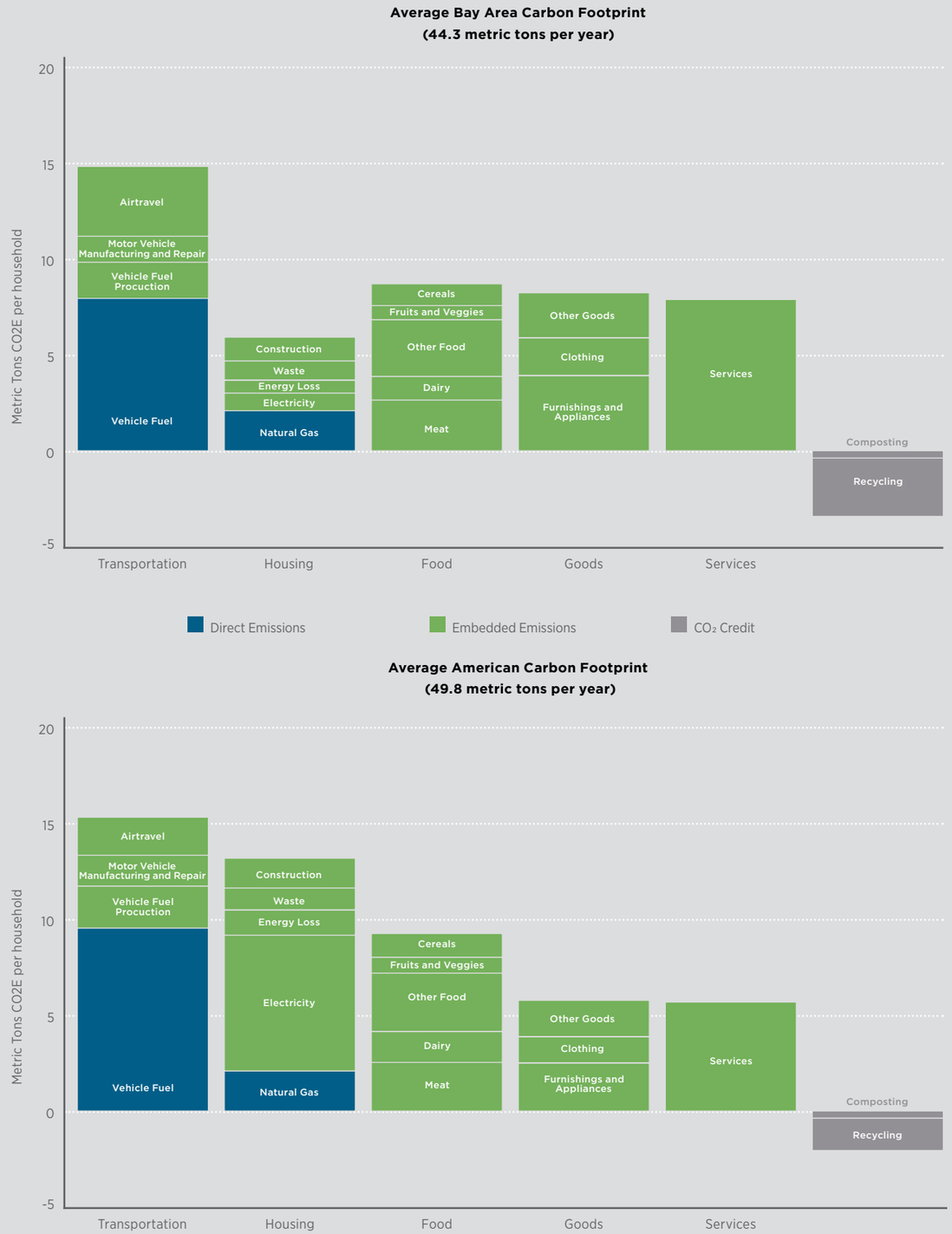


FIGURE 9 ▶

Household Carbon Footprints in the Bay Area and Nationwide

The average Bay Area household's carbon footprint is about 10 percent smaller than the average American household's footprint, owing to lower electricity demand for heating and cooling, cleaner electricity, less vehicle fuel consumption, and more recycling and composting. However, Bay Area households buy more goods, use more services and fly more than the average American household.

Source: http://www.baaqmd.gov/research-and-data/emission-inventory/consumption-based-ghg-emissions-inventory

BIG IDEA 1:

Consume Less Fossil Fuel

The quickest and least expensive way for the Bay Area to advance a fossil-free energy system is through efficiency — that is, consuming less fossil fuel while getting an equivalent level of service. Making our buildings, appliances, vehicles and transportation systems more efficient allows us to get the same or better levels of comfort and services while lowering energy and gas bills, cleaning the air and supporting a growing economy.[30] Public entities and utility customers benefit by not having to build new energy supplies, new highways or other supportive infrastructure; society benefits from cleaner air for the same or better economic output.

While this is a winning solution in theory, in reality efficiency can be hard to deliver and sustain. It involves getting many people to make behavioral and systemic changes, it can have high upfront costs, it requires enforcement and, in the end, its success can sometimes be difficult to measure. Overcoming these challenges involves creating incentives for changes in behavior and operations and setting standards that correct the problem of continued unabated fossil fuel use.

Local and regional opportunities to improve efficiency fall into two broad categories:

1. Improving the energy efficiency of buildings and the equipment inside them
2. Improving efficiency in the transportation system, mostly by reducing the annual number of vehicle miles traveled per capita

This chapter presents policy recommendations in these areas.

Vehicle fuel efficiency, or increasing miles per gallon, is of course a significant additional opportunity to improve overall efficiency of the transportation system. We do not devote attention to it in this chapter, however, because it is not something that can be meaningfully addressed at the local or regional level. Vehicle fuel economy standards are set at the federal level by the Environmental Protection Agency, which in 2012 allowed an exception for California to adopt even more stringent standards for its vehicle fleet by 2020. The Low Carbon Fuel Standard similarly aims to improve carbon efficiency through state level regulation of the fuel supply. It is not possible to regulate vehicle emissions more locally than that. Where local government or regional funding sources do have a role in supporting better vehicle efficiency is in rolling out infrastructure and incentives for electric vehicles. We address the opportunity of fleet electrification in Big Idea 2.

Improving Building Efficiency

Various state and federal policies advance minimum efficiency codes for buildings and standards for appliances; provide incentives for more efficient homes and buildings through customer-funded energy efficiency programs; fund research and development; and pilot demonstration programs, among other contributions. These activities, especially in California, have established a strong foundation that regional and local government action can go above and beyond. Local governments can leverage and support these efforts by setting and enforcing local building codes that go beyond those set by the state, launching public education programs and providing efficiency programs, especially for small businesses and middle- and low-income residents.

Building energy efficiency was expected to contribute at least 12 percent of the total anticipated greenhouse gas (GHG) reductions by 2020 under Assembly Bill 32 and will likely achieve this goal four years ahead of schedule.[31] However, continued progress will be even more important after that to meet the state's climate and energy goals, including reducing CO2e emissions 80 percent by 2050 and doubling energy efficiency in existing buildings by 2030. The California Public Utilities Commission and the California Energy Commission have set policy goals of zero-net energy buildings — buildings that use only as much energy as they produce — for all new low-rise residential construction by 2020 and for all new commercial construction by 2030. By Executive Order of the Governor, new state buildings must be zero net energy even sooner, by 2025, and 50 percent of existing state buildings must be zero net energy by 2025. These standards, combined with shifts of building energy consumption away from fossil fuels, sharply reduce carbon emissions related to building operations. One analysis found that achieving California's efficiency targets for new and existing buildings could avoid more greenhouse gas emissions by 2050 than any other single state climate policy.[32]

Existing buildings also have cost-effective efficiency opportunities that can be advanced by state agencies, California's utilities and local governments.[33] In California, 55 percent of residential buildings and 40 percent of nonresidential buildings were constructed before 1978, when energy efficiency standards were first required.[34] The California Energy Commission's 2015 Existing Buildings Energy Efficiency Action Plan (mandated by the California legislature) provides a 10-year framework to double energy savings in existing buildings — equivalent to a 20 percent reduction in total building energy use statewide by 2030. It calls on local governments to try innovative approaches to gather experience for wider application.[35] Existing buildings make up the overwhelming majority of the building stock, but since they are typically subject to fewer regulatory approvals, realizing efficiency gains will need a range of voluntary, incentive and regulatory approaches.

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New buildings in California are already required to be highly energy efficient, but local governments can support innovation toward net-zero construction by adopting more stringent standards and experimenting with outcome-based codes.

[30] A 2014 nationwide study of the cost of utility energy efficiency programs found that efficiency programs are the least-cost energy resource per dollar for both electricity and natural gas efficiency. http://aceee.org/sites/default/files/publications/researchreports/u1402.pdf

[31] NRDC and E2, 2015, p. 9.

[32] Jeffery B. Greenblatt, Modeling California policy impacts on greenhouse gas emissions, Energy Policy, 78 (2015), 158–172. Efficiency targets for existing buildings were developed by the CPUC in a Long Term Energy Efficiency Strategic Plan in 2008, advanced in 2009 with AB 758 and again in 2015 with the CEC's Existing Buildings Energy Efficiency Action Plan.

[33] Cost-effectiveness varies depending on who is making the energy infrastructure or usage decisions, what their ROI requirements are, what their other options for reducing CO2e are, whether lifecycle costs or triple-bottom-line costs are included and more. Each locality, utility or actor decides what criteria dictates cost-effectiveness for them and these criteria may differ.

[34] AB 32 Scoping Plan update, 2014, p.38

[35] California Energy Commission, Existing Buildings Energy Efficiency Action Plan, Sept. 2015, http://docketpublic.energy.ca.gov/PublicDocuments/15-IEPR-05/TN206015_20150904T153548_Existing_Buildings_Energy_Efficiency_Action_Plan.pdf

STRATEGY 1

Increase the energy performance of new buildings and improve code enforcement.

California adopted the nation's first state-mandated green building code in 2008. Known as CALGreen,[36] it covers residential and commercial buildings and is updated every three years, each time strengthening energy efficiency requirements for new buildings and major renovations and expanding coverage of what types of buildings must comply. The California Energy Commission, which adopts the energy efficiency standards part of CALGreen, expects the most recent standards (set in 2013) to reduce statewide GHG emissions by 215,000 metric tons annually.[37] Zero-net energy standards will be required by the energy code (and CALGreen) for all new low-rise residential buildings by 2020 and all new commercial buildings by 2030. A 2012 study for the state's utilities found that these standards are technically achievable for the most part, and that the technologies necessary to achieve zero net energy are widely in use today.[38] Much of the challenge lies in having enough available space for solar photovoltaic panels to offset building energy uses, especially for taller buildings in dense, urban areas. (See more on this in Big Idea 3.)

Recommendation 1: Establish high-efficiency standards for new buildings and major renovations, such as CALGreen Tier 1 or 2.

Who: City building departments, city councils to adopt ordinances

CALGreen includes voluntary "tiers" beyond the basic requirements that a city or county may adopt by resolution to spur even greener local building and demonstrate leadership in sustainability. This framework gives local jurisdictions flexibility while also setting "reach" goals that encourage cities or regions to innovate and exceed standards. In 2013, the Tier 1 and Tier 2 requirements exceeded CALGreen's mandatory minimum requirements for energy efficiency by 15 percent and 30 percent, respectively. Some Bay Area cities and counties have adopted Tier 1 requirements or linked their building codes with voluntary high-bar standards like LEED. These include San Francisco, Oakland, Palo Alto, Berkeley, Livermore and Sonoma County.

To require even more stringent standards, a city must prove cost-effectiveness to the California Energy Commission. This may make it difficult for California cities to adopt ultra-low energy codes such as the city of Brussels, Belgium, has done in adopting a "passive house" standard (about a 75 percent energy use reduction from average new buildings). Cities are not allowed to mandate the installation of more efficient equipment — such as heating and ventilation, water heaters and kitchen appliances — than federal and state government standards recognize. While more efficient equipment can be installed voluntarily, the Energy Commission's energy compliance software does not recognize any savings from these upgrades. In this context, voluntary zero net energy can be more readily implemented than a city's cost-effectiveness analysis, because people can choose extremely efficient appliances or obtain energy savings through plug-load reductions or other measures that can't be counted under current building energy standards.

Recommendation 2: To improve code enforcement, adopt recommendations made in the BayREN's compliance improvement best practices study:

- **Include energy code information in electronic permit tracking systems**
- **Require approved energy compliance documentation to be included on construction plans available at building sites, to improve internal consistency in plan review and inspection**
- **Reduce tolerance for changes from submitted project energy plans by requiring energy model updates when project scopes are significantly altered**

Who: City building and planning departments

Beyond adopting standards, local governments must also enforce the evolving energy code consistently, which requires diligence and resources, in order to ensure California's continued progress toward zero-net energy goals. The energy code and uniform building codes change every three years. The 2013 standards require new energy modeling, a new data registry and more. Unlike other parts of the building code (structural, fire, plumbing, etc.), energy measures allow for a performance-based approach, and thus offer many options for achieving compliance. Flexibility increases complexity and challenges even the most experienced code enforcement officials.[39]

A 2015 Bay Area Regional Energy Network (BayREN) review of nearly 50 building projects sampled from 15 Bay Area building departments found that only 16 percent of projects correctly met all the documentation requirements of the energy code at all stages of review. Some 51 percent of projects contained errors that indicated the building could perform worse than initial energy compliance documentation predicted. The most common discrepancies BayREN found stemmed from inconsistent interpretation and application of energy code. For example, the number and wattage of lighting fixtures indicated on plans differed from permits, mechanical equipment installed was lower efficiency than listed on permits and installed roofing did not meet roof reflectivity requirements.[40]

[36] Also known as Title 24, parts 6 and 11 of the California Code of Regulations.

[37] California Energy Commission, 2013 Building Energy Efficiency Standards, May 2012, http://www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF-REV2.pdf

[38] Pacific Gas & Electric Company and ARUP, "The Technical Feasibility of Zero-Net Energy Buildings in California," December 2012, http://www.energydataweb.com/cpucFiles/pdaDocs/904/California_ZNE_Technical_Feasibility_Report_Final.pdf, p. 6

[39] According to the Bay Area Regional Energy Network (BayREN), BayREN Codes & Standards Permit Resource Opportunity Program Final Report and Energy Code Resource Guide, April 2015, p. 9, https://www.bayren.org/sites/default/files/BayREN_CS_PROP_Final_Report_2015_0401.pdf

[40] BayREN 2015, p. 17.

Many Bay Area cities face a shortage of staff in building departments, especially since the last recession. Creative approaches are needed to optimize human resources and train staff. On a countywide basis, plans examiners from different cities could be pooled electronically, so that the varying work load is distributed over a larger workforce. Optimization and standardization of over-the-counter permits for such measures as water heater replacement shows promise. Pulling permits over the internet could mitigate the cost barrier of traveling to the relevant permitting office. Finally, jurisdictions could issue a joint request for proposals and award contracts to consulting firms that specialize in supporting building code implementation. Entities like BayREN, community choice aggregators (local government agencies that are electricity service providers) and PG&E Local Government Partnerships could work with Bay Area jurisdictions to enhance the human resources applied to code enforcement.

Cities should require regular energy efficiency assessments and performance-based retrofits for existing buildings, especially those built before energy codes were first developed in the 1970s.

Recommendation 3: Experiment with voluntary outcome-based building energy codes as a compliance pathway toward zero net energy and incentivize innovation by adopting priority permitting for projects that achieve high-energy performance through this path.

Who: City building and planning departments

Where capacity allows, local governments could prove to be valuable innovators in developing more effective and efficient approaches to improving building efficiencies.

An emerging idea is for cities to experiment with energy outcome-based codes for new buildings. Rather than requiring specific technologies, the idea is instead to mandate a measurable outcome like energy use intensity (EUI, a measure of energy use per square foot) calibrated by building type, usage and local climate characteristics. In theory, this approach could simplify enforcement while also encouraging innovation in building design. It could be readily adjusted toward zero-net energy goals and could expand the scope of energy codes to include currently unregulated energy loads, such as plug-in devices and cooking equipment.[41] And it could cover post-occupancy energy use, comparing a building's performance after its first year to its energy use design before construction. Bay Area cities could initially offer this approach as a voluntary alternative energy compliance pathway in order to test its validity and challenges

[41] http://aceee.org/files/proceedings/2014/data/papers/8-707.pdf


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and gain experience that could later be scaled up. Cities could offer the incentive of priority permitting for those projects that elect the more difficult alternative-compliance path and can demonstrate high performance.

While alternative compliance methods may prove resource intensive to develop and implement, jurisdictions with the capacity to take such measures could provide solid contributions to policymaking at the state and national level.

STRATEGY 2

Require systematic energy retrofits of existing buildings.

Thanks to progressively greener state and local building codes, new buildings in California are among the most efficient in the world. However, less than 2 percent of building stock, generally, is added or significantly renovated and brought up to code each year.[42] Because existing buildings are responsible for a significant amount of the region's consumption of electricity and natural gas, they must be retrofitted to become highly efficient if we want to attain the goal of becoming a fossil-free Bay Area.

A retrofit requirement would build on existing laws. Under state law,[43] utilities must provide building owners with energy use information for all multifamily buildings that have more than five utility accounts; large nonresidential and multifamily buildings greater than 50,000 square feet must likewise publicly disclose whole-building energy use. A San Francisco city ordinance has for several years required all buildings greater than 10,000 square feet to benchmark and publicly disclose building energy use annually and to undergo an energy audit or retrocommissioning every five years.[44] In 2015, Berkeley expanded upon this model, adopting benchmarking and energy audit requirements for commercial buildings, upgrading the city's existing time-of-sale requirements for residential properties to require assessment using a Home Energy Score and adding a program to follow up on these assessments and offering incentives to upgrade through Energy Upgrade California.[45] By contrast, San Francisco continues to require certain energy upgrades to be installed at the time of sale of residential properties. Known as the Residential Energy Conservation Ordinance (RECO), the San Francisco ordinance requires (and prior to 2015, the Berkeley ordinance required) that prescriptive measures supporting energy and water efficiency are installed or are already in place.

Bay Area cities can implement these higher-bar disclosure requirements and require the implementation of certain cost-effective measures. Building retrofit requirements should be based on energy performance information and should be implemented in a phased way over time: applying first to public buildings; second to large commercial buildings, major retrofit projects and residential multifamily buildings; and finally to smaller commercial and residential buildings. An energy audit should be required every five years, and all cost-effective measures should be required to be installed within one to two years.

Recommendation 4: Require regular energy efficiency assessments and performance-based retrofits for buildings that are more than 10 years old.

Who: City building, planning and public works departments to provide technical assistance; city councils to adopt ordinances; energy efficiency providers to audit/upgrade public buildings

Efficiency requirements for building retrofits could include some or all of the following policy options:

- Establish thresholds for energy benchmarking and disclosure that apply to smaller buildings and more classes of buildings than current state standards. This will improve access to building energy data for owners and occupants. The information can then be used to make energy upgrade decisions.
- Require regular energy audits and implementation of cost-effective upgrades, to be phased in over time by building class and size. Buildings that have the highest energy use, as evinced by benchmarking or energy ratings, should be upgraded first.
- Develop and enforce time-of-sale energy audit, rating and disclosure requirements for small residential buildings, which should include an energy performance test, a combustion safety test and a home energy score. These could also require near-term fixes, such as repairing any significant gas leaks and air sealing problems revealed by the performance tests within 90 days of a sale.
- Provide building owners with a "one-stop shop" for technical assistance with energy upgrade resources, such as utility customer-funded programs or other low-cost funding, and connect owners to programs such as those provided through BayREN, local governments, utilities (public or private) and third-party providers. For example, the PACE (Property Assessed Clean Energy) program now allows a property owner to borrow money for energy efficiency, renewable energy, water conservation and seismic improvements and pay these costs back over time through a special property tax assessment. In addition, the California Alternative Transportation and Advanced Transportation Authority, a unit of the State Treasurer's office, is now launching a suite of diverse financing options that leverages an investment of $65 million in utility customer funds as credit enhancements to attract private capital and the use of innovative repayment

[42] http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/business_case_for_energy_efficiency_retrofit_renovation_smr_2011.pdf

[43] AB 1103, replaced by AB 802 in 2015.

[44] AB 802 allows more stringent local ordinances like these to prevail in order to address smaller-sized and other classes of buildings. Retrocommissioning is a whole-building approach to improving how building equipment and systems work together to improve occupant comfort and energy savings.

[45] Energy Upgrade California is a statewide initiative to encourage energy savings and connect residents and businesses with energy efficiency programs, resources and rebates: https://energyupgradeca.org/en/


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Reducing the Inequities of Urban Air Pollution

Cities in air quality "areas of concern" (see Figure 2 on page 7) need to understand and address the burden of pollution on low-income people. People living in these areas and along heavily trafficked roadways throughout the region are sicker and more at risk of pollution-caused illnesses like asthma and cancer than the average Bay Area resident. To address and correct for these health inequities, low-income households in these communities and near major freeways should have low-cost pathways to address energy efficiency and improve air filtration and sealing. Mechanical air filtration is a known remedy for improving indoor air quality and could make immediate improvements in the lives of families impacted by asthma. The Air District could support a regional program or a set of city programs to evaluate heavily impacted air quality corridors and undertake healthy home retrofits to improve air filtration and sealing. Other state resources could be obtained to augment such a program, such as from greenhouse gas cap-and-trade auction proceeds that by state law must be directed into low-income communities. Cities could offer these resources through direct-install programs they currently run or through an outreach, education and concierge service such as we suggest in Recommendation 5.

Cities could also require new buildings near major roadways to include these air-improvement features from the start. For example, Article 38 of San Francisco's health code requires new residential construction projects in areas where models show poor air quality and pollution from roadways to install enhanced ventilation for every dwelling in the building.[46] Systems must be capable of reducing more than 80 percent of fine particulate matter within units. Generally the law applies to buildings within 500 feet of freeways and major roads, the area within which the California Air Resources Board recommends avoiding residential and other sensitive uses.

This idea is not about directly reducing or shifting fossil fuel use, but it could help address the inequitable impacts of the region's current fossil-fueled energy system — and it could be paired with the implementation of other building-efficiency strategies. Over time, as the quality of building stock improves, the need for such a program would hopefully diminish.

[46] https://www.sfdph.org/dph/EH/Air/Article38.asp

mechanisms (on-bill repayment) to offer new ways to fund energy efficiency projects for homeowners, tenants and commercial businesses.

- Lead by example: Ensure that all public buildings receive an energy audit and implement cost-effective upgrades within the next five years.

Recommendation 5: Support and accelerate energy retrofits for classes of buildings that have unique needs or may not be well-served by the efficiency market, for example, multifamily buildings and affordable housing.

Who: Cities, utilities, public housing providers, affordable housing owners and managers

Multifamily buildings have historically been one of the more complicated markets for efficiency programs, though they are already some of the most resource-efficient housing we have. They tend to be energy efficient on a per-capita basis, because their shared-wall geometry means less heating and cooling is lost to the exterior. They tend to be water efficient by having shared clothes washers and low outdoor water use. Their efficient form uses limited urban space to add density that supports public transportation and walkability.[47] But they are also very diverse in their physical configuration and usage and contain both common and private areas with a variety of individual and centralized systems. In addition, they suffer from split incentives, because frequently the economic benefits of efficiency do not flow to those responsible for investing in efficiency. In other words, renters may like to have more efficient clothes dryers to save on utility costs, but landlords are motivated to buy the cheapest dryer, not the most efficient one.

Multifamily buildings, especially those that provide affordable housing, need special technical assistance and resources to upgrade at various trigger points, such as when a unit turns over or when an owner undertakes a retrofit project that will require permits. Multifamily buildings especially benefit from whole-building evaluations and upgrades rather than piecemeal equipment replacements, which are typically offered through utility rebate programs. In recognition of the need for better-coordinated whole-building approaches to achieve energy and water efficiency,[48] in 2012–13 the California Public Utilities Commission authorized new multifamily energy upgrade programs to help address some of the identified challenges for this sector. This decision also included the funding of community choice aggregators and local government-led regional energy networks to complement utility programs to achieve deep energy efficiency, leverage multiple state and federal resources, and help hard-to-reach customers such as lower-income households and small businesses. These decisions resulted in programs such as the following:

- Since 2014, the BayREN has provided free energy consulting, cash rebates and access to low-cost financing to multifamily buildings in the Bay Area.[49] In its first year, the program improved the energy efficiency of more than 8,000 units by 15 percent or more and distributed more than $6 million in rebates. Common upgrades included heating/cooling/ventilation, hot water, air sealing, lighting and appliances.
- Marin Clean Energy, a community choice aggregator, has provided energy efficiency services to multifamily residences since 2012. These services include energy assessments (valued at $3,000–$5,000 each), energy and water saving measures for tenant units, technical assistance to solicit bids and develop a comprehensive scope of work for retrofits, and rebates averaging 25–60 percent of measure cost and with additional $25–$50 per-unit bonus incentives available. As of the end of 2015, Marin Clean Energy had audited 627 multifamily buildings, distributed more than $427,000 in rebates and provided 1,179 units with energy-saving equipment.[50]
- PG&E has evolved its technical assistance and incentives to help offset investment-grade audits and energy upgrades. The Multifamily Upgrade Program offers customized whole-building solutions, beginning at $600 per dwelling unit (when 10 percent of the building receives improvements) and escalating to $2,250 per dwelling (when 50 percent of the building is improved). In addition, the program has developed a new incremental path whereby property owners can complete upgrades when units turn over and receive a portion of the incentives in phases throughout the construction cycle. The incentives are designed to help offset a portion of the cost for these upgrades and to achieve deeper savings to the whole building.

These whole-building approaches have been successful so far and should continue to receive support from the state through ongoing authorization, expanded funding and regular evaluation to consistently improve effectiveness.[51]

Affordable and public housing are vulnerable to underinvestment and deterioration because maintenance and repairs are relatively costly and may be of low priority for building inhabitants and owners. Low-income rental housing may miss out on regular upgrades and energy-saving measures because of the split incentives between owners and occupants concerning facility investments and utility bills. But people with low incomes may especially benefit from energy efficiency improvements, as these can help lower utility bills and improve comfort even while access to capital and competing financial needs can make energy upgrades a low priority.

A promising solution to these barriers is direct-install programs. These concierge services help people navigate the complex process of identifying and implementing energy efficiency improvements and claiming rebates. This makes upgrades easier on the homeowner or tenant and may better enable a whole-building evaluation of opportunities. City government staff and community-based organizations tend to have deep knowledge of local communities and relationships with resource providers that work with lower-income communities. Because of this, local governments and their partners are well-suited to identify and reach out to potential lower-income and affordable housing sites with energy upgrade resources. They could go several steps further toward implementation by finding ways to help and partnering with utility customers to navigate the process through to completion.

Recommendation 6: Support programs, education, demonstration projects and energy performance monitoring to reduce plug-in and idle energy loads.

Who: Cities, utilities

Plug-in equipment and lighting are responsible for two-thirds of a typical household's electric use and make up a significant share of energy use in commercial buildings.[52] Yet much of this energy use is simply wasted as devices draw power even while not in use, a phenomenon known as "vampire" loads. Plug loads — energy uses from electronic equipment — are the fastest-growing use of electricity in buildings and will continue to grow as household devices increasingly become network-connected. Although they pose a significant barrier toward achieving zero-net energy buildings, they are generally unregulated by building codes. This is one reason we recommend that cities experiment with voluntary outcome-based building codes (rather than prescriptive ones, see Recommendation 3). It is also a reason for cities to support programmatic and educational efforts to help businesses and residents curb unnecessary energy use. Municipal programs like Energy Watch and regional programs like the BayREN could support plug-load reduction by analyzing smart-meter data, conducting outreach to attract participation and developing customized energy reduction plans. For example, the City of Mountain View's Energy Watch program signed up more than 2,000 people over three years and, through outreach and targeted recommendations, reduced overall electricity use by 6 percent and natural gas use by 16 percent.[53] Even larger savings accrued to larger users.

A promising nationwide pilot program to address plug load was launched in 2016, pairing the U.S. Environmental Protection Agency's Energy Star program with 15 utilities including PG&E. The program will provide utility customers with more energy-efficient

[47] SPUR wrote about the challenges and opportunities for upgrading multifamily buildings in our 2011 policy report Greening Apartment Buildings, http://www.spur.org/sites/default/files/publications_pdfs/SPUR_Greening_Apartment_Buildings.pdf

[48] In 2011, SPUR, the City of Berkeley (http://www.ci.berkeley.ca.us/multifamily/) and the Multifamily Home Energy Retrofit Coordinating Committee (MF HERCC) (http://www.multifamilygreen.org/hercc), convened by EPA and Alameda County, all released reports calling special attention to the challenges and opportunities of greening multifamily buildings.

[49] http://www.bayareamultifamily.org/sites/default/files/BAMBE%20workshop%20fall%202015.pdf

[50] Presentation at MCE's Board Meeting held March 17, 2016. Video available at https://www.youtube.com/watch?v=bd_J6QlQ1kI (starting at 1:41:25).

[51] Such as the 2015 recommendations delivered to the CPUC and program implementers by the MF HERCC: http://www.multifamilygreen.org/wp-content/uploads/2011/02/MF-HERCC-Report_January2015_FINAL.pdf

[52] NRDC Issue Brief, Plug-In Equipment Efficiency: A Key Strategy to Help Achieve California's Carbon Reduction and Clean Energy Goals, April 2015, http://www.nrdc.org/energy/files/home-idle-load-plug-in-efficiency-IB.pdf

[53] http://corp.hea.com/results/

CASE STUDY

Energy Efficiency on Private Property in Austin, Texas

Dozens of cities in the United States require municipal buildings to be audited annually for energy efficiency. But in 2009, Austin went beyond municipal buildings and required privately owned properties to perform audits administered by Austin Energy, the local municipal utility. First, large commercial buildings must report their efficiency ratings by June 1 of every year. Second, multifamily property managers must conduct yearly energy audits after their property turns 10 and release results to current and potential tenants. High-use multifamily properties (those that exceed 150 percent of average energy use) are required to upgrade and reduce their energy use by 20 percent.

Third, homeowners in Austin with homes older than 10 years are required to have an energy efficiency audit before listing their house for sale. A typical audit, which costs around $200 to $300, looks at air-conditioning systems, duct performance, air sealing in plumbing, weather stripping and attic insulation. City officials found 96 percent of audited homes received at least one energy efficiency recommendation. During the first year of the ordinance, 9,549 homes were sold that identified around 7,788,000 kilowatt-hours or 4,897 tons of carbon dioxide emissions in potential savings. (The homeowner or buyer would actually have to make the efficiency upgrades for the savings to happen.) While homeowners who fail to disclose their energy audit risk to potential buyers are charged with a misdemeanor, homeowners are not required to actually make the energy efficiency upgrades. Austin does provide financial incentives to encourage homeowners to do so.

Some homeowners and real estate agents complain that audits unfairly empower buyers to negotiate a lower price, even if they never actually make the upgrades after purchasing the home. Another criticism is that only 12 percent of homeowners in 2009 made the upgrades after auditing. Regardless, Austin Energy reported a surge in the number of efficiency rebates claimed by residents.

One clear benefit of the program: By requiring high-use multifamily building owners to improve energy efficiency, Austin will avoid having to construct a 700 megawatt power plant by 2020.[54]

[54] For more information on Austin's energy retrofit program: http://www.ci.austin.tx.us/edims/document.cfm?id=139825

Passenger cars and trucks are the largest source of fossil fuel emissions in the Bay Area.

options in the appliance and plug-load market. The pilot aims to capture a large volume of small energy savings by motivating retailers to promote, stock and demand more energy-efficient models not covered by state and national building codes. Scaling up this pilot could position California one step closer to achieving its goal of reducing plug load by 25 percent, established in its Long-Term Energy Efficiency Strategic Plan.[55]

Improving Efficiency in the Transportation System

Passenger cars and trucks are the largest single source of fossil fuel emissions in the region today, and their use grew 19 percent over the last 25 years.[56] The number of per-capita daily miles driven in the Bay Area has been fairly consistent over the last 15 years, averaging between 22 and 25 miles per day for the Bay Area as a whole,[57] and is even expected to decline 15 percent by 2030.

However, the Bay Area is expected to add 2 million people by 2040, and without deeper cuts in driving (measured in vehicle miles traveled, or VMT) this growth will overwhelm the transportation system with congestion. For this reason, transportation sources will still remain the biggest component of the region's emissions in 2050.[58] In fact, even with all California's policies to increase zero-emission vehicles, researchers at Energy Innovation found that VMT reduction is crucial in helping the state achieve its 2030 and 2050 emissions reduction target.[59]

If we want the Bay Area to be the least carbon-intense economy in the world, we must grow the region in a way that deeply reduces the need to drive while still providing people with convenient and affordable ways to get around. Seizing these policy opportunities will be the fastest way to decarbonize our region and confer immediate benefits such as better air quality, safer cities and improved mobility.

STRATEGY 3

Control sprawl by protecting open space, supporting infill development and increasing density in places served by transit.

Concentrating growth inside existing cities, where people can take transit, walk or bike, is a key goal of sustainable regional planning. It also allows undeveloped open space and farmland at the edges of the region to remain intact, where they support natural habitat, food systems, recreational opportunities and "ecosystem services" such as flood protection from wetlands and pollination from bees — functions society would otherwise have to fund. As SPUR has written and advocated for decades,[60] one of the most important ways we can improve transportation and land-use efficiency is by preventing further urban-edge development, especially the type of sprawling neighborhoods that require people to drive for every trip. The corollary to holding this line is the need to channel housing and job growth into denser, transit-served, walkable places, also known as infill development.

[55] http://www.energy.ca.gov/ab758/documents/CAEnergyEfficiencyStrategicPlan_Jan2011.pdf

[56] SPUR analysis of BAAQMD data, 2015.

[57] MTC Vital Signs, http://www.vitalsigns.mtc.ca.gov/daily-miles-traveled; counties range from a low in 2013 in San Franciso of 11 miles per day to highs of 30 miles per day in Marin and Solano counties.

[58] http://www.baaqmd.gov/~/media/files/board-of-directors/2015/agenda_14_preliminary-climate-protection-program-update-pdf.pdf?la=en

[59] Energy Innovation using E3 model of climate policies and GHG emissions from vehicles: http://energyinnovation.org/wp-content/uploads/2015/11/Moving-California-Forward-Full-Report.pdf

[60] *Agenda for Change* (2016), *Locally Nourished* (2013), *Getting to Great Places* (2013). Available at: http://www.spur.org

The idea that compact development near transit can reduce the carbon footprint of travel has been shown empirically through studies produced by the Urban Land Institute, the National Research Council and Australian professors Jeffrey Kenworthy and Peter Newman, who have researched and published on transportation policy since the late 1980s.[61] It has also been enshrined in California's state policy and climate framework in the form of Senate Bill 375 (2008), which requires each of the state's 18 metropolitan areas to reduce greenhouse gas emissions from cars and light trucks through coordinated regional transportation and housing growth planning. Plan Bay Area, the Bay Area's Sustainable Communities Strategy pursuant to SB 375, is a 30-year vision that aims to support the region's growth into priority development areas (PDAs), more than 170 places designated by local governments that will absorb 80 percent of new housing and 60 percent of new jobs on less than 5 percent of the Bay Area's land. (See Figure 10 on page 26.) The purpose of Plan Bay Area is to meet the Bay Area's targets under SB 375, including reducing per-capita VMT by 15 percent by 2030.

To ensure the vision of Plan Bay Area, local governments and regional agencies must enable people to have more and better transportation choices, rather than simply relying on driving for all or most trips. This means channeling investments into multiple modes of travel: transit, bicycling, walking. Cities must also permit much more housing to be built each year, especially in walking distance of transit, than many currently do.

Recommendation 7: Write zoning codes that direct high-density housing and jobs into priority development areas, especially within a quarter-mile of transit stations and stops.

Who: Cities and counties, planning departments

The region has written a blueprint for growth, but it can't be implemented unless cities write zoning codes that allow density in the right places. Zoning is how cities and counties determine the amount and density of housing that will be built. While local governments have near-exclusive control over this activity, regions and the state can intervene by offering incentives. To implement SB 375, for example, regional councils of governments assign cities and counties targets for how much housing they should build for different income levels. Then they distribute money for transportation projects to those whose zoning meets these targets. The state may also withhold grant funds from communities that do not adequately address housing in their general plans. Local governments that have control over zoning and land use must seize this tool in order to realize the region's vision of compact growth.

Recommendation 8: Make it easier to build new housing when it aligns with existing zoning that supports Plan Bay Area.

Who: Cities and counties, planning departments

In California, unlike in other states, individual development projects are often subject to case-by-case local approvals, which can especially encumber housing construction. Use and misuse of the local approval process has resulted in too little housing being built in areas that are experiencing job growth. A recent report by the state's Legislative Analyst's Office found that only a minority of communities in California have historically met home-building targets as established in their plans and zoning.[62]

[61] National Research Council, Driving and the Built Environment: *The Effects of Compact Development on Motorized Travel, Energy Use, and CO_2 Emissions—Special Report 298* (Washington, DC: The National Academies Press, 2009); R. Ewing and K. Bartholomew, et al., *Growing Cooler: The Evidence on Urban Development and Climate Change* (Urban Land Institute, Washington, DC, 2008); Newman and Kenworthy, *Sustainability and Cities: Overcoming Automobile Dependence* (Washington, DC: Island Press, 1999); *Newman and Kenworthy, Cities and Auto Dependency: A Sourcebook* (Aldershot, UK: Gower Publishing Co. 1989),

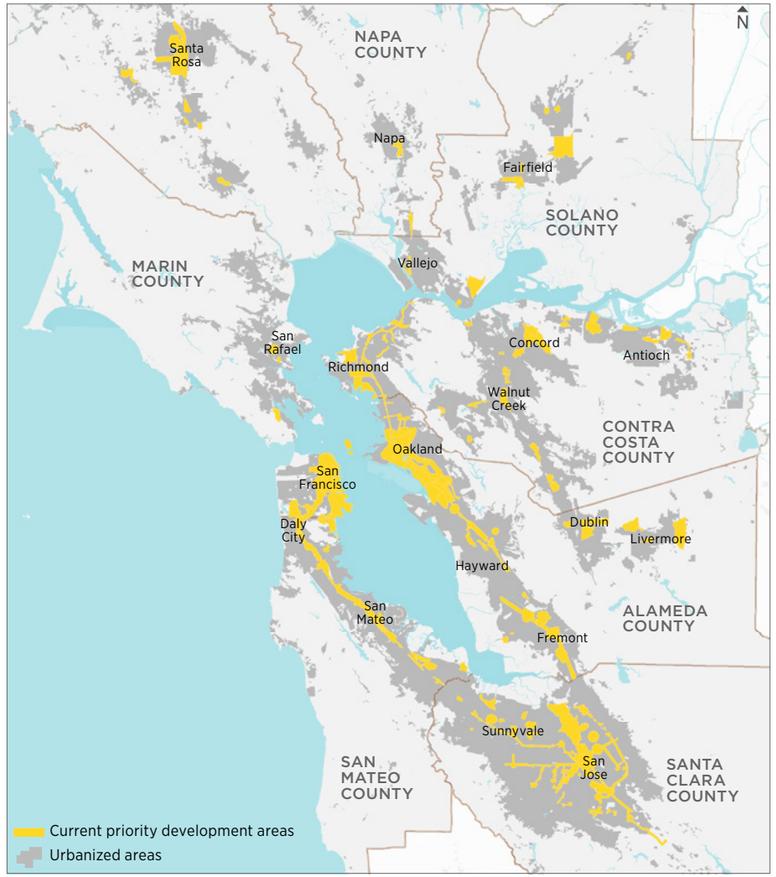
[62] http://lao.ca.gov/Publications/Report/3470

FIGURE 10

Where Will the Bay Area Grow?

Most of the region's growth by 2040 is projected to go into priority development areas, highlighted in yellow. If we can improve walking, biking and transit ridership in these places, as well as meet housing and development targets within them, we can accommodate the region's projected growth with a lower carbon transportation footprint.

Source: Association of Bay Area Governments' current priority development areas (as of July 2016): http://gis.abag.ca.gov/gisdata.html



This has resulted in a housing shortage (especially for those who can least afford housing) that is harming the state's economy and increasing pressure for sprawl development on the urban edge, where land costs are lower and the public process may be quicker. Since sprawl development leads to increased driving and greenhouse gas emissions, our failure to add housing can be viewed as worsening climate change while causing gentrification and displacement, as wealthier people outcompete poorer people for increasingly expensive places to live.

To address this, cities and counties should make approvals easier for new housing. Projects that align with local zoning codes should be permitted to proceed without requiring the additional approval of local elected officials. The idea of removing additional discretionary reviews is known as "by-right" or "as-of-right" approval. It consists of city staff reviewing a project's consistency with zoning, the general plan, design and building standards, and alignment with mitigations already approved in a California Environmental Quality Act review. (Many specific plans, neighborhood rezonings, general plan housing elements, station area plans and master plans are subject to CEQA review; projects that simply build out these plans and incorporate well-established urban design standards as better by city and county staff should not have to undergo their own separate reviews.) By streamlining the approval process, cities and counties could more quickly add needed infill housing and support building out the densities needed in the right places to implement Plan Bay Area.

Buildling housing and jobs near transit is a key way to improve mobility for people in the Bay Area while reducing the need to drive.

Recommendation 9: Protect existing open spaces, whether agricultural or natural lands, especially large, contiguous areas that contain high-quality farmland, ranchland or ecological habitat.

Who: Cities and counties, local agency formation commissions, open space managers, land trusts

Sustaining parks, open space, wilderness, watersheds and agriculture on the region's urbanized edge is as important to holding the line on sprawl as it is to sustaining our natural and cultural heritage, agricultural economy and biologically rich ecosystems. The region's open lands provide clean water and fresh local food, support recreation and livability, and host a broad variety of native plants and animals, many of which are endangered or threatened.[63] Furthermore, both agricultural and natural ecosystems can play a significant role in carbon sequestration, providing ecosystem services that would be lost should agricultural or natural areas be converted to development. For example, recent research in grazing lands in Marin County has demonstrated methods to increase carbon sequestration in rangeland soils at a rate that, if replicated across the entire state's rangelands, could sequester as much as 42 million metric tons of CO2e, an amount equivalent to the annual GHG emissions from energy use for commercial and residential sectors in California.[64]

As SPUR wrote in *Locally Nourished: How a Stronger Regional Food System Improves the Bay Area* (2013), many tools are available to restrict the types of development in the region's remaining contiguous open spaces and agricultural areas while creating long-term economic stability that affects land value and farm stability. Land acquisition, easements, zoning, transfer of development rights, tax incentives and mitigation fees are all ways that cities and counties can protect open space while encouraging development in the right places. This is important, as the Bay Area has lost more than 200,000 acres of farmland in the last 30 years, with some parts of the region more acutely affected than others: Between 1984 and 2010, Sonoma County lost 5 percent of its farmland and ranchland, while Santa Clara County lost 45 percent.[65] Agricultural land at the region's urban edge is the most at risk of loss to development in the next 30 years, especially in Sonoma County, east Contra Costa County and southern Santa Clara County.

[63] The Conservation Lands Network has produced numerous reports, including "Golden Lands, Golden Opportunity," providing recommendations about priority conservation landscapes and protecting the region's greenbelt: http://www.bayarealands.org

[64] R. Ryals and W. Silver, "Effects of organic matter amendments on net primary productivity and greenhouse gas emissions in annual grasslands," Ecol. Appl. 23 (2013): 46–59. See also Marin Carbon Project at http://www.marincarbonproject.org

[65] *Locally Nourished*, page 12. : http://www.spur.org/publications/spur-report/2013-05-13/locally-nourished

The Benefits of Walkable Urbanism

Sustainability

Urban dwellers consume far fewer resources and emit far less carbon than their suburban counterparts. Urban environments provide more activity in less space and facilitate access by foot, bike and transit. They save resources in transportation, energy, heating and cooling, and their compact physical footprint preserves land for open space and agriculture.

Mobility and Access

Compact mixed-use areas facilitate "access by proximity," resulting in less driving and more walking, cycling and transit use. Density supports transit ridership, allowing for improved service. Walkable environments also support access and independence for people with limited mobility, including the elderly, the disabled and those without access to a car.

Prosperity and Economic Development

Many of today's most dynamic firms and workers — particularly in the knowledge and innovation sectors — are favoring urban lifestyles and amenities. Attractive and memorable places become self-reinforcing, drawing new investment and sustaining long-term value.

Public Life

Compact urban neighborhoods offer public places for people to interact with one another, to gather together and to build community. These activities create a positive sense of place and interconnectedness. Research has shown that people living in walkable neighborhoods trust their neighbors more, participate in community projects and volunteer more than those in less walkable areas.[66]

Public Health

Americans' sedentary lifestyle and the associated epidemics of obesity and chronic disease have been repeatedly linked to the auto-dependent built environment.

Social Equity

Where suburbs are heavily privatized, urban environments rely on public amenities like transit and open space, which are available to everyone. Not only is this more efficient, but it's also more inclusive. Although urban areas can be expensive, suburban settings are especially punishing for low-income people, who find extremely limited housing and mobility options and can face spatial, social and economic isolation.

Source: SPUR, *Getting to Great Places* (2013). Available at: https://www.spur.org/sites/default/files/publications_pdfs/SPUR_Getting_to_Great_Places_spreads.pdf

STRATEGY 4

Make communities walkable, bikeable and transit accessible.

In order to become fossil-free, we must increase walking more than any other transportation mode. Whether a neighborhood is "walkable" is a measure of its urban design: When buildings, streets and open space are organized into places that work well for people, most of them will choose to walk rather than drive. Walkable cities have many benefits. (See sidebar at left.) Among those most important for achieving a fossil-free region are their resource and land use efficiency (versus sprawling, unwalkable environments) and how they make it easy to get around by foot, bicycle or transit.

SPUR has identified seven key ways urban design can support walkability:[67]

- Create fine-grained pedestrian circulation by making city blocks small and providing frequent crosswalks.
- Orient buildings toward streets and open spaces.
- Organize uses (retail, housing, parking, etc.) so they support public activity.
- Place parking behind or below buildings.
- Address the human scale with building and landscape details.
- Provide, clear, continuous pedestrian access.
- Build complete streets with space for bikes, transit vehicles, pedestrians and cars.

Despite its many benefits, walkability is hard to execute. Compact infill development is already harder to plan and build than greenfield or sprawl development: It typically involves more complex sites, higher land and construction costs and greater public scrutiny. Making places walkable involves a host of jurisdictional authorities all making coordinated decisions about streets, the placement and form of buildings, parking, open space, stormwater management and more. But these investments pay dividends for everyone — residents, workers and businesses.

[66] Rogers, Shannon H. et al. "Examining Walkability and Social Capital as Indicators of Quality of Life at the Municipal and Neighborhood Scales." University of New Hampshire, 2010, available at: http://link.springer.com/article/10.1007/s11482-010-9132-4

[67] SPUR, *Getting to Great Places* (2013). Available at: https://www.spur.org/sites/default/files/publications_pdfs/SPUR_Getting_to_Great_Places_spreads.pdf

Recommendation 10: Ensure that infrastructure investments improve walkability where growth is planned, particularly in priority development areas, and require places that are accommodating growth to meet benchmarks for walkability, bikeability and transit access.

Who: Metropolitan Transportation Commission (MTC), county congestion management agencies (CMAs), ABAG

The region's urban core has rich public transit access, and the urban form of many cities is conducive to walkability, even if not necessarily inviting at present. To build on their good bones and become truly walkable, cities need investments in sidewalks, transit facilities and access, and street improvements that facilitate safety and comfort while walking or bicycling. Designing for walkability requires more care than simple zoning and extends into thoughtful design of the built environment with a mix of uses, development of public spaces, provision of local alternatives such as bike shares or shuttles, and human-centered design.

Our fastest-growing places should reduce driving by design, especially to facilitate other travel modes like walking and biking for shorter errands, which typically make up 80 percent of vehicle trips.

Recommendation 11: Do not fund new transportation capital projects and system expansion projects that increase per-capita vehicle miles traveled.

Who: MTC, CMAs and other transportation system funders

Plan Bay Area forecasts about $57 billion to be available over the next 30 years for discretionary funding: resources that are not already committed to a specific project. While the vast majority ($45 billion) is for maintaining the existing road and transit network, there is still some flexibility in how these funds are actually used. Additionally, while less than 1 percent is set aside specifically to combat climate change, all the funds can be more effectively used as part of a broader fossil-free vision for the region.[68] Some of the funds are made available for complete streets project grants to communities that have agreed to accommodate housing growth.[69] But all proposed grants and projects should be evaluated on the basis of how much they reduce per-capita VMT and, by extension, fossil fuel use. We should not be spending regional resources on projects that increase VMT or otherwise increase fossil fuel usage.

To additionally support places that are undergoing rezoning to add density and take on jobs and housing, the region's planning agencies should develop benchmarks that set a high standard for making these places walkable, bikeable and transit accessible. The benchmarks should be included in Plan Bay Area. Without adding transportation choices and modes of travel that reduce driving, increasing density will only worsen congestion and decrease livability. These places should become outstanding examples of how people can get around without the need to drive for all trips.

[68] http://planbayarea.org/about/faq.html

[69] Complete streets are designed for safety and access for pedestrians, bicyclists, drivers and transit riders of all ages and abilities.

Sergio Ruiz

Sergio Ruiz

Recommendation 12: Retrofit the region's smaller neighborhood centers for walkability and bikeability — and create more of them.

Who: City and county planning agencies, CMAs, transportation departments

As mentioned earlier, most of the region's growth in the next 30 years will be channeled into priority development areas. By definition, PDAs are locally nominated, have a minimum level of transit frequency during peak commute hours and are accepting new growth, particularly of housing. But the designated PDAs do not constitute the Bay Area's entire universe of places deserving attention and investment. Many existing communities, especially those outside PDAs, could benefit from having more walkable neighborhood centers. Examples include Oakland's Dimond District; the downtown areas of Orinda, Lafayette, Kensington, Los Gatos and Menlo Park; the cities of Martinez, Rodeo and Pittsburg; and San Jose's Little Saigon, East San Jose, Willow Glen and Alum Rock neighborhoods.

Even areas that are not growing or well-served by transit can become more urban, more walkable and more bikeable, thus helping to reduce vehicle trips and creating healthier communities. Retrofit projects that support walking and biking to neighborhood centers include adding sidewalks, crosswalks, pedestrian signals, landscaping and lighting, painted bike lanes, bike signals and route signs; physically separating bikeways; and providing bike parking and/or a supply of shared bikes.[70]

Recommendation 13: Expand bicycle networks within and between suburban areas and urban centers.

Who: MTC, CMAs, city and county planning and transportation agencies

Bicycling uses much less energy than any other form of transportation (even walking), which makes it a superior fossil-free transportation choice. Most of the places where people live and work are within biking distance — a few miles — of local and regional transit networks, as well as retail and other daily life needs. However, the region's bicycle network is insufficient to make these trips a regular part of most people's daily lives, and this is reflected in the numbers: Only 2 percent of Bay Area commute trips are made by bicycle.[71] Improvements to bike infrastructure, such as physically separated lanes, complete or shared streets and secure bike parking, will be necessary for more people to feel safe and comfortable biking. Besides public improvements in bike infrastructure, large private developments, neighborhood shopping districts and corporate campuses can do their part by providing secure bicycle parking and even shareable bikes to speed travel and encourage people to try bicycling. Electric and three-wheeled bikes could be especially helpful in hilly places, for carrying cargo or children, and for people who are less active.

Walking and biking are modes of travel that can be endlessly accommodated: There is no upper limit or public cost to adding trips. Meanwhile, there is great public benefit — less congestion, cleaner air and improved safety — if more people travel by these modes. It is important to shift some travel demand in the region to these modes that have no supply-side constraints.

Recommendation 14: Build a great transit network by investing in places with high ridership potential.

Who: MTC, CMAs, city and county planning and transportation agencies, transit operators

The low-density development that characterizes much of the Bay Area makes it difficult to serve with transit, because there aren't enough riders in any one place to provide transit service cost-effectively at a frequency that would enable people to use it for daily needs. But even where the Bay Area's cities are dense enough to support transit, many people still choose to drive because service can be infrequent, slow, confusing and poorly integrated. With more than two dozen different operators, the system is fragmented and underutilized in some places while peak-time service on Caltrain, BART and some Muni lines can be extremely crowded and uncomfortable.

To accommodate regional growth while increasing viable transportation choices, the region must invest in making transit easier and clearer to use. This involves unifying the transit experience across operators with accessible maps, scheduling,

[70] We use "bikeable" as a proxy for many kinds of no-carbon personal mobility options, including electric bicycles, three-wheeled bikes, cargo bikes, scooters, e-skateboards and other types of human- or human-and-battery-powered vehicles that may not yet exist.

[71] http://www.vitalsigns.mtc.ca.gov/commute-mode-choice


flickr user Tony Webster

CASE STUDY

Scaling Up Cycling in Copenhagen, Denmark

Copenhagen is the gold standard for city planners trying to solve today's transit challenges with a simple 200-year-old machine, the bicycle. In the early 2000s, Copenhagen's urban planners decided to create a bicycle-first policy. The goal of Cykelpolitik was to increase the portion of the workforce that cycles to work by improving the safety, traveling speeds and comfort of biking in the city. Copenhagen achieved its goal in under a decade. How? The city's cycle-friendly policy steered away from trying to attract car drivers to big, glittering infrastructure like London's proposed Bicycle Super Highway, a glass sky bridge for bicyclists. Instead, Danish planners went for simple, straightforward micro designs that, despite being small, profoundly changed the urban landscape to make cycling the most common-sense option. Here's what they did:

- **Physically separated bike lanes:** Beginning in the 1980s, the city began building dedicated bike lanes that provide safety for bicyclists of all ages and abilities by separating their travel paths from other vehicles. Today, the city's streets have more than 217 miles of them and the city plans to add another 85 miles by 2025.
- **"Green wave" signal technology:** Traffic lights are coordinated to allow cyclists to flow into the city with minimal stopping; if a cyclist rides at a certain speed, he or she will never need to stop for a traffic signal. On certain paths, LED lights embedded in the asphalt help cyclists keep their speed in order to catch the green light at the upcoming intersection. Radar signs remind cyclists to maintain a speed of 20 km per hour in order to "surf the wave."
- **Footrests and railings:** Installed at intersections, they allow cyclists to wait for the light to change without the irritation of putting their foot down.
- **Intersection redesign:** Protected bike lanes run right up to the intersection, while stop lines are pulled back for cars.
- **Wider cycle tracks:** Wider tracks allow multiple lanes for biking, so faster cyclists can overtake slower ones.
- **Information screens:** Digital signage indicates current estimated arrival times to major destinations, with car and cycle ETAs listed side by side.
- **Track improvements:** Smoother asphalt on the cycle tracks, improved snow clearance and sweeping, and added services along the route such as air pumps make cycle tracks more inviting.

Overall, the micro design policy worked. Resident behavior quickly transformed: Car traffic dropped by 10 percent, cycling increased by 20 percent and 41 percent of the population now arrives at work or school by bike. Currently, cycling competes closely with public transit and individual cars when it comes to saving time. Nearly half (48 percent) of Copenhagen cyclists say the main reason they choose biking is that it's the fastest and easiest way to get around and to meet their daily needs.

Looking ahead, Copenhagen is expanding this work into neighborhoods with lower rates of cycling. New technologies are being added to the green wave, such as sensors that can register a group of cyclists riding together and keep the light at the intersection they're approaching green for a little longer. There are still more bicycles in the city than bicycle parking spots, which Copenhagen aims to resolve by 2025 by working with local businesses, schools and employers to add bicycle facilities and parking. These simple changes show that scaling up bicycling safety and facilities can radically move a city away from fossil fuel dependency.[72]

[72] For more information: Mikael Andersen-Colville, "Innovation in, lycra out: what Copenhagen can teach us about cycling," The Guardian, Oct. 16, 2014, http://www.theguardian.com/cities/2014/oct/16/copenhagen-cycling-innovation-lycra-louts-green-wave-bike-bridges; and City of Copenhagen, Roads and Parks Department, "Cykelpolitik 2002–2012 City of Copenhagen" (2002), http://www.cycling-embassy.org.uk/sites/cycling-embassy.org.uk/files/documents/413_cykelpolitik_uk.pdf

fares, station design and marketing.[73] It also involves investing in frequency, infrastructure and reliability in the places that have the highest ridership and the potential to attract new riders. Only 3 percent of all Bay Area trips are currently made by transit. We need to significantly increase this number to achieve our goal of a fossil-free, efficient transportation system.

STRATEGY 5

Use policy and pricing tools to make less carbon-intensive modes of travel easier, safer and cheaper than driving.

Parking and roadway space are limited resources, as anyone who has traveled by car through the Bay Area can tell you. Unmanaged, the infrastructure we have today will only grow more crowded as we add people and jobs to the region. But expanding highways and creating more free parking will not solve this problem. They will only make it worse: Adding capacity to roads actually generates more traffic,[74] and readily available parking encourages driving. Meanwhile, if roads are filled with cars, then lower-carbon modes of travel such as transit, cycling and walking can be slower and more expensive and can feel less safe. We not only need to make choosing these modes easier, we also need to level the playing field by reducing the subsidy currently provided for driving in the form of free roadways and parking. To that end we recommend the following actions.

Recommendation 15: Eliminate minimum parking requirements and implement demand-based pricing for commercial parking.

Who: Cities, CMAs, private parking providers

Most cities in the Bay Area currently require developers to build a minimum number of parking spaces for each new unit of housing. This can result in building too much parking, especially garage-type parking in dense, urban locations where it is expensive to build and likely to be underused because of low car-ownership rates. The requirement to build parking not only encourages driving, it also makes construction more expensive, which results in higher housing costs for residents. It especially limits the provision of affordable housing by increasing the cost to build each unit and decreasing the number of housing units that can fit on a particular site. In addition, it forces low-income households, who often do not own cars, to subsidize parking for everyone else.

A 2014 study of 68 affordable housing developments in the Bay Area found $136 million worth of underutilized parking, making up more than a million square feet of space.[75] Especially near transit stations and in dense, walkable places, parking ratios can be much lower than one unit per space. The state is making progress in this area: Assembly Bill 744 (2015) establishes a parking "maximum" of 0.5 parking spaces per unit for low-income rental housing or senior housing within a half-mile of a major transit station. (Cities may allow exceptions if they have a recent parking study that indicates a shortage.) But even projects that don't have a significant affordable component should be able to build less parking if the developer can justify it and the project is near transit. Parking should be managed and built as a separate commodity from housing; this decoupling can only happen if minimum parking requirements are eliminated so parking can be negotiated on a project-by-project basis.

Demand-based pricing for commercially and publicly provided parking is a good strategy for extracting more efficiency from the transportation system. Overpriced parking can give travelers incentives to use other modes of travel, such as transit, for regular trips, but it can also contribute to loss of business. Underpriced parking can lead to excessive driving — people driving around too much while looking or waiting for spots — and inadequate availability of parking, which can also lead to loss of business. Technologies that monitor supply and demand, and can vary rates accordingly to maintain adequate availability, are now mature and can be readily implemented. This type of parking management should be implemented in commercial corridors, parking garages and other areas with high visitation to reduce congestion and emissions while helping to pay for management services and facility maintenance.

Recommendation 16: Establish congestion-adjusted tolling for major highways, roads and bridges.

Who: MTC, Bay Area Toll Authority, CMAS

Just as we should do a better job pricing parking, we should likewise price roadways to reflect the true costs of driving in the Bay Area. SPUR has written many times about the benefits of road pricing, especially the practice of tolling existing lanes rather than expanding highways to add new ones.[76] Expansion of road pricing could quickly increase road capacity, reduce congestion, encourage modes of travel other than driving, speed up and improve the reliability of transit and goods movement, and reduce emissions and dependence on fossil fuels. As the region's vehicle fleet gets better gas mileage and electrifies, and as autonomous vehicles start to enter the fleet, revenue from gas taxes may decline. Road pricing will become an ever more important stable revenue source for road maintenance and to provide transportation alternatives. Current technologies enable tolls to be charged and enforced through toll tags and license plate photo capture. In the future, increasingly automated vehicles could be charged road user fees on a per-mile, congestion-adjusted basis. Variable-rate road pricing — which would fluctuate with congestion — should be implemented over time in the following order of priority:

[73] SPUR's report *Seamless Transit* describes the challenges and opportunities in depth. Available at: http://www.spur.org/publications/spur-report/2015-03-31/seamless-transit

[74] http://www.vtpi.org/gentraf.pdf and http://www.wired.com/2014/06/wuwt-traffic-induced-demand/ and reporting on a new Caltrans study: http://www.citylab.com/commute/2015/11/californias-dot-admits-that-more-roads-mean-more-traffic/415245/

[75] TransForm, GreenTRIP database, http://www.transformca.org/greentrip/parking-database and http://www.transformca.org/transform-blog-post/ab-744s-paradigm-shift-affordable-homes-instead-empty-parking-spaces

[76] For example, *Freedom to Move*, July 2014: http://www.spur.org/publications/spur-report/2014-07-17/freedom-move

CASE STUDY

Reducing Drive-Alone Commutes at Stanford University

The San Francisco Peninsula has long been home to a growing number of jobs, yet it is not settled densely enough for most commute trips to be taken by transit, bicycle or foot. As a result, the area experiences chronic traffic congestion. In 2000, when Stanford University was working on an expansion plan, the Santa Clara County Board of Supervisors established an agreement with the university to ensure that peak-hour vehicle trips would stay at current levels or decrease. In response, Stanford embarked on a transportation demand management (TDM) program to manage the commutes of more than 11,000 employees, 8,500 hospital staff and 15,000 students. Since then, Stanford has developed the most comprehensive university TDM program in the country.

Stanford's TDM program addresses transportation in multiple ways:

- Marguerite Shuttle System: The university shuttle system provides free transit around campus and to neighboring communities and connects Stanford to major public transit services including VTA buses, SamTrans and Caltrain. Stanford's Marguerite shuttle has 206 stops and 26 routes and is free to the public. The fleet consists of 87 buses, vans and shuttles, including 27 ecofriendly buses running on either electric or diesel-electric hybrid power. Ridership increased by 285 percent between 2004 and 2015, to 3.1 million rides a year.
- Commute Club: The Commute Club is made up of commuters who agree not to drive alone as their primary commute to campus. In exchange, they receive up to $300 a year in cash payments, free daily parking passes for carpools, reserved parking spaces for ridesharing, free vanpools, free emergency rides home, free rental car vouchers and Zipcar driving credits, and more. From 2002 to 2016, membership increased 165 percent, to more than 9,000 members.
- Parking: Stanford increased the cost of parking, which has been a disincentive to commuting alone by car. Between 2001 and 2016, the annual cost of parking permits increased substantially, from $124 to $360.

Steve Castillo

- Car sharing: Stanford has one of the largest university Zipcar fleets in the country, with more than 60 vehicles at more than 20 Stanford locations. All members of the campus community may join the program at a discount.
- Biking: Stanford built an extensive bicycle infrastructure with miles of bike lanes and more than 19,000 bike racks. Stanford's bike program staff manage bike and clothing lockers, provide safety information, register bikes and offer subsidies for purchasing folding bicycles and bike helmets.
- Regional transit subsidies: Almost all university and hospital employees receive free passes for regional transit systems, including Caltrain, VTA buses, express buses and light rail, and they receive a 50 percent discount on Altamont Corridor Express (ACE) trains. All Stanford affiliates ride for free on AC Transit's East Bay Express line, which connects the campus to BART. Roughly 24 percent of employee commuters used public transit as their main form of commuting in 2015.

The program is paid for by parking fees and other fees that Stanford levies on campus building developments.
The wide range of TDM programs transformed commuter behavior and resulted in single-occupant car trips dropping from 72 percent of all trips in 2002 to 50 percent in 2015. Stanford reduced commute-related emissions by 24 percent between 2002 and 2012. The university also saved $152 million in avoided construction costs for new parking spaces.[77]

[77] All information per email conversation with Stanford University TDM Program outreach manager, August 26, 2016.

Noah Berger

Congestion-adjusted tolling on highways and bridges can increase road capacity, reduce traffic, encourage modes of travel other than driving and reduce vehicle-related fossil-fuel emissions.

- Toll bridges at an appropriate, congestion-based price to eliminate traffic queueing. The current $4 to $6 range is not high enough to discourage driving, especially during peak periods. Using a price signal to shift driving to other travel modes, like transit or carpooling, or to a different time of day would vastly reduce traffic congestion. Adding tolls to bridges in currently unpriced directions, such as eastbound on the Bay Bridge and Dumbarton Bridge, would also eliminate queueing and congestion.
- Add tolls to all lanes on Highway 101 and manage the roadway to eliminate congestion. In addition to congestion relief and reduced emissions, this would have the co-benefit of funding Caltrain and capacity improvements in the crowded Peninsula corridor.
- Use means testing, based on license plate capture, to allow low-income people to pay reduced or even zero fees. Means testing assesses whether a person's income is low enough to enable them to qualify for assistance. Eliminating or reducing increased fees for driving will help correct the regressive impact of implementing road pricing.
- Use revenues from tolling to support alternative transportation in communities that do not have reliable transit and are unlikely to receive it soon. In addition to walking and biking investments that benefit everyone, congestion management agencies could support mobility for low-income people through subsidizing car-sharing, carpooling and even private taxi services like Lyft Line and UberPool.

Recommendation 17: Implement an indirect source rule to require new development to significantly reduce the number of new vehicle trips it will generate.

Who: Bay Area Air Quality Management District

An "indirect source" is a category of air pollution that comes not from a traditionally regulated "direct source" like a smokestack but rather from land development, construction and the new vehicle trips generated by these activities. In California, the San Joaquin Valley Air Pollution Control District has enforced an indirect source rule since 2006 to reduce smog and particulate pollution in the valley. It works by requiring new projects to model construction impacts and automobile-related emissions and then mitigate those emissions to a required level through tools such as commuter benefits or parking cash-out programs.[78] Developers must pay a fee to support emission reductions offsite if the requirements cannot be met onsite through mitigation. The Bay Area could use such a tool to reduce emissions from driving and to raise revenue that could be pooled to support offsite emissions reductions, such as improving transit or walkability.

[78] Commuter benefits are subsidized transit/alternative mode transportation checks passed from employers to workers and are tax-free up to a certain amount. A parking cash-out is a program that pays commuters who have access to free parking to not use it; it typically influences travel behavior at about $5/day.

Recommendation 18: Reduce vehicle use by adopting vehicle trip caps in megaproject developments.

Who: Corporate campus managers, cities, CMAs, master developers

Places that are preparing for housing or job growth through specific plans or rezoning can and should accommodate it without generating significant additional VMT. Besides adopting urban design standards and complete street designs that encourage walking, biking and transit, such plans can discourage single-occupancy vehicle trips by requiring employers and building owners to provide secure bicycle parking, bikes for sharing, priority parking and subsidies for carpools and vanpools, employer-sponsored shuttles and more. Another tool is to set a vehicle "trip cap," which specifies a maximum allowable number of vehicle trips that can originate in an area during a window of time. For example, the Mountain View North Bayshore Precise Plan[79] establishes a morning peak period vehicle trip cap, requiring new office and housing development in the area to demonstrate that 45 percent of inbound trips are made by single-occupancy vehicles and 10 percent are made by carpool. The cap could eventually enable a trading system among employers, encouraging competition and innovation in demonstrating ways employees can get to work without driving alone. It also enables densification and better land use without diminishing mobility and quality of life for existing residents and businesses. This recommendation works best in institutional settings like corporate campuses and community benefit districts, where programs and policy ideas can be managed and staffed at a large scale.

Recommendation 19: Implement policies and regulations to get the most benefits from autonomous vehicles.

Who: MTC, CMAs, cities

While traditional car ownership will persist into the future, various types of autonomous vehicles[80] are on the horizon and are likely to be commercialized in the near future. Because they reduce barriers to driving, autonomous vehicles could lead to dramatic increases in VMT. For example, a trip from the Central Valley to the Bay Area could become easier and faster than it is today, lessening the cost of long-distance travel and increasing the number of such trips. Additionally, driverless cars could circulate endlessly around neighborhoods, waiting to be hired. It will be important for cities and transportation authorities to develop incentives, policies and regulations to prevent these potential negative outcomes. Especially important will be creating incentives for autonomous vehicles to be shared, instead of individually owned, and ensuring that they are all-electric, to reduce fossil fuel use.

If autonomous vehicles are shared, they could eliminate the need for many people to own — and park — private vehicles, which are typically parked 95 percent of the time.[81] This could free up land in cities and provide opportunities and space for other modes of travel, increasing the number of people who could move through dense urban spaces. Shared vehicles could also save people money by lowering or eliminating the cost of car ownership and sharing the cost of rides. Shared autonomous vehicles could also enable people with limited mobility to travel more readily.

Cities have a large role to play in ensuring that they receive the benefits and avoid the potential negative outcomes of autonomous vehicles. They can make driving alone more expensive by limiting and tolling parking, reallocating parking space, and adopting cordon and road tolls. By investing in e-bikes and accessible transit, cities can make alternatives to single-occupancy autonomous vehicle trips more attractive. Regional transportation agencies have perhaps an even more important role in making sure that regulations and policies governing the emergent availability of autonomous vehicles are uniformly implemented across cities. Uniformity is important in ensuring that traffic rules and regulations are clear and predictable in every location.

Of course, autonomous vehicles, even if they are shared, will set us far back from a fossil-free future if they are not electric and powered with renewable energy. This topic is addressed in our next chapter.

[79] http://www.mountainview.gov/civicax/filebank/blobdload.aspx?BlobID=15038

[80] The U.S. Department of Transportation describes four levels of autonomy, from no automation to complete or driverless automation: http://www.nhtsa.gov/About+NHTSA/Press+Releases/U.S.+Department+of+Transportation+Releases+Policy+on+Automated+Vehicle+Development

[81] For a review of the research on this widely-cited number, see http://www.reinventingparking.org/2013/02/cars-are-parked-95-of-time-lets-check.html

BIG IDEA 2:

Electrify Most Energy Uses

After reducing wasteful energy consumption and boosting efficiency across our buildings and transportation network, we must take a hard look at our remaining energy use. Driving gasoline-fueled cars and using natural gas-fired water heaters, clothes dryers, oven ranges and other appliances are everyday examples of fossil-fueled activities that could instead be powered by electricity. Because electricity generated for the Bay Area is cleaner than gasoline and natural gas, switching to electricity would reduce our overall emissions.

In addition, California's electricity mix will only get cleaner over time. When Governor Jerry Brown signed Senate Bill 350 in 2015, he codified California's goal to generate half of its electricity from renewable sources by 2030,[82] up from 33 percent. This increase in renewable generation is expected to decrease the state's emissions by 14 to 15 million metric tons by 2030.[83] This would meet roughly 8.5 percent of the statewide 2030 goal to reduce emissions across the economy.[84] While 8.5 percent may sound small, other single policies achieve much less. As the percentage of electricity that comes from renewables will increase over time, switching fossil-powered end uses to the grid is a crucial step in becoming fossil-free over time.[85]

In California and the Bay Area, personal cars contribute more to greenhouse gas pollution than any other single end use. (See Figure 6 on page 11.) In Big Idea 1, we offer recommendations to reduce energy use in buildings and shift some mobility to shared vehicles and other modes of transit. But there will always be some level of energy use and personal car ownership, which we argue should become more and more electric. In this chapter we focus first on electrifying personal cars, then other vehicles and finally residential, commercial and industrial buildings.

In general, the solutions we propose for switching to electrified end uses rely on encouraging the adoption of new technologies and planning and financing greater electrified power infrastructure. The discussion and recommendations below try to find a balance between calling and planning for specific technologies and allowing the market and consumers to choose what will work best in relatively new and evolving technology markets.

STRATEGY 6

Electrify passenger vehicles and scale up infrastructure that supports them.

Numerous technologies allow vehicles to run on electricity. Plug-in electric vehicles (PEVs) use grid-connected power to recharge their batteries. This includes battery electric vehicles that rely solely on electricity and plug-in hybrid vehicles that rely partially on electric battery storage and partially on gasoline. The California Air Resources Board coined the term "zero-emission vehicles" to describe PEVs as well as other vehicles that have no tailpipe emissions, such as hydrogen fuel cell vehicles.[86] For a switch to a fossil-free Bay Area, we focus mainly on deploying battery electric vehicles, which we refer to simply as EVs,[87] at a greater scale.

The benefits of EVs are numerous compared to traditional cars. When driven, they emit no tail pipe pollution. As discussed in the section "The Case for Going Fossil-Free," the local health benefits of reducing emissions from passenger vehicles are substantial and well-documented. The burning of fossil fuels on roadways near where people live and work exposes residents and workers to harmful pollution and increases the risk of serious and deadly respiratory and cardiovascular disease.[88] Children, elderly people, low-income neighborhoods and marginalized communities of color are often disproportionately affected and at risk from such pollution, and thus stand to gain the most from its reduction.

Those who adopt EVs can also save money. The total lifetime cost of operating and maintaining an EV is often much less than the cost of other types of vehicles, depending on a consumer's driving habits, how far they drive, the difference in electricity and gas prices where they live and their "personal discount rate" (the extent to which they are happy to see savings over time as opposed to immediately). In a recent estimate on the total cost of ownership, the 2013 Nissan Leaf cost $36,892 over its lifetime[89] compared to $44,949 for a comparable gasoline-powered car or $44,325 for a generic hybrid.[90]

The three largest costs of owning an EV are the initial retail price, fuel and maintenance. Even after accounting for federal and state incentives,[91] the Leaf and other EVs still have slightly higher retail prices than their hybrid and conventional gas alternatives. However, most of this is due to high battery costs, which are expected to drop by as much as 30 percent by 2020.[92] In addition, fuel and maintenance costs are much lower over time for EVs. For example, in California, the electric equivalent to a gallon of gas costs roughly $1.60, or about half the cost of gasoline.[93] Bay Area customers taking advantage of Alameda Municipal's or PG&E's specialized electric rate plans can save even more in fuel costs. Maintenance costs are also lower for EVs because electric motors have fewer moving parts compared to internal combustion engines, which have hundreds of parts that have to be maintained, oiled and periodically replaced. Additional incentives in the form of lower insurance costs and HOV lane stickers are also available for EV drivers.

Lastly, developing a strong network of EV drivers gives the Bay Area a potential energy storage option. In the near term, there is the opportunity for vehicle-grid integration, which is currently being piloted by PG&E and other large investor-owned utilities. This technology involves one-way communication about the grid to EV drivers. The communication can encourage drivers to recharge at different times of day or lower the speed of charging to reduce the EV load.

Over time, technology advances could create two-way communication between EVs and the grid. This could enable the batteries within EVs to help balance grid supply and demand at any given time. In other words, when the grid needed temporary power to meet overall demand, EV owners would be able to sell power back to the grid. When too much power flowed over the grid, utilities could fill EV batteries to utilize and store excess energy.[94] However, there are technical and regulatory issues to solve before this technology could be developed at a significant scale.

Barriers to Electric Vehicle Adoption

While barriers change as EV technologies evolve, the conventional obstacles to widespread EV adoption include:

- The need for new infrastructure both to charge vehicles and to assure potential EV drivers that charging infrastructure is viable and sufficient.
- Limited consumer awareness of EVs and how they might work well to meet personal vehicle needs.
- High upfront costs compared to traditional vehicle alternatives.
- Limited classes of vehicles, though this is changing rapidly as the market expands. Today's EVs range from the Nissan Leaf at the low end to Tesla's Model X at the high end. Over the next decade, as battery prices come down, there are expected to be more affordable models.
- Operation limitations such as limited range and long charging times. However, EV range is increasing: EVs released today can go between 70 and 250 miles on a single charge, while the average commute is under 40 miles.[95]

While progress is being made on each of these, additional strategies are needed to help deploy EVs at scale throughout the Bay Area.

[82] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350

[83] Page 28: https://www.ethree.com/documents/E3_Final_RPS_Report_2014_01_06_ExecutiveSummary.pdf

[84] The 8.5 percent figure is arrived at by assuming a 1990 emissions level of 431 MMTCO2e adopted by ARB: http://www.arb.ca.gov/cc/inventory/1990level/1990level.htm; Governor Brown's 40% reduction of GHGs by 2030 set forth in Executive Order B-30-15 and E3's 14 to 15 MMTCO2e estimate.

[85] While the Bay Area has the potential to serve as a leader for other regions nationwide, it's important to note that deploying electric vehicles in areas that rely on coal-fired power will result in more GHG pollution. In these areas, greening the grid will be necessary before the large-scale deployment of EVs makes climate sense.

[86] For a visual representation of the different gasoline- and electric-powered vehicles, see EPRI's Electronic Transportation page: http://et.epri.com/ResearchAreas_IndustryTerms.html

[87] We focus less on hydrogen fuel cell vehicles because the hydrogen fuel that goes into them relies on fossil fuel inputs. Because plug-in hybrid vehicles can also run on gasoline, we focus less on these as well.

[88] Pollution includes nitrous oxides, sulfur oxides, particulate matter (PM10 and PM2.5), volatile organic compounds and carbon monoxide. Many of these gases combine in the atmosphere to create smog. Smog and direct exposure to these substances can exacerbate asthma, chronic obstructive pulmonary disease and risk of lung cancer, and increase the risk of hospitalization, premature death, heart attack, stroke and heart disease. See EDF (2014), page 4, for more details: https://www.edf.org/sites/default/files/content/edf_driving_california_forward.pdf

[89] In the Plug-In Electric Vehicle Readiness Plan, the Nissan Leaf is found to cost just $310 more than a gasoline-powered alternative after all federal and state rebates. See page 71: http://www.baaqmd.gov/-/media/files/strategic-incentives/ev-ready/bay-area-pev-readiness-plan-summary-2013-web-pdf.pdf?la=en

[90] See Figure 2-3: http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002004054. The total cost of ownership calculation relies on many assumptions, such as a $3.62 gallon of gas, $0.12 kWh electric cost, a vehicle lifetime of 150,000 miles and more. These are summarized in Table 1 on page viii.

[91] California currently offers up to $5,000 for the purchase of an EV, and consumers can get up to $7,500 in federal tax breaks for plug-in electric drive vehicles. See California's Drive Clean Tool: http://driveclean.ca.gov/Calculate_Savings/Incentives.php

[92] Page 8, Plug-In Electric Vehicle Readiness Plan: http://www.baaqmd.gov/-/media/files/strategic-incentives/ev-ready/bay-area-pev-readiness-plan-summary-2013-web-pdf.pdf?la=en

[93] http://energy.gov/articles/egallon-how-much-cheaper-it-drive-electricity#

[94] 2013 ZEV Action Plan: https://www.opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf

[95] http://driveclean.ca.gov/pev/Plug-in_Electric_Vehicles/BEVs.php

FIGURE 11

Options for Charging Electric Vehicles

There are currently three levels of EV chargers, which charge EVs at different rates. Different chargers work best in different locations. In general, Level 1 and Level 2 chargers are suitable for home and work, where EVs can remain plugged in for several hours. Fast-charging stations are suitable for highway corridors.

Source: US Department of Energy, Alternative Fuels Data Center. Available at: http://www.afdc.energy.gov/fuels/electricity_infrastructure.html

	Charge Time	Voltage and Current	Best Location
Level 1	2–5 miles of range per hour	140 volts, AC	Home, airports and work
Level 2	10–20 miles of range per hour	240 volts, AC	Home and work
Fast Charging	50–70 miles of range per 20 minutes	208/480 volts, AC three-phase input	Highway corridors

Current Strategies to Electrify Passenger Vehicles

For many years California has been working to make its vehicles more efficient through its Clean Car Standards. Under this program, the state's Zero Emission Vehicles (ZEV) mandate aims to put 1.5 million ZEVs on California's roads by 2025, of which 247,000 are expected in the Bay Area.[96] The state is on its way to success: An independent analysis expects the total number of battery electric vehicles and plug-in hybrid electric vehicles in California to be between 500,000 and 1.1 million by 2020.[97] Car manufacturers will need to sell more EVs to meet California's clean car standards, which require the entire vehicle fleet's average fuel economy to be 54.5 miles per gallon by 2025. (See Figure 3 on page 8.)[98] Fully 100 percent of cars sold in California by 2040 will need to be ZEVs to meet state goals.[99]

The Bay Area Plug-In Electric Vehicle Readiness Plan was created in 2013 in response to the need for regional and local action to help achieve these ambitious goals.[100] This plan serves as a guiding document for local and regional governments to support EV adoption and plan for electric vehicle charging through building codes, permitting and inspections, zoning and parking rules, training and education, grid considerations and regional planning. It also builds on other readiness guides and complements the work of other EV proponents and thought leaders.[101]

The Bay Area is well on its way toward increased EV adoption and higher numbers of EV charging stations. As of May 2015, the California Air Resources Board had issued almost 25,000 rebates for EVs through its Clean Vehicle Rebate Project throughout the Bay Area,[102] indicating that at least this many EVs have been deployed in the Bay Area since the program began in 2010.

In addition, the Bay Area is expected to add many more EV charging stations. Charging can occur at home (in single-family homes or in apartment buildings, when available), at work or in public spaces. As seen in Figure 12, the California Energy Commission and National Renewable Energy Laboratory have estimated how many chargers the Bay Area would need under the state's ZEV action plan. The number of chargers needed in specific locations is likely to evolve over time. The number of people who will own a personal car in the future, the types of EVs those people buy, their range and charge time, driving habits, home charging capability and other parking options will determine where charging stations should be sited.[103]

Of all the Bay Area chargers that have been installed, only two have been developed by utilities, but PG&E is currently in the process of gaining regulatory approval to install 7,500 Level 2 charging stations and 100 fast chargers throughout its service territory (which stretches beyond the Bay Area). Where exactly these would go will be determined by a number of factors, including a priority to put them in workplaces, multi-unit dwellings and disadvantaged communities.[104] These would be funded through PG&E's customers with approval from the California Public Utilities Commission.

[96] Executive Order B-16-2012, March 2012. Described in Governor Brown's 2013 ZEV Action Plan: https://www.opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf. For reference, this number of ZEVs is about 10% of the vehicles used in commuting in the nine-county Bay Area in 2014, according to American Community Survey, Table B08015 5-year estimates for 2014.

[97] Reducing Barriers to Electric Vehicle Adoption through Building Codes, page 1: http://aceee.org/files/proceedings/2012/data/papers/0193-000012.pdf

[98] These are also referred to as Corporate Average Fuel Economy, or CAFE, standards.

[99] Page 4: http://www.arb.ca.gov/msprog/clean_cars/acc%20summary-final.pdf

[100] The effort was commissioned by the Bay Area Air Quality Management District (BAAQMD) in partnership with the Metropolitan Transportation Commission (MTC) and the Association of Bay Area Governments (ABAG), and prepared by ICF: http://www.baaqmd.gov/plans-and-climate/bay-area-pev-program/bay-area-pev-ready

[101] These include "Ready, Set, Charge California! A Guide to EV-Ready Communities" and the "South Bay Cities Plug-in Electric Vehicle Development Plan." In addition, the Bay Area EV Coordinating Council is a forum to discuss the trends emerging in new vehicle and infrastructure markets, and the California Plug-In Vehicle Collaborative brings a variety of public sector and business stakeholders together to develop and grow the EV market. There are also three regional sub-chapters of Clean Cities in the Bay Area that each work on EV infrastructure and offer information on local efforts and achievements. The CEC also funds local efforts to implement EV readiness plans statewide and to deploy electric vehicle supply equipment permitting and inspection and installation processes, EV signage and awareness, and local government code adoption and training.

[102] Table 1, page 4: http://www.energy.ca.gov/renewables/tracking_progress/documents/electric_vehicle.pdf

[103] Page 10: http://www.baaqmd.gov/~/media/files/strategic-incentives/ev-ready/bay-area-pev-readiness-plan-summary-2013-web-pdf.pdf?la=en

[104] Interviews with PG&E as well as: http://greenlining.org/wp-content/uploads/2016/03/JtMotiontoAdoptSettlementAll-03-21-16.pdf

FIGURE 12

Scaling Up Charging Stations in the Bay Area

The Bay Area needs roughly 10 times the number of existing chargers to support the state's ZEV goals. Exactly where those should go will depend on the EVs people buy and their ranges and charge times, driving habits and home-charging availability.

Sources: CEC/NREL page 16, Table 4: http://www.energy.ca.gov/2014publications/CEC-600-2014-003/CEC-600-2014-003.pdf; Idaho National Laboratory: https://avt.inl.gov/sites/default/files/pdf/arra/SummaryReport.pdf and SPUR analysis of U.S. DOE Alternative Fuels Data Center http://www.afdc.energy.gov/fuels/electricity_infrastructure.html

	Needed in homes	Needed in workplaces	Needed in public spaces
If most charging is done at home	216,000 Level 1 and 2 chargers	25,000 Level 1 and 2 chargers	4,500 Level 1 and 2 chargers; 133 fast chargers
If most charging is done in public	200,000 Level 1 and 2 chargers	41,000 Level 1 and 2 chargers	12,000 Level 1 and 2 chargers; 377 fast chargers
Estimated chargers already installed	Roughly 25,000 based on EV rebates across the Bay Area	As of April 2016, the Bay Area hosts 847 nonresidential stations, of which 31 are public fast-charging and 69 are public Level 2 sites, most of which likely include multiple outlets and the capacity to charge multiple vehicles.	

Recommendations for Deploying and Supporting More EVs

Recommendation 20: Convert public vehicle fleets to electric as quickly as possible.

Who: Local governments

Most local governments operate fleets and thus have a direct opportunity to participate in the adoption of electric vehicles and EV-charging infrastructure. Local governments should work with fleet operators and drivers to set targets and policies for retiring gasoline vehicles and adopting EVs. In addition, as fleet managers buy a larger number of vehicles, they can do more to bring down the cost of EVs than single car buyers can, especially while state rebates for EV fleet purchases are still active.[105]

In terms of specific targets, the state has set the goal that ZEVs should constitute 25 percent of its light-duty vehicle fleet purchases by 2020.[106] Meanwhile, a regional consortium of Bay Area leaders has suggested that local governments aim to "achieve a 100 percent alternative fuel vehicle public fleet by 2025."[107] Local governments should adopt the most ambitious targets possible, including buying EVs as opposed to other technologies, as soon as possible. An interim step should include approving funding and planning for EV adoption through capital improvement planning processes.

Recommendation 21: Create incentives for taxis, car-sharing services and transportation network companies to purchase EVs.

Who: MTC, Bay Area Air Quality Management District

Passenger vehicles in taxi and car-share fleets and those driven by contractors of transportation network companies such as Uber and Lyft often spend prolonged time on the road. Electrifying these vehicles can help us become fossil-free.

Cities should work with taxi companies to offer their drivers appropriate and targeted incentives to drive EVs. For example, taxi permitting agencies can lower the cost to permit EV taxis and can offer drivers of such vehicles priority routes and destinations such as airports and tourist attractions.

Local governments can work with car-sharing companies to ensure that EVs are a part of their fleets. For example, City CarShare has used more than $2 million in funding from MTC and the Bay Area Air Quality Management District to deploy dozens of electric vehicles and supporting infrastructure,[108] providing an electric vehicle experience to its customers throughout the Bay Area and eliminating associated greenhouse gas emissions. Other car-sharing fleets should replicate these models.

Transportation network companies such as Uber and Lyft should work to organize individual contract drivers who are buying new cars into groups or fleets. This could enable them to gain access to grants for EV fleets under the Bay Area Air Quality Management District's EV funding programs. City and regional policymakers should further work with these companies to appropriately site charging infrastructure for their EVs.

Lastly, if and when taxi or transportation network companies adopt autonomous vehicles, as discussed in Recommendation 19, cities in the Bay Area should require that they be EVs. Because autonomous vehicles will be much easier to operate, many expect that their popularity will lead to an increase in vehicle miles traveled. It is therefore important that these vehicles run on electric power to help mitigate their climate impact.

Recommendation 22: Develop policies to ensure that EV batteries are recycled or sold in secondary markets after their useful life in vehicles.

Who: State lawmakers in coordination with state agencies such as the Integrated Waste Management Board

An often-used argument against EVs is that at the end of their useful lives they leave a large battery full of precious metals to be recycled or reused, and it's unclear who will or should take care

[105] The statewide Clean Vehicle Rebate Program offers up to $15,000 for ZEVs in public fleets. See http://www.driveclean.ca.gov/Calculate_Savings/Incentives.php

[106] 2013 ZEV Action Plan

[107] Page 14: http://www.rmi.org/Content/Files/Readysetcharge.pdf

[108] Page 20: http://www.baaqmd.gov/~/media/files/strategic-incentives/ev-ready/bay-area-pev-readiness-plan-background-and-analysis-web-pdf.pdf?la=en

of this. Many ideas have been promoted, such as recycling the lithium for new batteries in other devices or reusing the batteries as power storage for small-scale solar or wind generators at homes, data centers and other sites.

California should require that EV drivers sell back their used batteries at designated sites after their useful life. Car dealerships can play an intervening role in the transaction by offering a place for car owners to take their batteries and expertise in assessing their value. State lawmakers can give auto dealerships the option of buying the battery back, recycling it if it has no second-life value or letting a state agency or other vendor buy the battery. There are many options for how to ensure the batteries are used in a thoughtful and economic manner, and state lawmakers should consider them carefully.

This kind of intervention can serve as a way to more quickly and efficiently create a market for post-EV batteries and help bring down the overall cost of ownership to EV drivers.

Recommendation 23: Electrify transit vehicles where possible.

Who: Transit agencies and planners

While passenger vehicles are the single largest source of greenhouse gas emissions in the Bay Area, there is also room to electrify the other major forms of transportation: transit and goods movement.

Some effort to reduce emissions from these forms of transportation is already underway. For example, through the California Sustainable Freight Strategy, the state aims to coordinate a strategy to reduce emissions across the freight sector. The success of the Port of Oakland's electrification is discussed in the sidebar "Reducing Toxic Air Emissions at the Port of Oakland." In addition, through the Advanced Clean Transit rule administered by the California Air Resources Board, the state aims to have all transit fleets operating zero-emission vehicles by 2040.[109]

Getting more and more travelers into transit could help move more people more efficiently, and if transit vehicles travel on clean power, more people could be moved with lower climate impact. The cleanest urban bus, in terms of both fuel production and fuel use, is a battery-electric model.[110] The next closest is the hydrogen-fueled bus, but its fuel source is petroleum-based and emits three times the emissions over its lifetime compared to the electric alternative.[111] However, the widespread use of EV buses has limitations. Installing charging infrastructure and planning for charging along busy routes can be difficult. EV buses also cost more than traditional diesel buses but often less than hydrogen fuel cell buses.

To overcome these barriers, local transportation planners should consider which routes could be served with EV buses. For example, shorter, flatter routes are easier because they can be completed on a single charge. Because of their high energy needs during daytime hours, transit agencies with EV buses should also consider installing solar arrays on their facilities to recharge EV bus batteries.

For transit agencies with hilly and long service routes, a switch from fossil-fueled buses to hybrids that can run partially on electricity, or to hydrogen fuel cell buses, may be the next best option after EVs.

All transit agencies in the Bay Area should have plans in place for how they will retire and replace transit vehicles with cleaner vehicles and fuel sources in the future.

Recommendations for Supporting EV Infrastructure and Planning

Building out infrastructure to support EVs requires the collaboration of many who may not have long histories of working together. For example, utilities must work with state and federal highway planners; local governments must rely on the policy expertise of statewide energy agencies, and vice versa. While much collaboration is already taking place, we must continue to break down silos between areas of expertise and levels of government in order to plan together for the best EV charging network possible.

Another challenge to planning the Bay Area's EV charging network is that it relies on the placement of costly electric infrastructure, but we don't yet know which type of chargers at exactly which locations will work best over time. For example, for drivers to become comfortable with EV driving technology, they may need to see charging stations in familiar public spaces. But as batteries in EVs become better and ranges get longer, our need for chargers will likely change. For example, demand for home and work charging may fall over time while the demand for fast chargers on highway corridors increases. Making progress on the ideal EV charging network over the long run will require both collaboration and iteration between public and private actors at the local, regional, state and interstate levels.

A further consideration is that consumers will likely have preferences about the way they find and use charging equipment, both in their homes and on the road. Because the market is new, there's a lot to learn about consumer preferences regarding the charging experience. The technologies that consumers interact with should evolve with the market so that, at a minimum, this interface is not a deterrent to driving an EV over a gasoline alternative and, at best, is a better fueling experience altogether.

[109] http://www.arb.ca.gov/msprog/bus/bus.htm

[110] Slide 34: http://www.arb.ca.gov/msprog/bus/workshoppresentation.pdf

[111] Hydrogen fuel cell buses have the benefit of zero tail pipe emissions and are responsible for only half the fuel production and other emissions of a compressed natural gas bus. See slide 34: http://www.arb.ca.gov/msprog/bus/workshoppresentation.pdf

Recommendation 24: Engage a broad set of experts to continually monitor, prioritize and plan for EV charging infrastructure at the regional scale.

Who: California Energy Commission, California Public Utilities Commission, MTC

Key information on EVs should be aggregated wherever possible to help inform and prioritize public EV planning and funding. For example, anonymized data on EV sales and their battery storage and range, as well as the driving and charging habits of EV drivers across the region, could help guide more effective deployment of public infrastructure and private infrastructure grants. The California Solar Initiative's data on interconnected rooftop solar panels serves as a model for how such a dataset could be constructed and shared.[112]

Together with input from a wide range of experts (local and regional governments, automakers, utilities, EV charging companies, building developers and researchers), these data can help inform charging infrastructure strategies to meet the evolving mobility needs of the Bay Area and to best predict where the next EV charging stations should go. As EV infrastructure trends emerge from such efforts, cities should adapt their general plan frameworks and climate action plans, taking into consideration the EV infrastructure plans of utilities and regional agencies.

At the same time, charging infrastructure shouldn't be planned as if current trends will remain stable over time. Instead, planners should remain curious about the changing nature of personal car ownership (as discussed under Recommendation 19), and the charging experience for drivers. For example, most charging is currently done at single-family homes, but many Bay Area car owners have limited access to garages and may only switch to an EV if there are ample public charging sites. Policymakers will need to look for opportunities that allow for the strong deployment of charging infrastructure with an eye toward flexibility. And because the technologies that underpin EVs and EV chargers are evolving so quickly, local and regional governments should continue to work with clean tech companies to pilot the latest advances and prepare for the continual adoption of new technologies.

In addition, particular challenges to EV charging installations and EV adoption should be tracked. For example, the extent to which disadvantaged communities adopt the new technologies should be followed, as they lack resources for EVs and charging infrastructure. Similarly, the installation of EV charging infrastructure in existing multifamily buildings should be studied, as installation can be complicated by complex electrical structures as well as a lack of clarity around who should finance and own the infrastructure. The feasibility of these installations should be assessed and prioritized regularly, and best practices should be shared on these and other developments in EV and charging equipment deployment.

Recommendation 25: Require a high level of EV readiness for all new building types, both to meet future demand for EV charging and to lower the future costs of retrofitting buildings.

Who: City planning and public works departments, city councils

Because EVs and the chargers they rely on are likely to evolve more quickly than the lifespan of the average building, new building code should require EV-ready buildings of all types.[113] This means buildings should have electrical conduit (passageway for wires) and paneling to enable charging infrastructure to be installed and updated by drivers or building operators.

The latest iteration of California's CALGreen building code program[114] outlines minimum make-ready requirements. New one- and two-family dwellings must be built to accommodate a Level 2 charger of the homeowner's choice, and multifamily buildings with 17 or more residences must make 3 percent of all parking spaces ready to install EV chargers, in addition to other requirements about charging dimensions and accessibility.[115]

Local governments are in a unique position to advance EV charging installation by making CALGreen standards more aggressive and including retrofits under their building codes. For example, local governments can establish that building energy efficiency programs such as PACE include the installation of EV charging as a supported retrofit.

In a 2012 survey of the local governments of the Bay Area and Monterey Bay, only one in six jurisdictions had adopted EV charging requirements for building permits, and only one in 10 had proactively updated building codes to include electric vehicle supply equipment mandates.[116] However, progress has been made since then. For example, Palo Alto, San Francisco and others now have codes that reach beyond these.

Every city in the Bay Area should have more aggressive EV-ready building codes and should establish and prepare for implementing and enforcing the new code by 2020.

[112] https://www.californiasolarstatistics.ca.gov/data_downloads/

[113] Page 38: https://www.opr.ca.gov/docs/ZEV_Guidebook.pdf

[114] See: http://www.bsc.ca.gov/Home/CALGreen.aspx

[115] See 4.106.4 of CALGreen code updated in 2013 Intervening Code Cycle, effective July 1, 2015: http://www.iccsafe.org/wp-content/uploads/errata_central/5570S133.pdf

[116] Page 7: http://www.baaqmd.gov/~/media/Files/Strategic%20Incentives/EV%20Ready/Summary%20PEV%20Readiness%20Plan%20FINAL.ashx


Wikipedia contributor audiohlfi

Oil Refining in the Bay Area

The Bay Area is home to five major historic oil refineries located in the cities of Richmond, Rodeo, Benicia and Martinez. These refineries produce about 800,000 barrels a day of gasoline from crude oil and represent about a quarter of California's total refining capacity. They also produce jet fuel, diesel, lube oil, wax and other chemicals. They receive oil delivered in three ways: by tanker through marine terminals, from pipelines originating in the Central Valley and by rail from tar sand mines in Canada. About 38 percent of California's oil is produced in state, 12 percent comes from Alaska and 50 percent comes from Saudi Arabia, Ecuador, Iraq, Mexico and other countries.

Four out of the Bay Area's five refineries were built before 1915; the fifth was built in the late 1960s. Modernization projects costing more than $2 billion have been undertaken in the last 10 years or are underway, including a project to upgrade the largest, Chevron's Richmond refinery, in a way that will allow it to take in dirtier crude without increasing greenhouse gas emissions. In 2011, these five refineries released more than 14 million metric tons of CO_2e emissions, the second-largest source of fossil fuel emissions in the Bay Area behind passenger cars and trucks, which emitted more than twice this amount.

Growing demand for gasoline and fossil fuel-powered transportation impacts the Bay Area twice: first in the release of emissions related to refining, second in the burning of the fuels themselves to power our transportation systems. By having gasoline-refining industry in our region, we experience the adverse effects of fossil fuel dependency on both the supply and demand sides.

And there are equity consequences for the region. The concentration of refineries in Contra Costa County has worsened air quality and health in Richmond, Martinez and Benicia. While the frequency of air quality emergencies and chemical spills has decreased over time, especially since the pre-regulation era, both these rare events and the daily toll of refining emissions are concentrated locally and disproportionately impact communities of color.

In addition, refineries are currently proposing to increase the import of crude by rail, which could add even more devastating risks, as illustrated by oil train derailments and explosions in Oregon, North Dakota, Virginia and Quebec. A 2014 Natural Resources Defense Council study found that crude-by-rail imports to California increased more than 100 times between 2009 and 2013. It also identified that 152,000 people and more than 90 schools in the Bay Area would be "at risk" from proposed rail projects as they are located within one mile of crude-by-rail routes.[117] Railroads are federally regulated, and municipalities have little opportunity to understand the frequency or risk of oil trains in their vicinities, let alone control or reroute cargo to more remote or less sensitive areas. What they can do is evaluate — and reject — land use proposals that would site crude oil facilities near people or sensitive sites within their jurisdictions.

To address the refinery operations, but not the transportation of fuels, the Bay Area Air Quality Management District has jurisdiction over what is emitted in the Bay Area. The District is working on a suite of regulations to reduce certain emissions from the refineries by 20 percent by 2020. The rules will also require continuous monitoring, limit pollution to within the fenceline of refinery facilities and ensure best practices.[118] Cities in the region can support these efforts and request the most stringent regulations the Air District could impose.

Because we are still consuming gasoline and other fossil fuels — and it is almost impossible to site new refining facilities in California today — it seems likely that these five refineries will persist with us well into the 21st century. But we can support environmental justice and better health in the communities near them by making sure we limit new risks. This means rejecting new facilities and terminals, ensuring continuous safety improvement of the pipelines and equipment we already have and reducing air emissions as deeply as possible through regulation.

[117] https://www.nrdc.org/sites/default/files/ca-crude-oil-by-rail-FS.pdf

[118] The website http://www.fenceline.org shows real-time air monitoring in Richmond and Rodeo.

Recommendation 26: Give preference to EV drivers in citywide parking and zoning policies.

Who: City planning and public works departments, city councils

All new commercially provided parking structures should be ready to install charging stations to supply power to EV drivers. Where parking minimums still exist, EV-charging spaces should count toward that minimum.

In the near term, parking fees for publicly accessible chargers could be waived to encourage greater EV adoption.[119] However, after they are more widely adopted, these fees should be phased in for EVs. Some research shows that requiring even a minimal fee for workplace vehicle charging decreases congestion at chargers, because free workplace charging encourages people to charge at work rather than to pay at home. The small fee can increase the number of cars that can use the same workplace equipment.[120] In addition, cities should explore how to penalize the parking of gasoline-powered cars in public EV parking spots and how to enforce these rules.[121]

As required by California's Assembly Bill 1236, cities must streamline the application and permit process to install charging stations. The largest cities must complete this process by January 2017; cities with populations under 200,000 have until 2018. Some cities currently allow Level 1 and Level 2 charging as an accessory use across all land types by default. As an accessory use, the permitting is generally easier, although local governments should also streamline permitting for freestanding public charging infrastructure, including DC fast chargers.[122] Cities such as Lancaster and San Jacinto have chosen to streamline permitting by designating the type of charging to go in different land use zones. For example, San Jacinto allows Level 1 and 2 charging everywhere but restricts DC fast charging to commercial and office, industrial and special purpose zones.[123] However cities choose to streamline their permitting process, businesses and residents should be able to receive a permit within a few business days.

[119] The cities of Alameda, Berkeley, San Jose and St. Helena currently offer free parking for PEVs. See page 85: http://www.baaqmd.gov/~/media/files/strategic-incentives/ev-ready/bay-area-pev-readiness-plan-background-and-analysis-web-pdf.pdf?la=en

[120] https://trid.trb.org/view.aspx?id=1339540

[121] Page 16: http://www.rmi.org/Content/Files/Readysetcharge.pdf

[122] Page 115: http://sustain.scag.ca.gov/Documents/SCAG_PEV_Plan-Zoning_and_Bldg_Codes.pdf

[123] Southern California Plug-in Electric Vehicle Readiness Plan, UCLA Luskin School of Public Affairs, 2012, http://sustain.scag.ca.gov/Documents/SCAG_PEV_Plan-Zoning_and_Bldg_Codes.pdf

[124] 2013 GHG Inventory: http://www.arb.ca.gov/cc/inventory/data/data.htm

[125] Page 3: http://iopscience.iop.org/article/10.1088/1748-9326/8/1/014038/pdf

STRATEGY 7

Electrify fossil fuel uses in buildings.

Residential, commercial and industrial buildings burn fossil fuels directly, particularly natural gas in furnaces, boilers and water heaters. In commercial and residential buildings, emissions from these activities make up nearly 12 percent of California's annual greenhouse gas emissions.[124]

Some researchers say that electrifying all water heating and space heating and cooling in residential and commercial buildings is essential to meeting California's ambitious goals of reducing GHG emissions by 80 percent by 2050.[125] While advanced technology exists to achieve electrified end uses, these technology markets are unknown to many consumers and will require policy support to reach widespread adoption.

The most promising electric end use (in terms of its ability to reduce GHG emissions) involves using heat pump technologies in place of natural gas-fired applications that control air and water temperatures.[126] Much like refrigerators, heat pumps work by moving heat to and from ambient air or underground buried tubes (known as geothermal or ground source heat pumps), making indoor air or water hotter or cooler as needed.[127] Because heat pumps use electricity to *move* heat instead of burning fuel to *make* heat, they can be two to three times more efficient than fossil-fired alternatives (or even conventional electric heaters).[128] Air conditioners are one kind of heat pump, and their use for heating is well established in commercial, institutional, and larger apartment and hotel buildings.

The barriers to heat pumps are generally lack of familiarity by consumers, low natural gas prices compared to electricity, limited installation options (e.g., heat pump water heaters need to be placed in rooms with more airflow than a small utility closet) and, in some cases, a lack of training by those who install, inspect or maintain the technology.[129] In addition, ground source heat pumps don't work in all soil types or building environments.

Current Strategies to Electrify Fossil Fuel End Uses in Buildings

In 2009, the U.S. Department of Energy infused $40 million in American Recovery Funds into the heat pump market,[130] and a collaboration between the department, California Geothermal Energy Collaborative and researchers[131] estimated the costs and benefits of heat pump deployment across the country and the potential energy savings for different metropolitan areas.[132] These

[126] Electric Power Research Institute, "The Potential to Reduce CO_2 Emissions by Expanding End-Use Applications of Electricity" (2009).

[127] http://energy.gov/energysaver/heat-pump-systems

[128] http://www.sciencedirect.com/science/article/pii/S104061901500202X

[129] http://www.energy.ca.gov/2014publications/CEC-400-2014-019/CEC-400-2014-019.pdf

[130] Slide 5: https://www1.eere.energy.gov/geothermal/pdfs/ghp_workshop_cross.pdf

[131] http://energy.gov/sites/prod/files/2014/02/f7/gshp_battocletti_measuring_costs_benefits.pdf

[132] Slides 2 and 3: http://energy.gov/sites/prod/files/2014/02/f7/gshp_battocletti_measuring_costs_benefits.pdf

efforts helped lay a foundation for additional research and policy setting at all levels of government.

In the Bay Area, utilities have started to take up heat pump technology. For example, PG&E offers a $500 rebate for eligible installations of heat pump water heaters in homes,[133] and City of Palo Alto Utilities undertook a pilot of heat pump water heaters to promote the technology to residents.[134]

At a broader scale, the United Kingdom supported ground source heat pump technologies through federal grant funding and by establishing quality assurance and other standards to help infuse confidence into the heat pump market.[135] A survey of 900 adopters found that the technology was well-liked and that increased information and advice about the systems played a large role in helping consumers adopt it in the first place.[136]

Recommendation 27: Pilot and promote heat pump and other technologies for heating.

Who: Local governments, utilities, local businesses

Palo Alto's pilot program for heat pump water heaters offers an example of what cities can do to promote fossil-free technologies to residents and businesses. Cities should also consider hosting technology fairs featuring heat pump appliances and should work with utilities to advertise existing heat pump technology rebates. Local governments can also partner with local businesses or housing developers to pilot and showcase electrified end uses across different building types. For example, Prospect Silicon Valley is connecting leading technology experts with a Whole Foods store in San Francisco to retrofit and pilot zero-net energy technologies in the store. Pilots like this that intentionally incorporate public education can increase awareness about technology options. These pilots can also inform future building codes or technology incentive policies and help promote those that performed most positively in different building applications.

Utilities also have the power to help provide low-cost ground source heat pumps on a large scale in areas with the right soil and building conditions. These opportunities should be explored in the Bay Area. As an example, the Plumas-Sierra Rural Electric Cooperative has developed and owns extensive underground heat pump loops, much like utility wires. It offers customers a 15-year interest-free loan for in-home ground heat pump installations to connect to the loop, which customers can pay back as part of each month's utility bill. After loan payments, Plumas-Sierra estimates that customers save roughly $1,000 to $1,600 in home heating costs per year.[137] Such an arrangement offers a scalable, cost-effective way of promoting an electrified end use and should be explored and implemented in the Bay Area where soil and building conditions are suitable.

Recommendation 28: Make it easier to install electrified end-use projects by removing fees, streamlining permitting and training building department staff.

Who: City building departments

Cities in California charge up to $4,000 in fees for the permitting of heat pump technology.[138] Cities should greatly reduce or eliminate these so that it is not a deterrent.

In addition, because the technology is new, cities should ensure proper training of staff members who permit the installations and should approve a list of well-trained installers who can work directly with building owners and managers. Proper installation and maintenance is crucial because it can greatly affect the performance and lifetime of heat pump technologies.

[133] https://www.pge.com/includes/docs/pdfs/shared/saveenergymoney/rebates/Residential_Rebates_List.pdf

[134] http://www.cityofpaloalto.org/gov/depts/utl/residents/resrebate/smartenergy/heat_pump_water_heaters/heat_pump_water_heater_pilot_program.asp

[135] https://www.researchgate.net/publication/279291764_National_Deployment_of_Domestic_Geothermal_Heat_Pump_Technology_Observations_on_the_UK_Experience_1995-2013

[136] http://oro.open.ac.uk/31521/1/Domestic_HeatPumpPaper_CairdRoyPotter(Final27Jan12)).pdf

[137] Page 21: http://www.energy.ca.gov/2014publications/CEC-400-2014-019/CEC-400-2014-019.pdf

[138] Page 3: http://www.energy.ca.gov/2014publications/CEC-400-2014-019/CEC-400-2014-019.pdf

CASE STUDY

Reducing Toxic Air Emissions at the Port of Oakland

The Port of Oakland is America's fifth-busiest port and has brought many jobs to Oakland — but at significant environmental cost, particularly to its nearest residential neighborhood, West Oakland. The more than 1,800 ships and trucks that arrive at the port daily have historically emitted significant levels of air pollutants that cause asthma and cancer. In 2009, the Port of Oakland, in collaboration with the Lawrence Berkeley National Laboratory, announced reduction goals for nitrogen oxides and black carbon particulate matter.

The port's clean truck program, launched in 2009, requires regular harbor truckers to comply with state air quality regulations.[139] It also banned trucks not in compliance with 2007 Environmental Protection Agency engine emission standards. With $22 million in grants, the port helped drivers retrofit or replace old diesel trucks, 17 percent of which were of 1993 vintage or earlier, before the clean truck program began.

In addition, a $65 million private-public investment now allows ships to plug into new electrical outlets when they dock in order to power lights and other systems, instead of idling on diesel fuel. Under state law, half of containerships, passenger ships and cargo ships must use local power while docked, and this share will jump to 80 percent by 2020.

UC Berkeley researchers[140] found that, as a result of these efforts, the median age of port-serving truck engines dropped from 11 to six years and the installation of particulate filters jumped by 97 percent. The median rate of black carbon emissions decreased by 76 percent and nitrogen oxide emissions fell by 53 percent. Data from UC Berkeley indicates that from 2005 to 2012, the port's diesel particulate matter emissions — which are linked to respiratory issues — dropped dramatically, from 261 tons to 77 tons. These benefits went beyond Oakland, dropping particulate matter by 3 percent even as far away as San Jose and Livermore.

Reducing additional pollutants and regulating additional watercraft are part of the port's larger Maritime Air Quality Improvement Plan, which includes targeting emissions from harbor craft (tugs, ferries and fishing vessels), cargo railways and diesel equipment that moves cargo.[141]

Courtesy Port of Oakland

[139] http://www.portofoakland.com/port/seaport/comprehensive-truck-management-program/clean-trucks/resources/

[140] http://newscenter.lbl.gov/2014/12/11/air-pollution-down-thanks-to-californias-regulation-of-diesel-trucks/

[141] Port of Oakland, "Dramatic reductions' in emissions found at Port of Oakland" (press release, December 12, 2014). http://www.portofoakland.com/newsroom/pressReleases/2014/pr_359.aspx; Timonthy R. Dallmann, Robert A. Harley and Thomas W. Kirchstetter, "Effects of diesel particle filter retrofits and accelerated fleet turnover on drayage truck emissions at the Port of Oakland," Environmental science & technology 45, no. 24 (2011): 10773–79; Thomas Kirchstetter, "Drayage Truck Emissions at the Port of Oakland," Lawrence National Laboratory News 10, no. 3 (Winter 2012) http://eetd.lbl.gov/newsletter/nl38/eetd-nl38-4-oaklandport.html

BIG IDEA 3:

Decarbonize the Electricity Grid

After improving energy efficiency and electrifying end uses, the final step toward a fossil-free Bay Area is supplying enough renewable electricity to meet all energy needs. The energy generation facilities that we build next will stay with us for 20 to 40 years. Investing in fossil-free generation now will be cheaper than abandoning fossil-based generation assets before they've paid for themselves, "stranding" our original investment. This requires increasing renewable generation facilities of all sizes while stabilizing and supporting the electricity grid with better energy storage.

Today, the Bay Area's electric power portfolio overall is only 24 percent fossil fuel-based, and most of that fossil fuel is natural gas. (See Figure 5 on page 10.) The rest of our electric power is sourced from hydropower, nuclear and California-eligible renewable sources: solar, wind, small hydro, biomass and geothermal. Due to its history of policies that support renewable energy and other actions on climate change, California enjoys among the lowest electricity carbon footprint per person of any state.[142] With the passage of Senate Bill 350 in 2015, which increases the state Renewable Portfolio Standard to 50 percent by 2030, this will only improve. But there is more we can do to speed and expand local adoption of renewables and the infrastructure that supports them.

Millions of New Facilities Needed to Generate 100 Percent Renewable Energy

Small-scale rooftop solar installations are already popular and growing. PG&E has more solar customers than any other utility in the United States and is currently adding 6,000 solar customers per month across its service area in Northern California. This has been made possible by policy, declining technology costs and supportive utility practices that enable quick installations by residential and business customers. Federal tax incentives for residential solar arrays have existed since 2006. Some cities, such as San Francisco, have sweetened the pot with additional incentives. Through a program called Net Energy Metering (available in California since the mid-1990s and in many other states), utility customers who have solar photovoltaic systems can significantly reduce or eliminate their electricity bills on an annual basis by only paying for electricity use beyond what they generate. The continuance of this program, recently reauthorized through at least 2020, will further spur the popularity of rooftop solar. Meanwhile, the cost of panels continues to decline. Assembly Bill 2188 (2014) requires cities and counties to adopt a streamlined permitting ordinance for small solar projects.

To accommodate the growth in demand that will emerge from building and vehicle electrification, many more renewable facilities of all sizes must also be built. Modeling has illustrated how each of the 50 states could achieve 100 percent renewable energy for all end uses by 2050.[143] For California, this roadmap includes millions of small rooftop solar installations, thousands of utility-scale solar and concentrated solar power facilities, and tens of thousands of onshore and offshore wind turbines. (See Figure 13 on page 48.) To a lesser extent, the energy mix includes wave, geothermal, hydroelectric and tidal power. Strategies not recommended in the roadmap include nuclear, coal with carbon capture and storage, natural gas, biomass, biodiesel and ethanol. These sources have higher emissions of CO_2 and air pollution per kilowatt-hour of electricity generated, require much more land to generate or grow an equivalent energy content and have other risks (such as nuclear meltdown).

Fossil fuel power plants and renewable energy plants have different upfront costs and paybacks over time. Renewables may initially cost more, but because renewable power is free, their long-run payback is higher. The levelized cost of energy offers a helpful metric for accounting for full lifecycle costs: It reflects the "lifetime cost of operations and maintenance combined with the installed cost expressed as a constant stream of costs per unit of value over the lifetime of the plant."[144]

[142] http://www.eia.gov/environment/emissions/state/analysis/pdf/table5.pdf

[143] A presentation of Professor Mark Jacobson's modeling work: http://www.baaqmd.gov/~/media/files/board-of-directors/advisory-council/2014/presentations/021314-ac.pdf?la=en; the 50 state roadmaps are available from the Solutions Project: http://thesolutionsproject.org/

[144] Page 6: http://www.energy.ca.gov/2014publications/CEC-200-2014-003/CEC-200-2014-003-SF.pdf

flickr user Jill Clardy

Taking into account California's policies, incentives and fixed and operating costs,[145] the California Energy Commission estimates that in 2013, wind turbines had a lower levelized cost of energy than both gas turbines and cogeneration plants on a dollar per megawatt-hour basis, for all types of investors.[146] By 2023, all renewable generation is expected to become cheaper for commercial developers, photovoltaic (a subset of solar) is expected to become cheaper for investor-owned utilities and almost all solar technologies are expected to become cheaper for publicly owned utilities on a dollar per megawatt-hour basis.[147]

Given this, we should endeavor to remove the remaining barriers to generating 100 percent of our electricity from renewables as soon as possible. While the building of utility-scale renewables is typically a private market function best achieved by state and national policy, local governments and utilities should support the build out of renewables as quickly as possible to the extent that they can. Local governments can also lead by example by building new renewable facilities and removing barriers to siting them for any that require local permits. Here we lay out key strategies for local governments to support this transition.

[145] Fixed costs include those for equipment, construction, financing, insurance, property taxes, staffing, and state and federal corporate taxes. Variable costs include those for fuel, cap-and-trade allowances, and operation and maintenance of the technologies.

[146] This is for the CEC's "Mid-Case" and can be seen on Table 62, p. 147. Investors include publicly owned utilities, municipally owned utilities and investor-owned

[147] This is for the CEC's "Mid-Case" and can be seen on Table 63, p. 148: http://www.energy.ca.gov/2014publications/CEC-200-2014-003/CEC-200-2014-003-SF.pdf utilities: http://www.energy.ca.gov/2014publications/CEC-200-2014-003/CEC-200-2014-003-SF.pdf

The Challenge of Variability and a Flexible Grid

One of the challenges of increasing wind, solar and small hydro in the electricity supply is variability: Electricity production varies throughout the day and across seasons based on the availability of wind, sun and water. Variability makes it difficult to predict when and how much renewable electricity will flow to the grid and makes balancing demand and supply more difficult.

Matching the level of supply and demand at every second throughout the day is the job of the California Independent System Operator (CAISO) and is important in preventing blackouts and other grid disruptions. Demand for electricity tends to occur in distinct surges: when people start their days and when people turn on electronics in the evening for cooking, lighting and entertainment. (In Big Idea 1 we discussed how plug load is the fastest-growing use of electricity in the state.) But it's harder to predict renewable electricity generation due to natural variation in when the sun shines, the wind blows or river water flows. In other words, variability can lead to oversupply at some times of day and undersupply at others, coupled with surging or falling power demand, also known as "ramps." CAISO balances these differences by quickly adding generation from standby resources, which are often natural gas-fired plants. These sources can take minutes or hours to turn on and warm up, producing emissions as they do so.

FIGURE 13

How Many New Energy Plants Do We Need to Get to 100 Percent Renewable?

The number of new plants needed to power California with 100 percent wind, water and solar energy for all purposes by 2050 is significant, but the area of land needed to host new facilities is less than 4 percent of all land in California

Source: Table 2 of Jacobson et.al., "A roadmap for repowering California for all purposes with wind, water and sunlight," Energy, Vol 73, June 2014, 875-889.

Energy technology	Percent of 2050 power demand met by technology	Number of new units needed	Percent of California land area needed for new units (plus spacing)
5 MW onshore wind turbine	25%	25,211	2.77%
5 MW offshore wind turbine	10%	7809	0.86%
0.75 MW wave device	0.5%	4963	0.03%
100 MW geothermal plant	5%	72	0.006%
1300 MW hydroelectric plant	3.5%	0	0%
1 MW tidal turbine	0.5%	3371	0.003%
5 kW residential rooftop solar PV	8%	15,000,000	0.139%
100 kW commercial rooftop solar PV	6%	533,700	0.1%
50 MW utility-scale solar PV	26.5%	3450	0.32%
100 MW concentrated solar power plant	15%	1226	0.58%
Total	**100%**		**3.67%**

As policy pushes the grid to become more and more renewably powered, there is a lot more variability in hourly fluctuations of supply. For example, we get electricity when the sun shines or the wind blows, but not necessarily when homes and businesses are using the most electricity. This phenomenon is illustrated by the "duck curve." (See Figure 14.) The duck curve shows that as more renewables are added to the grid between now and 2020, there is growing potential for a mismatch between when large amounts of energy are supplied and when energy is used during a typical day. This presents a challenge for maintaining grid stability.

But emerging technologies — coupled with policy — can address these concerns and support continued advancement toward a highly renewable electricity portfolio. CAISO has called for flexible resources to support a "green grid," including those that can ramp quickly, store energy, react quickly and on short notice from a zero operating level and accurately forecast operating levels.[148] Some of the specific tools and technologies that can support greater flexibility include battery storage, water and ground storage, pumped hydro, demand response appliances and equipment, precise weather prediction and geographically expanding the pool of renewable sources that can be called on to provide backup power, including interconnection agreements with other regions of the United States. (The bigger the pool, the greater the stability of the resource in an environment that is variable.) The more storage available to capture renewable power, the less gas-fired or conventional power is needed to meet demand during high usage and low renewable-generation hours of the day. The falling costs of battery prices, paired with renewables being added near areas with high electricity use (like rooftop solar), are helping to make energy storage resources more readily available and even to serve as "virtual power plants."[149]

Some utilities have adopted the innovative approach of "pay for performance" programs that award incentives to frequency regulation assets — such as batteries — that most efficiently respond to capacity needs. PJM, a large utility in the eastern United States, has created one of the first wholesale markets for frequency regulation services of this kind and has seen considerable success in attracting significant third-party investment in battery storage: Two-thirds of the 62 megawatts of storage deployed in the United States in 2014 was located in PJM territory.[150]

To accommodate more renewable energy, we also need a smarter distribution grid. A "smart grid" is a data-rich, highly automated electricity storage and delivery system that is capable of self-balancing and accommodating electricity supplies from multiple geographically distributed sources. It is vastly different from the original grid (parts of which are more than 100 years old), which was built to supply houses and cities solely with electricity generated far away at large centralized facilities and delivered one way. Today there are more than 200,000 solar customers within PG&E's territory in Northern California. Not only is the network now decentralized, but these sources all feed

[148] CAISO, https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf

[149] Sunverge, "More Than Batteries: Turning Distributed Energy Storage into a Virtual Power Plant", https://s3.amazonaws.com/dive_assets/rlpsys/more_than_batteries.pdf

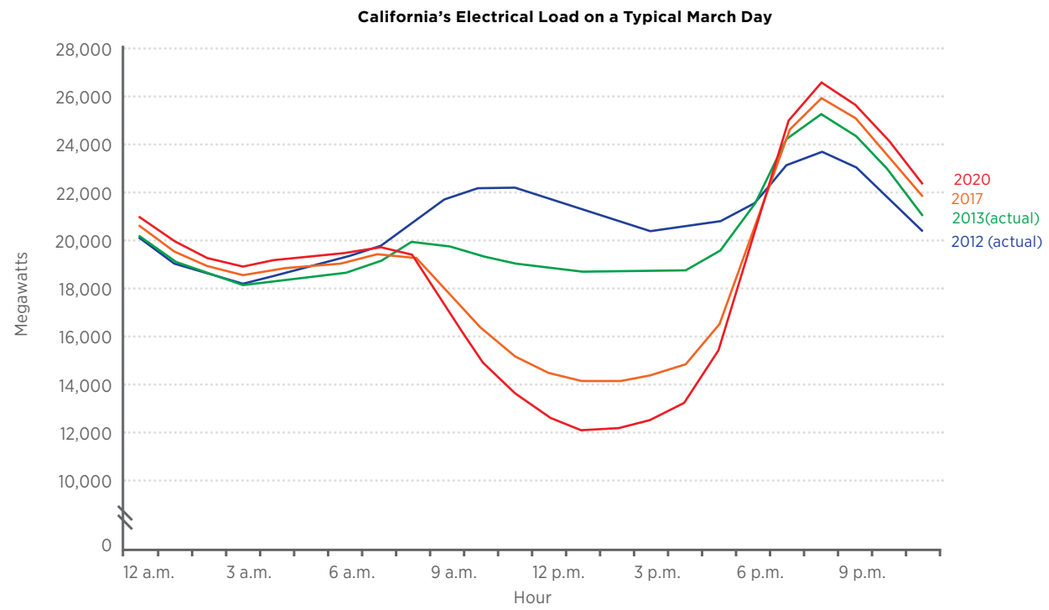
[150] GTM Research: http://www.greentechmedia.com/articles/read/us-energy-storage-market-grew-400-in-2014

FIGURE 14

A More Renewable Grid Will Require Better Energy Storage

The "duck curve" illustrates that as we add more and more renewable power to the grid, it's increasingly likely that there will be a mismatch between when the most power is provided and when the most power is used throughout the day. Over the years, the grid operator will need to supply less fossil-fuel or imported power in the middle of the day, when the sun is typically shining and the wind blowing. However, at the start of the evening, the operator will need to quickly ramp up supply as the sun sets and people turn on lights and use more appliances. Shifting more electric uses to mid-day and increasing solar and wind energy storage could help with this mismatch.

Source: California Independent System Operator, 2013. Available at: https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf



power back to the grid, so energy flow is now bidirectional in a way that grid operators have never seen.

Through real-time data collection and automated controls, or "smart meters," the smart grid can optimize and balance supply and demand across new grid-connected devices including rooftop solar, battery storage, electric vehicles and smart appliances. Smart grids are also necessary to support the expansion of these technologies. The ability to dynamically balance demand and supply across individual technologies improves overall grid reliability while reducing the need for fossil fuel "peaker" power plants — power plants built to run only during periods of high demand — and their associated emissions. For example, in the last year, PG&E estimated that its smart grid pilot projects and investments avoided 40 million minutes of outage time and nearly 23,000 tons of CO_2e emissions.[151] The smart grid, paired with interactive technology, also enables people to better understand, monitor and reduce their energy use and to participate in programs that ask for voluntary electricity reductions in times of high demand (also known as demand response programs). As the "internet of things" expands to appliances, vehicles and geographically distributed renewables and storage, demand response could become even more automated.

Building out smarter distribution grids will require investment on the part of local ratepayers. Sometimes this can be accomplished locally, as it has in cities like Palo Alto and Santa Clara, which have their own municipal utilities. Often this must be pushed for at the state level, through participating in discussions with the California Public Utilities Commission as it sets the path for future investment by the state's investor-owned electric power utilities.

[151] http://www.pge.com/includes/docs/pdfs/myhome/edusafety/systemworks/electric/smartgridbenefits/AnnualReport2015.pdf

Courtesy Nuclear Regulatory Commission and PG&E

Phasing Out Nuclear Power in California

In June 2016, PG&E announced that it had reached an agreement with labor and environmental organizations to phase out nuclear operations at the Diablo Canyon Power Plant — the last remaining operational nuclear power plant in California — by 2025. PG&E's proposal to cease operations includes replacing the loss of energy generation with investments in energy efficiency and GHG-free electricity, including the achievement of 55 percent renewable energy in its electricity portfolio by 2030. Diablo Canyon, which began operations in 1985, currently supplies about 18 percent of the Bay Area's utility-provided electricity and 9 percent of California's energy portfolio. Its pending closure means the state (and PG&E) will have to meet ambitious climate targets with even more efficiency investment and renewable sources than originally envisioned. While some are concerned, PG&E believes it can be done.

New nuclear power plants have been banned in California since the mid 1970s on the premise that new facilities should not be sited until the federal government could establish a safe place for disposal of spent fuel. That has still not happened. With no offsite storage options available, most decommissioned nuclear power plants in the United States have waste decaying in place and are constantly monitored. The decommissioning process can take up to 60 years and will cost more than $8 billion in California alone.[152]

California may have decided to eschew nuclear energy on its clean energy pathway, but this decision is not without controversy in other contexts. Some climate scientists and energy analysts believe the world cannot achieve the global warming limits established by the Paris climate agreement in 2015 without a significant replacement of coal power with nuclear. But nuclear power has significant unresolved challenges, including nuclear waste and the risk of catastrophic meltdowns that occur with generational regularity (most recently in 2011, when a meltdown of the Fukushima Daiichi plant in Japan was triggered by a tsunami). It also isn't carbon-free. Lifecycle nuclear power emissions are lower than coal on a per-kilowatt-hour basis, but they are twice as high as solar photovoltaic and six times greater than onshore wind.[153] In addition, the falling cost of renewables, coupled with advancing climate policy, makes these types of investments more attractive and less risky than nuclear for utilities and their customers.

Still, a handful of nuclear power plants are expected to come online in the United States in the next five years, and more than 20 are under construction in China, as are dozens more around the world, including in Russia, India and South Korea. While these projects proceed (or don't), California can move forward with its plan to add renewables paired with investments in efficiency and a smart grid — letting the nuclear debate go on elsewhere.

[152] http://www.cpuc.ca.gov/General.aspx?id=11369

[153] http://www.nature.com/climate/2008/0810/full/climate.2008.99.html

FIGURE 15

Solar Market Segments

According to the Rocky Mountain Institute, community-scale solar is at the sweet spot that leverages the economies of scale of utility-scale solar with the distributed benefits of behind-the-meter solar.

Source: Rocky Mountain Institute, http://www.rmi.org/Content/Files/RMI-Shine-Report-CommunityScaleSolarMarketPotential-201603-Final.pdf

	Behind-the-meter	Community-scale	Utility-scale
Typical size	5 kW - 0.5 MW	0.5-5 MW	20-100 MW
Energy user	Households Businesses	Utility customers: coops, municipal power companies, IOUs, direct access, community choice aggregators Residential subscribers Business subscribers	Utility customers: coops, municipal power companies, IOUs, direct access, community choice aggregators
Interconnection	Behind-the-meter	Distribution grid	Transmission grid
Distributed Benefits?	Yes	Yes	No

STRATEGY 8

Allow new renewable power facilities to be built quickly by expediting permitting and reviews, providing targeted incentive programs, setting requirements and leading by example.

Distributed solar and energy storage resources provide benefits beyond being fossil-free. They can support the grid's resilience by being sited near areas where electricity demand is high. They can reduce energy losses by closing the distance between generation and use, and thus contribute to reducing the need for imported electricity. Local governments should enable distributed resources to be built at all sizes within their communities. This means allowing exemptions to the design and environmental reviews that often delay projects. In addition to allowing priority permitting for new buildings that experiment with performance-based energy codes or can demonstrate achievement of zero net energy (see Recommendation 3), cities can expedite permitting for major building renovations that include a significant amount of new solar or the standalone installation of wind or solar facilities on underutilized land in infill locations that are otherwise unsuitable for housing or other commercial uses. They can also require new buildings not just to make roofs solar-ready, as is currently required by CALGreen but to go the next step and actually install solar photovoltaics, solar hot water and/or green roofs. San Francisco enacted such a rule in 2016.

Many local incentive programs in California intended to promote the development of distributed power facilities — particularly solar — have been phased out or significantly reduced in the past several years. This has largely occurred in tandem with the falling costs of solar. However, local cities, counties and municipal utilities could significantly increase access to distributed renewable energy resources for underserved segments of the population — notably low-income homeowners — by offering targeted rebates or other incentives for working with customers who fit this profile. These customers are often overlooked because it is harder for solar developers to obtain financing for their systems.

Recommendation 29: Support the scaling up of renewable energy throughout the Bay Area by expediting permitting, processing and review of projects that propose to install solar, wind or energy storage facilities.

Who: Cities and counties

Recommendation 30: Require new buildings and major retrofits to put solar photovoltaic or solar hot water on their roofs, with exceptions for green roofs and buildings taller than 10 stories.

Who: Cities and counties

Recommendation 31: Collaborate to develop best practices in building codes, permitting and fire risk reduction around renewable energy storage facilities such as batteries.

Who: Cities and counties

Energy storage technologies are generally considered safer than traditional gas and electricity equipment. They are also likely to become more commonplace in the future: The California Public Utilities Commission has required utilities like PG&E to acquire more than 1,000 megawatts of energy storage by 2020, and small-scale home energy storage is becoming available through

such recent introductions to the market as the Tesla Powerwall. But first responders have little experience with the possible ways these facilities could malfunction, and there are no universally accepted safety standards or fire codes to help direct installers to reduce risk. Cities in the Bay Area could collaborate to research and develop advice for fire departments, building inspectors and others on how to mitigate hazards and respond to risks in the emerging energy storage market.

Recommendation 32: Support community-scale solar by allowing larger solar projects (0.5 megawatt and up) to be built within city limits by-right and by considering the lease of underutilized public land or roofs for solar production.

Who: Cities and counties

There are three typical sizes of solar installations available on the market: small rooftop (sometimes called "behind-the-meter" because it produces power for onsite uses), community-scale and utility scale.[154] (See Figure 15 on page 51.) Typically, rooftop solar is sized to benefit a single building's owner or occupant and may be paid for through either an ownership or lease arrangement. Community-scale solar refers to midsize (0.5 to 5 megawatt) projects that may have a number of customers or subscribers. Utility-scale solar is typically located where land use is less intense and where facilities can be directly connected to higher voltage transmission grids.

Community-scale solar, which can be built by a utility or a third party, refers to two kinds of projects: those with a single utility customer and those that may have multiple customers who share the solar output (often referred to as "shared solar" or "community solar"). Shared solar allows renters, low-income households, commercial tenants and other occupants typically excluded from the rooftop solar market to access renewable energy through subscription to a shared facility. Both types of arrangements are an emerging opportunity for cities. A scenario study conducted by the Rocky Mountain Institute, an energy think tank, found that if the market is cultivated, the amount of community-scale solar that could be additionally installed by 2020 could equal the total amount of solar photovoltaics installed in the United States as of 2015.[155]

According to the National Renewable Energy Laboratory, about half of U.S. households do not have access to rooftop solar due to renting, living in multifamily housing or having unsuitable roofs.[156] About half of U.S. commercial buildings do not have enough rooftop space to meaningfully offset building electricity use. This is also true of very tall buildings in the densest parts of the Bay Area that have large loads and tiny roofs.

Community-scale solar could help fill this gap and has other benefits, including supporting distribution grid reliability, because these installations are connected to the distribution grid rather than the transmission grid (the latter covering longer distances and carrying more power at higher voltages). Underutilized land, parking lot canopies, contaminated sites and other locations within urban and suburban areas are good candidates for facilities of this size. Cities that have vacant land could even support development of solar at this scale by leasing sites that are unsuitable for other purposes to solar developers or utilities. For example, the San Francisco Public Utilities Commission entered into an agreement with a third-party developer to build 5 megawatts of solar on top of a covered reservoir facility that would be unlikely to be available for any other purpose.

Recommendation 33: Lead by example by purchasing and/or building renewable energy to supply municipal facilities, including schools, after energy efficiency improvements have been made.

Who: Cities and counties

As discussed earlier, local governments may underinvest in energy efficiency due to competing priorities, the lack of a driving internal advocate or the lack of resources for a retrofit. The same holds true with renewable facilities. Therefore, we recommend that local governments lead by example and invest in such facilities to power the balance of their electricity needs. Community-scale solar may be especially appropriate, as it would offer economies of scale while providing local benefits like reliability and resilience.

Local governments should purchase 100 percent renewable energy through arrangements that are cost-effective for them, whether through third-party community-scale solar agreements, PG&E's Green Power option or local Community Choice Aggregation programs.[157] It is important to note that these arrangements don't always result in new renewable generation facilities being built; sometimes they simply shift how renewably generated energy is accounted for. However, as a near-term strategy to demonstrate support and demand for renewables, they may eventually change the market and affect how and where large-scale projects are built.

Local governments should also leverage the educational value of solar and other forms of renewable energy by siting new facilities at schools where possible. Local governments can also cooperate to win bulk discounts on solar panels or other energy-efficient equipment. For example, in 2014, Alameda County launched a regional energy procurement program that has enrolled 19 public agencies to procure discounted solar for nearly 200 facilities, adding 31 megawatts of capacity to schools, libraries, fire stations and other facilities throughout the county.[158] The savings achieved through the bulk purchase was 17 to 45 percent better than market comparables.

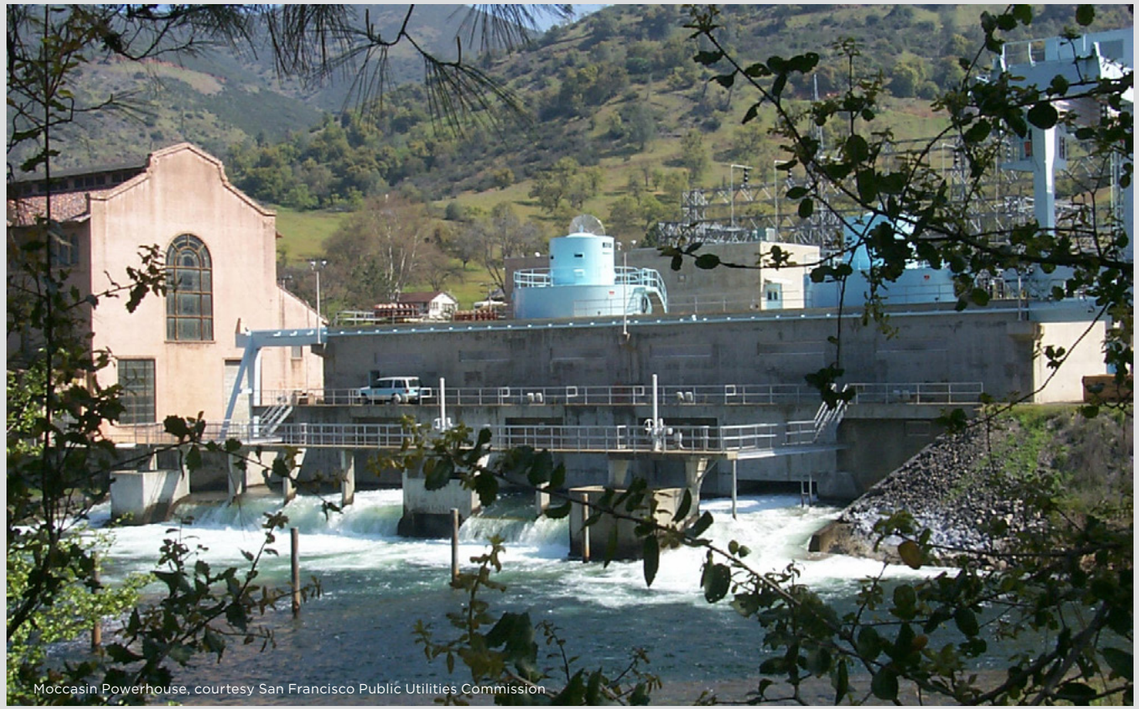
[154] Rocky Mountain Institute, "Community-Scale Solar: Why Developers and Buyers Should Focus on This High-Potential Market Segment" (March 2016), http://www.rmi.org/Content/Files/RMI-Shine-Report-CommunityScaleSolarMarketPotential-201603-Final.pdf

[155] ibid.

[156] Ibid., p. 5

[157] Community Choice Aggregation, or CCA, is a state law that allows local governments to go into the business of purchasing electric power for residents within their jurisdiction. Local governments that create CCA programs provide contracts to supply their customers with renewable power; the power is still conveyed through the transmission and distribution grids managed and maintained by the CAISO, investor-owned and municipal utilities where they exist.

[158] http://www.acgov.org/rrep/



Moccasin Powerhouse, courtesy San Francisco Public Utilities Commission

The Energy-Water Nexus

Water and energy interact in many ways in California and the Bay Area. About 20 percent of energy use in the state — including 19 percent of electricity and 30 percent of natural gas — goes to water-related uses, including water pumping, distribution, heating and treatment. For example, 2 to 3 percent of all electricity use in the state is consumed by the State Water Project, a 400-mile-long aqueduct conveying water supplies from the Sacramento–San Joaquin River Delta to Southern California, which uses significant energy to pump water over the Tehachapi Mountains.

Water is also used in energy production, to produce hydroelectricity and to cool nuclear, coal and natural gas power plants. One-quarter of water used in California goes to thermoelectric power plants for cooling (though it usually re-enters the water cycle thereafter). Hydroelectric facilities lose significant water through evaporation from dammed reservoirs.[159] Renewable energy facilities need less water than fossil fuels.

Saving water saves energy, and vice versa, in a positive feedback loop that has climate and air quality benefits. Researchers at UC Davis calculated that over a nine-month period during the height of California's recent drought (June 2015 to February 2016), the 24 percent water conservation rate during this time saved enough energy to power 135,000 houses for a year, reducing almost 220,000 metric tons of greenhouse gas emissions.[160] For a three-month period over the summer, the energy savings from statewide water conservation was equivalent to the combined energy savings from all efficiency and conservation programs supported by the state's investor-owned utilities, including PG&E. In addition, achieving this energy savings through water conservation was cheaper than through energy efficiency: $45 million versus $173 million. And these savings do not even include additional reduced emissions and energy savings from hot water use reductions, which would have accrued to consumers.

There are many good reasons to save water in California: Conservation is a least-cost alternative to developing new water supplies of any kind, and it also saves energy. Meanwhile, energy efficiency measures can yield water savings on both the utility and consumer sides, reducing our need for fossil-fueled energy production and water heating. The more energy and water we conserve, the sooner we can become fossil-free.

[159] Santa Clara Valley Water District, From Watts to Water (2011), http://www.valleywater.org/FromWattsToWater/

[160] https://www.newsdeeply.com/water/articles/2016/06/08/water-conservation-saves-energy-in-california

CASE STUDY

Scaling Up Renewables in Germany

After the Fukushima disaster in 2011, Germany established a national policy goal called Energiewende (energy transformation): to have the bulk of its energy supplied by renewable power sources by 2050, without endangering the country's strong economy. Germany's history with renewables is rooted in the anti-nuclear movement after the 1970s oil crisis and the Chernobyl nuclear meltdown in Ukraine in 1986. In the late 1990s, economic conservatives looking for energy security teamed up with environmentalists to advocate for renewables. This work was formalized in 2000 by the Renewable Energy Act, which offered Germans a generous price per kilowatt-hour for generating electricity and guaranteed the rate for 20 years. This made installing solar power a common-sense option for residents. By 2013, more than 25 percent of gross electricity consumption was renewable, an all-time high. Today, with more than 23,000 wind turbines and 1.4 million solar photovoltaic systems in German households, the country is known as the world's first major renewable energy economy. Within a decade, solar prices dropped by 80 percent and wind power dropped by 55 percent, making carbon-free energy competitive with fossil fuels.

Meeting Germany's 2050 carbon reduction goal continues to be a challenge, however, as Germans still use cheap coal for backup power to compensate for the fluctuations in renewable power production. In addition, carbon emissions have flatlined for several years as new renewables capacity has mainly served to compensate for the gradual phaseout of nuclear power. At the time the Energiewende was passed, there was a broad consensus to exit nuclear power but discussions of exiting coal were in their infancy. Now the lack of progress in reducing carbon emissions has led to a robust conversation about the appropriate timeline for phasing out coal. This will not only make room for the continued growth of renewables but also allow natural gas plants, which are currently hampered by high gas prices, to take their place as load-balancing peaker plants that come on when the wind isn't blowing or the sun isn't shining. By 2022 at the latest, when the last German nuclear plant goes offline, increased renewables production should begin to replace coal-fired electricity generation for good.[161]

[161] For more information, see Thomas L. Friedman, "Germany, The Green Superpower" The New York Times, May 6, 2015, http://nyti.ms/1EfucYw; Agora Energiewende, "The German Energiewende and its Climate Paradox" (April 2014), http://www.agora-energiewende.org/fileadmin/downloads/publikationen/Analysen/Trends_im_deutschen_Stromsektor/Analysis_Energiewende_Paradox_web_EN.pdf; and Heinrich Böll Foundation, "Energy Transition: The German Energiewende," http://www.energytransition.de

Recommendation 34: Incentivize renewables paired with storage as an alternative to new fossil fuel generation for all scales of power plants and eventually ban new fossil fuel generation.

Who: Cities and counties, Bay Area Air Quality Management District

The new energy infrastructure that we build today will likely be with us for the next 20 to 40 years. (See Figure 8 on page TK.) If we build new fossil-fueled energy facilities, we will be reliant on them far into the future, unless they break sooner than expected or we make the decision to switch fuels sooner than the natural replacement time, leaving the assets stranded and money to investors lost. To avoid locking ourselves in to future fossil fuel emissions, we should institute a high bar that requires any new fossil fuel power generation — such as peaker power plants and diesel backup generators — to outcompete renewables (paired with backup storage) on a cost and lifecycle emissions basis.

One creative approach to applying renewables in place of traditional diesel backup generation comes from Berkeley's Resilience Strategy,[162] a citywide plan that combines climate action, adaptation and hazard mitigation. The strategy cites "clear downsides" to diesel backup generators, including "noise, air pollution and limited capacity to provide power over the course of a prolonged outage without reliable access to diesel." Instead, Berkeley is pursuing funding to develop a series of microgrids — rooftop solar arrays paired with backup batteries — that can operate autonomously from the main electricity grid and connect critical public and private facilities in the event of a disaster like a large earthquake.[163] Microgrids are not just an investment in emergency power. They can be actively used year-round to supply clean energy during times of peak demand and enhance the overall stability of the grid.

[162] http://www.100resilientcities.org/page/-/100rc/Berkeley_Resilience_Strategy-LowRes.pdf

[163] Ibid., p. 28.

STRATEGY 9

Decarbonize fuel sources that will be hard to electrify within the next 20 years.

Natural gas is a growing component of the national electricity portfolio, and its use is also increasing in California. Natural gas was once seen as among the cleanest of fossil fuels for power production, with modern combined-cycle gas power plants emitting about 60 percent of the carbon of a coal plant per megawatt-hour produced.[164] But when accounting for methane leaks, which can range from 4 to 20 percent in the production (known as "fracking") and distribution of gas, its net climate benefit over coal is erased.[165] That's because the largest component of natural gas, methane, is a potent greenhouse gas, more than 80 times more heat-trapping than carbon dioxide in the short run. In addition, leakage and accidents related to natural gas — including two major disasters in California in the last 10 years[166] — warrant a transition to cleaner renewables as soon as possible.

Although our first choice to eliminate dependence on natural gas is electrification, some uses are unlikely to be electrified in the near future, such as heavy-duty vehicles like freight trucks, school buses and refuse trucks. One opportunity to reduce reliance on natural gas is to increase the amount of renewable biogas and biofuels as a substitute. To be clear, this does not mean growing crops for ethanol or harvesting forests to capture biomass for wood heat: These can be unsustainable land uses that often end up having greater climate impacts than net benefits.[167] Rather, it means preventing agricultural crop residues, yard and garden clippings, wood chips and non-recyclable paper from entering landfills or being burned and instead processing them chemically or biologically into biogas or "renewable gas." Then it can be used either to produce electricity or as a transportation fuel. Biogas is among the lowest carbon fuels per mile, currently beating electric or fuel cell vehicles.[168]

At the state level, one way to advance decarbonization of gas is to advance a Renewable Gas Standard, complementary to the statewide Renewable Portfolio Standard that currently requires utilities to procure 50 percent of their energy from California-eligible renewables by 2030, and the Low Carbon Fuel Standard, which requires providers of fuels to reduce carbon intensity by 10 percent by 2020. A Renewable Gas Standard, such as one that requires 10 percent of natural gas to be replaced with biogas by 2030, would help biogas compete with historically low-priced imported natural gas. The fossil fuel displacement would not only reduce statewide carbon emissions, it would have locally beneficial impacts by reducing toxic air contaminants, particulate matter and other pollutants associated with diesel combustion.[169] One estimate suggests that beneficial capture and reuse of organic waste could supply enough renewable gas to replace three-quarters of all motor vehicle diesel use in California.

Recommendation 35: Identify ways to capture methane from landfills or wastewater treatment plants for production of biogas that could be used for electricity production or as a mobile fuel.

Who: Cities, wastewater and landfill facility operators

Recommendation 36: Specify preferences for renewable fuels and gas in procurement contracts, especially until fleets are fully electrified.

Who: Cities, transit agencies, special districts that bulk purchase fuels

[164] http://www.utilitydive.com/news/on-earth-day-natural-gas-is-the-power-sectors-biggest-environmental-probl/417955/

[165] http://thinkprogress.org/climate/2014/10/22/3582904/methane-leaks-climate-benefit-fracking/

[166] Such as San Bruno and Aliso Canyon.

[167] http://reports.climatecentral.org/pulp-fiction/1/

[168] http://www.bioenergyca.org/resources/fact-sheets/bionergy-and-the-solid-waste-sector/

[169] http://www.bioenergyca.org/wp-content/uploads/2015/03/BAC_RenewableGasStandard_2015.pdf

Conclusion

Climate change challenges us to rethink the systems we rely on every day. As we consider doing our part individually, we may retrofit our homes or small businesses, study options for going solar, carpool or take transit more often, or purchase an electric bicycle or car.

These individual actions matter, but our collective actions matter more. This report lays a foundation for how our cities and the broader Bay Area region can move toward a fossil-free future: one that contributes to ending global climate change but also confers local benefits. It is at the local level that we make critical decisions about buildings and transportation networks that now burn a lot of fossil fuels. California is a leading state on climate and energy policy, and we in the Bay Area are uniquely poised to take action around zoning, transportation system investments, building energy use and adding renewable energy. It is also our opportunity to demonstrate to other regions what it takes to become fossil-free and showcase the freedoms and benefits this pathway confers.


Sergio Ruiz


San Francisco Public Utilities Commission


Sergio Ruiz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Plan of Action

		City building, planning and/or public works departments	City councils to adopt ordinances	Cities	Public housing and affordable housing providers, owners and managers	Energy utilities	Counties	Local Agency Formation Commissions		Open space managers and land trusts	Metropolitan Transportation Commission	County congestion management agencies	Association of Bay Area Governments	City transportation departments, planners, and transit operators	Private parking providers	Bay Area Air Quality Management District	Corporate and institutional campus managers, master developers	State lawmakers and state agencies	California Energy Commission; California Public Utilities Commission	Wastewater and landfill facility operators
Big Idea 1: Consume Less Fossil Fuel																				
Strategy 1: Increase the energy performance of new buildings and improve code enforcement	**Recommendation 1:** Establish high-efficiency standards for new buildings and major renovations, such as CALGreen Tier 1 or 2	●	●																	
	Recommendation 2. To improve code enforcement, adopt recommendations made in the BayREN's compliance improvement best practices study: • Include energy code information in electronic permit tracking systems • Require approved energy compliance documentation to be included on construction plans available at building sites, to improve internal consistency in plan review and inspection • Reduce tolerance for changes from submitted project energy plans by requiring energy model updates when project scopes are significantly altered	●																		
	Recommendation 3. Experiment with voluntary outcome-based building energy codes as a compliance pathway toward zero net energy and incentivize innovation by adopting priority permitting for projects that achieve high-energy performance through this path	●																		
Strategy 2: Require systematic energy retrofits of existing buildings	**Recommendation 4.** Require regular energy efficiency assessments and performance-based retrofits for buildings that are more than 10 years old.	●	●		●	●														
	Recommendation 5. Support and accelerate energy retrofits for classes of buildings that have unique needs or may not be well-served by the efficiency market, for example, multifamily buildings and affordable housing	●			●	●														
	Recommendation 6. Support programs, education, demonstration projects and energy performance monitoring to reduce plug-in and idle energy loads			●		●														
Strategy 3: Control sprawl by protecting open space, supporting infill development and increasing density in places served by transit	**Recommendation 7.** Write zoning codes that direct high-density housing and jobs into priority development areas, especially within a quarter-mile of transit stations and stops	●		●			●													
	Recommendation 8. Make it easier to build new housing when it aligns with existing zoning that supports Plan Bay Area	●		●			●													
	Recommendation 9. Protect existing open spaces, whether agricultural or natural lands, especially large, contiguous areas that contain high-quality farmland, ranchland or ecological habitat			●			●	●		●										

		City building, planning and/or public works departments	City councils to adopt ordinances	Cities	Public housing and affordable housing providers, owners and managers	Energy utilities	Counties	Local Agency Formation Commissions		Open space managers and land trusts	Metropolitan Transportation Commission	County congestion management agencies	Association of Bay Area Governments	City transportation departments, planners, and transit operators	Private parking providers	Bay Area Air Quality Management District	Corporate and institutional campus managers, master developers	State lawmakers and state agencies	California Energy Commission; California Public Utilities Commission	Wastewater and landfill facility operators
Strategy 4: Make communities walkable, bikeable and transit accessible	**Recommendation 10.** Ensure that infrastructure investments improve walkability where growth is planned, particularly in priority development areas, and require places that are accommodating growth to meet benchmarks for walkability, bikeability and transit access										●	●	●							
	Recommendation 11. Do not fund new transportation capital projects and system expansion projects that increase per-capita vehicle miles traveled										●	●								
	Recommendation 12. Retrofit the region's smaller neighborhood centers for walkability and bikeability — and create more of them	●					●					●		●						
	Recommendation 13. Expand bicycle networks within and between suburban areas and urban centers	●					●					●		●						
	Recommendation 14. Build a great transit network by investing in places with high ridership potential										●	●		●						
Strategy 5: Use policy and pricing tools to make less carbon-intensive modes of travel easier, safer and cheaper than driving	**Recommendation 15.** Eliminate minimum parking requirements and implement demand-based pricing for commercial parking			●								●		●	●					
	Recommendation 16. Establish congestion-adjusted tolling for major highways, roads and bridges										●									
	Recommendation 17. Implement an indirect source rule to require new development to significantly reduce the number of new vehicle trips it will generate															●				
	Recommendation 18. Reduce vehicle use by adopting vehicle trip caps in megaproject developments			●								●					●			
	Recommendation 19. Implement policies and regulations to get the most benefits from autonomous vehicles			●							●	●								
Big Idea 2: Electrify Most Energy Uses																				
Strategy 6: Electrify passenger vehicles and scale up infrastructure that supports them	**Recommendation 20.** Convert public vehicle fleets to electric as quickly as possible			●			●							●						
	Recommendation 21. Create incentives for taxis, car-sharing services and transportation network companies to purchase EVs										●					●				
	Recommendation 22. Develop policies to ensure that EV batteries are recycled or sold in secondary markets after their useful life in vehicles																	●		
	Recommendation 23. Electrify transit vehicles where possible													●		●				
	Recommendation 24. Engage a broad set of experts to continually monitor, prioritize and plan for EV charging infrastructure at the regional scale										●								●	
	Recommendation 25. Require a high level of EV readiness for all new building types, both to meet future demand for EV charging and to lower the future costs of retrofitting buildings	●	●																	
	Recommendation 26. Give preference to EV drivers in citywide parking and zoning policies	●	●																	
Strategy 7: Electrify fossil fuel uses in buildings	**Recommendation 27.** Pilot and promote heat pump and other technologies for heating			●		●														
	Recommendation 28. Make it easier to install electrified end-use projects by removing fees, streamlining permitting and training building department staff	●																		

		City building, planning and/or public works departments	City councils to adopt ordinances	Cities	Public housing and affordable housing providers, owners and managers	Energy utilities	Counties	Local Agency Formation Commissions		Open space managers and land trusts	Metropolitan Transportation Commission	County congestion management agencies	Association of Bay Area Governments	City transportation departments, planners, and transit operators	Private parking providers	Bay Area Air Quality Management District	Corporate and institutional campus managers, master developers	State lawmakers and state agencies	California Energy Commission; California Public Utilities Commission	Wastewater and landfill facility operators
Big Idea 3: Decarbonize the Electricity Grid																				
Strategy 8. Allow new renewable power facilities to be built quickly by expediting permitting and reviews, providing targeted incentive programs, setting requirements and leading by example	**Recommendation 29.** Support the scaling up of renewable energy throughout the Bay Area by expediting permitting, processing and review of projects that propose to install solar, wind or energy storage facilities	●		●		●	●													
	Recommendation 30. Require new buildings and major retrofits to put solar photovoltaic or solar hot water on their roofs, with exceptions for green roofs and buildings taller than 10 stories	●		●			●													
	Recommendation 31. Collaborate to develop best practices in building codes, permitting and fire risk reduction around renewable energy storage facilities such as batteries	●		●		●	●													
	Recommendation 32. Support community-scale solar by allowing larger solar projects (0.5 megawatt and up) to be built within city limits by-right and by considering the lease of underutilized public land or roofs for solar production	●		●		●	●													
	Recommendation 33. Lead by example by purchasing and/or building renewable energy to supply municipal facilities, including schools, after energy efficiency improvements have been made			●		●	●													
	Recommendation 34. Incentivize renewables paired with storage as an alternative to new fossil fuel generation for all scales of power plants and eventually ban new fossil fuel generation			●		●	●									●				
Strategy 9: Decarbonize fuel sources that will be hard to electrify within the next 20 years	**Recommendation 35.** Identify ways to capture methane from landfills or wastewater treatment plants for production of biogas that could be used for electricity production or as a mobile fuel			●																●
	Recommendation 36. Specify preferences for renewable fuels and gas in procurement contracts, especially until fleets are fully electrified			●										●						

Ideas + action for a better city

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