A Greater LA

CLIMATE ACTION FRAMEWORK

A project of the Los Angeles Regional Collaborative for Climate Action and Sustainability

Developed in partnership with LA County Metro

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EXECUTIVE SUMMARY

Climate change threatens the environment, economy, and health of Los Angeles like no other issue. Scientists project that climate change will bring the region more extreme heat, rising sea levels, intense droughts and floods, and less available drinking water, among the more severe potential impacts. At the same time, the region's role as a major population center, economic leader, and pioneer in solving past environmental challenges, positions it to tackle the challenge and emerge resilient. But while many tools and leadership may be in place, action will not occur automatically.

To that end, regional leaders formed the Los Angeles Regional Collaborative (LARC) in 2008. Convened by F. Noel Perry's Next 10 originally, regional leaders from the County and City of Los Angeles, Los Angeles County Metropolitan Transportation Authority (LA Metro), Southern California Association of Governments (SCAG), and other regional agencies, nonprofit organizations, and business leaders spent nearly a year developing a county-level charter to collaborate to address climate change impacts. This Framework is the outcome of that extraordinary effort. It will now require leaders from the region's cities, agencies, nonprofit organizations, and businesses, among other groups, to prioritize key goals, develop the strategies necessary to achieve them, and collaborate in the process of putting these words into action.

LARC developed this document, called the "Framework," to help regional leaders identify the most promising suite of measures available to reduce emissions and develop a more climate-resilient region. "Region" is defined here as within the geographical boundaries of Los Angeles County and is sometimes abbreviated here as "Los Angeles." The Framework is a result of a Strategic Growth Council grant applied to by Los Angeles County METRO and the LARC. The LARC and METRO came together to put forward a document that outlines strategic areas of action for Los Angeles County to address for climate action and sustainability. They are areas of action that require both regional collaboration and specific action within the region as the specific impacts of climate and particular measures may differ in emphasis, though the region is in it together, interdependent, interconnected, and integrated. Impacts to one area of the region will cascade throughout.

The document is organized into discrete sections covering: Transportation & Land Use, Water, Energy, Public Health, and Ocean & Coastal Resources. Each section contains an overview of the issue (regional context), including its specific threats to Los Angeles, the role of regional collaboration in addressing the challenge, and existing policy landscape that governs action on the issue. The sections

then identify the key goals for success, the strategies within those goals, and the actions necessary to achieve success.

The Framework is offered as a start for regional dialogue and organizing to address the impacts of climate change. It is not meant to be comprehensive, and issues such as land use, equity, and environmental justice, as well as local revenues to pay for needed changes, will be important to address as well. LARC aims to develop forums to address these and other issues going forward.

TRANSPORTATION & LAND USE

Transportation

Tailpipe emissions from cars and trucks contribute 40% of the greenhouse gas emissions in Los Angeles County, only slightly more than building emissions, but still more than any other single sector. Los Angeles's transportation system must, therefore, be transformed to minimize greenhouse gas and other emissions but also to enable more resilience in the face of increasing extreme weather events and rising temperatures. Improvements to Los Angeles's transportation system can bring multiple benefits, from reducing air pollution, improving mobility and accessibility, improving mobility and reducing the urban heat island, and improving livability and quality of life.

To meet these ends, the Framework identifies these priority goals for the region:

1. Decarbonize tailpipe emissions primarily through mass adoption of battery electric vehicles and use of low-carbon biofuels and hydrogen fuels when necessary, including an interim goal of 50% reductions by 2030
2. Design and redesign transportation infrastructure to improve public health and air quality through more transit, pedestrian and bicycle infrastructure, and redesign of existing automobile infrastructure to encourage vehicle-sharing, carpooling, and alternative travel modes

To meet these goals, regional leaders should:

- Plan, develop, and fund a multimodal transportation system that builds infrastructure for transit, biking, and walking, and focuses solely on spending to maintain existing roadways rather than adding new highway capacity for automobiles
- Adopt local policies that encourage alternatives to automobile use, such as reduced subsidies and excessive on-site requirements for parking
- Leverage advances in car- and bike-sharing technology, as well as autonomous vehicles
- Encourage more transit, biking, and walking by expanding and improving infrastructure, integrated across jurisdictions
- Decarbonize vehicle fuels by encouraging consumer adoption of battery electric vehicles (and low-carbon biofuels and hydrogen where necessary) through improved charging infrastructure and other incentives

Land Use

Land use decisions affect multiple sectors, including energy, equity, revenue to local governments, and public health. But they play a particularly central role in determining transportation emissions. Where planners and developers locate housing in relation to jobs, retail outlets, and services shapes how residents decide to travel. The more these uses are separated geographically, combined with a lack of viable alternative modes, the more residents will have to rely on automobiles for travel. Furthermore, local policies that encourage automobile usage, such as requirements for on-site parking, also prompt more vehicle miles traveled and therefore greater emissions. To address the challenge, the Framework identifies this priority goal for the region:

1. Adopt land use patterns that channel all new growth into compact development near transit, including retrofitting existing single-family suburban neighborhoods to include secondary residences and flexible extended family facilities and to be more walkable, bikeable, and transit-oriented

To meet the goal, regional leaders should:

- Adopt local policies that encourage alternatives to automobile use, such as reduced subsidies and excessive on-site requirements for parking
- Identify and prioritize through public investment and financing mechanisms infill development in previously developed areas
- Initiate a regional assessment and broad-based dialogue of the importance of protected lands as carbon sinks

Conserving lands in particular will be important for the region going forward, including protecting open space and agricultural land for carbon sequestration and other values. In addition, as mentioned, land use decisions are also important for topics such as renewable energy deployment, which can entail siting battles if not planned properly in advance.

WATER

Water remains a pivotal issue in the region's transition to a sustainable future. Contrasting and uncertain conditions have long shaped Los Angeles's water management strategy, which has historically relied heavily on imports while simultaneously creating infrastructure to safely and quickly channel voluminous floodwaters to the sea.

Climate change, though, is expected to alter the amounts and timing of precipitation, snowpack, and runoff, both locally and in regions from which Los Angeles imports water. Combined with increased temperatures and evaporation, scientists expect climate change may reduce local supplies within the region. The region has also long struggled with water quality problems for both surface and groundwater, which could be exacerbated by climate impacts in the coming years.

Over 100 public and private entities are involved in the management and distribution of potable water in the Los Angeles region, a legacy of fragmented urban growth and a historic reliance on local

control of services. As a result, many small private water companies and special districts may not be adequately equipped to meet climate change challenges and associated capital investment needs.

To address the challenge, LARC recommends prioritizing the following goals:

1. Set aggressive and mandatory water conservation targets that become permanent
2. Invest in infrastructure to increase and diversify supplies by better managing local water on a regional basis
3. Reduce water-related impacts on disadvantaged communities
4. Protect and improve water quality

As top strategies to meet these goals, regional leaders should seek to:

- Reduce outdoor water usage by transitioning landscapes to all California native or California-friendly plants
- Reduce distribution system losses through strong leak detection and enforcement programs
- Increase stormwater capture
- Improve collaborative groundwater basin management through adjudications that allow for conjunctive use, ensuring the basins serve as regional water banks
- Develop regional collaborations to increase the use of recycled water
- Improve water recycling technologies
- Preserve lifeline water rates for low-income customers
- Encourage communities with high rates of water usage to conserve more
- Maintain public recreation and invest in and protect parks and open spaces that create multiple benefits
- Address failing drinking water systems
- Protect and improve groundwater quality
- Adopt water-neutral new development ordinances

ENERGY

In Los Angeles County, 40% of greenhouse gas emissions come from electricity and natural gas used in buildings, similar to the transportation sector. Furthermore, the current energy system is aging, inefficient, and vulnerable to system-wide outages. Reducing emissions from energy usage in buildings and creating an energy system that is efficient and resilient can significantly reduce the region's carbon footprint and increase the sustainability of the region's energy supply and environment.

Los Angeles has significant opportunities to reduce energy emissions and increase overall resilience to climate-related events through an improved energy sector. Due to its climate and geography, Los Angeles has abundant renewable sources of energy, particularly solar. If captured efficiently, these

resources have the potential to not only reduce the region's greenhouse gas emissions but also increase energy security and create new economic development opportunities.

The Framework sets forth the following goals for the energy sector:

1. Diversify and decarbonize the energy supply to reduce climate vulnerability and greenhouse gas emissions
2. Promote demand-side measures, particularly in the commercial, industrial, and institutional sectors, and energy conservation that support resilience and thermal comfort, and reduce greenhouse gas emissions
3. Deploy distributed energy storage technologies in the already built environment of Los Angeles as a first priority

To meet these goals, regional leaders should:

- Source 100% of electricity sold in Los Angeles County from renewable sources, with an interim goal of 50% by 2025
- Increase percentage of energy derived from distributed energy to 33% of the total renewable mix
- Increase percentage of renewable natural gas from waste products
- Focus on data-driven decision making
- Improve energy performance of the existing building stock through targeted programs
- Strengthen energy efficiency for new buildings to ensure building size does not undermine efficiency
- Create a comprehensive regional strategy for targeting energy reliability programs
- Combine transportation electrification and renewable energy planning efforts
- Reduce urban heat islands to reduce energy consumption and improve building resilience to extreme heat

PUBLIC HEALTH

Climate change is anticipated to negatively affect the health of Angelenos in a variety of ways, most significantly through extreme temperatures, worsening air quality, more acres burned by wildfires, and a higher incidence of certain vector-borne diseases. Certain segments of the population are more vulnerable to these negative health outcomes, particularly low-income and minority residents.

Despite these challenges, climate change presents an opportunity to create healthier, more resilient, and more equitable communities. Actions that reduce greenhouse gas emissions often have notable health co-benefits. Public health agencies are ideally situated to identify and prepare for climate change impacts on public health and, therefore, reduce health inequalities. The Framework, therefore, seeks to support and strengthen collaborative efforts, with these goals for the region:

1. Facilitate partnerships among local governments, academics, and nonprofits to better understand and lessen the impacts of climate change on health
2. Reduce urban-rural temperature differentials

To achieve the goals, regional leaders should:

- Increase research and surveillance on climate-related illnesses and deaths
- Connect climate change adaptation and mitigation strategies to health risk reduction programs and activities
- Strategically expand and maintain the urban tree canopy, where tree maintenance and potential for trapped heat do not outweigh the benefits
- Increase shade structures
- Increase reflective surfaces such as cool roofs and cool and permeable pavements, after considering the negative potential impacts of increased localized heat during the day
- Reduce incidence of heat-related illness as well as excess emergency room visits during extreme heat events
- Improve outreach to vulnerable populations before and during extreme heat events
- Improve infrastructure to serve vulnerable populations during extreme heat events, including conservation measures in residential buildings
- Reduce the use of internal combustion engines

OCEANS & COASTAL RESOURCES

Climate threats to the Los Angeles coastal zone exacerbate an already complicated network of land, sea, and human pressures. With a highly urbanized coastline, the effects of climate change filter into the watershed and impact communities throughout the Los Angeles region, even beyond the coast. Meanwhile, Los Angeles County beaches stretch attract more than 50 million annual visitors, accounting for more than $16.5 billion in annual expenditures.

Los Angeles County's coastal communities are vulnerable to impacts from climate change, such as sea level rise and concurrent flooding from coastal storms and extreme tides. Warmer temperatures may also lead to greater stratification of coastal waters, weaker upwelling and less nutrient delivery from depth, and coastal low-oxygenated (or hypoxic) zones. Ocean changes due to climate impacts may cascade through ocean food webs and, therefore, link to public health concerns. Coastal ocean waters are also tightly connected to urban freshwater inputs.

The Framework recommends these priority goals for the region:

1. Prepare coastal infrastructure for higher sea levels and coastal storms
2. Prepare communities for higher sea levels and coastal storms
3. Protect natural resources from higher sea levels and coastal storms

4. Maintain and improve coastal and ocean health
5. Begin to develop policies to move the built environment back from the shoreline

To achieve the goals, regional leaders should:

- Support communities financially and through in-kind resources as they undertake scientific assessments of vulnerabilities to sea level rise and coastal storm impacts
- Incorporate sea level rise and coastal impacts into local planning, such as to protect and maintain beaches, relocate critical infrastructure, and mitigate through development permitting processes
- Identify examples of innovative solutions that utilize adaptive management approaches to managing assets and facilitate sharing of lessons learned
- Understand community social vulnerability
- Engage the community in understanding and planning for resilience in the face of climate impacts
- Foster economic sustainability of coastal communities by developing policies that pull developments back from vulnerable shorelines
- Protect and maintain coastal resources such as wetlands, aquifers, and rocky intertidal zones
- Understand status and trends in the Los Angeles oceanic regimes
- Facilitate community engagement
- Maintain coastal water quality to promote public health and ecosystem resilience in the face of perturbations caused by climate change

With the suite of options presented in this Framework, the challenge will be for leaders within the region to coalesce and focus on addressing near-term opportunities and developing the collaboration structures, institutions, and funding necessary to tackle the priority challenges. Leaders will need to achieve agreement and arrangements to marshal the resources and expertise to move forward, and then develop an implementation plan to achieve success.

INTRODUCTION

Climate change threatens the environment, economy, and health of Los Angeles like no other issue. More extreme heat, rising sea levels, severe droughts and floods, and less available drinking water are just a few of the potential impacts that could undermine the region's ability to function as a thriving metropolis in the coming decades.

At the same time, the county's role as a major population center, economic leader, and pioneer in solving environmental challenges, from clean air to clean water, positions the region to tackle the challenge and emerge resilient. The region already has much of the political will, financial resources, and leadership in place to reduce the carbon intensity of its energy and transportation systems, while building new infrastructure and programs that can be resilient in the face of likely climate impacts such as on water supply, public health, and coastal resources. The outcome could be a more equitable, healthy, and economically vibrant region.

Los Angeles County and its 88 cities are not alone in this fight. As California leads the world in an ambitious effort to reduce greenhouse gases, and as the federal government continues to support clean technologies and adaptation efforts, these entities can help local leaders. Meanwhile, success in a major world city-region like Los Angeles will help California, the United States, and other jurisdictions around the globe to reduce the overall greenhouse gas emissions that cause climate change. Through the power of its marketplace and dynamic economy, Los Angeles can help spur and refine the development of technologies and practices necessary to build a less carbon-intensive infrastructure that can better withstand the likely impacts of climate change, while building a more equitable and healthy society in the process.

But while the tools and leadership may be in place, action will not occur automatically. Leaders from the multiple cities, agencies, nonprofit organizations, and businesses, among other groups, will need to agree to prioritize key goals, develop the strategies necessary to achieve them, and then collaborate in the process of putting these words into action.

To that end, regional leaders formed the Los Angeles Regional Collaborative (LARC). Convened by F. Noel Perry's Next 10 originally, regional leaders from the County and City of Los Angeles, Los Angeles County Metropolitan Transportation Authority (LA Metro), Southern California Association of Governments (SCAG), and other regional agencies, nonprofit organizations, and business leaders spent nearly a year developing a county-level charter to collaborate to address climate change impacts.

This Framework is the outcome of that extraordinary effort. It will now require leaders from the region's cities, agencies, nonprofit organizations, and businesses, among other groups, to prioritize key goals, develop the strategies necessary to achieve them, and collaborate in the process of putting these words into action.

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The document is organized in the following sections:

- Transportation & Land Use
- Water
- Energy
- Public Health
- Ocean & Coastal Resources

Each section contains an overview of the issue (regional context), including the threats to Los Angeles, the role of regional collaboration in addressing these challenges, and existing policy landscape that governs action on the issue. The sections then identify the key goals for success, the strategies within those goals, and the actions necessary to achieve success. Notably, other important issues face the region and will need to be examined for action, such as social justice and equity, environmental justice, local revenues, reorganization of government and governance structures for more regionally coordinated responses, and management of waste, among others. This Framework, therefore, aims to present a first step toward highlighting and addressing the pathways for climate action and sustainability.

STATE OF THE REGION

The science is clear: Climate change is happening now. The effects, ranging from increased temperatures, less predictable water supply, rising sea levels, and more frequent wildfires, are already occurring. Although climate change is a global problem, its impacts are experienced locally. In fact, in a region as large and geographically diverse as Los Angeles, the type and intensity of impacts can vary down to the neighborhood level. To respond effectively, decision makers in Los Angeles must understand how this global phenomenon affects our unique region and communities. Inland communities will face different challenges than coastal ones, but the drivers of climate change are similar across the region.

Los Angeles County, as the most populous county in the nation, hosting the second-largest city in the county, is in an extraordinary position to lead the nation in addressing the impacts of climate change as a region. In essence, while there may be distinct climate impacts in specific areas – sea level rise versus high heat – the county must begin to address these impacts collaboratively. Though there are 88 distinct cities within the county, success in addressing climate change requires regional approaches, each place bringing its strength and commitment to the whole region's ability to adapt. The region cannot approach such a pervasive impact city-by-city. This dynamic means a commitment to thinking out of the box, beyond the past and the present, and to seek new solutions and ways of thinking that take us to greater collaboration and toward new governance arrangements and funding sources. The passage of Measure M in 2016, a sales tax increase for more transportation spending, is an indication of the region's capability for new directions. Climate change will require this same level of commitment.

What every decision maker needs to know about climate change:

1. Climate change is real and is happening now.
2. Even if global greenhouse gas emissions are reduced now, the climate will continue to change through midcentury.
3. Reducing greenhouse gas emissions remains critical to mitigating the most severe and potentially catastrophic impacts of climate change that are predicted to occur after midcentury.
4. Climate change impacts will vary across the Los Angeles region, even down to the neighborhood scale. Therefore, mitigation and adaptation strategies must be place-based but understood as having regional benefit.

5. At the same time, impacts such as sea level rise, and emissions reductions strategies, such as reducing vehicle miles traveled and the use of fossil energy, cross jurisdictional boundaries and require a collaborative decision making approach.
6. Climate change is deeply integrated into many aspects of the challenges the region faces and has faced. It risks exacerbating a number of them. For example, measures to improve air quality will strengthen Los Angeles's ability to respond to climate change and improve people's health. Therefore, such actions should be seen as a component of building climate resilience.
7. In the Los Angeles region, climate change impacts include increased temperatures, altering rainfall patterns, increased wildfires, and rising sea levels.
    - Increased temperatures will impact public health through more extreme heat events and by creating conditions conducive to poor air quality. In addition, higher temperatures will increase the incidence of vector-borne diseases, stress our current electricity systems and conventional building technologies.
    - Changes to snowpack in the state's mountain ranges will necessitate large-scale changes in water management, consumption, infrastructure, and regulatory systems.
    - More wildfires will threaten people, property, and ecosystems in urban-wildland interface and cause negative health impacts through increased air pollution, raising questions about where growth should occur.
    - Sea level rise coupled with storm surge and high tides will inundate portions of the Los Angeles regional coastline, impacting certain neighborhoods and socially vulnerable populations.

Climate models predict changes in the environment due to increases of carbon dioxide in the atmosphere. For example, models estimate changes in temperatures, water flows, sea level, and wildfire patterns. Climate models predict the expected change by a certain date, such as increase in average temperature by midcentury. They do not provide information regarding the rate of change (x degrees warmer per year). There is often a mismatch between the time and geography at which a scientist predicts changes and the time and geography at which decision-makers seek information. This was found to be particularly true for predictions regarding changes in water flows. Climate models are best at long-term forecasts. However, while they may seem far-off, they enable the development of plans, strategies, and programs to be implemented to mitigate and to even alter these forecasts. They enable people in the present to anticipate in a proactive manner how to adapt and to ensure that human well-being is protected and that the ecosystem services the region depends upon are protected.

The following Framework document is an attempt to identify the top issues that have regional impact and that must be addressed by the county's inhabitants together, to ensure the region remains livable and vital. It will require compromise and change.

TRANSPORTATION & LAND USE

REGIONAL CONTEXT

Los Angeles originally developed around streetcar lines, which real estate developers funded to boost property values and demand for homes in outlying areas of the county. With the advent of the automobile and later investment in highways, those "hub and spoke" communities filled in with developer-driven auto-oriented development. This history shaped the development patterns of the Los Angeles region and leaves cultural and infrastructural legacies today. Car travel has enabled residents of this diverse and expansive region to live and work across 88 cities and over 4,700 square miles. It has also led to environmental degradation. The high rate of driving miles (vehicle miles traveled or "VMT") emits significant amounts of greenhouse gases and other harmful air pollutants, while the associated infrastructure has left the region more vulnerable to climate impacts.

Tailpipe emissions from cars and trucks contribute 40% of greenhouse gas emissions statewide, and at least a third of the emissions in Los Angeles County, more than any other single sector (although building energy use is a close second).[1] In addition to carbon pollution, cars and trucks are the single largest source of air pollution in the region and a major contributor to high asthma and other respiratory disease rates. Internal combustion engines are also major contributors to the urban heat island in and of themselves. Perhaps more importantly for the region's future, 25% of all land is now dedicated to roadways and parking.[2] These surfaces are made of impermeable, heat-trapping materials that increase temperature, air pollution, stormwater runoff, and water pollution throughout the region, as well as preclude other uses, such as housing, open space, and civic spaces. All of these impacts further exacerbate the negative effects of climate change in the region. Los Angeles's transportation system must be transformed to minimize greenhouse gas and other emissions and to enable more resilience in the face of increasing extreme weather events and rising temperatures. This system should ultimately create minimal environmental impact and improve public health. It will also free up land for more housing and open space provision.

The coming decades are anticipated to bring the development of new, cleaner fuel sources, transformation of vehicle technologies, advancement in transit information systems, and the investment of billions of dollars in new public transit infrastructure. Some of these changes are underway, such as

the rapid increase in car- and ride-sharing through services like Zipcar, Uber, and Lyft, and in access to transit information through new apps and mobile devices such as the GoLA app. But these still largely rely on internal combustion engine (ICE) vehicles. Other changes, such as the development of new transit lines and the associated land use changes, will likely take decades unless there is concerted dedication to change and funding. As Phillip Washington, Metro's Chief Executive noted, "We're not building for today. We're building for 100 years down the road."[3]

While the transformation of Los Angeles's transportation system is underway, the carbon footprint and resilience of this future system is still undetermined. New technologies have the potential to enable efficient, equitable, and environmentally friendly mobility to an extent not previously possible. But they could also exacerbate driving miles, congestion, and inequity, among other impacts. Decision-makers should begin working today to minimize the long-term environmental impacts and ensure the system is resilient in the face of climate change and moves toward zero carbon fuels. They should leverage changes in technology, create synergies among travel modes, and build infrastructure that improves public and environmental health. They also must alter policies and avoid infrastructure investments that have unsustainable environmental impacts. They will need forward-thinking, creative solutions to the political challenges and create new partnerships across sectors and jurisdictions.

THE ROLE OF REGIONAL COLLABORATION

Multiple business, government, and nonprofit groups have spent recent decades working to create a more sustainable, just, reliable, and efficient transportation system. Their efforts have included municipal and regional actions coordinated by SCAG and Metro, sub-regional actions organized by various Councils of Government as well as several active and expert organizations and nonprofit coalitions.

Given the wide variety of existing reports, plans, and activities, the Framework focuses specifically on: 1) activities that will lead to the greatest climate benefit and 2) actions that require cross-jurisdictional and cross-sectoral partnership.

Reducing greenhouse gas emissions from transportation and building climate-resilient transportation infrastructure

Improvements to Los Angeles's transportation system can bring multiple benefits, from reducing air pollution, improving mobility and accessibility, reducing congestion, and improving livability and quality of life. The Framework seeks to provide clarity in decision making and prioritization of goals and activities by focusing on some of the most promising activities to reduce greenhouse gas emissions significantly and improve climate resiliency, particularly through infrastructure that promotes alternatives to automobile travel.

Developing opportunities for regional collaboration and coordination

While federal, state, and local actions all help shape our transportation system, regional collaboration has a critical role to play in reducing tailpipe greenhouse gas emissions and increasing the overall

resilience of the transportation system. Most travel occurs within the region and can, therefore, best be improved through collaborative regional actions. The Framework offers recommendations that can be used to bridge multiple governmental efforts, maximize the efficacy of investments, and ensure that the region's actions lead to real, tangible climate benefits.

To meet these ends, the Framework identifies three goals that will reduce the transportation sector's contribution to climate change and make the associated infrastructure more resilient in the face of climate impacts. It defines a set of strategies for each of these goals and then describes actions to meet each of the strategies.

Goal 1 — Decarbonize tailpipe emissions primarily through mass adoption of battery electric vehicles and use of low-carbon biofuels and hydrogen fuels when necessary, including an interim goal of 50% reductions by 2030

Goal 2 — Design and redesign transportation infrastructure to improve public health and air quality through more transit, pedestrian and bicycle infrastructure and redesign of existing automobile infrastructure to encourage vehicle-sharing, carpooling, and alternative travel modes

Goal 3 — Adopt land use patterns that channel all new growth into compact development near transit, and retrofit existing single-family suburban neighborhoods to be more walkable, bikeable and transit-oriented

POLICY LANDSCAPE

The transportation sector, as the biggest emitter of greenhouse gases, represents a major focus of climate action at the state, regional, and local levels. The majority of state efforts focus on reduction of tailpipe emissions, primarily by encouraging low-carbon fuels, including for battery electric vehicles (depending on the electricity source). The section below summarizes the key policy goals.

Reducing tailpipe greenhouse gas emissions through improved fuels and technology

A major component of state efforts to decarbonize the transportation sector involves changing vehicle fuels and technology. Reducing the carbon content of gasoline, switching to low-carbon and no-carbon fuels, and increasing fuel efficiency are all part of this transition. Assembly Bill 1493 Clean Car Standards (Pavley, 2004) is the cornerstone legislation, which was the first legislation to mandate greenhouse gas emissions reductions from passenger vehicles. It directed the California Air Resources Board to adopt measures to maximize reductions.[4] To meet the requirements of Assembly Bill 1493, the state has developed a series of additional laws and initiatives, most prominently the state's low carbon fuel standard, which the Air Resources Board adopted pursuant to Assembly Bill 32 authority.

Two programs aim to pull the diverse set of actions together: 1) The Air Resources Board's Advanced Clean Car Standards Program and 2) DRIVE, The California Energy Commission's Alternative Fuel and Vehicle Technologies Program. A study by the University of California Berkeley analyzed 49 state

greenhouse gas reduction policies and found that Assembly Bill 1493 is one of the five most important initiatives to help meet the state's 2020 and 2030 reduction targets.[5]

The Advanced Clean Car Standards program pulls the state's greenhouse gas emissions goals together with vehicle air pollution mandate and zero emissions vehicle targets into one package of standards. Together these standards are predicted to reduce the greenhouse gas emissions from cars by 34% and smog forming emissions 75% when fully implemented in 2025.[6] However, these goals are unlikely to be sufficient to help Los Angeles achieve its greenhouse gas emissions reductions goals.

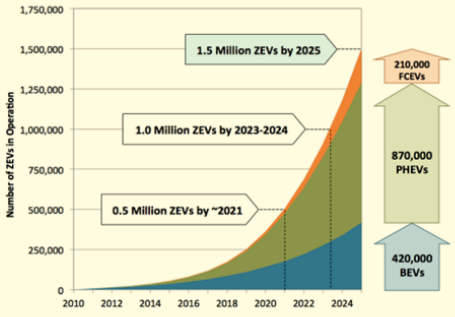
DRIVE, the California Energy Commission's Alternative Fuel and Vehicle Technologies Program, aims to accelerate the development and deployment of advanced fuels and technology through financial incentives. With as much as $100 million available annually, the program provides incentives to "businesses, vehicle and technology manufacturers, workforce training partners, fleet owners, consumers and academic institutions to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policy objectives."7

Fuel and technology transitions are implemented mainly through state action and through private enterprise. Local and regional action can support through facilitating the installation of electric vehicle charging stations, purchasing clean fuel vehicle fleets, and encouraging the siting of low-carbon biofuel infrastructure. As fuels and vehicles become cleaner, the emissions from passenger vehicles will decrease. Battery electric vehicles in particular represent the most promising technology to achieve significant, long-term reductions, and regional action will be integral to successful adoption at a large scale. The following section discusses options to maximize consumer adoption of this technology.

Increasing vehicle electrification

In 2012, Gov. Gerry Brown issued Executive Order B-16-20124, which set goals for the number of zero emissions vehicles (ZEV) in California, along with electric vehicle charging infrastructure. It set the goal for 1.5 million ZEVs by 2025, 1 million by 2024, and 500,000 by 2021. The graph below depicts these goals. The 2013 ZEV Action Plan, developed by a state interagency working group and updated in 2015, lists actions that state agencies and others should consider taking to meet these targets. DRIVE, The California Energy Commission's Alternative Fuel and Vehicle Technologies Program, mentioned above, is providing financial incentives to accelerate the transition.

Figure 3: ZEV Growth Scenario to Achieve ZEV Executive Order Goals



Source: Melaina, Marc, Michael Helwig (National Renewable Energy Laboratory) 2014. *California Statewide Plug-in Electric Vehicle Infrastructure Assessment.* California Energy Commission. Publication number: CEC-600-2014-003.

Successful consumer adoption of electric vehicles will require new charging infrastructure such as at workplaces, multi-unit dwellings, and along interstate corridors and other heavily traveled locations. Local and regional planning will be integral to efficient and equitable placement of these chargers, and financial incentives for rapid deployment will ease installation where current business models are lacking. In Los Angeles, where more than 50% of the housing stock is multifamily, policy makers need to overcome barriers to charging access (primarily lack of incentive to install) so apartment dwellers will be willing to purchase or lease electric vehicles and access them for the first or last miles to transit stations. Local governments are already facilitating streamlined and consistent permitting requirements for EV charging installation across the state by implementing Assembly Bill 1236 (Chiu, 2015).

Electric vehicles will also increase the demand for energy. Energy providers (utilities and Community Choice Aggregators) will be responsible for meeting this increased demand, such as through increased energy efficiency and demand response, and clean renewable sources. Managed "smart" charging can also help improve grid reliability, particularly with more intermittent renewables on the grid, by soaking up surplus renewables at key times of the day.

Los Angeles has a number of efforts to accelerate the transition to electric vehicles. For example, the City of Los Angeles adopted goals in its sustainability pLAn,[8] including:

- **Charging stations.** By 2017, install more than 1,000 new publicly available EV charging stations throughout the city, including more than 100 on City of Los Angeles property.
- **Light duty electric cars.** By 2025, 10% of all light-duty passenger vehicles on the road will be electric or zero emission; by 2035, 25% of all light-duty passenger vehicles on the road will be electric or zero emission (notably these targets are less aggressive than what this Framework recommends).
- **Goods movement.** Increase the percentage of Port-related goods movement trips that use zero-emissions technology to at least 15% by 2025 and 25% by 2035.

Los Angeles County has also set a goal of installing 500 chargers at its facilities by 2017.[9]

As another example, SCAG predicts there could be as many as 700,000 electric vehicles in its territory by 2022 and has developed a PEV Readiness Plan[10] to help ensure adequate infrastructure is in place.

A significant missing element is the electrification of public transportation as well. As the region's mode shift moves toward public transportation, all transit agencies must also provide electrified public transportation options. This new strategy is being piloted by the Los Angeles County Metro, arguably the largest public transit system in the U.S., which will provide the model and the testing of options for the other transit agencies in the region.

Reducing vehicle miles traveled

In addition to reducing the carbon intensity of fuels, the state recognizes the importance of reducing vehicle miles traveled (VMT) as a means to reduce emissions. Senate Bill 375, the Sustainable Communities and Climate Protection Act (Steinberg, 2008), aims to reduce emissions and VMT through land use measures that connect regional transportation and housing planning. The state, through the California Air Resources Board, sets greenhouse gas reduction targets for the municipal planning organizations (MPO) in the state to meet through the development of a Sustainable

Communities Strategy (SCS). The SCS must demonstrate how the region will meet that target through a combination of transportation and housing plans (failure to meet the target prompts the development of an alternative plan). Due to the size and complexity of the SCAG region (with SCAG as the MPO), the sub-regional "Councils of Government" have the option of either adopting SCAG's SCS or developing their own. Under Senate Bill 375, the SCAG territory must meet an 8% per capita reduction in vehicle miles traveled by 2020. The state set a conditional target of 13% per capita for 2035.[11] Notably, these targets were largely the result of political compromise and are unlikely to achieve the amount of emissions reductions needed to meet long-term climate goals. This is an important area for greater regional collaboration and ambition.

Over the long term, the connection between housing and transportation will become even more important. California has a significant shortage of housing, particularly in coastal metropolitan areas. Finding solutions that enable more housing (and jobs) to be built near transportation or that densifies existing neighborhoods will not only help to meet this fundamental need, but also increase the feasibility of transit to move more people without increasing driving miles. In addition, local land use planners, with regional coordination, need to develop plans to retrofit suburban neighborhoods with access to transit with more compact development, such as through dividing large homes into smaller units and faster permitting for second-unit dwellings.

Within Los Angeles, SCAG's Regional Transportation Plan/Sustainable Communities Strategy lays out a detailed plan to reduce greenhouse gas emissions from passenger vehicles and comply with the mandate of Senate Bill 375. In addition, Los Angeles County Metro's short and long range transportation plans describe options for increasing mobility across the region. Furthermore, several Councils of Government and individual cities have transportation plans that define a path to greater sustainability for their jurisdictions. All of these efforts will work together to shape Los Angeles's transportation future but will require local implementation and possibly stronger targets to help achieve long-term climate goals in the region.

Other state level measures to reduce VMT include implementing congestion pricing options, such as Los Angeles's High Occupancy Toll (HOT) lanes, and policies that would create fees based on annual vehicle miles travelled. Recent reforms to the California Environmental Quality Act (CEQA) have also prioritized streamlined environmental review for low-VMT projects over high-VMT ones, while state officials have explored options for tying auto insurance to the number of miles driven in the vehicle, through higher premiums on those who drive more.

Ultimately, local and regional action will play a key role in reducing VMT. The three goals listed below highlight the most important and effective regional actions to reduce VMT.

GOAL 1 — Decarbonize tailpipe emissions primarily through mass adoption of battery electric vehicles and use of low-carbon biofuels and hydrogen fuels when necessary, including an interim goal of 50% reductions by 2030

Tailpipe emissions

Reducing and eliminating the carbon content of fuels is essential to meeting state greenhouse gas reduction targets. Regional and local actors can influence vehicle technology and fuel sources by encouraging electric vehicle adoption and other low-carbon fuels and creating more options for reducing driving. The Framework describes three strategies to reduce tailpipe emissions through reduced driving and promoting cleaner fuels and lists actions for each of these strategies:

Strategy 1 — Plan, develop, and fund a multimodal transportation system that builds infrastructure for transit, biking, and walking and that only maintains and retrofits existing roadways rather than adding new automobile capacity

Strategy 2 — Adopt local policies that encourage alternatives to automobile use, such as reduced subsidies and excessive on-site requirements for parking

Strategy 3 — Leverage advances in car- and bike-sharing technology, as well as autonomous vehicles, to encourage more transit, biking, and walking

Strategy 4 — Decarbonize vehicle fuels by encouraging consumer adoption of battery electric vehicles (and low-carbon biofuels and hydrogen where necessary) through improved charging infrastructure and other incentives

Providing efficient, reliable, and enjoyable alternatives to driving is fundamental to enabling people to make other choices. But land use policies and infrastructure must work together to support different modes of travel. Local land use policies, particularly parking policies, often work in opposition to the sustainable, multimodal system that agencies and municipalities across Los Angeles are funding. In fact, policies such as those that subsidize the cost of parking make walking, biking, and public transit more expensive and difficult. In addition, multimodal strategies and investments and policy reforms should be structured to encourage new clean fuel and other carbon-reducing technologies.

The Framework's recommendations below are based on academic and other research and a recognition of the existing political, legal, and financial constraints. The best practices compendium contains additional information regarding case studies.

Strategy 1.1 — Plan, develop, and fund a multimodal transportation system that builds infrastructure for transit, biking, and walking and focuses solely on maintenance and retrofitting of existing roadways rather than adding new automobile capacity

Multimodalism is based on the understanding that different modes of travel are suitable for different types of trips. An integrated multimodal system allows people to choose the mode that is best for a particular trip at a particular time, which reduces car dependence and the associated greenhouse gas emissions. A multimodal system invests in and plans for choices including biking, walking, car sharing, taxis, and the enabling of the option not to travel at all (such as telecommuting).[12] Successful multimodalism requires place-making. Urban design elements, housing and employment location, and neighborhood elements all contribute to reducing car dependence and increasing the attractiveness of other modes. With the recent opening of the Expo line to Santa Monica, for example, Metro demonstrated a commitment to multimodalism by opting to build less parking than with past rail transit lines, more

housing development near stations, and more integration of other modes such as buses and shared ride services, to increase connectivity.

Multimodalism represents a dramatic shift away from car-centered planning and investments.[13] It requires including multiple players in decision making, which can lead to changes in a jurisdiction's traditional role and authority and, therefore, sometimes more conflict and competition.[14]

> *More travel choices also mean private entrepreneurs will take the lead on some services normally offered by the public sector: from taxi or bus services to parking management to goods movement. And with the benefits of redefining and reallocating street space in a multi-modal system come new political problems in terms of fighting for that space, too.*[15]

Planning for a multimodal system involves integrating infrastructure and policy decision making to enhance connections among modes, leveraging public and private partnerships so that public transit can benefit from the increase of car- and ride-sharing, and creative thinking and risk taking, given that the future of transportation technology is changing rapidly. Regional collaboration and inter-jurisdictional coordination is fundamental to multimodal planning, because residents travel across jurisdictional lines and would benefit from an integrated system with seamless connections and services.

Finally, multimodal planning is fundamentally place-based. Just as certain trips are best suited to certain modes, different neighborhoods and corridors are best served by different options. For example, dense corridors near the downtown core may be served almost entirely through public transit, small compact neighborhoods are prime places for walking and biking, and rural and suburban areas may be best served through electric vehicles and commuter van pools. Suburban areas can simultaneously become more urban through retrofitting, as discussed above, which in turn requires better transit service. In other words, what works in Lancaster will be different than what works in Santa Monica, and the solutions for West Hollywood will be different than the solutions for Compton. Ultimately, entities like SCAG and Metro must support place-based transportation planning with the goal of zero-carbon fuels powering the region's transportation sector.

A truly multimodal transportation system is fundamental to reducing car dependence in Los Angeles, improving mobility, and reducing emissions. Collaboration can help to build partnership and identify opportunities with multiple benefits to assist in overcoming the political challenges of changing land use patterns. Partnerships between multiple jurisdictions agencies can leverage a more diverse set of funding and financing options to pay for needed changes. Finally, regional coordination can help create consistency across the region so that the system operates as a contiguous whole.

The actions listed below represent opportunities for collaboration and coordination that could increase multimodalism.

Action 1.1.1 — Integrate payment systems across agencies.

Action 1.1.2 — Establish public and private partnerships between car-sharing companies, bike-sharing companies and transportation agencies in order to test and improve synergies for users.

Action 1.1.3 — Design streets to increase the safety and reliability of multiple modes, not just cars (while also enabling multiple modes and revising road standards to create opportunities for

walking and biking by narrowing roads and breaking up large blocks in to smaller ones, among other strategies).

Action 1.1.4 — Promote telecommuting, "alternative" work schedules (4/40 or 9/80), and flexible work hubs.

Action 1.1.5 — Coordinate street signal syncing, to improve the service of multiple modes.

Strategy 1.2 — Adopt local policies that encourage alternatives to automobile use, such as reduced subsidies and excessive on-site requirements for parking

> *The cheap and abundant provision of parking incentivizes drivers to continue driving to their activities instead of considering other options of travel such as carpooling, taking transit, or working at home.*
>
> —Mohja Rhoads, PhD, South Bay Cities COG

> *Perhaps the greatest barrier to walkable, thriving commercial districts is mismanagement of public parking.*
>
> —Civic Enterprise, Los Angeles-based developer

The design and management of parking is one of the most critical areas of local land use policy in determining how much people drive. Current policies often encourage driving and discourage other modes by providing excessive and cheap parking. Better parking management will reduce driving and increase biking, walking, and transit use. Without changes in parking management, significant reductions in driving and increases in other modes are unlikely to occur.

FREE PARKING LEADS TO MORE DRIVING AND LESS TRANSIT, BIKING, AND WALKING

Ninety-nine percent of parking is free to motorists.[16] And while parking constitutes half of the cost for the typical commute to work, drivers rarely pay this cost.[17] Yet because drivers do not pay for the costs of building and maintaining parking lots, garages, and spaces, they are paid for through increased prices in goods and services throughout the economy. Since the cost of parking is "collectivized" (paid for by everyone), "no one can pay less for parking, by using less of it."[18] This has the effect of "skew[ing] travel choices toward cars and away from public transit, cycling and walking."[19] Furthermore, "free parking gives the largest subsidy per mile to the shortest vehicle trips – the ones that, without a parking subsidy, we would most likely make by walking, cycling, or public transport."[20] These subsidies and incentives, coupled with the lack of integrated alternatives, work against goals to reduce greenhouse gas emissions, improve air quality, and increase public transit, biking and walking.

To illustrate the significance of parking subsidies to increased driving, a research study compared the parking supply to driving rates and found that "as a city went from 0.2 parking spaces per person to 0.5 per person, the share of car commuting went from 60 to 83 percent."[21] Another study found that commuters living in Queens were 45% more likely to commute by car than commuters living in neighborhoods with higher incomes, less transit, and greater car ownership (the factors usually correlated with more driving) because they had much greater access to parking.[22] Finally, another

study compared travel choices in D.C., Miami, Seattle, San Francisco, and New York and found that even when employees are offered the same financial benefit for parking as for transit, they are unlikely to take transit. As a result, "the net effect was more driving."[23] A reduction in car commuting only occurred in cases where employers provided a transit benefit but offered no free parking.[24] Put simply, "the power of the free parking spot…overwhelms transit benefits of any size," while the lack of density and viable alternatives to driving compounds the problem.[25]

PARKING IS CURRENTLY OVERSUPPLIED

In almost every location at most hours of the day, parking throughout Los Angeles County is oversupplied and underpriced. Current parking standards are determined based on peak demand for an individual space. As a result, for all other times outside the peak, more parking is available than needed.[26] The land set aside for excess parking increases urban heat islands, stormwater runoff, and air pollution, exacerbating the negative environmental and public health consequences. Furthermore, the oversupply of parking reduces opportunities to create places that mix housing, jobs, open space, and other destinations and that boost transit ridership.

PARKING INCREASES CAR OWNERSHIP

Most housing is bundled with parking, meaning the cost of a residential parking space is included with the cost of owning or renting a home. Local land use policies typically require a standard minimum parking amount for development, regardless of proximity to transit and without regard to other transportation options. While individual project developers may obtain variances from these minimum parking standards, they typically rely on costly studies to justify a lower parking rate and incur increased permitting costs to secure approval. The high parking requirements, therefore, increase the cost of development, impede rehabilitation of old buildings, and undermine the goal of more compact development, particularly near transit. A recent study by UCLA shows that the practice of requiring parking and bundling it in rental rates increases car ownership and driving and "that the odds of households being vehicle free are 50 to 75% lower than the odds of households without bundled parking." Furthermore, the study found that "households in dense center cities near transit are twice as likely to be without vehicles if they lack bundled parking." The research results support the growing movement to reduce or eliminate minimum parking standards."[27]

Since current parking policies increase car ownership and incentivize driving, efforts to reduce driving must include reforms to parking. Actions could include replacing *minimum* parking standards with *maximum* parking standards, unbundling the cost of parking from housing, and replacing employer parking benefits with transit benefits to provide individuals with information about the true cost of parking and the opportunity to reduce this cost by traveling less or by taking another mode. Shared mobility options may be key to reducing the demand for parking, because shared vehicles spend more time in motion moving people than they do parked. Sharing could be further enabled through technology advances ranging from software to autonomous vehicles.

PARKING POLICIES INCREASE THE COST OF WALKING, BIKING, AND TRANSIT

Parking spots take up 10% of all land in Los Angeles County.[28] Due to this massive footprint, parking supply dramatically shapes Los Angeles's land use patterns. All of this parking leads to greater

distances between destinations (urban sprawl) and wider streets that make walking less desirable and more dangerous. The following section lists actions to better manage the supply of parking.

ACTIONS TO BETTER MANAGE THE SUPPLY OF PARKING

Local governments implement most actions to manage the supply of parking, therefore 1) a coordinated approach undertaken by multiple cities will create the most meaningful reductions in driving while removing potential competition and conflicts; 2) the regional transportation infrastructure investments will not be successful at curbing driving without complementary parking policies; and 3) collaboration among multiple local jurisdictions, with the support of the Southern California Association of Governments or Los Angeles County Metro, can help to minimize competition among cities and increase the political feasibility of action on parking reform.

Actions to improve parking management include:

Action 1.2.1 — Unbundle the price of parking from the price of housing.

Action 1.2.2 — Remove or significantly reduce minimum parking requirements for new development.

Action 1.2.3 — Establish parking maximums for new development.

Action 1.2.4 — Allow different land uses to share parking spaces since different activities have different peak demand times.

Action 1.2.5 — Manage curb space for passenger loading near front doors, delivery zones, disabled parking, and car-sharing spaces as well as transit stops.

Action 1.2.6 — Ensure employers offer financial incentives to employees to use alternative modes to work (such as the Parking Cash-Out Program (PCOP) created by AB 2109 (1992) and implemented until recently by the Southern California Air Quality Management District).

Action 1.2.7 — Create variable priced street and off-street parking based on demand.

Action 1.2.8 — Allow project developers to substitute bicycle parking for vehicle parking.

Action 1.2.9 — Encourage car-to-go or other short term vehicle rental programs to develop an infrastructure in the region

Strategy 1.1.3 — Leverage advances in car- and bike-sharing technology, as well as autonomous vehicles, to encourage more transit, biking, and walking

> *Transportation will change more in the next decade than it has in the past half-century. LA must have the right plans and policies in place to ensure that these changes help support our environmental sustainability goals.*
>
> —Juan Matute, UCLA Lewis Center

After decades of relative stagnation, the transportation sector is experiencing rapid innovation. Information and communication technologies are opening up new options for ride sharing and making

it easier for people to gain accurate information about transportation options, locations and real-time schedules. Some experts believe that fully autonomous vehicles may be the norm within a few decades, while partial autonomy has already arrived.[29] This technology could entail significant impacts for the environment, both negative and positive, but could be deployed to reduce the need for car and bicycle ownership (and with it the need for parking and bicycle storage). Lower car ownership rates mean less driving and less parking, which could free land (and garages) for other purposes.

These technology changes, however, are not guaranteed to produce greater sustainability and fewer carbon emissions. Planners, advocates, and decision-makers should, therefore, be active participants in the transportation technology revolution. Emerging issues could include the need for new governance and financing, closed versus open business models and data access, concerns about labor equity, and the role of private companies in providing transportation services that have traditionally been public.

Changes are already happening across Los Angeles, although without coordinated planning. Through the "GoLA" app, created through a partnership between the City of Los Angeles and Xerox, Angelenos can now choose the cheapest and fastest mode for any particular trip based on real-time information on their smart phone. Metro's Office of Extraordinary Innovation and the City of Los Angeles's Office of Innovation were recently established to integrate advanced technology and innovation into planning efforts. The South Bay Cities COG is also actively engaged in efforts to incorporate advanced technologies into planning and is currently testing the viability of small electric vehicles as a means to meet Senate Bill 375 targets.

Innovation has the potential to greatly reduce the environmental impact of travel while improving safety, reliability, and efficiency. While agencies and municipalities will continue to advance efforts, the regional nature of the transportation system requires regional coordination and collaboration, which can leverage resources and make sure that the system works seamlessly across geography and jurisdictions. The following four technological advances should form an integral part of transportation planning and collaboration in Los Angeles.

1. Shared mobility
2. Autonomous vehicles and connected vehicles
3. Vehicle electrification
4. Data access and information

Each of these is discussed briefly below.

SHARED MOBILITY

Shared mobility includes ride sharing through companies such as Lyft and Uber, car sharing through companies such as Zip Car, and bike sharing, such as the Breeze program in Santa Monica and the recently launched program by Los Angeles Metro. Shared mobility enables individuals to pay for mobility on demand, reducing the need to own a car and making alternative modes of travel, including walking, more feasible.

In order to take advantage of existing and emerging strategies, Los Angeles should refocus its employer-based transportation demand management program to facilitate adoption of long-standing services

(vanpools), new options (car and ride sharing and bike sharing), and emerging shared ride services (shuttles, point-to-hub first/last-mile solutions versus point-to-point). These options can leverage the maturing market for shared rides, which introduces more travelers to alternative modes.

AUTONOMOUS AND CONNECTED BATTERY ELECTRIC VEHICLES

Autonomous vehicles or "driverless cars" are being developed and tested around the world. While fully autonomous vehicles may be years away from being market ready and legal, nearly every major auto-maker and several technology companies, such as Google, are developing and testing these vehicles now. Connected vehicles are vehicles with a wireless internet connection that allows them to connect with data and information services, such as traffic information, and also to other vehicles on the road (which helps prevent accidents). Connected vehicles are on the market today and the technology continues to expand.

Both autonomous and connected vehicles have the potential to reduce traffic congestion and automobile accidents. They also have the potential to shift Americans' relationships with their cars. As people ride in cars more than drive them, vehicle ownership could decrease while shared mobility could increase.

At the same time, they may have significant impacts on employment and the environment through increased vehicle miles traveled. Policy makers, therefore, need to analyze the technology carefully with a fully engaged social process of decision making around its deployment. They should plan for a future where the technology will allow people to own fewer cars and travel by alternative modes more, rather than one in which people consider congestion more productive or less strenuous time and thus increase vehicle miles traveled. By partnering with car and technology companies, requiring more battery electric vehicles and related infrastructure, and developing infrastructure and land use patterns that support more sustainable options, decision makers have the capacity to increase the likelihood of increased environmental and public health benefits. They should also encourage more car-sharing and less vehicle ownership with these technologies, allowing private companies to maintain and operate a network of shared, on-demand, and "right-sized" electric and autonomous vehicles for each trip. They can also consider transitioning from a gas tax to a vehicle miles traveled fee to discourage long commutes and excess driving.

ACCESS TO DATA AND INFORMATION

The ability to share data and information can transform how people travel. Individuals can now access real-time travel data to inform decision making on a trip-by-trip basis. Travelers can compare the cost, time and availability of different modes for a particular trip using their smart phones, provided they can afford the phones and the charges. Platforms that provide information across multiple transportation agencies and mode service providers, such as Google transit, enable travelers to move between modes and across jurisdictions more easily. Transportation planners should continue to improve these services by providing real-time data and by creating incentives for more environmentally friendly modes.

In addition to making data available to travelers, transportation agencies and companies can benefit from sharing data among themselves. Open data facilitates coordination among agencies and between

the private sector and government, such as to ensure better service across agency jurisdictions to meet demand, in addition to allowing individuals and groups to access relevant information from third parties. The data flowing among traditionally siloed organizations and disciplines can help accelerate Los Angeles's pursuit of reduced emissions and climate resilience.

BRINGING THE PIECES TOGETHER

Each of these technological innovations have the capacity to spur significant change. Yet taken together, these technologies can synergistically meet the Framework's transportation strategies. Better management of parking will encourage shared mobility. Shared mobility and autonomous vehicles will decrease demand for parking. Car sharing, ride sharing, and access to information all support an efficient multimodal transportation system. Yet while these technological advances are inevitable to some extent, the path to greater sustainability and reduced greenhouse gas emissions will depend on strong policies, shaped by innovative thinking and smart investment in decarbonization technologies and programs.

The section below lists actions that will leverage technology for greater sustainability.

Action 1.3.1 — Provide easy access to real time transportation options and costs across multiple modes and providers, including for private transportation providers and multiple transit agencies.

Action 1.3.2 — Enable data access between transportation agencies and partners.

Action 1.3.3 — Develop plans, strategies, and partnerships at the county level, such as through the Los Angeles County Metro or a joint agency consortium, to build a system of shared mobility.

Action 1.3.4 — Develop public private partnerships that prioritize sustainability.

Action 1.3.5 — Plan and develop an integrated system of electric vehicle charging stations across the region that is coordinated with public transit and other modes.

Strategy 1.1.4 — Decarbonize vehicle fuels by encouraging consumer adoption of battery electric vehicles (and low-carbon biofuels and hydrogen where necessary) through improved charging infrastructure and other incentives

VEHICLE ELECTRIFICATION

Battery electric vehicles (including electric motorcycles and bicycles) emit fewer greenhouse gas emissions than internal combustion engines. And if charged with electricity from renewable sources such as wind or solar, the emissions decrease even further. California has set a goal of putting at least 1 million electric vehicles on the road by 2023, and electrification of transportation is essential to meeting the state's Assembly Bill 32 and Senate Bill 32 (Pavley, 2016) emission reduction goals. As battery prices decrease and range increases, and with automakers developing more diverse options for zero-emission vehicles, consumer adoption will likely increase.

One of the keys to successful adoption of electric vehicles is well-planned and abundant charging infrastructure. "Fast chargers" in particular, which can charge 80% of a typical battery in 30 minutes,

will help with intercity travel and enable longer-range travel. Local and regional planners will play an important role in the siting of charging stations. They can streamline permitting for these stations and develop incentives for installation. They can also install public chargers and purchase electric vehicles for municipal fleets.

GOAL 2 — Design and redesign transportation infrastructure to improve public health and air quality through more transit, pedestrian and bicycle infrastructure, and redesign of existing automobile infrastructure to encourage vehicle-sharing, carpooling, and alternative travel modes

One quarter of Los Angeles's land area is used for parking (14%) and roadways (10%).[30] These impervious surfaces increase water pollution, storm water runoff, and heat islands. This runoff contains pollutants from oil, gas, and chemicals that impair Los Angeles's water quality by seeping into the groundwater supply and flowing into impaired water bodies. Impervious surfaces also inhibit groundwater recharge, a natural process essential to future water supply.

Local leaders have the opportunity to transform this infrastructure to ensure it improves rather than hinders efforts to reduce carbon emissions and increase resilience to extreme climate impacts. Policy makers can reduce heat islands through concerted and coordinated efforts on increasing cool surfaces and promoting and implementing standards for low-impact development and living streets, roads, and parking lots. Cooler roads and parking lots will keep parked cars cooler, which will reduce off-gassing and the need for air conditioning.

Most of the actions to meet this strategy fall within other sectors and are discussed in detail in other sections of this report. For example, the discussion of the heat island effect and how infrastructure can be used to cool rather than heat ambient temperatures, is discussed in the public health and energy sections. The water section of this report provides details on how impermeable surfaces (including alleyways and parking lots) can be transformed to assist in water filtering and groundwater re-charge. The energy section of this report discusses how fleet electrification will impact overall grid stability and the potential for more renewable energy.

However, due to the tremendous impact the transportation infrastructure has on climate resilience, this section contains an overview of these issues as well. The impacts of the transportation system go beyond travel, and the benefits of a more sustainable system will also be far-reaching. The transportation system should not only be resilient on its own but should support the resilience of other regional and urban systems.

Strategy 2.1. — Transform Los Angeles's transportation infrastructure into a system that improves climate resilience and public health

Collaborative regional action will be necessary for innovation and success. Roads and parking lots span multiple cities and, thus, coordination among cities will be necessary. Furthermore, multiple actors are

responsible for the construction and maintenance of roadways, including municipal general service and public works departments, Los Angeles County Metro, CalTrans, and others. These entities are not typically responsible for focusing on public health and environmental outcomes. Partnerships among environmental departments, public health agencies, transportation organizations, nonprofits, and agencies could enable the funding and knowledge base needed for successful implementation.

The actions listed below will build collaboration among agencies and across jurisdictions to transform the transportation infrastructure into one that improves public health and climate resilience.

Actions for greater collaboration to improve transportation infrastructure resilience and public health outcomes:

Action 2.1.1 — Create and fund an inter-agency working group between Los Angeles County Metropolitan Transportation Authority and the Los Angeles County Department of Public Health. This group will work to identify appropriate indicators for measuring the interaction of public health and transportation (focusing on those stressed by climate impacts), quantify those indicators, set future goals, work across the two agencies and with other departments to coordinate action and integrate goals, and track progress towards successes, as well as regularly reevaluating goals as needed.

Action 2.1.2 — Identify urban heat island priority areas to target efforts.

Action 2.1.3 — Identify and apply for co-funding opportunities to retrofit and upgrade permeable surfaces and develop new codes to encourage retrofits of privately owned surfaces.

Action 2.1.4 — Coordinate research and development efforts to develop rating systems and guidelines for appropriate materials. A joint research and development effort can secure funding for product development and enable pilot projects to be tested under a variety of conditions. Public facilities (such as parking lots, access roads, etc.) provide a tremendous opportunity to test new product durability and safety standards.

GOAL 3 — Adopt land use patterns that channel all new growth into the already built urban area, with compact development near transit and retrofitting of existing single-family suburban neighborhoods to be more walkable, bikeable, and transit-oriented, and to accommodate second units and extended families

To further reduce vehicle miles traveled and the emissions that result, land use choices will play a central role. The Los Angeles region needs to make land use and planning decisions that accelerate and support the transformation of energy and transportation strategies while accommodating a growing and thriving economy. As identified in the recently released draft state strategy paper *Vibrant Communities and Landscapes: A Vision for California in 2050*, "As the State works toward its 2030 and 2050 climate change goals, its land base, including natural, working, and developed areas, is recognized as foundational and integral to the State's climate policy, economy, and quality of life."[31]

Prioritizing infill development to grow healthy, equitable, and sustainable communities, and conserving natural and working lands that both avoid carbon emissions and provide carbon storage, are essential to meeting climate goals. Co-benefits from choosing a more compact development pattern include reduced pressure on natural and working lands in the region, increased transportation choices through modest increases in density, lower emissions from more compact development, reduced cumulative infrastructure costs, lower household costs for energy, and reduced health care costs.[32]

Yet all infill is not equal in terms of carbon reduction benefits. Recent studies have identified the importance of prioritizing affordable housing to achieve VMT reduction near transit.[33] Tailoring infill incentives to the Los Angeles region will be essential to identify and implement strategies that capitalize on and maintain existing quality of life, avoid displacement of families and existing affordable workforce housing, and maintain the fabric of neighborhoods and communities, including historic resources.

> *Every future net zero home or neighborhood located on a greenfield takes the region farther from achieving climate goals and other co-benefits.*
>
> —Geof Syphers, Sonoma Clean Power

Strategy 3.1 — Identify and prioritize through public investment and financing mechanisms infill development in previously developed areas

Action 3.1.1 — Create and fund an inter-agency working group among Los Angeles County regional leaders to initiate a comprehensive and detailed infill locator study for the region. The effort can use information already developed by SCAG, the county, and cities within the county. Those data can provide a foundation for tailored policies to prioritize infill in terms of location and type (e.g. housing affordability range and mix of uses to foster walkability and transportation investment and choices). The study should make use of a platform capable of supporting broad stakeholder engagement, transparency of results, and durability of the information for implementation and monitoring. The regional effort can be modeled on the 2005 infill locator study conducted by UC Berkeley for the state's Business, Transportation and Housing Agency.[34]

Action 3.1.2 — Set regional infill goals regionally and locally, based on the study and achievement of minimum densities to support transit and walkability.

Action 3.1.3 — Tailor incentives, including public investment, policy and ordinance changes, and financing mechanisms to identified infill areas in the study and evaluate the potential to pool funding regionally to accelerate infill in priority locations. Local leaders should consider leading-edge infill strategies including but not limited to: maximizing land use potential within transit walksheds; increasing walkability through the strategic location of essential daily services in existing neighborhoods by right; identifying policy and implementing ordinances to allow additional unit formation in single-family neighborhoods where transportation choice addresses potential traffic impacts; and regionally and locally tailored by-right options for infill where impacts are addressed.

Strategy 3.2. Initiate a regional assessment and broad-based dialogue of the importance of protected lands as carbon sinks

This effort should produce strategies to enhance the ability of these landscapes to store additional carbon. It can follow the example set by the Coastal Conservancy to explore opportunities to offset emissions from protected coastal landscapes and operations.[35] It should also include discussion of voluntary strategies and incentives to conserve the region's natural and working lands. Such action could help store carbon and avoid emissions associated with development through more compact development patterns.

Yet carbon storage is only one of the benefits of additional conservation of natural and working landscapes in the region. Other co-benefits include:

- preservation of grasslands, agricultural lands, forests, and wetlands
- enhanced water quality and quantity
- safeguards against fire, flood, and erosion
- habitat for refugia and critical landscape linkages for species and natural communities increasingly stressed by climate change
- enhanced recreational and tourism opportunities and revenue
- improved air quality
- job creation associated with working lands, recreation, and tourism

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WATER

REGIONAL CONTEXT

Water has arguably been the central determinant of the history of Los Angeles, and it remains a pivotal issue in the region's transition to a sustainable future. Los Angeles's Mediterranean-type climate is defined by semi-arid conditions with strong seasonal precipitation that varies widely from year to year. The region's topography creates additional variation and flooding risk. While the average annual precipitation in the coastal plain is 15.5 inches, the San Gabriel mountains average 32.9 inches per year,[36] with some of the highest rainfall intensities on record in the continental Unites States.[37] Such contrasting and uncertain conditions have long shaped Los Angeles's water management strategy, which has historically relied heavily on imports while simultaneously creating infrastructure to safely and quickly channel floodwaters to the sea. However, the realities of climate change, layered upon ecological concerns and a growing population, demand a new approach to water management in the region.

Water impacts planning in the Los Angeles region

Climate change is altering the amounts and timing of precipitation, snowpack, and runoff, both locally and in regions from which Los Angeles imports water.[38] Combined with increased temperatures and evaporation, scientists expect climate change to reduce local supplies. In particular, imports from the Bay Delta are highly at risk due to sea level rise and the potential for earthquake damage to levees.

The current statewide drought, although falling within the range of natural long-term variability, has added urgency to sustainability planning for water management. The drought has also elevated the importance of expanding water conservation measures and creating reliable local supplies. As of 2016, California is in its fifth year of drought conditions. Rain and snow amounts the previous winter improved from recent years, but not enough to draw the state out of the current drought; rain and snow levels also varied significantly by region, with parts of Northern California receiving better than average precipitation while most of Southern California received below average precipitation.[39]

Climate change responses for water resources management include adopting more water conservation measures, developing reliable local sources, developing new institutional arrangement for water

management, improving groundwater quality and management, and ensuring that disadvantaged communities are not disproportionally affected by water resource constraints. Several cross-cutting approaches could help ensure that measures taken in these areas are coherent and cost effective.

In essence, Southern California is moving toward a new water regime; droughts may be part of the new normal and thus a different vocabulary must be developed and a deeply different concept of landscaping and water use that is appropriate to a place with less reliable water supplies, warmer weather, and potential floods.

A number of regional planning efforts have established strategies and set targets around water management, with consideration of climate change impacts. These include:

- Metropolitan Water District's (MWD) 2015 Integrated Water Resources Plan (IWRP).[40] MWD serves 91% of the total population in Los Angeles County and is the regional wholesale water agency, importing water from the Bay-Delta via the State Water Project and from the Colorado River via the Colorado River Aqueduct. The 2015 IWRP addresses conservation, development of more local supplies, and planning for a new generation of supplies in the face of decreased availability of imported water.
- Urban Water Management Plans (UWMPs) are filed every five years by urban water suppliers under Department of Water Resources (DWR) regulations.[41] The goal of UWMPs is to support the suppliers' long-term resource planning and ensure adequate water supplies are available to meet existing and future water demands. Notably, these plans are unlikely to be sufficient to meet the region's long-term water conservation goals.
- The Greater Los Angeles County (GLAC) Integrated Regional Water Management Plan (IRWMP) was initiated in response to the 2002 Regional Water Management Planning Act (Senate Bill 1672) and associated bond act funding. This act incentivized the formation of regional water management groups (consisting of cities, counties, water districts, and community organizations) for the purpose of developing integrated plans. The GLAC IRWMP was issued in 2014 and includes planning targets for 2035 for water supply, water quality, habitat, open space, and flood risk reduction.[42]
- Watershed Management Plans (WMPs) are a voluntary means of complying with a number of water quality provisions of the Los Angeles County Municipal Separate Storm Sewer System (MS4) Permit. This approach allows permittees to join together to collaboratively address stormwater management on a watershed scale through customized strategies, control measures, and best management practices (BMPs), in order to meet permit requirements including receiving water limitations, total maximum daily load (TMDL) provisions, and prohibitions against non-storm water discharges. Among BMPs identified in these plans, structural approaches such as stormwater infiltration and rainfall harvesting will support water supply goals in addition to improving surface water quality. The Los Angeles Regional Water Quality Control Board (LARWQCB) has approved WMPs for most of Los Angeles County over the last year.[43]

Water management in the Los Angeles region

Over 100 public and private entities are involved in the management and distribution of potable water in the Los Angeles Region, a legacy of fragmented urban growth and a historic reliance on local control of services.[44] As a result, many small private water companies and special districts may not be adequately equipped to meet climate change challenges and associated capital investment needs.[45] Further, fragmentation may hinder new collaborations around conjunctive water management that can better meet the regional water need, rather than each entity doing it on its own.

Approximately 58% of the water used in Los Angeles County is sourced from outside the region (53% is met by MWD service water, and 5% is supplied by the Los Angeles Aqueduct, used only by the City of Los Angeles). Groundwater meets 38% of total countywide demand but is available only to groundwater rights holders, and local recycled water contributes about 4%.[46] Within the City of Los Angeles, approximately 89% of the water supply is imported from outside the region.[47]

Significant reductions have been made over the last few years in per capita water use, measured in gallons per capita per day (GPCD). In April 2016, the South Coast Region's residential water use was approximately 77 GPCD, representing more than a 14% reduction over the April 2015 usage of approximately 90 GPCD.[48] Data for potable consumptive demand (a broader measure than residential demand that includes municipal and industrial use) are not available at the monthly timescale, but annual MWD service area potable consumptive demand in 2015 was 131 GPCD, which is more than a 27% reduction from the 2005 baseline of 181 GPCD.[49]

The region has long struggled with water quality problems for both surface and groundwater, which could be exacerbated by climate impacts in the coming years. Approximately 85% of Los Angeles County assessed rivers and streams are impaired for one or more pollutants. Recent reports have shown that 39% of community water systems in Los Angeles County are completely dependent on groundwater for drinking water, and 40% of community water systems had a principal contaminant detected in an active untreated drinking-water well at a concentration above the maximum contaminant level on at least two occasions between 2002–2010.[50] Further studies have identified industrial chemicals prevalent throughout the county's groundwater basins in concentrations near or above comparison concentrations, including: 1,4-dioxane, perchlorate, perchloroethene (PCE), 1,1-dichloroethene, trichloroethene (TCE), atrazine, n-nitrosodimethylamine, carbon tetrachloride, and hexavalent chromium (Cr6).[51] State Water Board data for 2014 showed over 25% of supply wells exceeded comparison concentrations for 1,4-dioxane.[52] However, state regulations do not require drinking water suppliers to monitor this chemical. As of March 2016, chemical contamination above comparison concentrations for one or more chemicals existed in 439 supply wells across Los Angeles County.[53]

Despite the extent of groundwater contamination, nearly all customers have been provided with clean water based on publicly available data for systems serving >100 people in Los Angeles County.[54] Over the period from 2008–2012, the number of annual Maximum Contaminant Limits (MCLs) violations for systems serving more than 100 people in Los Angeles County ranged from a low of 6 to a high of 16, with the population impacted ranging from approximately 57,600 to over 144,000 people. In 2014, 16 systems in Los Angeles County had maximum contaminant limits violations, all of which served 1,500 or fewer people.[55]

Even when contamination is detected in time to prevent public exposure, groundwater contamination limits the siting options for infiltration BMPs, and cleanup requires tremendous resources. The 2009 California Water Plan estimates that cleanup of leaking underground tanks with MTBE can range up to $1.5 million per site, and sites where solvent contamination has reached groundwater may take decades and cost millions of dollars.[56]

The majority of the region's groundwater basins are adjudicated, meaning that a court has determined who has pumping rights to the water and in what amounts. The major adjudicated basins include the Upper Los Angeles River Area (the San Fernando Valley Basin), the West Coast Basin, most of the Central Basin, the Puente Basin, the Raymond Basin, and the main San Gabriel Basin.[57] Currently, the Santa Monica Basin, the Hollywood Basin, and the part of the Central Basin are not covered by any court-approved management agreements.

Coastal groundwater basins (Central and West Coast Basins) underlie 410 square miles and provide over 400,000 acre-feet of water annually. An extensive barrier system of freshwater injection wells is in place, designed to control saltwater intrusion to these basins. Sea level rise (discussed in more detail in the Coastal Resources section) is anticipated to increase saltwater intrusion and will, therefore, require an adaptive response by agencies responsible for the coastal barrier system, including the Water Replenishment District of Southern California, and the Los Angeles County Department of Public Works, among others.[58]

Wastewater recycling offers an addition source of local water for the region. Most of the large treatment plants in the region are owned either by the County or the City of Los Angeles. The combined volume of treated wastewater discharged in 2013 from 12 of the largest plants was approximately 247 billion gallons.[59] Many of these plants also produce recycled water that is being used in place of potable water for non-consumptive uses such as industrial, landscape, and recreational purposes, as well as indirect potable reuse for groundwater recharge. Expanded application of recycled water for direct potable reuse (defined as serving purified water directly into potable water supply distribution or into the raw water supply immediately upstream of a water treatment plant) is pending the development of state regulations. Metropolitan Water District is exploring a plant that would produce up to 150 MGD of purified water and up to 60 miles of distribution lines to convey the water to spreading basins and/or injection well sites in both Los Angeles and Orange Counties.

Currently, the only desalination plant producing drinking water for the general public in Los Angeles County is located on Santa Catalina Island, and the only planned facility is the West Basin's Ocean Water Desalination Project, with a projected capacity of 20–60 MGD.[60]

THE ROLE OF REGIONAL COLLABORATION

While the groundwater adjudications in Los Angeles County were precedent setting for the state, they currently allocate water according to historical precedent. Some cities have groundwater rights, others do not, and amounts vary widely, not correlated to city populations. Further, most basins have been overdrawn, relying on imported water to ensure safe yield. As a result, the basins have more room for additional water injection, but questions abound about who that additional water belongs to and

for what period of time. It is a propitious moment to bring all the groundwater masters together to discuss a greater Los Angeles groundwater basin joint powers authority (JPA) to manage the basins as water banks for the region and to create water balancing among them. As there is more interest in using them for treated wastewater storage, as well as more projects to infiltrate water into them, the adjudications will no longer be adequate to manage the new resources. The region should establish a groundwater basin JPA and explore the retirement of individual water rights to free up the water for regional benefit.

POLICY LANDSCAPE

The following is a summary of relevant state policies and recent regulations, provided as context for the discussion of goals, strategies, and actions. This summary is not an exhaustive, and further information is in the footnoted references.

Water conservation policy

Historic steps toward water conservation at the state level began in 2009, with Senate Bill X7 7 (Steinberg), a package of water reforms that included a goal of achieving a 20% reduction in per capita water use by 2020 (referred to as 20x2020), compared to baseline use from 1995–2005. This act also required local water agency planning and reductions. In January 2014, the Governor declared a drought state of emergency, which was continued in April 2014. In April 2015, the governor issued Executive Order B-29-15, which required an immediate 25% reduction in overall potable urban water use. The corresponding State Board emergency regulations prohibited certain uses of water, such as hosing down driveways and sidewalks, and also mandated monthly reporting by urban water suppliers.

In response to the continuing drought, the governor issued a new executive order in November 2015 (B-36-15), which was then further extended in May 2016 (B-37-16). Accordingly, the State Board adopted a statewide water conservation approach that replaced the prior percentage reduction-based water conservation standard with a localized "stress test" approach.[61] This new approach mandated urban water suppliers to ensure at least a three-year supply of water to their customers under drought conditions. These emergency regulations only apply to residential gallons per capita per day (R-GPCD), with data from monthly reporting to the State Water Board available for public review.[62]

In addition to setting conservation targets, the state has established code-based standards for new construction and retrofits. New stringent indoor plumbing standards have been set through recent legislative action, including Assembly Bill 715 (Laird, 2007), which applies to toilets and urinals sold in California after January 1, 2014, and Senate Bill 407 (Padilla, 2009), which requires water-conserving plumbing fixtures be installed in single-family residential real property as part of any building alterations or improvements made after January 1, 2014, and as a required replacement by the owner on or before January 1, 2017.

Assembly Bill 1881(Laird, 2006) broadly addresses outdoor water use by requiring local agencies to adopt the state's Model Water Efficient Landscape Ordinance (MWELO) by January 2010 and

requiring the Energy Commission to adopt performance standards for irrigation equipment. Assembly Bill 1881 was bolstered by Executive Order B-29-15 on April 1, 2015, which resulted in an updated MWELO issued on July 15, 2015. The ordinance revisions increased water efficiency standards for new and retrofitted landscapes through more efficient irrigation systems, graywater usage, installation of landscape water meters, on-site stormwater capture, and by limiting the portion of landscapes that can be covered with turf. It also required reporting on the implementation and enforcement of local ordinances, with adoption and required reports due by December 31, 2015. MWELO primarily applies to new construction projects equal to or greater than 500 square feet and to rehabilitated landscape projects equal to or greater than 2,500 square feet. Existing landscapes and cemeteries over one acre may be subject to irrigation water use analyses, surveys, and audits, with penalties and enforcement mechanisms to ensure compliance with conservation goals.

Senate Bill 555 (Wolk, 2015) requires urban retail water suppliers to conduct and submit water loss audits annually starting on October 1, 2017. DWR must make these reports available to the public on its website and provide technical assistance on water loss detection programs to urban retail water suppliers. The State Water Board is required to adopt water loss performance standards by July 1, 2020.

Water recycling and desalination policy

The State Board's "Recycled Water Policy," adopted in 2009, established a target of increased use of recycled water by 200,000 ac-ft./yr. by 2020 and by an additional 300,000 ac-ft./yr. by 2030. This same policy also required "Salt and Nutrient Management Plans" to be completed by 2014 for every groundwater basin in order to ensure that groundwater quality objectives were not exceeded. The state board regulations for groundwater replenishment using recycled water became effective in 2014. The board also planned to adopt regulations for augmenting surface water with recycled water by December 31, 2016 and will submit a report to the legislature by December 31, 2016 on the feasibility of regulations for direct potable reuse of recycled water.

A May 2015 amendment by the state board to the *California Ocean Plan* established a process for permitting seawater desalination facilities statewide, to address potential marine life mortality and harm to aquatic life beneficial uses associated with source water intake and brine discharge.[63]

Groundwater management policy

The statewide Aquifer Storage and Recovery permit, adopted in 2013 by the State Water Resources Control Board, allows water purveyors to store water of drinking quality in a local aquifer (as allowed by a water rights permit). More recently, the Sustainable Groundwater Management Act (SGMA) requires local agencies to adopt groundwater management plans, in order to protect local water sources against drought and climate change.[64]

GOALS, STRATEGIES, AND ACTIONS

While there are hundreds of possible actions related to water management, this Framework focuses on those that will benefit most from collaborative planning and implementation. These highest

strategies support four target areas for water management: conserving water, increasing and diversifying supplies, reducing water-related impacts on disadvantaged communities, and protecting and improving water quality.

Policy makers will need to implement these individual actions within the context of a truly integrated water management approach. Achieving our water management targets will require policy makers and others to consider carefully and holistically the interconnections between stormwater, wastewater, greywater, and recycled water. However, the complex, decentralized, and uncoordinated nature of the region's water infrastructure and governance obscures these relationships and creates barriers to the integrated management of the urban water cycle.[65] Furthermore, while numerous planning and collaboration efforts are underway throughout the region, the misalignment between municipal boundaries, surface watershed delineations, groundwater basin recharge zones, and water supply service boundaries often limits the effectiveness of these efforts and may create unintended consequences.[66] The absence of a centralized data infrastructure that cuts across these multiple physical and governance boundaries is also a barrier to optimal decision making. The work needed to achieve truly integrated planning across the county requires broad, collaborative support region-wide.

The following cross-cutting measures should be the highest priority for water management in the Los Angeles region:

1. Develop a water supply system across the county and its cities that ensures water resources are fully used and reused to minimize imports, while ensuring a basic human right to water
2. Implement a suite of policy recommendations to improve institutional capacity for data management, performance metrics, and agency collaboration, including:[67]
    - Publicly available centralized data repository for management of Southern California water to provide:
        - Standardized numerical identifiers for each utility and its service area
        - Up-to-date public geospatial data for retailer service areas
    - New guidelines to assess water utility performance capacity, including:
        - Retain and expand current emergency water use reporting requirements and require reporting by sectors
        - Standardized metrics for commercial, industrial, and institutional water consumption
        - Establish minimum performance thresholds
        - Require regular utility-scale leaking pipe audits and repairs

These measures will improve the effectiveness of all the following actions and are essential to the region's ability to respond quickly and equitably to critical climate challenges. The best practices compendium has additional information regarding case studies and steps for implementation.

GOAL 1 — Set aggressive and mandatory water conservation targets that become permanent

Reducing total usage remains a cornerstone of water management for the region, despite the significant progress made over recent years. The Framework prioritizes two areas where additional reductions can be made in non-essential water use: outdoor watering and distribution system losses.

Strategy 1.1 — Reduce outdoor water usage by transitioning landscapes to all California native or California-friendly plants

Large landscape and residential exterior water use are estimated to constitute approximately 26% of urban water use within California's South Coast Region.[68] A recent study using data from the City of Los Angeles determined that landscaping irrigation represents 54% of single-family water use.[69] The study also concluded that residents are overwatering when there are no restrictions in place, because landscape greenness did not change significantly when watering restrictions were in effect. A related study showed that voluntary restrictions were not effective in reducing water use and that mandatory restrictions resulted in an average of 19 to 23% decrease in water use.[70] Recommendations to address these findings included dual metering for indoor and out-of-door watering, water pricing adjustments specifically targeting customers with higher landscaping irrigation, and mandatory restrictions on outdoor water use. Dual-metering data to partition indoor and outdoor use is critical to more accurately assessing landscape irrigation needs and to calculate potential savings (for both money and water) from reducing over-watering. However, due to the additional expense to implement dual-metering systems, decision makers will need further analysis of the costs and benefits. New landscaping norms for the region must be developed and implemented widely that are suited to their specific water-scarce region. Integrating native vegetation that is adapted to aridity should be part of urban landscapes, bringing local ecosystems into the city.

Water pricing strategies such as steeply tiered block rate structures can influence water use behavior by allocating a greater share of service costs to those with greater demand. However, care must be taken to ensure low-income households are not adversely impacted.[71] Furthermore, informational, behavioral, and cognitive barriers can reduce the effectiveness of such an approach and should be addressed as part of a water pricing strategy.[72] Furthermore, a 2015 court ruling determined that, under Proposition 218 (1996), cities must demonstrate that proposed tiers correspond to the actual cost of providing service at a given level of usage,[73] although there are widespread calls to reform Proposition 218 to remove such unintended barriers to sustainable water management.[74]

Passive, or code-based, water conservation relies on the use of plumbing codes that will be adopted over time for new construction or remodeling and which do not require financial incentives from water agencies. However, oversight and enforcement are key to ensuring that builders and remodelers incorporate such codes, especially for remodeling. This enforcement will be particularly important for the recently adopted MWELO requirements for new construction and redevelopment. MWD has identified MWELO enforcement as a critical action to achieve demand reduction.[75]

Active water conservation strategies include the use of grants, loans or rebate programs to persuade water users to improve efficiency in existing systems. MWD has fostered active conservation since

1990, and in 2008 launched SoCal Water$mart, which consolidated the residential and commercial rebate programs into a singular regional program.[76] In addition to rebates for many indoor water-using appliances, rebates are available to residential and commercial customers for turf removal, landscape equipment such as sprinkler nozzles and smart irrigation controllers, and water audits.

Programs such as turf removal rebates aim to transition high-water-use landscapes to more California native and California-friendly plant choices. Additional approaches to facilitating this transition involve working directly with other key participants including the nursery trade (to encourage stocking more natives and providing education to consumers) and gardeners (to train them on care and maintenance of native plants and low-water landscapes). Composting is also an important element of climate-appropriate landscaping by reducing water evaporation and erosion losses from areas of bare soil.

Reductions in urban water use are not without downsides, however, including potentially contributing to tree mortality and exacerbating the urban heat island effect, which results in increased energy use for cooling and further contributes to global warming. As discussed under Goals 2 and 3 below, expanded use of recycled water to maintain urban green spaces equitably throughout the region can address these impacts and maintain health benefits.[77]

Action 1.1.1 — Adopt Model Water Efficient Landscape Ordinance (MWELO) provisions for a dual water metering (indoor-outdoor) for all new construction, and assess costs and benefits associated with retrofitting existing buildings.

Action 1.1.2 — Adopt and implement conservation pricing approaches for water rates using tiered block rate structures (or implement budget-based water pricing), while avoiding impacts to low-income households and addressing informational, behavioral, and cognitive barriers to effectiveness.

Action 1.1.3 — Adopt the Model Water Efficient Landscape Ordinance (MWELO) for new construction and require retrofits upon sale, lease, or remodel of existing buildings.

Action 1.1.4 — Achieve a retrofit rate of at least 1% of existing building stock per year by incentivizing MWELO retrofits and by implementing requirements for retrofit, upon sale for properties meeting MWELO threshold landscape areas.

Action 1.1.5 — Research and support water-neutral development through "zero net water" technologies in new developments.

Action 1.1.6 — Expand programs and funding to support the creation and health of appropriate landscapes, including: assisting the nursery trade to shift to low water-using plants, with an emphasis on natives; educating gardeners about low-water landscape maintenance; and increasing the number of composting facilities and compost distribution.

Strategy 1.2 — Reduce distribution system losses through strong leak detection and enforcement programs

The California Department of Water Resources (DWR) estimated in the 1980s that leaks in water district distribution systems amounted to over 700,000 acre-feet of water a year in the state, enough to supply 1.4 million homes for a year, and likely higher now. Meanwhile, audits of water utilities have found an average loss through leaks of at least 10% of their total supply.[78] Furthermore, a recent study in Los Angeles County found that most small water retailers do not report prioritizing adoption and implementation of best management practices to minimize water loss.[79]

Action 1.2.1 — Require leak detection and repair through the development of sustainable funding mechanisms.

Action 1.2.2 — Allocate funding to assist small retailers (not covered by Urban Water Management Plan requirements) to install leak detection systems, conduct water audits, and implement other related BMPs.

GOAL 2 — Invest in infrastructure to increase and diversify supplies by better managing local water on a regional basis

Expanding reliance on local supplies will require increasing stormwater capture and infiltration, improved management and protection of groundwater, and increasing water recycling, in addition to the water conservation measures described above.

Strategy 2.1 — Increase stormwater capture

Over the past two decades, policy makers and water experts have increasingly recognized the value of stormwater as a resource and become more educated on the deleterious impacts of impervious surfaces on stream ecology, stream channel stability, water quality, and the urban hydrologic cycle as a whole.[80] Widespread efforts have occurred across the state to move toward increased stormwater capture and infiltration, including the implementation of Low Impact Development (LID) techniques, green infrastructure, and related approaches to stormwater management for new development and redevelopment. In 2014, Proposition 1 was passed, which authorized a $7.5 billion water bond to provide funding for multi-benefit projects that include stormwater capture, improved water quality, decreased downstream erosive flows, and increased groundwater supplies. However, due to the complexity of subsurface geology and the lack of a coupled surface-groundwater model for the region, researchers have insufficient information to quantify the extent to which distributed infiltration BMPs will contribute new volumes to drinking water aquifers and where they should be implemented.[81]

Action 2.1.1 — Develop high resolution spatial estimates of recharge potential for stormwater capture to prioritize installation of regional and distributed BMPs.

Action 2.1.2 — Use the IRWMP process or other regional forums to systematize region-wide sharing of information on conceptual projects (in addition to shovel-ready projects), to facilitate potential cost sharing and efficiencies.

Action 2.1.3 — Enforce the Low Impact Development (LID) provisions of the MS4 permit for new construction to achieve a 100% compliance rate.

Action 2.1.4 — Require LID retrofit upon sale for properties exceeding some threshold acreage.

Strategy 2.2 — Improve collaborative groundwater basin management through adjudications that allow for conjunctive use, ensuring the basins serve as regional water banks

Existing groundwater basin adjudications prevent non-rights holders from accessing infiltrated storm-water resulting from structural BMPs financed by the non-rights holder. As a result, this dynamic creates financial barriers to implementation of stormwater infiltration projects required under the MS4 Permit.[82]

Action 2.2.1 — Develop approaches to encourage aquifer storage and recovery, including possible modification of groundwater basin adjudications via state law, in order to allow conjunctive use.

Action 2.2.2 — For basins not currently adjudicated, address the issue of storage and recovery as part of collaborative efforts to comply with the Sustainable Groundwater Management Act and form groundwater joint powers authorities to manage the basins.

Strategy 2.3 — Develop regional collaborations to increase the use of recycled water

Public perception and health concerns have created some of the greatest challenges to implementing potable reuse systems.[83] Public perceptions are slowly changing, although further education is needed, and work on statewide standards has progressed (see policy section above). More work is needed, however, on ecological, technical, and infrastructure barriers. Regulations are needed to require water recycling where available. Policy makers should undertake careful study before making any significant expenditures, in order to assess tradeoffs between distributed wastewater treatment and centralized treatment/reinjection into aquifers. This study should take into account cost, effectiveness, water availability, and equity impacts, as part of an integrated approach to sustainable water management.

Action 2.3.1 — Assess requirements for new developments to hook up to recycled water distribution pipes if they are within reasonable distance (e.g. 200 yards) for potable uses.

Action 2.3.2 — Assess and quantify the tradeoffs between distributed and centralized wastewater treatment using an integrated water management approach.

Action 2.3.3 — Create acceptable, effective solutions to increase demand for recycled water.

Action 2.3.4 — Provide input to the feasibility assessment of direct potable reuse, currently ongoing by the State Board, Division of Drinking Water.

Action 2.3.5 — Increase reinjection of treated waste water in groundwater basins where adjacency exists.

Strategy 2.4 — Improve water recycling technologies

Advancements in water recycling technologies, including salt and nutrient management, will facilitate the expansion of recycled water use by driving down costs, as well as help to address ecological concerns related to desalination of seawater and brackish groundwater.

Action 2.4.1 — Support the demonstration and scale-up of new technologies for seawater and brackish groundwater desalination that reduce associated cost, energy demand, greenhouse gas emissions, and impacts to marine wildlife and coastal ecosystems.

Action 2.4.2 — Support the demonstration of improved technologies for the treatment and reuse of greywater for potable uses.

GOAL 3 — Reduce water-related impacts on disadvantaged communities

Policy makers should enact water conservation programs equitably, focusing on areas with the greatest need and being aware of the relative financial capacity of the affected communities. If not explicitly considered, these policies may inadvertently cause costs to be borne disproportionately by those who can least afford to pay. This risk is particularly significant given that wealthier areas use much more water than disadvantaged communities per capita.

Strategy 3.1 — Preserve lifeline water rates for low-income customers

The recent successful legal challenge to tiered rate structures highlighted the need for reforms to Proposition 218 and related laws.[84]

Action 3.1.1 — Implement any local actions available to preserve lifeline rates, including the option of state legislation to allow and require municipal water providers to offer these rates.

Action 3.1.2 — Support state constitutional reforms for sustainable water management.

Strategy 3.2 — Assist communities with high rates of water usage to conserve more

In Los Angeles County, 10 to 20% of single-family households have water bills that exceed 2% of annual incomes.[85] The California Department of Public Health uses 1.5% as the threshold for water affordability.[86]

Action 3.2.1 — Continue low-flow toilet distribution.

Action 3.2.2 — Provide assistance to replace high-water-using appliances.

Action 3.2.3 — Provide assistance to transition to low-water-using landscaping.

Action 3.2.4 — Provide incentives for owners of multi-unit dwellings to conserve water through shared savings with tenants and deployment of water conversation technologies and practices.

Strategy 3.3 — Maintain public recreation and invest in and protect parks and open spaces that create multiple benefits

Intensive reductions or limits on landscape irrigation can reduce the cooling and shading benefits of urban greenspaces, which serve great value in disadvantaged communities.[87]

Action 3.3.1 — Transition urban greenspaces to California native and California-friendly landscapes, in part in order to maintain public health benefits.

Action 3.3.2 — Consider advancing stormwater projects that create new parks and open space.

GOAL 4 — Protect and improve water quality

Strategy 4.1 — Address failing drinking water systems

Small water systems, particularly those that serve disadvantaged communities, have the highest rate of non-compliance with drinking water standards, which may only worsen with climate change.[88] The technologies needed to meet primary standards may be too costly and technical for small systems to operate and maintain, however, consolidation with larger systems can be an effective solution.[89] The State Board provides incentives to large systems for such consolidation.

Action 4.1.1 — Consolidate failing drinking water systems with larger public systems.

Strategy 4.2 — Protect and improve groundwater quality

Groundwater quality varies throughout the region, and ensuring no further degradation should be a top priority.

Action 4.2.1 — Groundwater contamination plumes are complex in their movement. Careful monitoring needs to occur to make sure that no activities accelerate the dispersion of contaminated groundwater.

Strategy 4.3 — Adopt water-neutral new development ordinances

Action 4.3.1 — For any new development in the region, measures must be developed such that the development does not require additional new water. This may occur through a menu of options that each locality develops from investment into a fund that assists existing building owners to retrofit their appliances, to new irrigation technologies for public open spaces or water recycling facilities.

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ENERGY

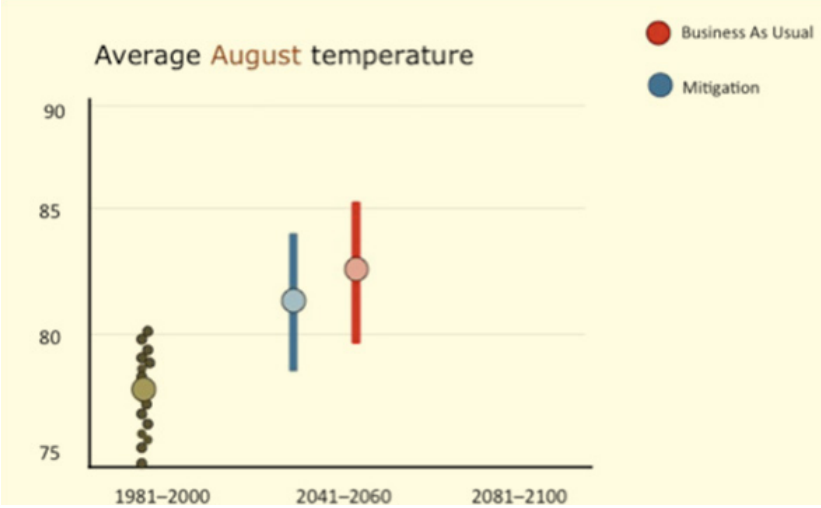
REGIONAL CONTEXT

Energy is essential for the economic, social, and environmental vitality of communities. Yet the current generation, transmission, and distribution of energy creates greenhouse gas emissions, air pollution, and negative land use impacts. In Los Angeles County, 40% of greenhouse gas emissions come from electricity and natural gas used in buildings, similar to the transportation sector in both emissions and urgency of the need to decarbonize this sector. Furthermore, the existing centralized energy system that concentrates large generation infrastructure in few locations (as opposed to a distributed, renewable one) results in approximately 65% of the energy being lost across generation and transmission processes. The current energy system is aging, inefficient, and vulnerable to system-wide outages. Reducing emissions from energy usage in buildings, and creating an energy system that is efficient and resilient, can significantly reduce the region's carbon footprint and increase the sustainability of the region's energy supply and environment. This progress will happen in three ways: 1) by improving the efficiency of energy use to encourage conservation, 2) by optimizing energy demand, and 3) by reducing the carbon intensity of energy. While officials throughout the Los Angeles metropolitan area have taken leadership steps in all three areas, the region faces many challenges to success.

The Framework describes a set of goals, strategies, and actions to aid in the regional transition to a decarbonized, sustainable energy future. Many of these recommendations are backed by state mandates. Yet compliance will offer regional benefits. Implemented thoughtfully, a sustainable energy system based on these goals will bring economic, public health, equity, and environmental benefits to Los Angeles.

Los Angeles has significant opportunities to leverage to reduce energy emissions and increase overall resilience to climate-related events through an improved energy sector. Due to its climate and geography, Los Angeles has abundant renewable sources of energy, particularly solar. If captured efficiently, these resources have the potential to not only reduce the region's greenhouse gas emissions but also increase energy security and create new economic development opportunities.

The region also faces challenges to this vision. Los Angeles is home to 40% of the state's disadvantaged communities, despite the county making up only 25% of California's total population. As the impacts of climate change increase, the risks to these populations will also increase. In the coming decades, Los Angeles will face an increasing number and intensity of extreme heat events (discussed in greater detail in this section as well as the Public Health section below).



On the graph above, the large brown dot shows present day average temperatures in August in Los Angeles, based on several years of monthly average (brown dots). The blue dot shows the expected future average temperature in August under a scenario with global greenhouse gas mitigation. The red dot shows expected future average August temperature under a scenario with no major global effort to reduce greenhouse gas emissions. The red and blue bars show the range between the individual global climate models with the largest and smallest increases, representing the range of possible future averages within each scenario.[90]

Vulnerable populations living in poor housing conditions without access to air conditioning, weatherized buildings, or quality transportation to escape oppressive conditions may be at greater risk for health impacts from these events. In addition, increased energy demand during heat events can cause brownouts and blackouts, which creates additional vulnerability. Current UCLA research is investigating grid vulnerabilities to determine the likely locations of these events and to see how vulnerable populations could be impacted. Finally, increased heat will mean reduced air quality. Vulnerable populations already face disproportionate risks from air pollution; climate change will only exacerbate this effect. Any efforts to reform the energy sector to reduce emissions and improve resilience should, therefore, ensure the equitable distribution of benefits.

THE ROLE OF REGIONAL COLLABORATION

In developing the Framework, research revealed three key obstacles that hinder the transition to climate resilience: 1) lack of information, 2) political and regulatory constraints that work at cross-purposes with renewable energy and greenhouse gas mandates, and 3) lack of funds (these

obstacles are discussed in more detail in the introduction). These three issues are also barriers to meeting many of the specific energy strategies laid out in this chapter. A lack of data related to building energy consumption hampers energy efficiency program decision making. Entrenched jurisdictional and agency and utility sunk investments and business models limit the creative and adaptive planning necessary to pilot innovative projects. A lack of upfront capital limits the ability to invest in energy efficiency measures.

Collaboration can help agencies and municipalities overcome these barriers and lead to a greater benefit for the region. Partnerships between public sector actors and universities can make data more accessible. Cooperation among multiple agencies, NGOs, and municipalities can lead to a more flexible vision and set of planning goals to overcome political obstacles. Joint funding applications can make partners more competitive to receive the grant awards necessary to fund critical planning efforts and pilot projects. Finally, new and innovative alternatives to current energy utilities should be explored. The current development of CCAs, the potential of "Sustainable Energy Utilities," and other new institutional forms and paradigms should be part of an ongoing dialogue about how to make the region more energy self-reliant, while using renewable sources of energy and ensuring high penetration of energy conservation retrofits in existing buildings.

POLICY LANDSCAPE

The energy sector is a fundamental component of the state's climate action goals. Energy policy in California is both complex and broad. The summary below covers three overarching areas of policy. These three themes are repeated throughout several pivotal pieces of legislation as well as the fundamental state guidance documents, including the California Energy Commission's Integrated Energy Policy Report, the California Public Utility Commission's Energy Efficiency Strategic Plan, and the Department for Natural Resources Safeguarding California Plan.

Policies aim to reduce greenhouse gas emissions by increasing renewable generation, storage, energy efficiency, and conservation

California has a long history of policies aimed at reducing pollution from energy generation and increasing energy efficiency. Electricity generators are required to participate in California's greenhouse gas emissions cap-and-trade program. This system requires utility companies (and other regulated entities) to obtain allowances (through initially free allocation, as occurred in the State of California) to emit carbon. If an entity emits fewer emissions than its supply of allowances, it can sell its excess allowances to other emitters. If it emits more, it must purchase additional permits from another entity willing to sell.

Another way that California's energy supply is decarbonizing is through the state's Renewable Portfolio Standards (RPS). Established in 2002 by Senate Bill 1078 (Sher, 2002) and accelerated in 2006 under Senate Bill 107 (Simitian), the standards required that as of 2010, 20% of retail electricity sales must come from renewable sources. The standards were extended again by Executive Order S-14-08 and Senate Bill X1-2 (Simitian, 2011) to require 33% renewables by 2020. Most recently,

under Senate Bill 350 (de Leon, 2015) mandates 50% of all electricity purchased in California must come from renewable sources by 2030.

In addition to reducing the carbon intensity of energy production, the state aims to reduce greenhouse gas emissions by making buildings more efficient. California's energy efficiency policies were first passed in 1974 and have been updated regularly since. Under Title 24, California created the most far-reaching energy efficiency codes in the nation, including a requirement for all new residential buildings to be net zero energy by 2020. More recently, Senate Bill 350 requires the state to now double the energy efficiency of buildings over the next 15 years, through 2030. Stakeholders are currently working to plan how to meet this target. Assembly Bill 802 (Williams, 2015), a complementary piece of legislation, states that energy savings should be measured according to actual meter-level savings, rather than based on the current practice of estimated savings. This practice, and the underlying technology that enables it, will help ensure that investments in energy efficiency are directed at the most effective measures, building confidence and trust in the marketplace to facilitate more investments and possibly larger-scale financing, and providing local governments and other actors with valuable information. Assembly Bill 802 also directs the California Energy Commission to establish a "Statewide Benchmarking and Transparency" program, through which building owners must report energy benchmarking data for public disclosure. It also directs the California Public Utilities Commission to work with utility providers to offer whole building aggregated energy data so owners can comply with the program. The data will ensure that local governments and other actors can make data-driven decisions on energy policies and investments.

Drive to increase data transparency

Better data can lead to better decision making in the complex field of energy policy. Although energy efficiency policies have been in place in California since the 1970s, as discussed above, few long-term before-and-after studies exist to detail how these investments have impacted actual consumption over time. Most studies rely on modeled results rather than actual data. While these models have provided valuable information, they are limited by their underlying source data.[91] Advanced computing and information technologies can open up new avenues for utilizing data, rather than just modeling, for decision making. As a result, several state guidance documents call for better access to data, a more transparent data process, and a move towards data-driven decision making.

Los Angeles is particularly well-positioned to lead the state in data-driven decision making. The LA Energy Atlas (energyatlas.ucla.edu), a collaboration between UCLA, Los Angeles County, and the SoCal Regional Energy Network, provides Los Angeles decision makers, utilities, and property owners with granular and historic energy consumption data across the region over the past decade. This project provides a variety of energy and building statistics, disaggregated to the neighborhood level. Individual account data are kept private, aggregated for the website and highly protected. The project provides a platform by which decision makers in the Los Angeles region can collaborate with researchers to gain tailored, specific, and accurate analysis.

Focus on social equity

Low-income communities often have the least efficient buildings and homes, despite having populations who would benefit the most from lower bills (if they are not on subsidized rates) and less

physical discomfort from building retrofits. State efforts seek to correct this inequity. The California Public Utilities Commission's Energy Efficiency Strategic Plan, Safeguarding California, and the 2015 IEPR all emphasize the importance of expanding, and even directing, the programs and benefits of sustainable energy programs, specifically energy retrofits, into disadvantaged communities. In addition, several state policies are aimed at increasing the equity outcomes of energy programs. Senate Bill 535 (De Leon, 2012) required 25% of the state's Greenhouse Gas Reduction Funds be directed to disadvantaged communities.[92] Senate Bill 350 (De Leon, 2015) directed state agencies to give preference to communities with high poverty and unemployment in deploying renewable energy, prioritizes job training in disadvantaged communities, and requires agencies to coordinate with environmental justice organizations.[93] These programs would benefit from greater access to data and processes to then base decision making on the data.

GOALS, STRATEGIES, ACTIONS

In order to meet state mandates and municipal greenhouse gas targets, and to increase regional sustainability, Los Angeles must reduce and manage energy demand and diversify the energy supply. Regional efforts that build collaborations between municipalities, agencies, NGOs, and researchers should leverage the resources of multiple partners to ensure success and to maximize benefits equitably.

The Framework sets forth the following goals for the energy sector, as well as an accompanying set of strategies and actions for each, which will lead to reduced greenhouse gas emissions and increased resilience.

Goal 1 — Diversify and decarbonize the energy supply to reduce climate vulnerability and greenhouse gas emissions

Goal 2 — Promote demand-side measures and energy conservation that support resilience and reduce greenhouse gas emissions, prioritizing commercial, industrial, and institutional sectors first

Goal 3 — Deploy distributed energy storage technologies in the already built environment of Los Angeles as a first priority to integrate intermittent renewable energy and reduce peak demand

Due to the interconnected nature of the energy sector, several actions can benefit all three goals. For example, energy efficiency upgrades can lead to both reduced greenhouse gas emissions and buildings that are cooler and more resilient to heat from a warming climate. If targeted appropriately, distributed solar can reduce greenhouse gas emissions while improving grid reliability.

The discussion of the goals, strategies, and actions follows below. The best practices compendium contains additional information including case studies and steps for implementation.

GOAL 1 — Diversify and decarbonize the energy supply to reduce greenhouse gas emissions and climate vulnerability

As discussed above, reducing carbon in California's energy supply is a state priority and foundational component of the Assembly Bill 32 scoping plan. A more diversified and decarbonized energy supply will also decrease vulnerability to climate impacts. In addition, distributed generation can provide opportunities for resilience by shielding communities from power outages, particularly during extreme weather events.

Distributed energy provides local governments and communities an opportunity to create local, reliable, and clean energy located closer to where the energy is needed. Centralized energy systems lose efficiency due to waste heat rejected into the atmosphere, as well as line loss in transmission. Therefore, diversifying the energy supply to include local distributed energy through generation, energy storage, efficiency, and demand response, in configurations that ensure long term savings, represents an important solution for providing clean, reliable, and cost-competitive energy to any building or system connected to it.

Regional collaboration is essential to maximizing the benefits and potential of a more diversified energy supply. While energy providers are responsible for meeting renewable portfolio standards, the greatest regional benefits from a diversified supply will come from the collaborative efforts that focus on increasing regional resilience, equitable benefits, energy reliability, and public health. Such direct regional benefits are otherwise not guaranteed simply from meeting state mandates. Instead, regional leaders will need to develop cross-jurisdictional, inter-agency, and cross-sectoral partnerships that identify and implement the optimum solutions for Los Angeles County specifically. The recommended strategies and actions below address this need.

Strategy 1.1 — Source 100% of electricity sold in Los Angeles County from renewable sources, with an interim goal of 50% by 2025

The region needs to completely decarbonize its electricity supply to meet long-term climate goals. In the interim, as discussed above, Senate Bill 350 (De Leon) mandates utilities to source 50% of electricity they sell from renewables by 2030. This target increases the state's Renewable Portfolio Standard and requires significant effort by utilities and other stakeholders to implement.[94] The Framework adopts a more aggressive policy mandate as the energy sector's top strategy, with an interim goal of 50% renewables by 2025. Notably, two proposed Community Choice Aggregation (CCA) programs for the region have set goals to provide 100% renewable power within 10 years of forming. If these efforts are successful, Los Angeles County would likely meet this more aggressive renewables supply target.

Beyond the state mandates, important regional benefits result from increasing renewable energy. Los Angeles has abundant solar resources, with an estimated 19,000 megawatts of annual solar potential. Nearly 97% of these resources remain untapped.[95] According to UCLA's Luskin Center for Innovation, if just 10% of Los Angeles's solar capacity was used to generate energy, it could create 47,780 jobs and reduce nearly 2.5 million tons of carbon dioxide annually, the equivalent of taking almost 500,000 cars off the road.[96]

More renewable energy generation also has the potential to improve air pollution in the region in two specific ways. First, tailpipe emissions from transportation are a leading cause of air pollution. New solar resources can provide the additional grid capacity needed to transition to electric vehicles, thus

reducing transportation-related air pollution. Second, if managed properly and integrated into the grid supply efficiently, regional renewable resources, coupled with bulk energy storage technologies, have the potential to replace both the natural gas "peaker" plants located within Los Angeles and the diesel back-up generators used by hospitals, universities, industries, and others during power outages. To make such opportunities a reality, renewables will need to be connected to energy storage, which is still an emerging market, as well as demand response programs.

Actions to increase renewable generation to 50% include:

Action 1.1.1 — Expand the local feed-in tariff program (e.g. offering additional capacity and opening the program to larger projects).

Action 1.1.2 — Simplify state and municipal Net Energy Metering requirements to identify areas of improvement to encourage greater customer participation.

Action 1.1.3 — Promote the implementation of asset-owning Community Choice Aggregation in investor-owned utility territories and explore other alternative utility models.

Action 1.1.4 — Identify opportunities for community solar projects and support the implementation of such projects in both the Southern California Public Power Authority (SCPPA) and Southern California Edison (SCE) areas of Los Angeles.

Action 1.1.5 — Identify barriers to increasing solar generation in disadvantaged communities and develop programs to overcome them.

Action 1.1.6 — Assess grid modernization needs based on more renewable and distributed technologies, and develop equitable financing and funding programs

Strategy 1.2 — Increase the percentage of energy derived from distributed energy to 33% of the total renewable mix

RESOURCES

Increasing distributed energy resources is an important state strategy that has strong regional benefits. Distributed generation has the potential to provide direct benefits to Los Angeles residents. Collaboration between multiple stakeholders will help to fully leverage regional opportunities and maximize the benefits of distributed generation. Distributed generation can be located on blighted or underutilized land, provide shade and cooling via solar canopies in parking lots (which are a major contributor to urban heat island), add to cooling roofs, create local jobs, and, if properly planned and assessed, increase energy reliability in vulnerable areas. The greatest regional benefit will come through regionally coordinated action between community groups, academics, nonprofits, local government, and energy providers to determine optimum locations, technologies, and financing structures for distributed renewables in Los Angeles.

Actions to increase distributed energy include:

Action 1.2.1 — Expand the SCPPA utilities' feed-in tariff program to allow larger and more sources to participate.

Action 1.2.2 — Create permitting and other financial incentives (such as strong net metering programs) to develop more locally generated renewable energy.

Action 1.2.3 — Ensure that storage resources are created to reduce dependence on natural gas peaker power plants.

Strategy 1.3 — Increase percentage of renewable natural gas

While solar energy is and will likely remain the predominant source for renewable generation, policy makers must tap into a diverse set of renewable resources. Renewable natural gas in particular may hold potential because of the existing infrastructure in place for transmission. Local governments also own and operate many landfills that could provide renewable natural gas from methane.

Recommended action to increase the supply of renewable natural gas:

Action 1.3.1 — Identify opportunities to produce agricultural and biological waste-capture and renewable natural gas in Los Angeles, and develop and support incentive programs to implement such projects, based on adequate cost-effectiveness and emissions performance, among other metrics.

GOAL 2 — Promote demand-side measures, particularly in the commercial, industrial, and institutional sectors, and energy conservation that support resilience and thermal comfort, and reduce greenhouse gas emissions

Reducing electricity and natural gas consumption is a fundamental component of climate action. "Demand-Side Management" (DSM) involves electric utilities engaging in planning, implementing, and monitoring activities to encourage customers to modify their level and pattern of electricity usage to match grid needs.[97] According to research conducted by UC Berkeley, which reviewed 49 greenhouse gas reduction policies, successful implementation of the California Public Utilities Commission's Energy Efficiency Strategic Plan is essential to meeting the state's goals. The study found that successful implementation of this plan had the most significant long-term reduction impact of any of the 49 policies studied.[98] The regional benefits, however, provide even more compelling reasons to implement the plan than simply meeting state mandates. Measures to reduce energy consumption can increase regional climate resilience, reduce air pollution, and provide economic opportunities. For these reasons, demand-side measures should be a key part of climate action in Los Angeles. To maximize benefits, efforts should be far-reaching, innovative, and focus on performance outcomes. Strategic regional collaborations that leverage knowledge and resources across partners will maximize benefits.

REDUCING PEAK DEMAND THROUGH DEMAND RESPONSE

Reducing the carbon intensity of energy consumption is related not only to energy supply but also to the amount, time, and location of energy usage. The dirtiest electricity is typically generated to meet peak demand, usually from about 10am to 6pm, when consumers typically use the most energy.[99]

Demand also varies by season, with higher demand in the summer and winter months when more air conditioning and heating are used. During these times, the grid is most constrained and requires carbon-intensive back-up natural gas "peaker" plants to meet demand reliably. In addition to more greenhouse gases, diesel generation also emits serious health-impairing particulate matter into the air. The three plants that burn diesel in Los Angeles are all located in disproportionately impacted, low-income communities where the majority of residents are people of color.[100] Reducing peak load, particularly during the summer and winter months, is critical for climate action and for public health, and in particular as more solar resources come on-line during the day, creating a potential mid-day glut, as well as a related need to ramp up fossil fuel-based resources to serve the evening load. Solutions that encourage energy conservation, storage commensurate with demand, and optimal shifts in times of consumer demand could address these challenges.

Further underscoring the need to reduce demand, and in particular peak demand, the California Energy Commission predicted in 2014 that electricity usage will increase between .8% and 1.5% per year.[101] This increase is mainly due to a growing population and number of electric vehicles on the road. Over the course of their life cycle (including manufacturing of batteries and parts), electric vehicles emit roughly half the greenhouse gas emissions of standard internal combustion engine cars.[102] As the electricity supply is decarbonized, this benefit will increase. At the same time, grid capacity must expand to meet this new and expanding load. Reducing demand, particularly among large commercial customers and through residential retrofits and advanced software to respond to grid signals, is an important first step to providing increased capacity and allowing Los Angeles to experience the multiple and significant benefits of transportation electrification.

Strategy 2.1 — Focus on data-driven decision making

> *"The single biggest weakness in our energy efficiency policies in this country is our failure to properly analyze, incorporate, and account [for] the benefits."*
>
> —Steve Crowell, chairman and CEO of the Conservation Services Group[103]

Limited access to data and information represents a key barrier to transitioning to a more sustainable energy supply. As discussed above, several state guidance documents and recent pieces of legislation emphasize the importance of data to improved decision making. While important at the state level, improved data access will be imperative at the regional level. Many state energy mandates must be implemented at the local and regional level, which is also where the benefits of success will accrue and have the greatest impact.

The Los Angeles region can play an important role in forming collaborations that better enable data-driven decision making. Partnerships among the various local governments, municipal utilities, and utility associations involved in program development and implementation could improve outcomes in Los Angeles, while providing an example that could be replicated and tailored throughout the state. The recommended actions below will improve the capacity for data-driven decision making in Los Angeles.

Action 2.1.1 — Support energy performance disclosure and data management. Accurate energy performance data must be collected, organized, analyzed, integrated, and made appropriately available to market actors and decision makers. Use the data collected to establish baselines.

Action 2.1.2 — Utilize standardized and open source tools for benchmarking, energy assessments and audits, and building retro commissioning in commercial and public buildings, such as ENERGY STAR Portfolio Manager, the Department of Energy Building Energy Data Exchange Specification, and the Building Energy Asset Score. Support California-specific tools that are compatible with these federal tools and standards.

Action 2.1.3 — Develop a region-wide energy data portal that tracks energy consumption among residential and other users, monitors impacts of implemented policies, and provides decision making support, building on the UCLA Energy Atlas (energyatlas.ucla.edu).

Action 2.1.4 — Focus energy retrofits in neighborhoods and building types with the lowest efficiency.

Action 2.1.5 — Develop performance-based policies, programs, and incentives.

Action 2.1.6 — Develop standards for Title 24 permit tracking software in order to organize and standardize the vast amount of data not electronically captured by the majority of land use and retrofit permitting jurisdictions (i.e. local governments).

Strategy 2.2 — Improve energy performance of the existing building stock through targeted programs

Improving the energy performance of buildings will be fundamental to reducing greenhouse gas emissions and increasing regional climate resilience. As stated above, the successful implementation of the California Public Utilities Commission's Energy Efficiency Strategic Plan is essential to meeting the state's greenhouse gas reduction goals. Senate Bill 350 mandates a doubling of energy efficiency in buildings throughout California by 2030. In Los Angeles, where the majority of energy consumption occurs in existing buildings (rather than in new construction), policy makers must focus on retrofitting and improving the performance of existing buildings and in newer, large buildings that have significant energy consumption based on their higher square footage.

While the benefits of energy efficiency are clear (lower utility bills, less need for expensive new generation infrastructure, and less pollution in general), improving energy efficiency is challenging. The effectiveness of California's aggressive energy efficiency goals and policies will involve myriad factors, including human behavior, technology, and adequate funding and financing. Key challenges to energy efficiency are described below. Regional coordination and collaboration will offer an important means of addressing many of these challenges, meeting state goals, and realizing the benefits of reduced energy use.

DATA ACCESS AND MEASURING EFFECTIVENESS

Since 2002, California has spent over $13 billion in PUC required-investor owned utility ratepayer dollars on energy efficiency programs. The California Public Utilities Commission funds evaluation of these efforts. Because utility data are private and protected under the California Public Utilities Code, third parties have difficulty conducting additional evaluations. Most studies also rely on modeled savings, rather than actual before-and-after savings, as discussed above. These models, while helpful, have limitations such as an inability to determine how long reduced energy usage continues after

retrofits. In addition, human behavior is difficult to model, which is otherwise a key determinant of the success of energy efficiency upgrades.

UCLA is beginning to develop a data repository that tracks consumption and retrofit programs over time that will be an invaluable resource for providing real returns on investments for energy upgrades. However, this initiative must be institutionalized to be a long-term resource.

REBOUND EFFECT

When buildings become more energy efficient, building occupants may decide to use more energy, which can outpace the reduction benefits of the efficiency upgrades (notably, this dynamic can also occur in the transportation sector, with improved fuel economy encouraging more vehicle miles traveled).[104] This dynamic is commonly referred to as "the rebound effect." While analysts generally agree that the rebound effect is real and poses distinct challenges, policy makers will need more study on the size and impact of the effect.[105] Certain retrofits are likely to be more sensitive to this rebound than others. For example, evidence indicates that more efficient air conditioners can cause increased use by 30%, while more efficient refrigerators have nearly no rebound.[106] The rebound effect can also be both direct and indirect. A direct effect is exemplified by the air conditioner dynamic referenced above, while an indirect effect happens when increased efficiency in one system leads to increased energy consumption elsewhere. As an example, the reduced consumption from lighting upgrades may lead a customer to purchase a new piece of equipment that increases overall on-site consumption. Rebound effects can also occur by encouraging people to purchase or lease larger buildings, which have greater overall energy consumption.

SPLIT INCENTIVES

Split incentives are one of the fundamental challenges faced by energy efficiency providers. The split occurs when one party is responsible for paying the cost of the energy efficiency upgrade, while another receives the benefit. A classic example is in rental housing, when the landlord pays for a retrofit (such as double-paned windows) but the tenant benefits by paying less in utility costs. This dynamic also happens frequently in commercial properties, when the cost of upgrades comes out of one department's budget but another department pays the energy bills and, thus, realizes the savings. In these examples, the building or company owners have no incentive to invest in energy efficiency because they will not benefit, barring any options for shared savings.

CODE ENFORCEMENT AND COMPLIANCE PATHWAYS

Though Title 24 created aggressive statewide energy efficiency standards, municipal building departments are often under-resourced and unable to track and enforce code compliance regularly. While many cities recognize the importance of building performance, they may not have the means to retrofit their own government buildings. One innovative approach is "Measured Performance Compliance Pathways to Title 24" as an alternate compliance pathway. To align with Assembly Bill 802, Title 24, and the Building Energy Efficiency Standards, the pathway provides an opportunity to streamline and simplify the permitting, compliance, and enforcement process. It allows building owners to submit 12 months of measured performance data in order to comply with the energy code

by demonstrating they have energy use intensity targets. The California Energy Commission will likely further develop and integrate this approach into the next cycle of the code rulemaking process.

In addition to the environmental and economic benefits of reduced energy consumption in buildings, retrofitting buildings can improve thermal comfort, health, and well-being. These improvements can improve social equity, as most of Los Angeles's least-performing buildings are in disadvantaged communities with greater vulnerability to health impacts from heat and the changing climate. As a result, reducing consumption in these buildings through improved building performance can save residents and businesses money, while insulating them from extreme weather. These improvements, therefore, can increase equity and the overall economy. Finally, reducing demand for energy can make the transition to emerging renewable generation technologies more feasible. Energy efficiency can slow the growth of energy demand overall and allow clean sources to meet most – if not all – of demand. Otherwise, without energy efficiency, renewable energy development will chase a receding target of ever-increasing consumption.[107]

There are several ways in which regional coordination and collaboration can assist in improving the building stock in Los Angeles. Collaborations between researchers, governments, and property owners to pilot technologies can help determine the best applications and spur the business innovation and incubation that can move products to market. Partnerships to determine the highest-value building types and locations for retrofits can ensure that investors maximize returns, and, therefore, attract new investment. Coordinated peer learning can leverage educational resources to build the capacity of the workforce, such as contractors, building inspectors, and energy managers. These workers are at the frontlines of energy efficiency and central to its success but are often under-resourced.

The actions listed below can help improve existing building performance and the associated benefits.

Action 2.2.1 — Develop and implement solutions to increase compliance with, and enforcement of, California's Building Energy Efficiency Standards for alterations to existing buildings.

Action 2.2.2 — Require energy audits and/or retrofits at time of sale or renovation for commercial and residential properties.

Action 2.2.3 — Establish multi-scaled utility billing tiers to incentivize energy efficiency in residential and commercial buildings to the extent permitted by law.

Action 2.2.4 — Establish peer learning and training capacity for building inspectors.

Action 2.2.5 — Develop region-wide incentive and training programs for contractors to improve code compliance.

Action 2.2.6 — Focus energy retrofits in a way that will prioritize and maximize their health benefits.

Action 2.2.7 — Include public health outreach and education, particularly around heat, during the energy audit and retrofit process.

Action 2.2.8 — Develop a cross-jurisdictional campaign to retrofit existing buildings and to leverage resources from multiple partners to build overall capacity in the field.

Action 2.2.9 — Develop collaborative purchasing partnerships among governments to reduce the costs of retrofitting municipal buildings, such as neighborhood-level retrofits through cooperatives or neighborhood councils, via a regionally supported revolving fund.

Action 2.2.10 — Develop Measured Performance Compliance Pathways for the upcoming Building Energy Efficiency Standards rulemaking at the California Energy Commission.

Action 2.2.11 — Develop a standardized approach and tool for collecting and electronically tracking building permits in an analogous way to the oversight of Title 24 compliance through specialized software programs.

Action 2.2.12 — Implement a "square foot tariff" for buildings using over a certain threshold of energy per square foot.

Strategy 2.3 — Strengthen energy efficiency for new buildings to ensure building size does not undermine conservation efforts

While most energy consumption occurs in existing buildings, new buildings provide important opportunities to implement innovative energy efficiency measures. Including energy efficiency measures at the time of construction is often easier and more cost effective than retrofitting existing buildings. As a result, new buildings can be designed to be much more efficient than older counterparts. However, the efficiency per square foot does not necessarily lead to energy reductions. Average home size nationwide has increased over the last several decades, which can erase energy savings from improved efficiency per square foot.[108] The trend in increasing home size is occurring mostly in new construction and to a lesser extent from increasing the size of existing homes.[109] Smaller lot sizes and zoning ordinances in the urban areas of Los Angeles County, however, have limited this trend locally compared to other parts of the country. Energy conservation, and not just improved performance per square foot, is, therefore, the most important overall metric for achieving greenhouse gas reductions and should be the focus of efforts and prioritization of funding.

Action 2.3.1 — Promote adoption of California Green Building (CalGreen) Tier 2 standards or equivalent or better throughout Los Angeles.

Action 2.3.2 — Promote the adoption of "cool roof ordinances" for new buildings across the county, following on the models of Los Angeles and Pasadena.

Action 2.3.3 — Evaluate the potential for net zero energy requirements for new construction and support implementation of such requirements where feasible, at potentially a faster timetable than what the California Energy Commission envisions.

Strategy 2.4 — Create a comprehensive regional strategy for targeting energy reliability programs

Energy providers face a key challenge in maintaining a consistent and reliable supply of energy amid constantly changing conditions. Suppliers do not want to provide either too much or too little energy to meet demand. But at the same time, the demand profile for electricity changes nearly almost every minute, making the task difficult. When particularly high surges in demand occur, such as during

heatwaves or when certain supply sources are unavailable, utilities must fire up backup systems. These systems tend to be high emitters of both greenhouse gases and other air pollutants. In addition, when the utility system fails and causes blackouts, entities such as hospitals and other industries will shift to back-up generators, usually fueled by high-polluting diesel fuel, to provide power. These units can, therefore, create significantly more air pollution per unit of energy than standard grid electricity.

Sustainable energy projects can address this challenge by increasing both grid reliability and regional resilience. Smaller-scale energy storage projects can be installed at critical facilities, particularly in vulnerable and pollution-burdened areas, to replace or supplement diesel backup generators. Collaboration between community-based organizations, local governments, researchers, and technology companies can help identify the most viable locations for community-based solar and storage.

A regional or city-scale approach to energy master planning can help optimize energy infrastructure investments. Combining a data-driven decision making process with a master planning process can enable market actors and local governments to set goals and develop informed implementation strategies to deploy distributed energy systems where they bring the most benefit.

Action 2.4.1 — Conduct a vulnerability assessment to determine areas and critical facilities at risk of energy disruptions due to climate change-related events (e.g. sea level rise; more frequent and intense storms; more frequent, longer, and intense heatwaves; more frequent, longer, and intense droughts, etc.).

Action 2.4.2 — Identify areas or facilities where energy storage, voltage regulations, and microgrids can improve energy management or ensure functionality during climate events, and develop programs and policies to support deployment.

Action 2.4.3 — Conduct energy master planning efforts by local governments in order to make data-driven decisions for optimal investment in energy infrastructure.

Strategy 2.5 — Combine transportation electrification and renewable energy planning efforts

Vehicle electrification provides a critical means of reducing greenhouse gas emissions. California has a goal of 1.5 million electric vehicles on the road by 2025 (see above discussion in the transportation section). Cities and regional entities across Los Angeles are also taking steps to transition to electric vehicles. Electric vehicles can also reduce in-basin air pollution and the urban heat island. Improved air quality means improved health for all Angelenos, particularly the poorest and most vulnerable who tend to live in the communities most affected by air pollution. But increasing electric vehicle deployment will also increase electricity demand. Electric vehicle planning should, therefore, be coordinated with renewable energy planning in order to maximize climate benefits.

The actions below will coordinate electric vehicle (EV) charging with renewable generation:

Action 2.5.1 — Develop programs to enable solar-powered EV charging in multifamily units.

Action 2.5.2 — Assess whether, how, and to what extent EVs can help provide energy storage to support the electric grid.

Strategy 2.6 — Reduce urban heat islands to minimize energy consumption and improve building resilience to extreme heat

Urban areas are hotter than rural areas because the roof, pavement, and other surfaces in cities increase heat, whereas vegetation in rural areas has a cooling effect. For example, temperatures in downtown Los Angeles increased .5°C per decade as the area urbanized between 1900 and 1990. Every increase in degree entails approximately 500 additional megawatts of air conditioning load in the region.[110] Increased heat also means more air pollution. In Los Angeles, every 1°C in temperature rise above 22°C, the incident of smog increases by 5%. Nationwide, urban heat islands are responsible for 10% of urban peak-energy consumption and as much as 20% of urban smog.[111] Reducing the heat island effect is essential for improving energy conservation, air quality, and public health.

> *Resurfacing about two-third of the pavements and rooftops with reflective surfaces and planting three trees per house can cool down LA by an average of 2–3K. This reduction in air temperature will reduce urban smog exposure in the LA basin by roughly the same amount as removing the entire basin of on road vehicle exhaust. Heat island mitigation is an effective air pollution control strategy, more than paying for itself in cooling energy cost savings [although water use, maintenance, and trapped heat can offset the vegetation's energy savings].*[112]
>
> —Hashem Akbari, "Energy Saving Potentials and Air Quality Benefits of Urban Heat Island Mitigation"

Action 2.6.1 — Implement smart or living streets to reduce the urban heat island effect (and which can also help capture stormwater for groundwater recharge).

Action 2.6.2 — Develop new and/or expand existing programs to increase the urban forest or shade structures to reduce the urban heat island effect.

Action 2.6.3 — Implement cool roof and cool surfaces programs across the region, particularly in the most impacted communities, while balancing the potential harmful effects of potentially more daytime heat in the immediate areas from these reflective surfaces.

Action 2.6.4 — Identify priority urban heat island retrofit areas, where the negative impacts are greatest and the potential benefits of cool surfaces are most needed.

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PUBLIC HEALTH

REGIONAL CONTEXT

Climate change is anticipated to negatively affect the health of Angelenos in a variety of ways, most significantly through extreme temperatures, worsening air quality, more acres burned by wildfires, and an extended period of activity for certain vector-borne diseases. While all Angelenos will be impacted to some degree, certain segments of the population are more vulnerable to negative health outcomes. Low-income and minority populations in particular are more likely to be exposed to climate-related impacts and less likely to have the resources to adapt to them. These disproportionate impacts to already disadvantaged populations are a reminder that climate change is an important equity issue. As a result, the California Department of Public Health created a Health Equity Office to provide technical assistance and resource-sharing on climate and public health challenges affecting disadvantaged communities.

Climate change also presents an opportunity to create healthier, more resilient, and more equitable communities. Research has shown that framing climate change as a health issue is most likely to prompt support for climate change mitigation and adaptation strategies.[113] In addition, many of the goals, strategies, and actions outlined in the Framework represent what the Lancet Commission on Health and Climate Change (a multidisciplinary and international collaboration between academic centers in Europe and China) termed "no-regret" options that can be "win-wins" for the region across different fronts. Actions that reduce greenhouse gas emissions often have notable health co-benefits. For instance, promoting active transportation reduces vehicle miles traveled, improves air quality, and promotes physical activity, lessening the burden of chronic disease.[114] As a result, climate change can spur reforms that enable new pathways for partnerships, solutions, and funding opportunities across multiple sectors and agencies.

Public health agencies are also ideally situated to identify and prepare for climate change impacts on public health and, therefore, reduce health inequalities. Public health professionals work to promote healthy vibrant communities and mitigate any harm, illness, or injury for people.[115] They research and monitor diseases, educate policy makers, and perform outreach to communities to support healthy

behavior and environments. Using a public health lens provides an opportunity to reduce greenhouse gas emissions across multiple sectors and enhance climate resilience across communities.

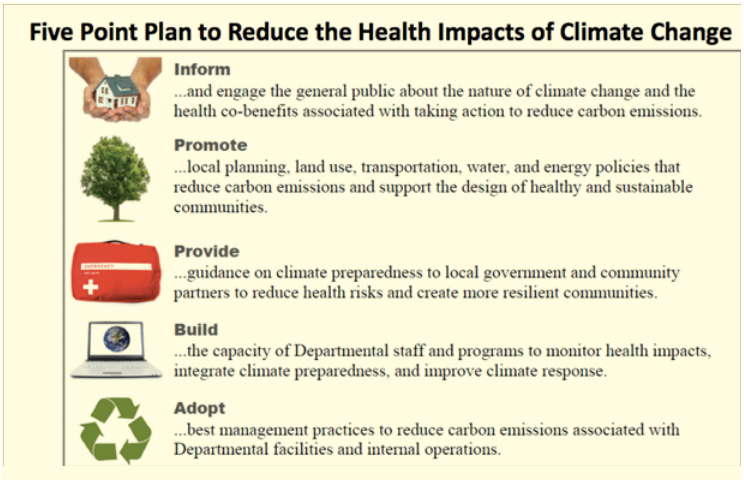
THE ROLE OF REGIONAL COLLABORATION

The Los Angeles County Department of Public Health (LADHP) is one of the most forward thinking in the nation, and addressing each part of the county and the interacting set of conditions that create public health threats is complex. Establishing new interagency/interdepartmental communication channels is important. For example, urban heat regulation lies in building codes as well as how streets are configured, pavement choices, and shading opportunities. Coordinated approaches to protect public health that use understanding from public health experts on the impacts of exposure to heat can inform transportation or public works department codes and construction specifications to reduce urban heat. Transportation policies that reduce reliance on internal combustion engines will also reduce urban heat. Finally, building energy use and retrofits should be targeted with the assistance of public health departments who may be able to best identify vulnerable populations.

To assist in this cross agency/departmental communication, the County should develop a climate mitigation public health task force that expands on the existing LADHP work group to include additional agencies.

POLICY LANDSCAPE

The region has made progress addressing the public health impacts of climate change. The Los Angeles County Department of Public Health developed a framework entitled "The Five-Point Plan to Reduce the Health Impacts of Climate Change"[116] (see below). This plan is an important tool for integrated climate change planning across different sectors. It utilizes a range of strategies including education and building capacity for (and adopting) best practices to improve regional climate response.



Los Angeles County Department of Public Health, 2014[117]

Additionally, the Los Angeles County Department of Public Health (LADPH), in collaboration with the UCLA Fielding School of Public Health, hosted workshops and developed curriculum to educate public health professionals on the impacts of climate change in the region. Subsequently, the LADPH released two reports entitled "Your Health and Climate Change in Los Angeles County" and "Framework for Addressing Climate Change in Los Angeles County."[118] The first report outlines regional climate change impacts and educates residents and communities on how to address them, while the second report calls for collaboration among local government agencies and provides examples on how best to integrate climate change plans across different sectors.

At the state level, the California Department of Public Health developed an implementation plan for the state's adaptation strategy, entitled *Safeguarding California: Reducing Climate Risk*.[119] It outlined how climate adaptation can be integrated into state public health planning and how public health can be improved by the work of other departments and agencies.

These state and local efforts notably emphasized collaboration and partnerships across sectors and organizations. For instance, Los Angeles County created a "climate committee" in 2014 to develop an Urban Heat Island Reduction Plan. Participants include the County Departments of Beaches and Harbors, Fire, Internal Services, Parks and Recreation, Public Works, and Regional Planning. Due to the interrelated nature of problems arising from greenhouse gas emissions (pollution, air quality, rising temperatures, health impacts, etc.), public health can, therefore, serve as the integrated lens to develop mitigation and adaptation strategies across sectors and agencies.

This Framework seeks to support and strengthen these collaborative efforts. Many of the recommendations in this section echo those of the "Safeguarding California: Public Health Sector Plan." This section outlines first a broader set of recommendations that reinforce and build upon collaborative practices already being conducted at the intersection of climate change and public health. It then provides more in-depth regional recommendations for reducing the urban heat island effect and ensuring Angelenos are prepared for higher incidences and intensity of extreme heat days, wildfires, and vector-borne diseases.

GOALS, STRATEGIES, AND ACTIONS

Climate impacts will affect the region differently from the coast to inland areas. However, all areas will face increased heat and vector borne disease impact. Ensuring that the public is educated about these hazards can be done at a regional scale.

The best practices compendium has additional information with case studies and implementation steps.

GOAL 1 — The LADHP, in collaboration with the county's Chief Sustainability Officer, should facilitate partnerships among local governments, academics and nonprofits to better understand and lessen the impacts of climate change on health

Building on the work conducted by the UCLA Fielding School of Public Health, in conjunction with the Los Angeles County Department of Public Health, this Framework recommends greater collaboration across universities, public agencies, and nonprofit organizations to ensure that solutions are defined and integrated by practitioners and experts in the field. Success depends upon incorporating these practitioners' ideas into climate change mitigation and adaptation strategies using existing resources. Los Angeles County Department of Public Health staff learned about climate change science and regional public health impacts and helped define implementation practices for the entire department. Given climate change's implications across all sectors, developing joint action plans will be critical to enhancing the resiliency of the region. This effort should be led by the LADHP, in partnership with the county's Chief Sustainability Officer. Partnerships and collaboration can be strengthened in the region in key areas, which we outline below, as well as actions to implement these strategies.

Strategy 1.1 — Increase research and surveillance on climate-related illnesses and deaths

Research by Dr. Alex Hall at UCLA has advanced the understanding of the specific impacts that climate change will have on the region. His team created a peer-reviewed climate model that provides a granular understanding of how and where climate change will affect the county.[120] In order to best incorporate these findings into mitigation and adaptation strategies on the ground, however, policy makers will need further research and surveillance, particularly on climate-related illnesses and deaths (such as heat cramps, heat exhaustion, heatstroke, and hyperthermia, among others).[121] Research must also correlate the health data with climate resilience and vulnerability indicators, such as transportation access and neighborhood heat indices, in order to develop comprehensive prevention and response tactics to prevent future illnesses and deaths. To that end, local agencies should formally define surveillance factors and determine which risks and outcomes should be mandatorily tracked and reported. In addition, public health officials and climate science researchers should collaborate on a permanent, on-going basis to ensure that they integrate up-to-date climate information into public health services and action.

Policy makers and researchers should consider the following actions to address these public health and environmental challenges:

Action 1.1.1 — Establish criteria for and implement routine surveillance of climate-related illnesses and deaths, as well as climate vulnerability and resilience, across the region (e.g. neighborhood heat indices, shade, social support, and transportation access); define the risks and outcomes to be mandatorily reported and set up reporting metrics.

Action 1.1.2 — Expand the use of syndromic surveillance (analysis of medical data to detect or anticipate disease outbreaks) of climate-related health effects to provide real-time information for public health action (e.g. real-time heat illness surveillance).[122]

Action 1.1.3 — Increase partnerships among public health practitioners and climate science researchers to integrate climate information and services into public health action (e.g. use of seasonal temperature and rainfall forecasts to implement heightened vector-born disease surveillance and interventions).

Strategy 1.2 — Connect climate change adaptation and mitigation strategies to health risk reduction programs and activities

As demonstrated by the success of UCLA and the Los Angeles County Department of Public Health's workshops, public health practitioners can begin implementing climate change adaptation and mitigation strategies into their practices by utilizing existing resources. They should find creative methods to integrate climate change mitigation and adaptation strategies into health risk reduction activities. Some of these include:

Action 1.2.1 — Incorporate climate change education, mitigation, and adaptation strategies into health risk reduction activities (e.g. combined home health and climate assessments, advancing heat mitigation strategies during household visits).

Action 1.2.2 — Incorporate health risk reduction factors into climate risk reduction activities (e.g. address indoor air quality in energy efficiency and weatherization retrofits).

Beyond these recommended cross-sectoral approaches to climate change, the Framework provides specific recommendations to address heat factors in order to support the region's current work to reduce the urban heat island effect.

CLIMATE CHANGE AND HEAT

Extreme heat constitutes one of the most significant impacts of climate change in the Los Angeles region. According to UCLA's "Climate Change in the Los Angeles Region" project, researchers project extreme heat days (days over 95°F) to increase by two to five times by the middle of the century under a business-as-usual scenario.[123] The heat will affect inland and mountain areas in particular, with neighborhoods in the northern San Fernando Valley expected to experience about 100 extreme heat days annually by midcentury (compared to about 55 days currently). Researchers even expect Downtown Los Angeles to be afflicted by nearly four times as many extreme heat days than currently experienced (23 days by midcentury, compared to about 6 days currently).[124] Under a medium-high emissions scenario, more than 8.2 million residents of Los Angeles County would be exposed to more than 38 days of extreme heat each year by the end of the century.[125] More than 80% of those people (6.7 million) would be living in areas of medium or high social vulnerability, as measured by a 19-indicator social vulnerability to climate change index.

Extreme heat has public health consequences, contributing to more deaths each year in the United States than floods, storms, and lightning combined.[126] California has not been immune to these impacts: 650 Californians died as a result of a 2006 heatwave, which also led to a reported 16,166 excess emergency room visits and 1,182 excess hospitalizations, for conditions such as acute renal failure, diabetes, cardiovascular disease, electrolyte imbalance, and nephritis.[127] Those residents most vulnerable to heat include the elderly (especially those who are socially isolated), young children, those with chronic medical conditions, outdoor workers, athletes, the homeless, low-income residents, residents without access to air conditioning or reliable transportation, and people in areas with minimal tree canopy and/or vegetation. Vulnerability factors are typically concentrated in low-income populations, whose members are more likely to suffer from existing medical conditions, live in areas with sparse vegetation, have neighborhoods with high concentrations of impervious surfaces (see the

description of the urban heat island phenomenon below), and avoid using air conditioning (if they have it) because they cannot afford the higher energy bills that would result.

The urban heat island effect contributes to significantly higher daytime and nighttime temperatures in Los Angeles than in surrounding rural areas. In fact, recent research has indicated that the Los Angeles area has the greatest urban heat island effect in California.[128] The effect is created by heat transmitted by internal combustion engines, a lack of shade, the proliferation of dark-colored and impervious surfaces (such as roads and rooftops) that absorb and re-emit heat. As a result, daytime temperatures can be on average 1 to 6°F hotter, with nighttime temperatures up to 22°F hotter than in nearby rural areas.[129]

Policies and programs can help reduce the urban heat island effect by increasing shade with minimal maintenance (including shade canopies, shrubs, and appropriate trees), transitioning away from internal combustion engines, and increasing the reflectivity of impervious surfaces. For example, cool roofs reflect rather than absorb heat, lowering building energy costs and cooling the surrounding neighborhood. Various studies have modeled the potential benefits of urban heat island reduction strategies, estimating a potential 0.5 to 2°C reduction in peak temperatures in the Los Angeles region, assuming aggressive adoption of cool roofing and possibly increased tree canopy and shade structures.[130] According to one report, if all Los Angeles rooftops became cool roofs, the resulting cooling of the atmosphere could "offset the warming caused by…nearly 80% of the city's total annual greenhouse gas emissions" for one year.[131]

Following the City of Los Angeles's lead, the Framework focuses on cooling the region as one of the top strategies for tackling the most harmful effects of climate change. The City of Los Angeles is the first in the U.S. to set a temperature target, and the greater region should adopt similar strategies to multiply the benefits beyond the city's borders.

GOAL 2 — Reduce urban-rural temperature differentials

Measures that reduce the urban heat island serve both climate mitigation and adaptation goals. In terms of mitigation, cooling neighborhoods – and cooling specific buildings through the use of cool roofs and/or shade structures as well as trees and shrubs – reduces air conditioning use and, therefore, reduces energy consumption and associated emissions. In terms of adaptation, neighborhood temperature reductions may help offset some of the temperature increases that climate change will bring to Los Angeles. At the same time, reducing the use of the internal combustion engine and exhaust heat from combustion to heat and cool buildings also have a great impact on daytime urban heat islands. Areas with high roadway density have a higher local air temperature.[132]

The California Department of Public Health's *Preparing California for Extreme Heat* report recommends expanding urban greening, the use of cool roofs, and cool and porous pavements in order to address the urban heat island.[133] Additionally, the County of Los Angeles is developing an Urban Heat Island Reduction Plan, which may include components related to maintaining and expanding the urban forest, cool roofs, and cool and permeable pavements. The Framework echoes these strategies for the region and also strongly recommends the transition away from internal combustion engines and

improved building thermal properties to reduce the use of heating and cooling whose exhaust heat also significantly contributes to the urban heat island.

Strategy 2.1 — Expand and maintain the urban tree canopy, where tree maintenance and potential for trapped heat do not outweigh the benefits, and appropriate shade structures, including planting native bushes that provide canopy

Tree cover and vegetative cover provided by native tall bushes across the county vary widely. Many areas lack sufficient trees, such as the San Fernando Valley, Lancaster, and Palmdale vicinities, and South and East Los Angeles, contributing to hotter temperatures and an increased heat island effect. Sufficient studies have not been conducted to understand the impact on urban heat islands of reducing thermal heat from internal combustion engines and heating and cooling as well as change in urban albedo in contrast to increased trees and vegetation. However, reducing thermal heat caused by fossil fuel burning would have the significant additional benefit of reducing air pollution.

In 2015, the State of California awarded City Plants, a public-private partnership among the City of Los Angeles, nonprofits, and local businesses, $3.3 million in funding from the cap-and-trade auction proceeds to plant and maintain over 4,000 trees. The program will plant these trees primarily in areas with the least amount of canopy including South Los Angeles, Pacoima, Sun Valley, and San Fernando. They will be planted and maintained along streets and in open spaces and yards. Maintenance will have to be addressed so that they can achieve their purported benefits. Great attention will have to be paid to planting the right trees in the right places so as to not increase the maintenance burden on communities and requirement for additional water resources. Further, shade structures should be encouraged as well.

Beyond their cooling effect, planting and maintaining appropriate trees in urban areas can beautify areas, contribute to well-being, and help replenish groundwater basins. Following the city of Los Angeles's example, policy makers and other leaders should consider the following actions:

Action 2.1.1 — Adopt a tree-planting ordinance and native canopy-providing shrubs pertaining to Los Angeles County unincorporated areas that prioritizes low-maintenance and drought tolerant trees and shrubs.

Action 2.1.2 — Pursue funding for planting appropriate trees and shrubs in low-income neighborhoods.

Action 2.1.3 — Streamline procedures to request tree and shrub planting in public rights-of-way.

Action 2.1.4 — Secure funding for maintenance of new, drought-tolerant trees and shrubs by government agencies.

Strategy 2.2 — Increase reflective surfaces such as cool roofs and cool and permeable pavements, after considering the negative potential impacts of increased localized heat during the day

To reduce the heat island effect, regional leaders should prioritize cool roof ordinances and continue expanding research to identify potential and future projects for green streets and cool and permeable

pavements. In 2013, Los Angeles became the first large city to pass a cool roofs ordinance (Ordinance No. 183149), requiring cool roofing materials to be used on new roofs and retrofits or replacements of over 50% of existing roofing material. Other local jurisdictions have also taken action, with the City of Burbank offering a refund program to offset the cost of roofing permits when cool roofs are installed and the City of Pasadena providing recommendations for new developments regarding roofing materials. Notably, however, cool roof and pavements may increase heat in daytime but will dramatically contribute to reduced nighttime heat.

These measures can have other demonstrated benefits to the region, including helping to replenish groundwater basins that have lower recharge rates due to a proliferation of asphalt. These measures also expand the potential for urban farms that can create healthier and resilient urban environments. Regional leaders should prioritize projects according to need such as by geography, population, and infrastructure characteristics. The Framework recommends the following actions to address this goal:

Action 2.2.1 — Adopt cool roofs ordinances in Los Angeles County cities and unincorporated areas.

Action 2.2.2 — Explore potential for cool and permeable pavements, particularly for parks, playgrounds, parking lots, and alleys.

Action 2.2.3 — Identify priority areas for reducing urban heat island based on population, sociological demographics, and infrastructure characteristics.

Strategy 2.3 — Reduce incidence of heat-related illness as well as excess emergency room visits during extreme heat events

Extreme heat events lead to spikes in heat-related illness and death, as well as surges in emergency room visits and hospitalizations, as described above. To protect public health during extreme heat events, the California Department of Public Health's *Preparing California for Extreme Heat* report recommends improving outreach strategies for vulnerable populations as well as adopting strategies that improve social cohesion in neighborhoods. Other health departments around the country promote similar strategies; for example, the Minnesota Department of Health's *Extreme Heat Toolkit* recommends improving outreach to vulnerable populations, such as through organizations that serve or employ them.[134] For example, government entities could develop a database of social service agencies, senior living centers, daycare centers, schools, and companies that employ outdoor workers, in order to provide messaging to those organizations before and during heat events. Government entities can also work with neighborhood councils, other community groups, and utilities to implement programs that encourage residents to check on vulnerable neighbors during extreme heat events. In addition to outreach, infrastructure improvements should be made to improve the availability of and access to cooling centers. Specific strategies can include increasing the number of official cooling centers and improving public transportation options to them.

Strategy 2.4 — Improve outreach to vulnerable populations before and during extreme heat events

As with the recommendations above, planners should consider heat-related illnesses and deaths in targeting populations most at risk. Outreach leaders can improve information efforts for vulnerable populations by implementing the following actions:

Action 2.4.1 — Develop maps of vulnerable populations and of geographic incidences of past heat-related illness and death to inform planning.

Action 2.4.2 — Use the "reverse 911 system" (a public safety communications system to communicate with groups of people in a defined geographic area) or a voluntary notification system to alert vulnerable residents before and during extreme heat events.

Action 2.4.3 — Develop a system through which organizations that serve or employ vulnerable populations receive targeted messaging during extreme heat events.

Strategy 2.5 — Improve infrastructure to serve vulnerable populations during extreme heat events, including conservation measures in residential buildings

Beyond outreach, vulnerable communities will need improved infrastructure and access to cooling centers, decent housing, and health centers or hospitals in case of increasing emergencies. The following actions can address this challenge:

Action 2.5.1 — Designate official cooling centers in neighborhoods that are currently lacking them.

Action 2.5.2 — Improve access to official cooling centers, via public transit or other options.

Action 2.5.3 — Update and retrofit housing in vulnerable areas to be more resilient to heat.

Action 2.5.4 — Develop programs to provide air conditioners to those individuals most vulnerable to serious heat-related health impacts and without economic resources.

Action 2.5.5 — Provide vouchers through ridesharing companies to those with health conditions during heat emergencies.

Strategy 2.6 — Reduce the use of internal combustion engines and fossil fuel-generated heating and cooling

Action 2.6.1. Accelerate the transition to electrification throughout the region and the adoption of electric vehicles and electric public transportation systems.

Action 2.6.2 — Accelerate alternative transportation options from bicycle lanes to walkability to alternative intermediate share vehicles such as electric bicycles and small electric vehicles.

Action 2.6.3 — Increase thermal comfort of buildings through whole-house retrofits to reduce the need for heating and cooling.

GOAL 3 — Reduce building in fire-prone ecosystems

Curbing development in fireprone areas is a direct way to reduce wildfires, while building in fire-prone ecosystems is largely responsible for the increase in wildfires in these areas.

Strategy 3.1 — Reduce building in the urban/wildland interface through policies such as density bonuses, transfer of development rights, and zoning and building codes that inhibit further fragmentation and intrusion of development in fire-prone wildlands

Action 3.1.1 — Prohibit further development in the urban-wildland interface, responsible for accelerating wildfires, through transfer of development rights or other mechanisms.

Action 3.1.2 — Ensure native habitat is preserved in the urban-wildland interface to ensure ecosystem and habitat resilience, water infiltration, and flood protection.

Action 3.1.3 — Enable the greater use of controlled burning to reduce fire risk in the surrounding National Forest.

CONCLUSION

Los Angeles County faces significant increases in urban heat as the climate changes. This change will pose serious public health threats, especially for vulnerable populations. However, effective mechanisms exist to both mitigate urban heat and establish coordinated policies and programs to protect the most vulnerable. Addressing the contributors to the urban heat island, including the use of fossil energy in transportation, heating, and cooling, and the use of dark surfaces in construction and road building, can significantly reduce the impact of high heat days. Increasing the thermal comfort of existing building through whole-house and building retrofits will be important as well. Aditionally, increasing urban shade through shade structures and carefully chosen vegetative material will be important. Finally, LADHP should coordinate with the Los Angeles County Chief Sustainability Officer, as well as other sustainability programs across the region, to create coordinated and integrated responses to heat that include not only emergency responses during high heat incidents but long-term integrated programs to reduce the urban heat island.

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OCEAN & COASTAL RESOURCES

REGIONAL CONTEXT

The joining of land and sea along Southern California's coastlines is a dynamic place where terrestrial and ocean characteristics jointly shape the coastal environment. The effects of climate change filter into the watershed and impact communities throughout the Los Angeles region, even beyond the coast. Los Angeles County's coastal zone is a critical asset for the entire region, consisting of 11 coastal cities and a few unincorporated areas, many with convoluted and discontinuous coastal boundaries. The region's major watersheds – the Los Angeles River, Ballona Creek, Santa Monica Bay, and Dominguez Watershed – touch all of these communities and eventually flow to the Pacific Ocean. Los Angeles County beaches stretch approximately 25 miles and attract more than 50 million annual visitors. Beach-related tourism plays a major role in the region's economy, accounting for more than $16.5 billion in expenditures in 2012.[135] The areas that constitute this large region are intensely interconnected through their geographies, communities, and economies, and decisions made in one jurisdiction will undoubtedly affect its neighbors.

Climate threats to the coastal zone exacerbate an already complicated network of land, sea, and human pressures, all of which are rapidly changing. These variables are regionally specific and manifest in unique impacts to a highly urbanized coastline, necessitating strategies for building coastal resilience that are informed equally by regional monitoring, research, and planning.

Sea level rise and coastal impacts planning in Los Angeles

Los Angeles County's coastal communities are vulnerable to impacts from climate change, such as sea level rise, which can be further exacerbated by concurrent flooding from coastal storms and extreme tides. The National Research Council projects that sea levels south of Cape Mendocino will increase between 10 and 167 cm, with 12 to 61 cm rise by 2050, and 42 to 167 cm rise by 2100.[136] These projections have been adopted by the State of California through the Ocean Protection Council's *Sea Level Rise Guidance Document* as well as by the California Coastal Commission's Sea Level Rise Policy Guidance. These guidance documents, however, are currently under revision by the state to consider the potential for higher, and thus direr, sea level rise projections, due to the current global

greenhouse gas emissions trajectory and more rapid melting of ice sheets than scientists had previously projected.[137] Civic and community leaders in the Los Angeles region recognize the need to build capacity and begin planning for the impacts of climate change now, rather than in 20 or 30 years when disruptions and damage to business, critical infrastructure, and communities will prompt ad hoc and poorly coordinated responses.

In 2011, the City of Los Angeles engaged the University of Southern California Sea Grant Program to develop "AdaptLA," a science-based, stakeholder-supported sea level rise vulnerability study and adaptation planning process.[138] AdaptLA provides a methodology to help the City of Los Angeles identify the climate vulnerabilities of its assets, resources, and communities. The vulnerability study, released in January 2014, focused on the potential impacts of sea level rise and associated flooding from storms and high tides on the coastal areas within city boundaries. The study examined the physical, social, and economic impacts of sea level rise, discussed the ecological vulnerability of the Ballona Wetlands, and provided a set of guidelines for identifying and evaluating possible adaptation strategies and measures.

AdaptLA brought together key city department officials at the forefront of confronting the impacts of sea level rise and regional stakeholders with a shared concern and interest in the results of this process and scientific study. This group included representatives from Los Angeles County, the State of California, city governments in the region, business, industry, government associations, and non-governmental organizations. Through the USC Sea Grant engagement process, regional stakeholders expressed a need for expanding this process to include all coastal sub-regions, such as neighboring cities and unincorporated areas of the county that are outside of the discontinuous coastal political boundaries of the City of Los Angeles but are still interdependent and interconnected.[139] As a result, 11 coastal cities, Los Angeles County, and six supporting organizations formed a regional coalition. The State of California provided additional funding for this coalition to expand the AdaptLA project to the regional scale. This new project is entitled Regional AdaptLA: Coastal *Impacts Planning for the L.A. Region*, and it will give the region access to sophisticated modeling information for coastal storms, shoreline change, and sea level rise. USC Sea Grant has been funded to conduct outreach around the model findings and to build local technical capacity to help coastal communities use the information.

The U.S. Geological Survey is currently updating its Coastal Storms Modeling System (CoSMoS 3.0) for the Southern California coast, from Point Conception to the U.S. and Mexican border. This model will provide a suite of 40 sea level rise and coastal storm scenarios (daily, annual, 10-year, and 100-year), shoreline evolution, and fluvial discharge projections. Bolstering this information for the region, two consultant teams from Environmental Science Associates (ESA) and TerraCosta Consulting Group (TCG) are developing high-resolution information on changes to beach width due to short-term winter storms and long-term sea level rise, shoreline-change projections focusing on the Los Angeles coast, and high-level vulnerability assessment for the entire county coastline.

Sea level rise adaptation in Los Angeles requires regional cooperation and planning due to the large number of stakeholders and the intensely interconnected nature of its geographies, communities, and economies. Although the municipal authorities are independent entities, actions taken by any single one will affect the others. Addressing climate change issues in a regional context builds opportunities for cooperative and mutually beneficial planning while taking advantage of economies of scale in

training, information acquisition, and scientific guidance. Los Angeles has a strong coalition of regional stakeholders working to address coastal climate impacts, and LARC, with USC Sea Grant, will continue to provide opportunities for this coalition to coordinate and collaborate.

Ocean and coastal health in the Los Angeles region

The ocean is Earth's largest climate buffer and serves as a massive sink for global heat and greenhouse gases. Humans have benefitted from this natural heat and carbon sequestration for millennia. However, anthropogenic-induced changes to the climate have begun to outpace the rate at which the ocean can absorb heat and gases in a balanced manner. Since 1971, over 90% of the excess heat trapped by greenhouse gases has been absorbed in the ocean, correlated with a 0.10°C increase in surface ocean temperature each decade.[140] Similarly, a third of the anthropogenic carbon has been absorbed by surface water, driving our oceans to become about 30% more acidic since the Industrial Revolution.[141]

These changes to the ocean environment could have significant implications for Southern California coastal ecosystems. Warmer temperatures may lead to greater stratification of coastal waters, weaker upwelling and less nutrient delivery from depth, and coastal low-oxygenated (or hypoxic) zones. Scientists have correlated these changes with impacts on marine life. Locally, researchers have correlated warmer waters with an 80% reduction in zooplankton off Southern California since 1951 and negative impacts on kelp forest ecosystems.[142] In laboratory tests, acidifying ocean waters also impose ecological challenges on marine species, impinging upon some species such as shell-forming organisms, while other species and habitats may benefit.[143] These impacts have potential to alter the ecological interactions that underpin today's living ocean.

Ocean changes due to climate impacts may also cascade through ocean food webs and, therefore, link to public health concerns. Scientists have observed a global increase of harmful algal blooms in recent decades. This trend is generally attributed to increasing nutrient availability and changes in water temperature and chemistry.[144] While blooms can be related to many algal species, of key concern are blooms that produce noxious or toxic compounds related to domoic acid poisoning, paralytic shellfish poisoning, and diarrhetic shellfish poisoning that are harmful to wildlife and humans.

Several areas along the California coast, including the San Pedro Shelf and Santa Monica Bay, are known to be 'hotspots' for harmful algal bloom events. For example, King Harbor in Redondo Beach has suffered recurrent algal blooms in the last two decades, with two massive fish mortality events in 2005 and 2011.[145] In the latter phenomenon, more than 2 million (175 tons) of sardines swam into the marina and died due to low oxygen levels associated with an algal bloom. Cleanup from that event reportedly cost the city about $425,000. The San Pedro shelf region has also become one of the biggest wildlife intoxication hotspots in California, with domoic acid regularly detected along California coasts since 1991 and linked to periodic fisheries closures and marine mammal strandings in the region. During 2003 and 2004 alone, domoic acid-poisoning was implicated in more than 1,400 mammal stranding incidents within Southern California waters.[146] As recently as 2015, the California Dungeness crab fishery was closed for months as a result of high domoic acid levels along the coast, halting a California fishery valued at $60 million per year. The closure had implications for the rest of the state's commercial, recreational, and aquaculture industries, along with impacts to wildlife. It resulted in the state seeking federal disaster declarations in February 2016.

Data records for the ocean are often less complete than those on land, and for many variables, researchers still have difficulty discerning long-term climate-related trends from natural variability. As relevant data accumulate on local ocean conditions and wildlife impacts, managers will better be able to anticipate, identify, and mitigate threats to coastal resources as they arise. Monitoring Southern California's ocean conditions over time is, therefore, critical to sustaining resilient coastal resources for the region. Sustained funding and research for monitoring programs will be vital, as well as improved methods for integrating local-scale observations and public alerts into coastal communities. This ability to rapidly identify emerging coastal health risk events is a prerequisite for preventing human exposure and for taking steps to minimize or mitigate potential ecological impacts, which will intensify as coastal resources are increasingly challenged by changing climates.

Finally, as discussed in the Water section of this Framework, coastal ocean waters are tightly connected to urban freshwater inputs. Anthropogenic urban sources, such as non-point source pollution from untreated stormwater, may increase if precipitation and episodic storm patterns alter with changing climates. Policy makers should ensure reduced impacts to coastal water quality through coordination and planning with stormwater and wastewater regulators throughout the region. Regional leaders should use a watershed-level approach that considers the interconnectivity from precipitation to surface water to the coastal ocean environment, in order to properly maintain and manage water resources and ensure the vitality of the coastal environment.

POLICY LANDSCAPE

Sea level rise policy in California

Coastal communities in California are concerned about the projections for sea level rise and have begun planning efforts throughout the state. Results from the 2011 California Climate Adaptation Needs Assessment led by USC Sea Grant, in partnership with 15 local, regional, state and federal organizations, demonstrated that the majority of California coastal communities believe climate change is happening and is caused by humans.[147] Ninety percent of these communities indicated that they are in the early stages of planning for sea level rise and other climate-induced coastal impacts. Many of these communities began planning without state- or federal-level mandates, including many coastal communities in the Los Angeles region. When asked about barriers to planning for and implementing adaptation strategies, these communities identified the lack of financial and staff resources and capacity as the top challenges.

In response to the barriers identified in the 2011 survey, the California Ocean Protection Council (OPC) launched a grant program to help build local capacity and improve scientific information for adaptation planning. The California Coastal Commission and State Coastal Conservancy have also offered several climate-focused grant programs. Recognizing the need for sophisticated and downscaled sea level rise and storm modeling, state-level funding was also provided to support the development of the Coastal Storm Modeling System (CoSMoS) for Southern California.

In addition to the financial grant programs and incentives, the California Coastal Commission released its Sea Level Rise Policy Guidance document in 2015, which provides information on how coastal

communities can "apply the Coastal Act to the challenges presented by sea level rise through Local Coastal Program (LCP) certifications and updates and Coastal Development Permit (CDP) decisions."[148] The new guidance encourages communities to incorporate the best available science in their permitting and planning and to employ an "adaptive management" approach that allows them to update their planning as new information becomes available. The guidance also states that a range of sea level rise estimates should be used and that local officials should consider more extreme flooding scenarios if they will cause significant impacts to coastal resources. This guidance is not regulatory but is already informing how coastal communities are approaching future coastal planning.

In 2014, the California Natural Resources Agency (CNRA) released its update to the state climate adaptation plan, *Safeguarding California: Reducing Climate Risk*. CNRA also released *Safeguarding California: Implementation Action Plans* in 2016 that shows how state government is acting to adopt the 2014 recommendations. Both policy guidance documents include a chapter on ocean and coastal ecosystems and resources to help inform state decision makers when preparing for climate risks and describe current state government actions. Local and regional entities are also using this guidance document to help develop local actions. The plan outlines four action areas: 1) better understand climate impacts on the coastal and ocean resources and ecosystems, 2) improve management practices and increase capacity to withstand and recover from impacts, 3) better understand evolving trends, and 4) information sharing and education. The plan stresses that the state should not allow development of new structures and infrastructure if sea level rise protection is required during the life of the structure, "unless there is compelling need." The plan prioritizes the use of innovative design, especially green or nature-based infrastructure when appropriate. The plan also prioritizes continued modeling to support local planning and the need for vulnerability assessments and cost analyses to fully assess risks and evaluate potential solutions. The plan emphasizes that local coastal programs and general plans are key tools to address sea level rise under California law and that the state will continue to invest in these local planning efforts.

Federal leaders must also take sea level rise considerations into account for federal infrastructure construction and investment projects. In 2015, President Obama issued an executive order requiring that sea level rise projections be incorporated into construction and planning on the nation's coasts. It established a Federal Flood Risk Management Standard, requiring that all federally funded projects located in floodplains, including buildings and roads, be built to withstand flooding. This mandate followed recommendations from the President's *State, Local and Tribal Task Force on Climate Preparedness and Resilience*. The Federal Emergency Management Agency also issued a new policy requiring states to have climate resilience plans to qualify for preparedness funds.

Ocean health policy in California

Ocean health policy is largely the purview of the Natural Resources Agency in California, with policy setting charged to the California Ocean Protection Council (OPC). The council has a mandate to ensure that California "maintains healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations." Recognizing the interconnectedness of the land and the sea, supporting sustainable uses of the coast, and ensuring the health of ecosystems, the council develops policy guidance for the protection, conservation, restoration, and management of coastal and ocean ecosystems through enhanced scientific understanding, including monitoring and data gathering. To this end, the council coordinates the activities of ocean-related state agencies, establishes

policies to coordinate scientific data among agencies, and recommends changes in state and federal law to the governor and legislature. In partnership with the Ocean Protection Council, the California Ocean Science Trust (OST) is an independent nonprofit body that convenes and manages the Ocean Protection Council's Science Advisory Team. The California Ocean Science Trust's executive director serves as Ocean Protection Council's science advisor.

In 1999, the California Legislature passed the Marine Life Protection Act (Assembly Bill 993, Shelley). The goal of this Act is to protect California's marine natural heritage through establishing a statewide network of marine protected areas (MPAs). The California Fish and Game Commission established marine protected areas following multi-stakeholder-based regional deliberations, and they are managed by the California Department of Fish and Wildlife. As of 2016, there are 50 marine protected areas in the Southern California region, covering approximately 356 square miles or about 15% of Southern California state waters. Sites within Los Angeles County include marine protected areas at Point Vicente, Point Dume, and Santa Catalina Island. Although climate change was not explicitly incorporated into the goals and objectives of California's marine protected areas, the network is viewed as a key management strategy for monitoring climate impacts on California ocean environments. The MPA Monitoring Enterprise, managed by the California Ocean Science Trust, was tasked with developing and implementing monitoring of California's emerging statewide marine protected area network. The program recognized that future evaluations of marine protected area performance would occur in the context of a changing climate. As such, program leaders are designing monitoring efforts to include tracking climate change effects on habitats and species, understanding the effects on marine protected area performance, and evaluating climate change adaptation measures. Within Los Angeles County, the Los Angeles Collaborative Network brings together agency and nonprofit representatives to further develop strategies for local marine protected area management and outreach. Citizen-science activities, such as the MPA Watch program, also help with observations of human uses of marine resources and reporting of violations.

The West Coast Ocean Acidification and Hypoxia Science Panel, convened by California Ocean Science Trust at the request of the Ocean Protection Council in 2013, brought California experts together with counterparts in Oregon, Washington, and British Columbia to present the current state of knowledge and emerging scientific consensus about available management options to address ocean acidification and hypoxia on the West Coast. The Panel, which was convened for a three-year period, released its report *Major Findings, Recommendations and Actions* and recommended development of a coordinated regional management strategy.[149] Although local actions cannot wholly undo the global impacts of ocean acidification, the panel advised West Coast managers to take action to improve local conditions by managing local factors that contribute to declining water quality. In particular, they cited opportunities to implement better controls on nutrients and organic matter pollution that flow from land into coastal waters, as these chemicals provide nourishment for algae and bacteria that, in turn, can trigger hypoxia and exacerbate acidification. The panel also advised on the need for a comprehensive monitoring network, research priorities investigating ocean acidification impacts in the context of multiple stressors, and modeling tools to meet management needs.

With regard to harmful algal blooms, a California workshop in 2008 of leading harmful algal bloom research groups, water quality managers, public health managers, and animal rescue groups led to the 2009 formation of the California Harmful Algal Bloom Monitoring and Alert Program ("California HABMAP"). The goal of California HABMAP is to implement a proactive harmful algal bloom alert

network that provides information on current algal blooms and facilitates information exchange among researchers, managers, and the general public throughout California. The Southern California Coastal Water Research Project (SCCWRP) manages the program with Steering Committee representatives from NOAA, the Ocean Protection Council's Science Advisor, Northern and Southern California harmful algal bloom researchers, and the commercial shellfish and wildlife management communities. The program maintains a shared data portal and an active communication network across California's harmful algal bloom stakeholders. Ongoing research helps to continually refine the program's predictive capabilities. The California Department of Public Health's Marine Biotoxin Program also works to monitor for toxic phytoplankton, such as domoic acid, and issues health advisories against consuming seafood products during toxic events.

GOAL 1 — Prepare coastal infrastructure for higher sea levels and coastal storms

Critical infrastructure that sustains Los Angeles County is located in the coastal zone. Coastal roadways, rail lines, power generation and transmission infrastructure, waste water treatment facilities, local groundwater resources, coastal buildings, and the tourism industry are all threatened by projected sea level rise in the coming decades. The 2009 Climate Adaptation Strategy prepared by the California Climate Action Team identified the need to fortify existing protective infrastructure by 0.1 to 0.2 feet per year to maintain adequate levels of protection. The report stated that Los Angeles County will require 20% of future statewide funding allocations for sea level rise adaptation to maintain adequate protection of coastal infrastructure.

Policy makers should adopt the following strategies and actions in order to prepare the coastal infrastructure for climate change impacts:

Strategy 1.1 — Support communities financially and through in-kind resources as they undertake scientific assessments of vulnerabilities to sea level rise and coastal storm impacts

Action 1.1.1 — Assist infrastructure managers to utilize modeling information provided by AdaptLA to identify infrastructure vulnerability.

Action 1.1.2 — Examine the costs and benefits of a suite of adaptation strategies, with an emphasis on nature-based solutions, that are potentially applicable in the Santa Monica Bay.

Strategy 1.2 — Incorporate sea level rise and coastal impacts into local planning, such as to protect and maintain beaches, relocate critical infrastructure, and mitigate through development permitting processes

Action 1.2.1 — Build capacity in local communities to support adaptation planning and vulnerability assessment processes.

Action 1.2.2 — Provide technical assistance to communities that are updating local plans to include sea level rise considerations, such as local coastal programs and general plans.

Action 1.2.3 — Facilitate the sharing of lessons learned and best practices in incorporating sea level rise considerations into planning.

Action 1.2.4 — Facilitate the development of a robust beach-width monitoring program that provides critical information to beach managers, public works officials, planners, and other municipal and county staff on the response of the beach to short-term seasonal and storm events, as well as to long-term sea level rise-driven beach position change.

Action 1.2.5 — Facilitate the development of a robust cliff-monitoring program that provides critical information to beach managers, public works officials, planners, and other municipal and county staff on the vulnerability of the cliffs along the coastline.

Action 1.2.6 — Integrate coastal climate change considerations in emergency management and hazard-mitigation planning.

Action 1.2.7 — Train local government and community leaders on the key dimensions of social vulnerability and how to use social vulnerability assessments in emergency management, climate preparedness, and adaptation planning.

Action 1.2.8 — Evaluate the effectiveness of coastal strand and dune ecosystem restoration and enhancement as an appropriate sea level rise adaptation strategy for coastal communities in Southern California.

Action 1.2.9 — Facilitate the development of a robust beach-width monitoring program that provides critical information to beach managers, public works officials, planners, and other municipal and county staff on the response of the beach to short-term seasonal and storm events as well as long-term sea level rise-driven beach position change.

Strategy 1.3 — Identify examples of innovative solutions that utilize adaptive management approaches to managing assets and facilitate sharing of lessons learned

Action 1.3.1 — Provide capacity-building and knowledge-sharing opportunities to showcase innovative solutions and processes to address sea level rise in the state and nationally.

GOAL 2 — Prepare communities for higher sea levels and coastal storms

As local governments begin evaluating and implementing various adaptation measures to address vulnerabilities, they will need to enhance public knowledge and develop a public engagement strategy to successfully implement these strategies. Those responsible for emergency preparedness and response, climate change adaptation, and the long-term resilience and sustainability of regional

communities should utilize a human-centered approach. The impacts of climate change are often disproportionately distributed across populations, and the diverse socio-economic communities of Los Angeles vary significantly in their ability to prepare for, cope with, and respond to threats such as climate change. Some populations, especially those who experience social inequalities, are less able to prepare for, respond to, or recover from a disastrous event.[150] Los Angeles County has a high proportion of the population that is socially vulnerable to the impacts of climate change. Twenty-seven percent of Californians live in Los Angeles County, and 40% of that population lives with high social vulnerability to extreme events.[151] An examination of social vulnerability of the region's coastal communities used U.S. Census data to screen for those socioeconomic characteristics associated with higher sensitivity and lower adaptive capacity.[152] The communities of Venice, Wilmington, and low-lying portions of San Pedro had the highest vulnerability to sea level rise impacts. In portions of San Pedro and Wilmington, average income is about $13,000. These communities also have large proportions of renters and single-parent families, and English is often not the primary language. Expanding this work in all communities in Los Angeles County, and developing outreach and engagement strategies focused on building resilience in vulnerable communities, is critical. Examining community strengths and weaknesses can become an empowering and creative way to engage the public and build cohesion. The social cohesion of a community can be a critical factor in its resilience both during and after an emergency.

Strategy 2.1 — Understand community social vulnerability

Action 2.1.1 — Identify vulnerable communities through social vulnerability analyses and conduct community workshops to validate results and develop strategies to build community resilience.

Strategy 2.2 — Engage the community in building resilience

Action 2.2.1 — Create opportunities to foster periodic, meaningful public engagement that gathers information about affected neighborhoods and communities' concerns, vulnerabilities, and constraints.

Action 2.2.2 — Engage community members in discussion of social vulnerability, understand its implications for their community, and help develop strategies to build community resilience.

Action 2.2.3 — Engage students, schools, educators, and informal education institutions in community-resilience building activities.

Action 2.2.4 — Develop materials and provide engagement opportunities in multiple languages, especially Spanish.

Strategy 2.3 — Foster economic sustainability of coastal communities by developing policies that pull developments back from vulnerable shorelines

Action 2.3.1 — Compile information on costs and benefits of adaptation methodologies.

Action 2.3.2 — Develop economic indicators to help decision making on sea level rise.

Action 2.3.3 — Engage communities in understanding the costs and benefits of coastal adaptation methods.

GOAL 3 — Protect natural resources from higher sea levels and coastal storms

As sea levels rise and impacts from coastal storms lead to more flooding and subsequent inundation of the county coast, the vulnerability of coastal resources, such as beaches, wetlands, rocky intertidal zones, and groundwater water aquifers, will increase. Many of these ecological systems have ambulatory (shifting) lines that migrate throughout seasons, decades, and climate cycles. However, when backshore development constrains these lines, as along most of the Los Angeles County shoreline, they lose the ability to naturally migrate and shift.

Accordingly, the California Coastal Commission Sea Level Rise Guidance identified commercial fisheries, coastal agriculture, public beaches, recreational resources, and wetlands as at risk due to the impacts of sea level rise. The natural systems that protect and maintain water quality are threatened by the increased severity of "King Tides" and coastal storms under the predicted sea level rise scenarios. Protecting ocean and inland ground water quality is essential for the sustainability of coastal ecosystems and the viability of local groundwater resources. Protecting and rebuilding coastal dunes, wetlands, and natural ecosystems to minimize saltwater intrusion, in conjunction with more traditional shoreline protection techniques, can mitigate the more severe impacts of sea level rise on regional water quality.

Strategy 3.1 — Protect and maintain coastal resources such as wetlands, aquifers, and rocky intertidal zones

Action 3.1.1 — Evaluate the impacts of sea level rise to coastal habitats (i.e. lagoons, estuaries, marshes, and rocky intertidal zones) and freshwater aquifers, and provide recommendations for conservation, restoration, and governance strategies to build resilience of these critical resources.

Action 3.1.2 — Identify the vulnerabilities and adaptation potential for tidal marshes in Southern California under projected sea level rise scenarios, and identify opportunities for conservation and restoration.

GOAL 4 — Maintain and improve coastal and ocean health

Many of the factors influencing ocean health are global in scale. Working to curb local greenhouse gas emissions will have global implications that can limit many of the direst projected oceanic climate impacts. Improving global ocean health locally will also lead to a healthier Santa Monica Bay and San Pedro Basin in the Los Angeles region. As a result, complying with global greenhouse gas emissions reductions will translate to local benefits to coastal waters. The Framework addresses these actions in other sections. However, in a highly urbanized coastal environment such as Los Angeles, anthropogenic actions have an equal amount of impact on coastal and ocean ecosystems. Local planning and actions, taken in concert with planning and actions throughout the watershed, will allow the Los Angeles region to positively influence the health of its coastal waters.

Managers should reduce relevant ecological stressors within their jurisdictions, such as overfishing and coastal pollution. Untreated stormwater is the primary conduit for non-point source pollution of coastal ecosystems and human health. The confluence of runoff impacts with changing and unpredictable ocean climates calls for the design of more robust stormwater management solutions. Upland management is key, particularly with strategies that mitigate runoff and emphasize stormwater reclamation as close to the source as possible. Policy makers should link efforts to watershed management (see the previous Water section), including the use of green infrastructure to make Los Angeles surfaces more permeable and to divert runoff through infiltration and retention, as well as public education and monitoring to reduce non-point source pollution. The outcomes of these efforts would augment water resources for Southern California communities while reducing the human footprint on the fragile and changing ocean resources.

Finally, regional leaders should understand the linkages between the region's ocean health and the ecosystem services on which local coastal populations depend. Sustained funding and research for Southern California's harmful algal bloom, ocean acidification, and hypoxia, and marine protected area monitoring programs will be vital, as well as methods for integrating local-scale observations and public alerts into coastal communities.

Strategy 4.1 — Understand status and trends in the Los Angeles oceanic regimes

Action 4.1.1 — Promote and sustain ongoing monitoring programs for ocean health indicators.

Action 4.1.2 — Better understand the biological impacts of regional ocean change.

Action 4.1.3 — Prioritize and maintain sustainable fisheries and healthy ecosystems.

Strategy 4.2 — Facilitate community engagement

Action 4.2.1 — Evaluate effectiveness of public alert systems for ocean health indicators.

Action 4.2.2 — Reinforce public awareness of MPA function and regulations to aid in enforcement and stakeholder participation.

Strategy 4.3 — Maintain coastal water quality to promote public health and ecosystem resilience in the face of perturbations caused by climate change

Action 4.3.1 — Develop and foster a watershed-level hydrological community of practice that includes all actors that regulate and manage local water resources. This COP will be comprised of storm-, waste-, and potable water managers and regulators as well as coastal managers.

The best practices compendium contains additional information regarding case studies and steps for implementation.

GOAL 5 — Begin exploring opportunities and policies to move the built environment back from the shoreline in at risk areas

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CONCLUSION & NEXT STEPS

The Framework presents an overview of the key issues related to climate change facing Los Angeles, both to reduce greenhouse gas emissions and to adapt to the likely impacts of climate change and create a more resilient region. With this suite of options presented, the challenge will be for leaders within the region to coalesce and focus on addressing near-term opportunities, developing the collaboration structures, institutions, and funding necessary to tackle the priority challenges. Leaders will need to achieve agreement and arrangements, marshal the resources and expertise to move forward, and then develop an implementation plan to achieve success.

LARC will assist in this process as a convener of stakeholders, resource for action, and institution to monitor and motivate the necessary change. Without this regional approach, the solutions described in this document will be at risk of remaining printed words only. Local leaders must demonstrate the will to translate these recommendations into action, in order to ensure that Los Angeles can transition to a resilient, healthy, carbon-free, and thriving metropolis for the next century and beyond.

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LARC Executive Committee

Jonathan Parfrey

Shannon Parry

Stephanie Pincetl, Chair

Steve Baule

Project Manager

Zoe Elizabeth

Project Partner

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Strategic Advisors

Terry Watt

Walker Wells

LARC Staff

Krista Kline (former)

Kristen Holdsworth (former)

Zoe Elizabeth

Contributing Authors

Alyssa Mann

Celine Kuklowsky

Ethan Elkind

Felicia Federico

Gary Gero

Juan Matute

Juliette Hart

Katharine Reich

Stephanie Pincetl

Zoe Elizabeth

Reviewers

The following people reviewed and provided feedback on this project at various stages of development:

Anne Kjemtrup

Celine Gallon

David Fink

Deborah Brandes

Drew Boronkay

Elena Maggioni

Gary Gero

Ginachi Amah

Hilda Blanco

Hillary Firestone

Ignacio Fernandez

Ivar Ridgeway

Jacob Lieb

Jess Dutton

Jonathan Parfrey

Juan Matute

Laura Zahn

Laurma Lurkevics

Lee Alexanderson

Lena Luna

Marc Costa

Mark Gold

Marty Meisler

Melinda Bartlett

Michael Manville

Mohja Rhoades

Phyllis Grifman

Sabrina Bornstein

Shannon Parry

Stephanie Pincetl

Steve Baule

Terry Watt

Youn Sim

Identity design
Website design and development

Yay Brigade

Website

climateaction.la

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ABOUT LARC

The Los Angeles Regional Collaborative for Climate Action and Sustainability (LARC) is a membership organization, fostering a network of local and regional decision-makers in the Los Angeles County region to perform climate mitigation and adaptation work, using cutting edge research on local climate impacts and information management systems. LARC's mission is to ensure a sustainable Los Angeles prepared for the impacts of climate change.

LARC is the sole climate collaborative in the LA region and its network is a cross-section of climate practitioners and decision-makers including academia, cities, LA County, regional agencies, non-profits, and businesses.