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San Diego Regional Decarbonization Framework

Summary for Policy Makers

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Summary for Policy Makers

The global scientific consensus is unequivocal: the world is in the midst of a climate crisis and our window to meaningfully reduce greenhouse gas emissions (GHGs) is closing.[i] Human activities and influence have warmed the atmosphere, ocean, and land through rapid accumulations of GHGs in the atmosphere and the ocean, causing rapid and alarming changes. Global agreements, like the Paris Climate Agreement, and California executive orders recognize the immediacy of decarbonization required across industries. Where past diplomatic efforts have failed to achieve enough progress on climate change, regional models of problem-solving that account for both global commitments and local needs can emerge as a more effective approach.

The San Diego Regional Decarbonization Framework (RDF) Technical Analysis provides *technical and policy pathways to decarbonization in the medium-term to inform near-term policy-making* in regional, county, and city governments. The report models science-based pathways to net zero carbon emissions for the region by 2045, which is consistent with the Paris Climate Agreement and with State mandates. The pathways can provide a shared vision for the San Diego region towards collectively reducing net GHG emissions such that they align with State goals for net zero. This report is a technical analysis of how different sectors in the energy system can contribute to decarbonization, but it does not identify the "right" pathway and instead shows multiple ways forward to highlight tradeoffs, co-benefits, decision points, risks, and synergies. This analysis is meant to be constantly updated as technologies evolve or as uncertainties are resolved or clarified, and the report explores policy processes that will help jurisdictions in the region learn about uncertainties and adjust strategies in light of new information.

Study Framework and Key Policy Considerations

This report looks at ways to reduce carbon emissions in San Diego's regional energy system, which is defined as the total production and consumption of energy in the electric power, transportation, and buildings sectors, to align with State and national pathways to reach net zero. By "net zero," this report means that human-caused carbon dioxide (CO_2) emissions from the energy system equal human-caused CO_2 removal and storage and therefore do not

[i] Intergovernmental Panel on Climate Change (IPCC), "Climate Change 2022: Impacts, Adaptation, and Vulnerability. Summary for Policymakers." WGII Sixth Assessment Report, February 2022. Available at: https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FinalDraft_FullReport.pdf

contribute net emissions to the atmosphere.[ii] The RDF Technical Analysis does not rely on offsets outside the San Diego region to reach net zero targets. It is important to note that there are emissions from other sectors, such as waste, that were not included in this analysis.

The RDF Technical Analysis's decarbonization pathways were modeled from larger national and State deep decarbonization scenarios to ensure that the San Diego regional pathways are aligned with Statewide pathways to decarbonization. Evolved Energy Research (EER) developed these regional models under five model cases (sometimes referred to as scenarios).[iii] The models of deep decarbonization, which is the process of drastically reducing carbon dioxide and other greenhouse gas emissions throughout the economy, allow for quantitative comparative analyses of regional policy options and decarbonization outcomes in different sectors. An example of EER's modeling outputs for the energy sector show how the different model cases will affect Statewide decarbonization in both the total installed electricity capacity required (Figure 1) and the energy and industry CO_2 emissions that occur through 2050 (Figure 2). Using these downscaled models is also important because local energy and transportation systems are interconnected with other regions and states, so regional jurisdictions should move in unison with other regional and state jurisdictions as they decarbonize.

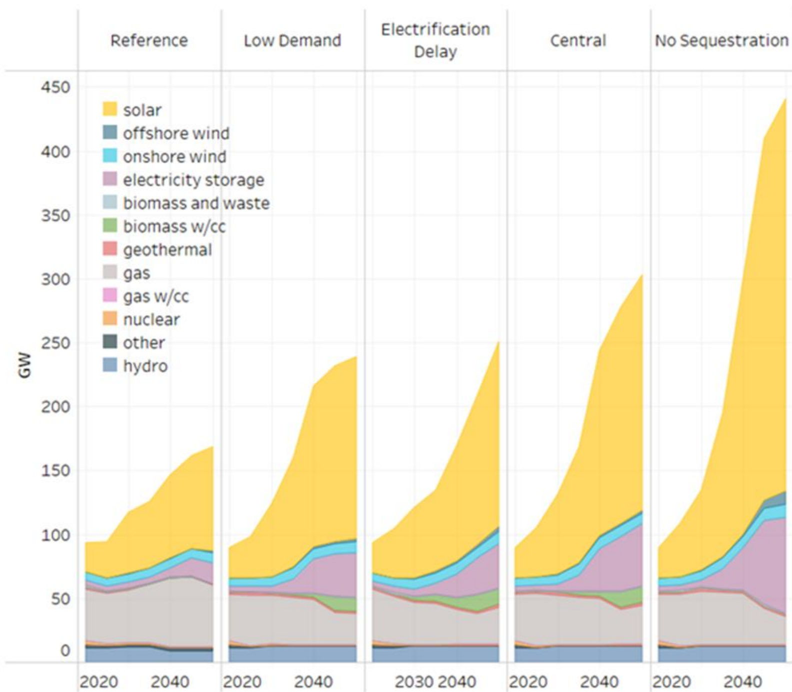

Figure 1. Results for the total installed electricity capacity required in California to reach net zero Statewide emissions by 2050 under five different model scenarios in the EER model. More information about the EER model, downscaling, and model cases is available in Appendix A.

[ii] Note that the energy system modeling only considers CO_2 emissions, where the natural climate solutions and Climate Action Plan analyses consider other greenhouse gases as well, including methane, nitrous oxides, ozone, etc. These GHGs are converted to their "carbon dioxide equivalent" (CO_2e) for easier comparison.

[iii] More details on the model cases can be found in Chapter 1 and Appendix A.

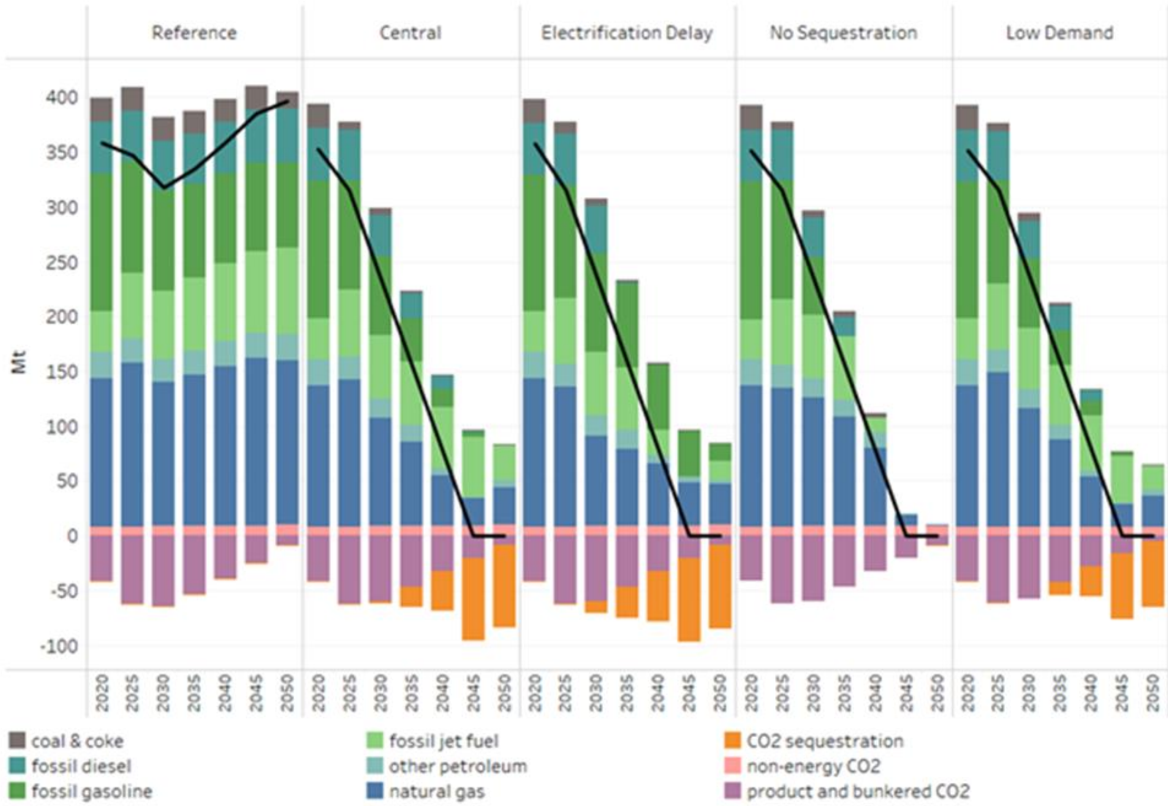

Figure 2. Results for CO_2 emissions from energy and industrial processes in California from the EER model. Colors above the x-axis represent positive emissions, and colors below represent offsetting negative emissions. The black line indicates net CO_2 emissions. "Product and bunkered CO_2" is either CO_2 that ends up sequestered in materials (e.g., asphalt sequesters CO_2 during its production) or CO_2 reductions not counted in current inventories (e.g., interstate aviation emissions reductions are not included in a single state's emissions accounting, but intrastate aviation is).

Experts in renewable energy production, transportation, and buildings modeled technically feasible decarbonization pathways for the region to create a science-based roadmap of regional decarbonization to net zero emissions by mid-century. These models focused on proven, scalable technologies for decarbonizing the region's largest GHG emitters (Figure 3) that are within the jurisdiction of local governments and agencies. Thus, technologies that are still in experimental or early phases were not included because they cannot immediately be deployed at scale by regional authorities. Similarly, resource deployments in State and federal waters were not included except to give context to the resource availability in the San Diego region.

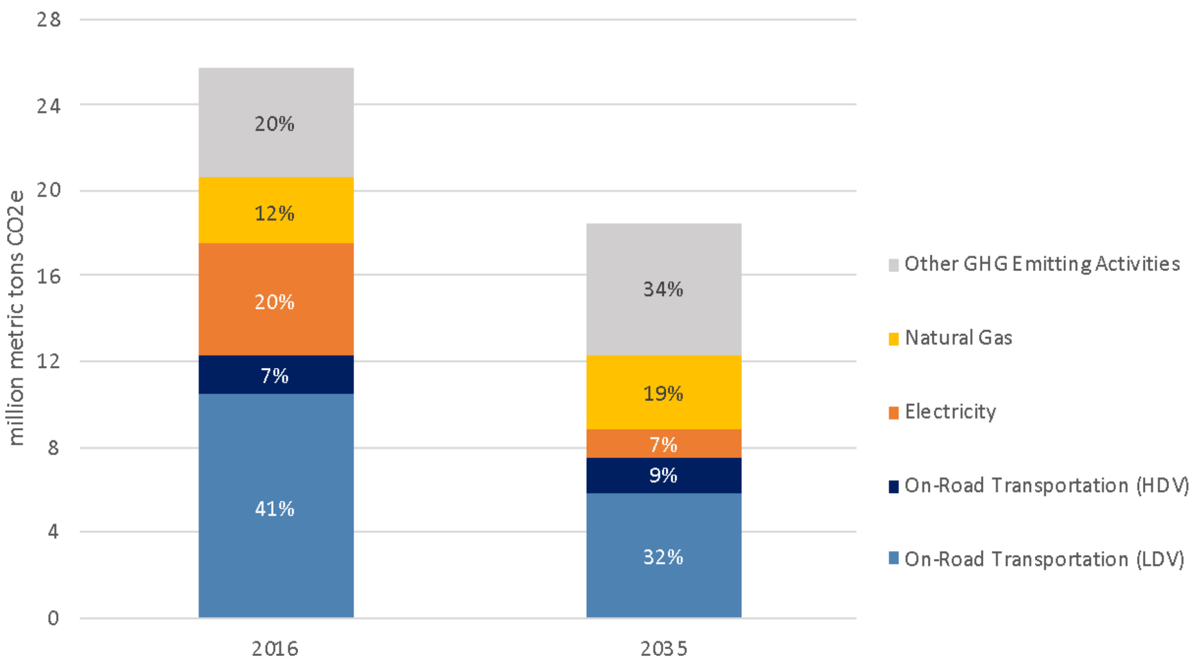

Figure 3. Region-wide estimates of the emissions of carbon dioxide equivalent (CO_2e) measured in million metric tons. The "other" category includes emissions from industrial sources, off-road transportation, waste, aviation, water, etc., which were not considered in the RDF Technical Analysis. Note that 2035 values account for the impacts of certain State and federal actions. Source: the SANDAG 2021 Regional Plan's Appendix X, available here: https://sdforward.com/docs/default-source/2021-regional-plan/appendix-x---2016-greenhouse-gas-emissions-inventory-and-projections-for-the-san-diego-region.pdf?sfvrsn=8444fd65_2

Additionally, the RDF Technical Analysis highlights uncertainties in the decarbonization process and the need for ongoing planning processes that can adapt as the technology and policy landscapes evolve. For example, increased renewable energy availability from Imperial County or Mexico may affect the San Diego region's renewable energy mix, which could avoid the need to build higher-cost renewable energy infrastructure locally. Similarly, State and/or Federal development of offshore wind could reduce the need for land-based renewable infrastructure development in the San Diego region. Therefore, the decision-making systems developed from the RDF Technical Analysis's findings should allow for continuous updating as technology and policy landscapes change.

Key Policy Considerations

Successful decarbonization will require technical solutions as well as policy strategies that can adapt with scientific advances as well as local political and economic conditions. The RDF technical analysis provides the best assessment of least cost and most effective near-term solutions for reducing emissions in each sector. These "low-regrets" actions will be robust decarbonization actions in the near-term regardless of how uncertainty is resolved, but whether they are the best pathways over the long term is still unknown. Effective learning and policy adjustment requires that local actors – both leaders and people on the front-line – first implement solutions and then engage in systematic and continuous review of results to drive meaningful learning about what works and what doesn't. The "best" solutions and pathways can and should evolve over time as science and technology advance and as local actors learn what is effective in the San Diego context.

The RDF Technical Analysis proposes region-wide institutional governance that can facilitate continued collaboration and learning across jurisdictions.[iv] Organized into a Regional Steering Committee, Sector Working Groups, and Front-Line Advisors, this structure would bring together knowledgeable government officials, planning bodies, regulators, industry stakeholders, experts, and front-line workers in each sector from across the region to test, evaluate, and adjust solutions and goals. Such a structure is necessary because achieving the big changes and rapid learning needed to address climate change is a collective action problem. Individually, local jurisdictions and agencies in the San Diego region have a limited degree of direct authority over the full suite of actions needed to decarbonize (though some may have more indirect influence). Region-wide cooperation can increase their effectiveness through clear, credible, and consistent policy signals, joint problem-solving and pooling of experience about what does and does not work, and increased leverage and capacity from combined resources. As discussed in Chapters 7 and 8, examples of regional cooperation could include setting county-wide incentives to motivate action, collecting and tracking data, conducting analyses, providing support to develop and implement policies, and convening stakeholders and working groups to develop regional strategies and monitor progress. A formal mechanism, such as a Regional Climate Action JPA, could facilitate such cooperation and, in doing so, help scale strategic thinking and decision-making around decarbonization. Figure 4 outlines an institutional process through which regional governance, informed by the technical solutions proposed in the RDF and ongoing engagement with stakeholders, can drive meaningful learning in each sector.

Within this institutional process, the RDF Technical Analysis also proposes two strategies for engaging with actors and agencies outside the region to maximize impact within the region. First, regional decarbonization leaders will need to engage continually with outside agencies, especially at the state level, to influence policies that affect local efforts (e.g., renewable energy regulations). Second, local leaders should take advantage of the county's technology-focused private sector and multiple university communities to establish the San Diego region as a test bed for pilot and demonstration projects. While regional-scale investments in innovation alone are not likely to have dramatic impacts on technological readiness across all sectors, local testing and deployment of technologies developed outside the county can contribute to the global effort to push the frontier of science on climate solutions. In addition to driving local

[iv] More information on collaboration and learning across jurisdictions is available in Chapter 7.

emissions reductions, external engagement is an opportunity to bring outside resources and attention from State and federal policymakers to the region, with potential positive effects on the local economy.

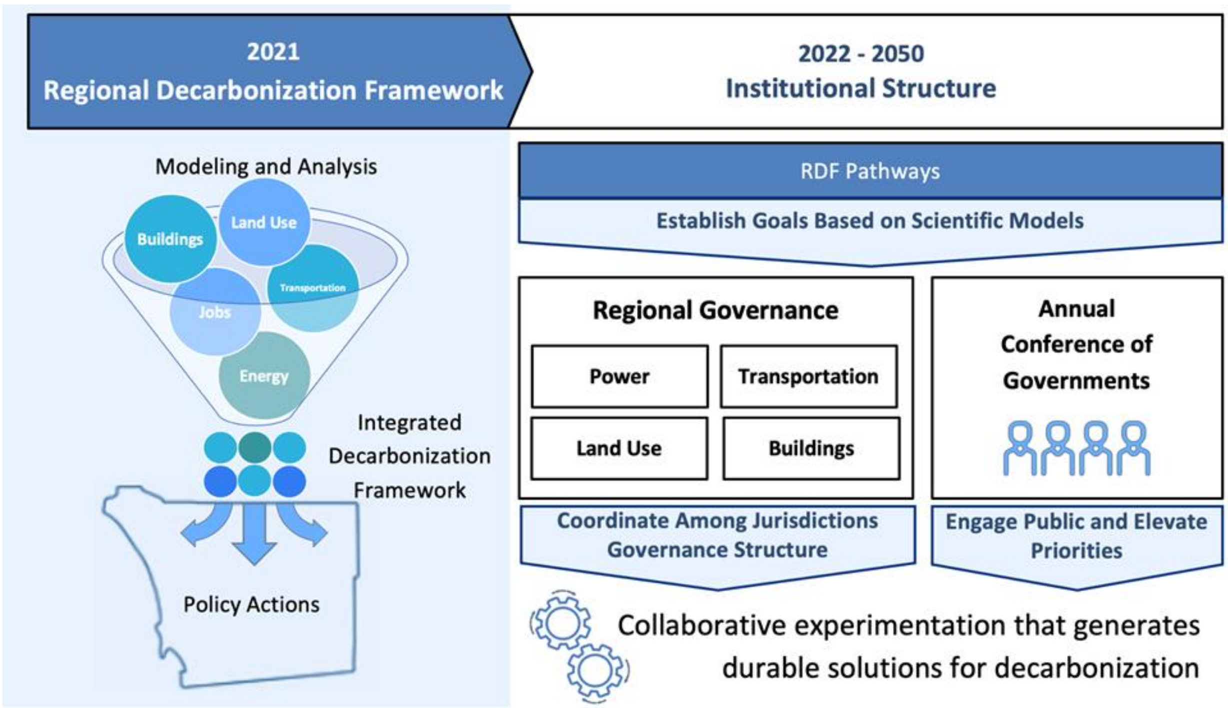

Figure 4. RDF Technical Analysis as part of an Integrated Decarbonization Framework and an institutional structure. This structure could include regional governance bodies for the San Diego region and a conference of governments, for example.

In sum, the RDF proposes institutionalizing a highly transparent, cooperative process for eliciting new information about "what works" with deep decarbonization, comparing best practices within the county, and engaging outside the region with policymakers, industry stakeholders, and other experts contributing to the evolution of the national strategy. This is important not just to maximize local emissions reductions, but also for San Diego to influence State and federal climate policy and become an effective leader for other jurisdictions. Given that the San Diego region makes up just 0.08% of global emissions, generating followership is vital for the region to truly make an impact on mitigating climate change.

Decarbonizing Electricity

The RDF Technical Analysis identifies low-impact, high-quality, and technically feasible areas for renewable energy infrastructure development in the San Diego region and neighboring Imperial County. Electricity emissions accounted for approximately 20% of the 2016 Regional Greenhouse Gas Emissions Inventory for the San Diego region and are the second largest emissions source in the region (Figure 3). Decarbonizing electricity production will require substantial deployment of new renewable resources. Siting renewable energy infrastructure and facilities can have significant impacts on the environment and will require new and upgraded transmission infrastructure.

The San Diego region has sufficient available land area for wind and solar generation to approach a fully decarbonized energy system in line with the California-wide system model under the least-cost scenario. However, meeting standards for reliability will require significant, but uncertain, investments in a suite of additional resources, including excess intermittent and flexible generation, storage, and demand-side management. The region can produce the projected 2050 energy demand with local utility-scale onshore wind and solar development. However, demand for energy may be higher or lower than the renewable energy supply at a given time (for example at night or on cloudy days), so investments in additional energy storage infrastructure are necessary to supply reliable renewable energy to the region. However, the costs of these additional resources, such as batteries and pumped storage hydropower, are highly uncertain.

The RDF Technical Analysis creates multiple site-selection scenarios for renewable energy infrastructure to inform decision-making. These scenarios include least-cost scenarios, scenarios that include Imperial County (including its geothermal potential), scenarios with different mixes of wind and solar resources (both distributed and utility scale), and brownfield sites. The primary scenarios selected utility-scale renewable energy sites from lowest to highest cost, while additional scenarios prioritize different policy goals such avoiding high conservation value lands, lands with high monetary value, lands with high carbon sequestration potential, and lands that were not already deemed developable. All scenarios include infrastructure costs expressed as the levelized cost of energy (LCOE), which is a way to compare costs across energy projects. The analysis includes the following renewable energy development scenarios:[v]

1. Least-cost, high local capacity (San Diego county only) (Figure 5);
2. Least-cost, high transmission deliverability (San Diego and Imperial counties) (Figure 6);

[v] See sections 2.4.5 and 2.4.6 for descriptions of the data and methods for site and candidate project area selection. See sections 2.5.1 and 2.5.2 for scenario results, discussion, and maps.

3. Minimized environmental impact (avoids areas of high conservation value) (Figure 7);
4. Minimized loss of land that has high monetary value (avoids high monetary value land) (see Chapter 2, Section 2.5.2 for figure);
5. Minimized loss of lands that naturally sequester high levels of carbon (avoids land with natural carbon sequestration potential) (see Chapter 2, Section 2.5.2 for figure);
6. Maximized development of areas that are developable (includes lands that are vacant or slated for redevelopment) (see Chapter 2, Section 2.5.2 for figure); and
7. Midrange scenario (includes a combination of developable areas in the region and nearby areas with transmission upgrades, nearby geothermal, rooftop solar, and brownfield solar and brownfield wind) (Figure 8).

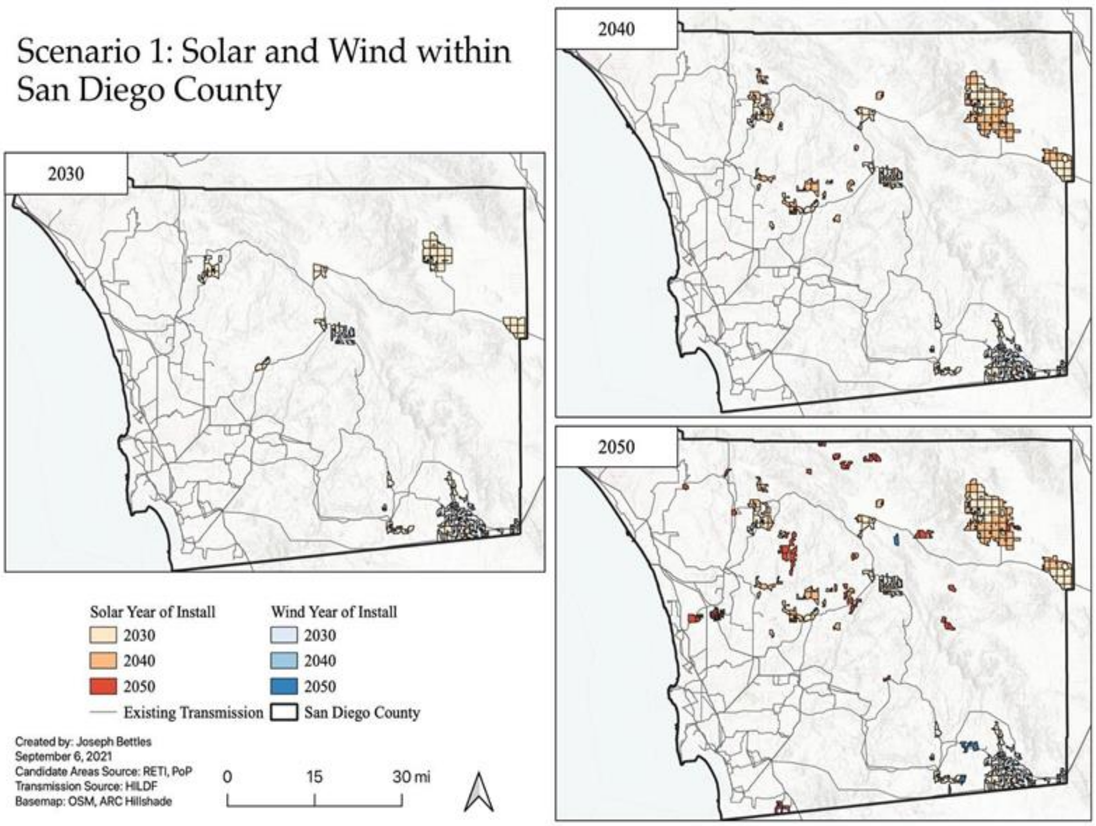

Figure 5. CPA Scenario 1: San Diego region only. This analysis selects utility-scale solar and onshore wind resources from lowest to highest cost to meet projected energy demand. The three panels show the build out required by each year that would allow the region to approach full energy decarbonization by 2050. Lighter colors represent Candidate Project Areas (CPAs) that would be built earlier because they are less expensive. Blue colors are wind resources and orange/red colors are solar resources. This scenario has an average LCOE of $40.65 per megawatt hour (MWh).

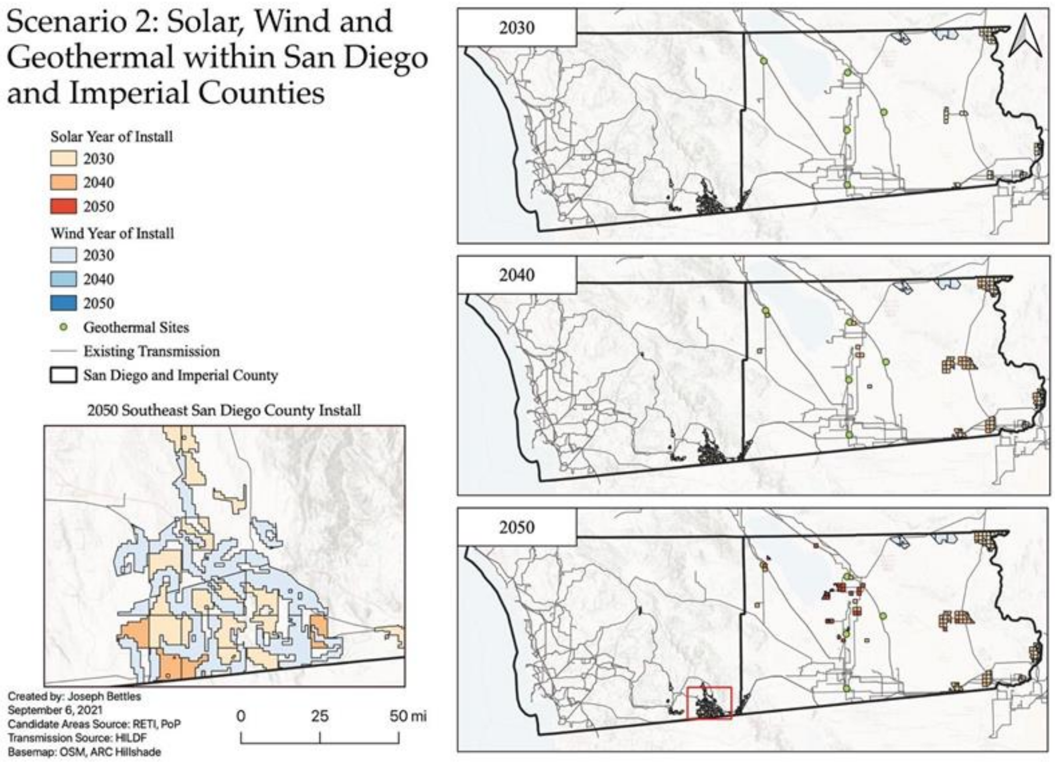

Figure 6. CPA Scenario 2: San Diego and Imperial counties. This analysis selects solar, onshore wind, and geothermal resources from lowest to highest cost to meet projected energy demand. These maps show build out over three time periods where colors represent build out year (lighter colors are earlier) and resources (red/orange for solar, blue for wind, and green for geothermal). The inset shows the Jacumba Hot Springs area site selection by 2050 and the area that includes the proposed/planned Jacumba Valley Ranch (JVR) sites. This scenario has an average LCOE of $42.04 per megawatt hour (MWh).

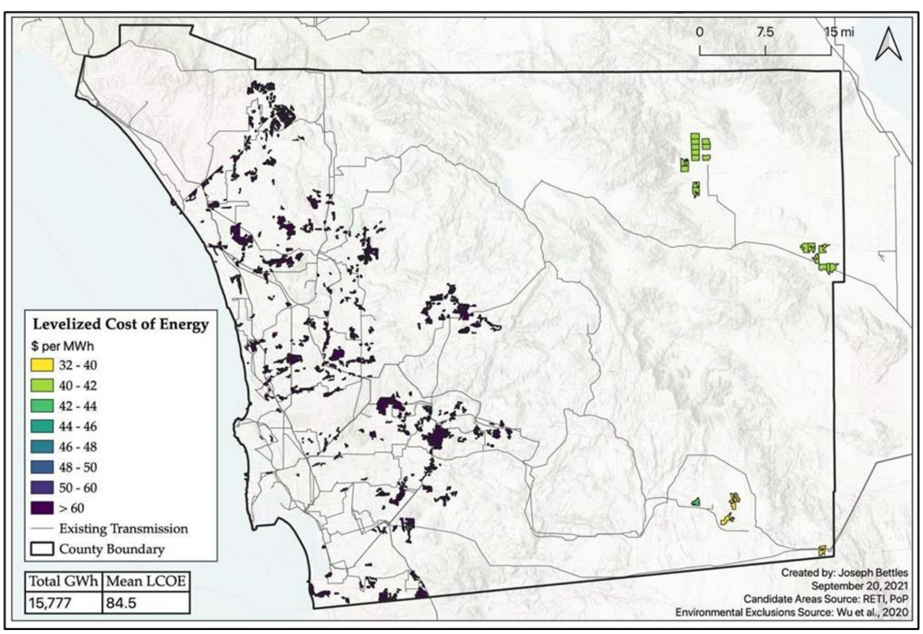

Figure 7. CPA Scenario 3: Restrict land with high conservation value. This scenario minimizes impacts to areas of high conservation value and other areas that are environmentally sensitive or important. It does not meet regional energy demand and is relatively more expensive (with an average LCOE of $84.5 per MWh).

The midrange scenario utilizes a mix of proven, scalable technologies that are within the jurisdictions of San Diego county, Imperial county, or regional entities to build in order to meet regional demand both in the near-term (2025) and by mid-century (shown in Figure 8). The technologies include brownfield infrastructure development (solar and wind infrastructure built on currently or formerly contaminated sites); utility-scale solar and wind in both San Diego and Imperial counties; rooftop and infill solar (where “infill solar” is defined as solar projects built in dense, urban settings); and geothermal (which is a clean, firm power source).

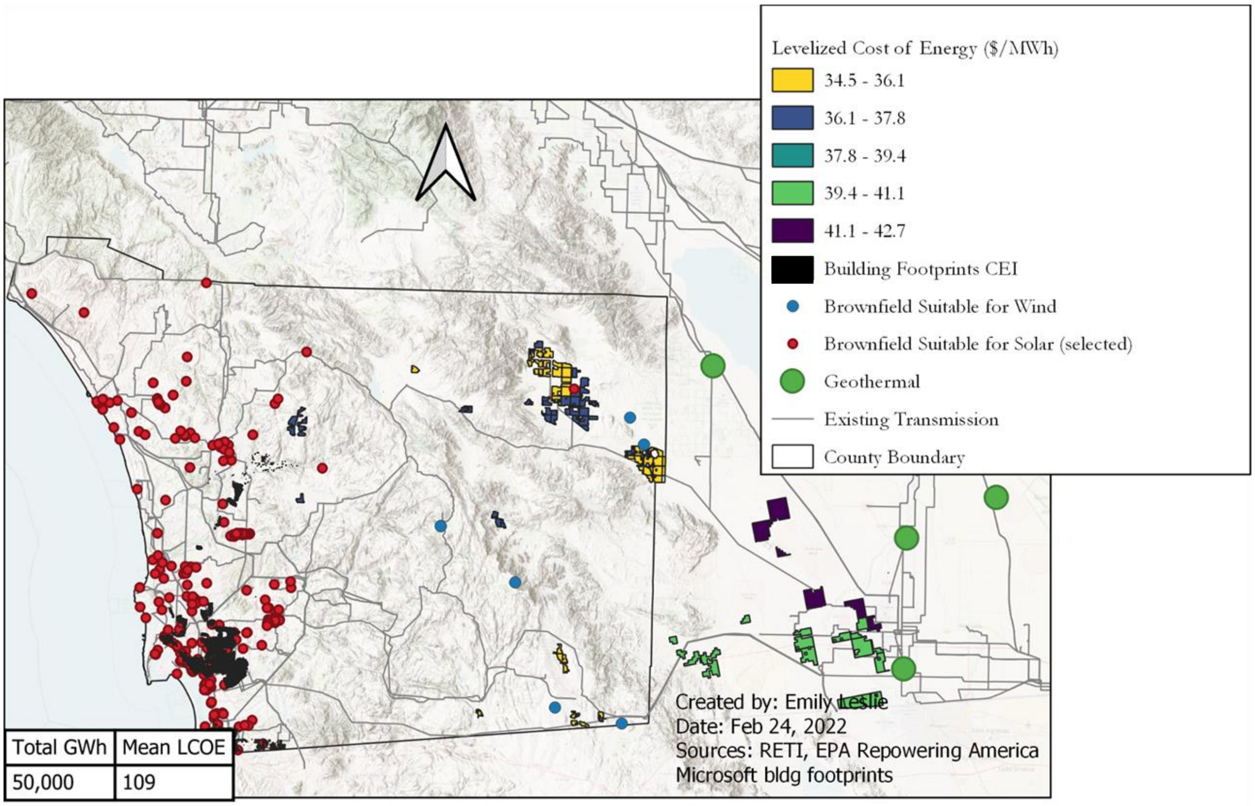

Figure 8. CPA Scenario 7: Mid-range Scenario 2050. This figure shows sites selected to meet the 2050 electricity demand under the mid-range scenario. In this scenario, the 2050 annual generation from new renewable sources is as follows: 12% rooftop solar, 23% brownfield solar, 0.1% brownfield wind, 6% utility scale solar on developable land in San Diego county, 0.4% utility scale wind on developable land in San Diego, 38% Imperial solar, 21% Imperial geothermal. The addition of rooftop solar and brownfield resources together results in 35% reduction in land area impacts. It meets regional energy demand but has a high average cost (average LCOE of $109/MWh) partly because of the high costs of rooftop and brownfield development.

There are some commonalities across scenarios in the results, suggesting that these might be “low-regret” renewable energy infrastructure options. These geospatial analyses have demonstrated that rooftop and infill solar can bring co-benefits to communities, and, along with brownfield development, these are low-regret strategies. Despite their relatively high costs compared to utility-scale development, they have low impacts on the environment, agriculture, and rural communities, and they have high job training opportunities near homes and urban centers. Given the high commercial interest and the relative location near planned or existing renewable sites, the models selected the JVR renewable area in most scenarios. This area is favored by Statewide planning proceedings, including those by the California Independent Systems Operator (CAISO) (which is California's grid operator) and the California Public Utilities Commission (CPUC) and may represent a low-regret scenario for utility-scale build-out. All scenarios require careful consideration of environmental justice issues and a deeper understanding of the effects that these energy developments will have on communities of concern, low-income communities, and/or disadvantaged communities.

Significant solar and geothermal availability in Imperial County is a large potential resource for San Diego that may require upgrades to the transmission network. As renewable energy infrastructure is developed in neighboring areas - such as Imperial County, Mexico, or State waters - the site selection scenarios will change in iterative energy supply and demand analyses. Similarly, as new technologies and permitting make additional renewable energy resources available (e.g., offshore wind, wave energy, etc.), the scenarios will need to be updated to account for the energy supply from those novel resources. This framework is flexible enough to account for additional renewable energy demand as it becomes available.

The region should coordinate with State agencies to ensure the reliability of the system. The San Diego region is a part of a larger energy system network, so coordination across agencies will be crucial to decision-making, planning, and implementation of renewable energy infrastructure into the future. For example, there is a State-level Integrated Resource Plan (IRP) proceeding at the CPUC. Load Serving Entities (LSEs) throughout the State are Parties to this proceeding, and local LSEs, such as San Diego Gas and Electric (SDG&E) and Community Choice Aggregators (CCAs), are required to submit their procurement plans on an annual basis. These submittals help the State anticipate potential reliability issues, and they help the CAISO plan transmission upgrades which may be needed to accommodate LSE plans and to meet climate goals. To the extent that LSE plans include local distributed generation, rooftop solar, community solar, equity-eligible contractor projects, or other specifications, this information should be indicated in LSE submissions to the CPUC. Additionally, City Council members and other government officials often serve on CCA boards and participate in procurement planning and target setting. Board members can help ensure that LSE plans are implemented for consistency with regional GHG reduction targets, as well as with State targets. This is especially important where local targets are more ambitious than State targets. Beyond the IRP, there are additional State agency proceedings which could benefit from input from local players (e.g., the CPUC Resource Adequacy proceeding, CAISO Transmission Planning Process, and the CAISO Local Capacity Requirements proceeding). In the Resource Adequacy proceeding, CPUC staff conduct analyses to ensure the reliability of the electric power grid. In the Transmission Planning Process, the CAISO conducts analyses to ensure reliability, policy compliance, and cost-effectiveness of the planned transmission system upgrades. In the Local Capacity

Requirements proceeding, the CAISO takes a more local approach to reliability analysis than other proceedings. For example, Section 3.3.10 of the CAISO 2022 Local Capacity Technical Study is devoted to the San Diego-Imperial Valley region. Load Serving Entities such as SDG&E and SDCP and CEA should coordinate on procurement, resource adequacy and other issues addressed in these proceedings.

The State requires a fully decarbonized electricity system by 2045 and has requirements for rooftop solar on certain new buildings. Nevertheless, there are additional opportunity areas to decarbonize beyond the State goals. Electricity decarbonization is the most common CAP measure analyzed and on average contributes more GHG reductions than any other measure. Most CAPs include a measure to form or join a CCA program, but there are opportunities to increase CCA participation and for CCAs to commit to 100% carbon-free energy prior to the State 2045 deadline. Additionally, there are local opportunities to enhance or complement State rooftop solar requirements by adopting reach codes (or local codes that go beyond State requirements) and evaluating mandates or incentives for energy storage systems paired with rooftop solar to decrease marginal emissions during the electric system's peak GHG emission and to increase reliability.

Additional work would be needed to make carbon-free electricity supply more accessible. Historically, rooftop solar has been installed in higher-income neighborhoods and/or in areas with higher levels of homeownership. Numerous options exist to address the inequitable distribution of solar installations, including targeted incentives and financing. Additionally, CCA programs can maximize participation in the Disadvantaged Communities Green Tariff Program, subsidize customers in income-qualified discount programs to opt-up to 100% carbon-free electricity service options, and support inclusive financing for energy upgrades.

Legal authority to regulate energy production:[vi] Jurisdictions in the San Diego region have the authority to require levels of carbon-free electricity supply through CAPs and to procure carbon-free electricity supplies through a CCA and can therefore supply more carbon-free energy than required by State agencies. However, State and/or federal agencies or entities still regulate local energy supplies for reliability, which complicates fully decarbonizing the electricity supply with renewable energy. Additionally, local jurisdictions are also authorized to support alternatively fueled thermal power plants and related infrastructure that can provide low- or zero-emission electricity to meet reliability and air quality requirements (e.g., green hydrogen production and/or power plants). Local jurisdictions are also authorized to increase distributed generation through CCAs and reach codes, and to streamline permitting. Further

[vi] See Chapter 8, section 8.7 "Decarbonize the Electricity Supply" and Appendix B for further discussion of legal authority.

regulating most fossil-fueled thermal power plants emissions is limited given current State regulation and uncertainty over federal preemption.

Decarbonizing Transportation

The transportation sector is the largest contributor to regional GHG emissions. In 2016, on-road transportation emitted almost half of regional emissions. In 2035, emissions from on-road transportation are projected to account for about 41% of the total projected emissions (Figure 3).[vii] Statewide legislation, executive orders, and agency targets have set goals for GHG reductions in the transportation sector and the San Diego region has implemented several measures to reduce regional transportation GHG emissions, which have included a variety of vehicle miles traveled (VMT) reduction strategies and vehicle electrification strategies.

The region has a strong policy foundation for reducing emissions related to transportation. However, current commitments through CAPs and other policies are inconsistent with the levels of reductions required by State executive orders for carbon neutrality. Even the best CAP commitments to reduce on-road transportation emissions through VMT reduction, EV adoption, and fuel efficiency strategies, if applied to the whole region, are not projected to achieve the State's zero emissions goals.

Opportunity areas exist to accelerate EV adoption and VMT reduction based on existing regional policies and patterns of vehicle ownership, travel behavior, and land use development. These opportunity areas include CAP measures to reduce VMT and to reduce vehicle emissions. Current policies and consumer, driver, and developer behaviors are already increasing EV adoption and reducing VMT. However, there are additional opportunity areas to accelerate regional transportation decarbonization. To reduce VMT, jurisdictions can enhance transit and active transportation (biking and walking), and encourage smart growth, urban connectivity, and density by changing zoning to promote mixed-use developments, and disincentivizing parking.[viii] To reduce emissions, jurisdictions can identify areas for traffic calming measures, establish anti-idling requirements (especially around schools), and provide driver behavior incentives. Further, local jurisdictions have the opportunity to affect vehicle retirement, which can be prioritized in communities of concern to rapidly reduce the air pollution burden in those communities. Finally, local governments can increase use of alternative, low-carbon fuels and EVs, particularly for medium-and heavy-duty vehicles, in

[vii] See Chapter 8, section 8.5 for a detailed analysis of CAP commitments as they relate to transportation. Note that this value includes projected EV sales changes but does not include CAP measures.

[viii] Opportunities to increase density in in-fill areas have been identified in Chapter 3. More details on how to reduce VMT are in Chapter 8.

existing and future fleets. Figure 9 shows a menu of policy opportunities to increase EV adoption, illustrating policy options that range in both effectiveness (i.e., how good the policy is at increasing EV adoption) and breadth (i.e., how many people it can reach).

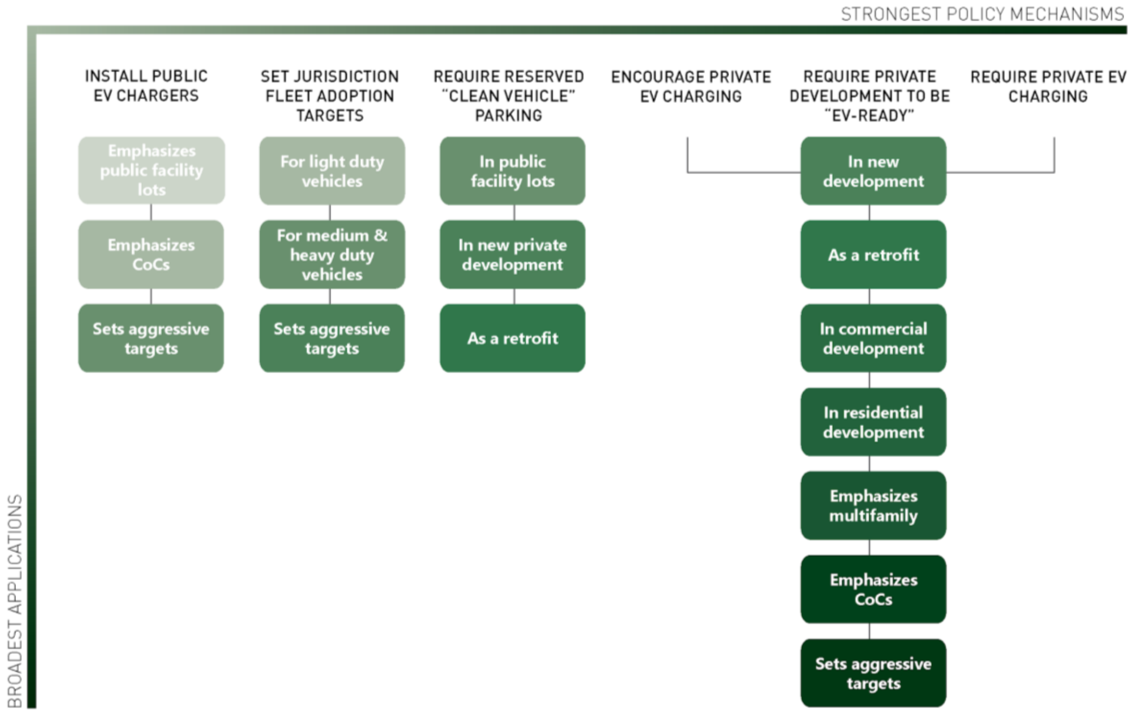

Figure 9. A spectrum of policy options to accelerate EV adoption. Policies are likely to be more effective moving right and are likely to have a broader application moving down. Thus, the bottom right is predicted to be the most effective and to have the broadest application of the policy measure shown where the top left is predicted to be the least effective and to have the narrowest application of the policy measures shown.

Multiple opportunities for regional collaboration and coordination exist. The nature of on-road transportation and of existing institutional frameworks that coordinate transportation decisions suggests that regional collaboration on transportation decarbonization will be more effective than individual CAP measures. CCAs provide an example of a local mechanism, usually through Joint Powers Agreements (JPAs), that can support transportation electrification by developing programs to locally incentivize EV uptake beyond State and federal programs. Similarly, other regional transportation decarbonization may be identified which can promote local funds for transportation decarbonization. Additionally, local jurisdictions can collaborate to assess the equity impacts of EV use versus increasing use of mass transit in various communities, and to align regional transportation equity analyses (e.g., SANDAG's equity analyses) with CAP equity analyses (e.g., the City of San Diego's equity analyses).

Legal authority to regulate transportation decarbonization:[ix] Local jurisdictions and agencies in the San Diego region have broad authority over transportation, based both on locally derived land use authority over planning and development and delegated authority from the State and the federal governments. These authorities can be limited or preempted by State or federal laws, as is the case with regulating fuels and tailpipe emissions. Additionally, local jurisdictions can establish climate change policies and regulations to reduce GHGs from transportation in general plans (GPs), CAPs, zoning, or transit-oriented development regulations. Further, they can require infrastructure for fuel switching in buildings (e.g., EV charging equipment), build supporting infrastructure in public right-of-ways or on public land, and support alternative fuel production and infrastructure, such as hydrogen. Local jurisdictions can regulate their own fleets through purchasing, maintaining, or changing their fleets. They also have the authority to regulate indirect transportation emissions to keep local emissions in line with federal and State air quality standards. State statutes and regulations create an opportunity to align local action that decreases costs for implementation by bringing State funded projects to the region, particularly in communities of concern, and deploying technology developed by State or federal funding. Finally, jurisdictions appear to have more legal authority through land use, transportation infrastructure siting, delegated authority, and taxation powers to reduce transportation GHGs, than represented by commitments in CAPs. Additional work by local jurisdictions would be needed to assess the limits of their authority to increase on-road transportation GHG reductions.

Decarbonizing Buildings

The RDF Technical Analysis studies the building mix and associated emissions from the region's infrastructure and building sector. Direct emissions from buildings come from on-site fossil fuel combustion and contribute to regional GHG emissions, so this chapter focuses on decarbonizing buildings by eliminating their fossil fuel-based emissions by 2045. The analysis focuses on electrifying systems that are responsible for end-use emissions, like space and water heating, and using lower-carbon fuels, like biomethane and hydrogen, where electrification is not yet feasible. The analysis considers three modeled pathways to reach a carbon-free building sector by 2050: a pathway that emphasizes high electrification of fossil-fuel systems, a pathway where heat pumps are highly efficient when electrified, and a pathway where low-carbon fuels are used to reduce emissions while a slower adoption of electrification occurs.[x]

[ix]See Chapter 8, section 8.5 "Decarbonize Transportation" and Appendix B for further discussion of legal authority.

[x] More details on the modeled pathways are available in Chapter 4, section 4.4 and elsewhere in the chapter.

Replacing fossil fuel-based space heating and water heating systems with electric systems should be a primary policy focus for building emission reductions. Space heating and water heating represent large shares of emissions from buildings in the San Diego region because they tend to rely on natural gas (Figure 10), so replacing these systems, as well as other fossil fuel-based systems like ovens and dryers, with electric versions will have large impacts on building decarbonization. Space and water heating are especially conducive to electrification because heat pump technologies available for both uses are more efficient than natural gas systems, providing more heating per unit of energy input. For building temperature regulation, electric heat pumps offer both heating and cooling from the same unit, making them ideal for homes that do not yet have air conditioning. Water heaters produce the most emissions in buildings, so replacing them with electrified versions will have outsized emissions reductions for the costs. Finally, this analysis finds that costs do not differ substantially between new construction and the addition of electric units and retrofitting old appliances. Thus, regional policies should support increasing adoption of efficient heat pump-based space and water heating systems in both new and existing buildings.

Additionally, policies aimed at replacing fossil-fuel based space and water heating systems should focus on increasing uptake among low-income residents and rental building owners through assistance. Such policies would address some historic inequities in housing quality, environmental injustice, health disparities due to indoor air pollution, and/or utility costs and would ensure that low-income residents and renters are not excluded from building decarbonization goals and that they are not left paying increasingly higher gas rates.

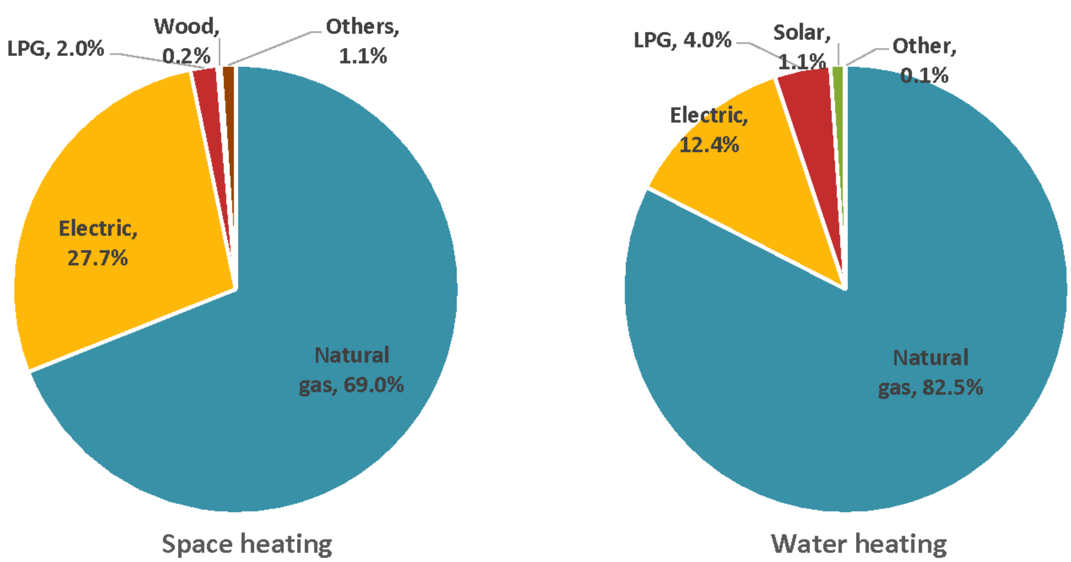

Figure 10. Residential space and water heating energy use by fuel type (% of customer accounts) in the San Diego region. Source: DNV GL Energy Insights. 2021. 2019 California Residential Appliance Saturation Study (RASS).

There are several near-term actions that are low-regret for building decarbonization. First, setting "electrification-ready" or "all-electric" standards for new construction and major renovations through building energy codes will reduce costs associated with transitioning away from fossil fuels. Second, some existing fossil fuel equipment systems will only turn over once by 2050. Replacing end-of-life fossil fuel heating systems with electrified systems is low-hanging fruit. This is a near-term priority. Third, improved data gathering is a low-cost, foundational action for future policy development. More data on building emissions and decarbonization will better inform decision makers as they craft policies to address the building sector's contributions to a net zero region.

Low-carbon gaseous fuels can be used for hard-to-electrify end uses, though research and piloting are required. Some building systems are hard to electrify, so one way to reduce GHG emissions from those systems is to use fuels that do not emit net GHGs into the atmosphere. Similarly, such fuels can be used for these or other systems prior to electrifying them. Low-carbon gaseous fuels could include biomethane and/or hydrogen. However, each of these alternate fuels have cost and efficiency trade-offs as well as uncertainties, so more research and piloting will be necessary before implementation.

The gas utility's risk of not recovering its investment in assets (that is, its stranded cost risk) can be mitigated by minimizing unnecessary extensions or replacements of the gas pipeline system and by accelerating depreciation of existing utility assets. Phasing out end-use natural gas consumption in buildings can lead to stranded natural gas assets, defined as infrastructure such as a natural gas pipeline that has stopped being used before reaching the end of its useful life. For companies like SDG&E, stranded assets represent potential financial losses because of the high capital costs of creating or replacing gas infrastructure. Mitigating these stranded assets will be an important policy consideration. One tool is to minimize unnecessary extension or replacement of gas pipeline infrastructure. SDG&E invests in natural gas assets when it extends pipes to serve new customers and when it replaces old or damaged pipes and other assets. Policies like requiring all new construction to be fully electric would mitigate stranded asset losses for new pipe investments going to new customers, but this would not mitigate losses from investing in replacing aging infrastructure. Exploring and piloting non-pipeline alternatives to both new and replacement infrastructure, including electrifying end uses instead of replacing infrastructure, could identify opportunities to mitigate risk.

CAPs have relatively few measures to electrify buildings and the GHG impact of the measures is relatively low, despite their importance to regional decarbonization. Only six CAPs include measures related to building electrification and the GHG reductions in CAPs associated with efficiency and electrification are relatively low. Compared to the level of electrification needed in both new and existing buildings as outlined in Chapter 4, the CAP measures fall short of the level of building decarbonization in the RDF Technical Analysis pathways.

Policies for decarbonizing new and existing buildings are crucial. 80% of the buildings that will exist in 2050 already exist, so decarbonizing these buildings will be critical to decarbonizing the building sector. While State building codes regulate alterations and additions to certain existing buildings, local policies could further encourage or require energy efficiency and electrification in many other existing buildings.[xi] Decarbonizing municipal buildings may be a low-regret policy because implementing cost effective measures and electrifying those buildings may help reduce operating costs and modeling these actions may encourage owners of homes and businesses to act.

There is an opportunity and a need to assess social equity considerations of building decarbonization policies. In the context of building decarbonization, there are several aspects of equity to consider, including the high proportion of renters in communities of concern, the relative lack of data and analysis related to equity and building-related policies, and potential cost implications of building decarbonization policies, particularly electrification. Additional work would be needed to develop the capacity and tools to understand and address the equity implications of building and other decarbonization policies in the San Diego region.

Legal authority to regulate building decarbonization:[xii] Local jurisdictions have the authority to regulate GHG emissions from building end-use of fossil fuels and other energy sources, which is the primary means of decarbonizing buildings. Local jurisdictions also act with delegated authority over the built environment to require more stringent energy codes, directly regulate air pollution emissions from buildings, and procure alternate energy supplies in public buildings. Additional authority may come from the California Environmental Quality Act (CEQA) by setting a more stringent threshold to determine environmental impact. Local governments are preempted from establishing energy efficiency appliance standards, regulating natural gas supply, transmission, and storage, and high global warming potential refrigerants (e.g., HFCs).

[xi] See Chapter 8, section 8.6, for more details on examples of local authorities decarbonizing existing buildings. Also see Chapter7 section 7.3.1 for a local example.
[xii] See Chapter 8, section 8.6 “Decarbonize Buildings” and Appendix B for further discussion of legal authority.

Natural Climate Solutions

The RDF Technical Analysis investigates the natural climate solutions (NCSs) available in the San Diego region and their potential to naturally sequester and store CO_2 and other GHGs. NCSs are processes that protect or enhance natural and working lands' (NWLs) ability to capture and store GHGs from the atmosphere through plants and soils. "Working lands" include agricultural lands like orchards, vineyards, pastures, etc. "Sequestration" is an annual measure of how many GHGs are removed from the atmosphere and "storage" is the total amount of GHGs that have been sequestered. Carbon storage in the region (Figure 11) is important because there are ways to prevent stored carbon from being released into the atmosphere, as occurs when land use changes from NWLs to urban areas, for example. By understanding a landscape's carbon storage and sequestration potential, areas with high levels of stored carbon can be prevented from emitting their carbon into the atmosphere and areas with high sequestration potential can be protected.

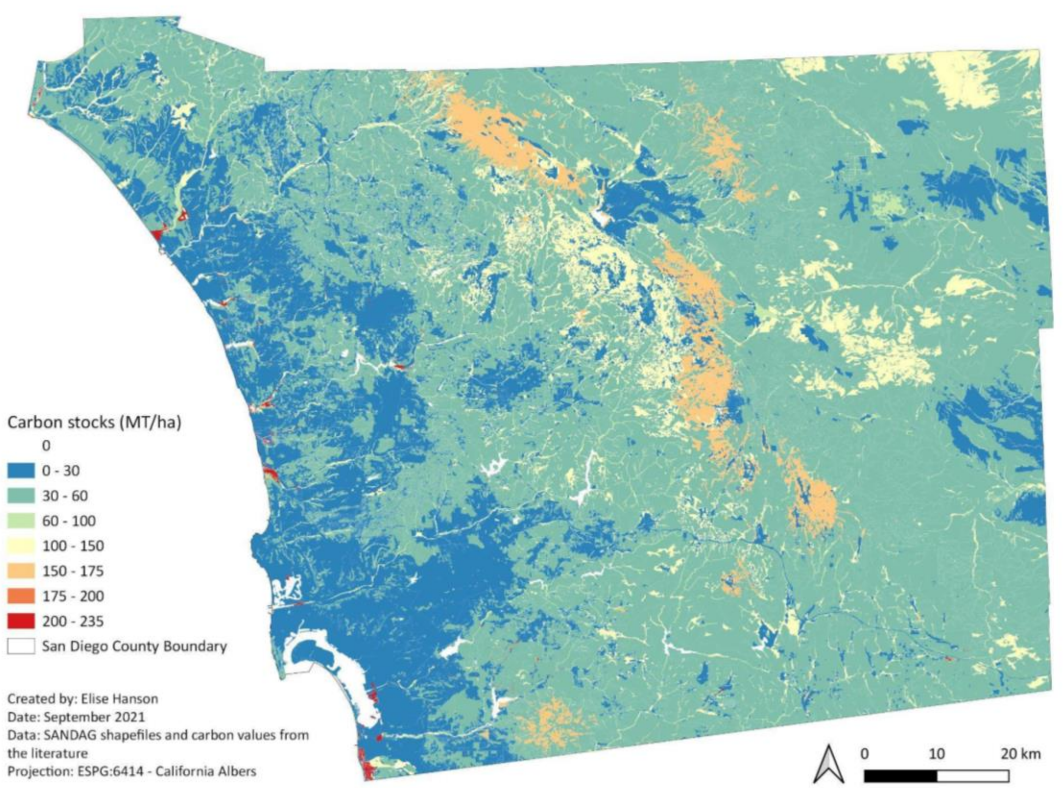

Figure 11. Total stored carbon (measure in metric tons of carbon dioxide equivalent per hectare, or MT CO_2e ha^{-1}) estimates for the San Diego region. Warmer colors represent larger carbon stock estimates, cooler colors represent lower stock estimates, and white represents no carbon stock.

Regional NWLs sequester and store large amounts of carbon dioxide, but they do not sequester enough to account for human-caused emissions. NWLs can act as stronger *net* sinks than they currently do, though this will require investments in bolstering NCSs and minimizing carbon emissions from land and land use activities. To accurately account for net carbon land use emissions, local data need to be collected and integrated into regional carbon calculations. The region can expand annual carbon sequestration and long-term carbon storage through investing in NCSs that both increase natural sequestration and that reduce emissions from the land, such as investing in "carbon farming," restoring and expanding "blue carbon" habitats, planting trees and other plants in urban areas, preventing wildfires, and planting trees in NWLs. Local data can improve NCS policies and management techniques and thus increase regional sequestration.

The most effective and inexpensive NCS in the San Diego region is to avoid land use change by protecting natural and working lands, except where land use change is required for other decarbonization actions, like siting renewable energy infrastructure. Existing natural and working lands are natural carbon sinks, so preventing these lands from changing into urban or built-up areas will allow for 1) continued annual sequestration and 2) prevention of one-time emissions from vegetation removal, soil disturbance, etc. This report estimates that natural annual sequestration in NWLs may be up 2 million metric tons (MMT) of CO_2 under ideal circumstances and that there may be 58 MMT of CO_2 stored in vegetation, woody debris, leaf litter, and soils, some of which would be released with land use change. The annual sequestration in NWLs is important to continue to build natural CO_2 storage. Natural sequestration was not included in the RDF technical analysis of emissions given the focus on the energy system. Land use change will be necessary to install utility-scale renewable energy infrastructure, which will support decarbonization, and to allow housing development. It will be important to minimize land use change in the areas with the largest natural carbon stores and with the highest sequestration potential and to protect areas with high co-benefits (such as areas that provide air and water quality improvements, biodiversity protection, and public health outcome improvements).

Other important regional NCSs considered by the RDF Technical Analysis may be less effective and/or more expensive for carbon sequestration, although they yield important co-benefits. These include carbon farming (farming practices that increase carbon sequestration and storage and minimize GHG emissions on agricultural lands), wetland protection and expansion/restoration, and urban forestry. Large-scale habitat restoration and reforestation, which were not considered in this report, are expensive and may not be effective. Wildfire prevention will also be important for emissions and numerous other economic and social reasons. Other NCS options require significant capital investments and are likely to have smaller short-term sequestration returns than preservation.

NCSs offer quantifiable co-benefits beyond decarbonization. Each of the analyzed NCSs offer numerous quantifiable co-benefits. These co-benefits include, but are not limited to, improved air and water quality, improved public health outcomes, biodiversity protection, ecosystem functioning protection, increased shading in urban areas, decreased water and fertilizer requirements on farms and rangelands, improved aesthetics in urban areas, and the potential to increase environmental justice. These co-benefits should be considered when crafting and implementing policies in order to build ecological, economic, and social resilience.

Equity must be a central consideration for all NCS decisions. NCSs should be viewed through the lens of both decarbonization and equity. Whenever possible, communities of concern should be prioritized for urban greening, tree planting, climate farming, and habitat restoration because these NCSs have outsized co-benefits of improving air and water quality as well as human health. Historically, these communities have received less investment and have borne disproportionate levels of environmental harm. All efforts should be made to actively address these historic inequities.

The only quantified CAP measure relevant to this pathway is urban tree planting, but there are opportunities to implement additional NCSs in a collaborative way. Additional measures are possible under local land use authority. Tree planting measures contribute on average just over 1% of local GHG reductions in CAPs. These can be enhanced through jurisdictional collaboration. Additional NCS CAP measures are possible under existing authority and can contribute to land conservation, preservation, and restoration on natural and working lands. Private landowners and tribal governments can also preserve land, test and fund pilot projects for carbon removal and storage and collaborate with public agencies. Collectively, there is an opportunity to expand protections for natural and working lands to fulfill the new SB 27 (2021) mandate that calls for the creation of natural and working land carbon removal and storage projects.

There are also opportunities to include local data in land management and planning as well as in CAPs. For instance, CAPs can utilize the California Air Resource Board's (CARB's) carbon accounting methodology in natural and working lands and universities' data to create stronger goals and measures. Additionally, the region can implement regular carbon accounting and track changes in carbon in natural and working lands over time to understand how carbon stocks are being preserved and whether net emissions occurred due to changes in land use.

Legal authority to regulate negative emissions from natural climate solutions and land use:[xiii] It is unclear if local jurisdictions' ability to use their authority over land use, zoning, land preservation, and agricultural easements extends to activities on private natural and working

[xiii] See Chapter 8, section 8.8 "Natural Climate Solutions" and Appendix B for further discussion of legal authority.

land beyond land use designation that would affect GHG emissions or sequestration. The region's land use jurisdiction is further complicated because it is composed of federal, State, tribal, and privately held land, submerged land, and waters. Various statutes and agencies regulate the different land types, with none focused on GHG emissions or sequestration as it relates to land use. State land use and regulating agencies also operate with a wide range of statutory mandates, which apply to lands under multiple jurisdictions and impact GHG emissions and accounting. California's statutes and executive orders require State land use agencies to account for GHG emissions from natural and working lands. Additionally, these State agencies are beginning to assess and regulate carbon removal and storage on these lands with significant targets in 2030. An opportunity exists for local jurisdictions to work with landowners and managers to achieve State, regional, and local goals related to natural and working lands.

Employment Impacts of Decarbonization for the San Diego Region

The RDF Technical Analysis calculates the net change in jobs in the energy sector in response to the central case of the modeled decarbonization pathways from the EER model. The analysis focuses on employment changes from 2021-2030, following California's Jobs and Climate Action Plan for 2030, to inform workforce development strategies. Additionally, this report analyzes overall average annual job creation from 2020-2050, based on the full timeline in the EER model. For phasing out fossil fuels and modeling associated job losses, the analysis focuses on the 2021-2030 period, where the central case of the EER model estimates modest reductions in fossil fuel-based activities. This is primarily due to the model's estimates of steady natural gas consumption and a 20% decrease in oil consumption by 2030, relative to current consumption levels. The RDF Technical Analysis focuses on the quantitative impacts to employment as a result of deep decarbonization efforts in the energy, building, and transportation sectors and informs a report by Inclusive Economics[xiv] on workforce development strategies.

Between 2021 – 2030, the regional decarbonization pathways would generate an average of nearly 27,000 jobs per year in the San Diego region. Through the creation of direct, indirect, and induced jobs, the RDF Technical Analysis estimates that the decarbonization pathways will create 27,000 jobs per year for the region.[xv] Table 1 shows that expenditures on *energy*

[xiv] To access the Inclusive Economics report titled "Putting San Diego County on the High Road: Climate Workforce Recommendations for 2030 and 2050," please visit the County of San Diego's engagement platform and select the report for download or for commenting at https://engage.sandiegocounty.gov/rdf.
[xv] For a more detailed accounting of these jobs, please refer to Chapter 6, section 6.3.

demand will create approximately 13,500 jobs between 2021 and 2030. Table 2 shows that expenditures on *energy supply* will create approximately 13,500 jobs between 2021 and 2030.

The RDF Technical Analysis estimates that no workers in the region's fossil fuel-based industries will have to experience job displacement before 2030, even with contractions in fossil fuel demand. The energy supply mix in the EER model suggests that there will be small to no changes in the consumption of fossil fuels before 2030.[xvi] This suggests that there will not be job losses in the oil and gas sectors in the San Diego region prior to 2030.

San Diego County and local governments should begin now to develop a viable set of just transition policies for the workers in the community who will experience job displacement between 2031 – 2050. After 2030, the EER model's central case estimates large contractions in both oil and gas. The model predicts 95% contraction rates in oil and 75% in gas by 2050. It is important for regional governments to begin to develop policies for a just transition for these workers now so that they can transition into jobs of equivalent or better quality in the clean energy economy or elsewhere.

The costs of a just transition will be much lower if the transition is able to proceed steadily rather than through a series of episodes. Under a steady transition, the proportion of workers who will retire voluntarily in any given year will be predictable, which will avoid the need to provide support for a much larger share of workers at any given time. The rate of the transition from fossil fuel to renewable energy-based jobs will impact the equity and fairness of the transition. Sudden changes and contractions would potentially result in sudden job losses, where steady changes and contractions would potentially result in fewer job losses as employees could transition to new jobs or could voluntarily retire.

Geothermal production of the five sites identified in Imperial County would generate 1,900 jobs per year over a 10-year period. Chapter 2 identifies five areas for geothermal energy production in Imperial County. This chapter's analysis finds that there will be 1,900 jobs created per year in the Southern California region over a 10-year period for the development and operation of these five geothermal power plants. Some of these jobs may be created in the San Diego region.

[xvi] Details on the EER model's Central Case, which was used here, can be found in Appendix A.

Table 1 Average number of jobs created in the San Diego region annually through energy demand expenditures from 2021-2030, by subsectors and technology. *Figures assume 1 percent average annual productivity growth.*

Investment Area	Average Annual Expenditure	Direct Jobs	Indirect Jobs	Direct Jobs + Indirect Jobs	Induced Jobs	Direct Jobs + Indirect Jobs + Induced Jobs
Vehicles	$7.7 billion	3,427	1,427	4,854	1,508	6,362
HVAC	$897.0 million	1,345	699	2,044	764	2,808
Refrigeration	$761.9 million	1,315	491	1,806	711	2,517
Appliances	$188.6 million	143	77	220	78	298
Construction	$113.4 million	263	149	412	146	558
Lighting	$106.6 million	177	95	272	100	372
Manufacturing	$45.7 million	40	32	72	27	99
Other commercial and residential	$38.9 million	59	30	89	33	122
Agriculture	$17.2 million	144	21	165	45	210
Mining	$2.4 million	1	1	2	1	3
TOTAL	$9.9 billion	6,914	3,022	9,936	3,413	13,349

Source: IMPLAN 3.1

Table 2 Average number of jobs created in the San Diego region annually through energy supply expenditures from 2021-2030, by subsectors and technology. *Figures assume 1 percent average annual productivity growth.*

Investment Area	Average Annual Expenditure	Direct Jobs	Indirect Jobs	Direct Jobs + Indirect Jobs	Induced Jobs	Direct Jobs + Indirect Jobs + Induced Jobs
Fossil fuels	$4.4 billion	2,538	3,777	6,315	3,805	10,120
Clean renewables	$629.5 million	1,488	601	2,089	848	2,937
Transmission and storage	$45.9 million	34	17	51	31	82
Additional supply technologies	$45.1 million	118	35	153	57	210
Other investments	$4.5 million	10	3	13	6	19
TOTAL	$5.1 billion	4,188	4,433	8,621	4,747	13,368

Source: IMPLAN 3.1

Local Policy Opportunity[xvii]

The RDF Technical Analysis assesses current GHG reduction commitments in Climate Action Plans (CAPs) to determine if additional activity would be needed to put the region on a trajectory to meet decarbonization goals. Additionally, it identifies opportunities for local jurisdictions in the region to take further action to support the decarbonization pathways for energy production, transportation, buildings, and natural climate solutions.

To do this, several novel analyses were conducted. First, it analyzes the authority of local governments and agencies to influence and regulate GHG emissions and summarizes the authority of key federal, State, and local agencies, and key legislation and regulation at the federal and State levels to help to clarify the ability of local governments to act to reduce GHG emissions.[xviii] Second, it reviews all CAPs in the region to determine how often a given measure was included in CAPs, the relative GHG impacts of CAP commitments, and the integration of social equity considerations.[xix] Third, it does a scenario analysis to estimate the total regional GHG reductions that would result from all adopted and pending CAPs' commitments. It then estimates the potential GHG impact of a scenario that applies the best CAP commitments to all jurisdictions.[xx] This scenario analysis takes the CAP commitment for a given CAP policy category – say goals for planting trees in urban or rural areas – that will produce the single greatest relative GHG reductions and then applies that commitment to every jurisdiction in the San Diego region, regardless of current or planned commitments in that category. This may be considered the upper limit of potential GHG reductions from current CAP commitments. Finally, this chapter uses the results from these analyses, in addition to results from other research and analyses, to identify opportunities for further local action and regional collaboration in each of the four decarbonization pathways.[xxi]

Local jurisdictions have the authority to influence and regulate GHG emissions. Local governments can influence and regulate GHG emissions by accelerating State statutory targets and policies, adopting ordinances to go beyond State law, and using unique authority to adopt and implement policies. Local authority comes from both constitutionally derived power, which is a broad authority to promote public health, safety, or the general welfare of the community,

[xvii] See Chapter 8 for more details.
[xviii] See Appendix B for more details.
[xix] See Chapter 8, section 8.3 for an overview and sections 8.5-8.8 for sector specific findings. These are also used to illustrate the gap between the deep decarbonization goals in Chapters 2 through 5 and the regional CAP commitments.
[xx] See section 8.4.
[xxi] These opportunities were included in each relevant section for this Executive Summary, but they are included in the sector specific section in Chapter 8.

and delegated authority from State statutes. The full extent of a local jurisdiction's power to regulate GHG emissions is unknown.[xxii]

Current CAP commitments are insufficient to reach decarbonization goals. Current local CAP GHG reduction commitments for transportation, electricity, and buildings contribute a relatively small portion of the total reductions needed to reach net zero GHG emissions in 2045 (Figure 12). Even if the most aggressive CAP measures are applied to all jurisdictions in the region, significant emissions would remain, mostly from natural gas building end-uses and on-road transportation (Figure 12).

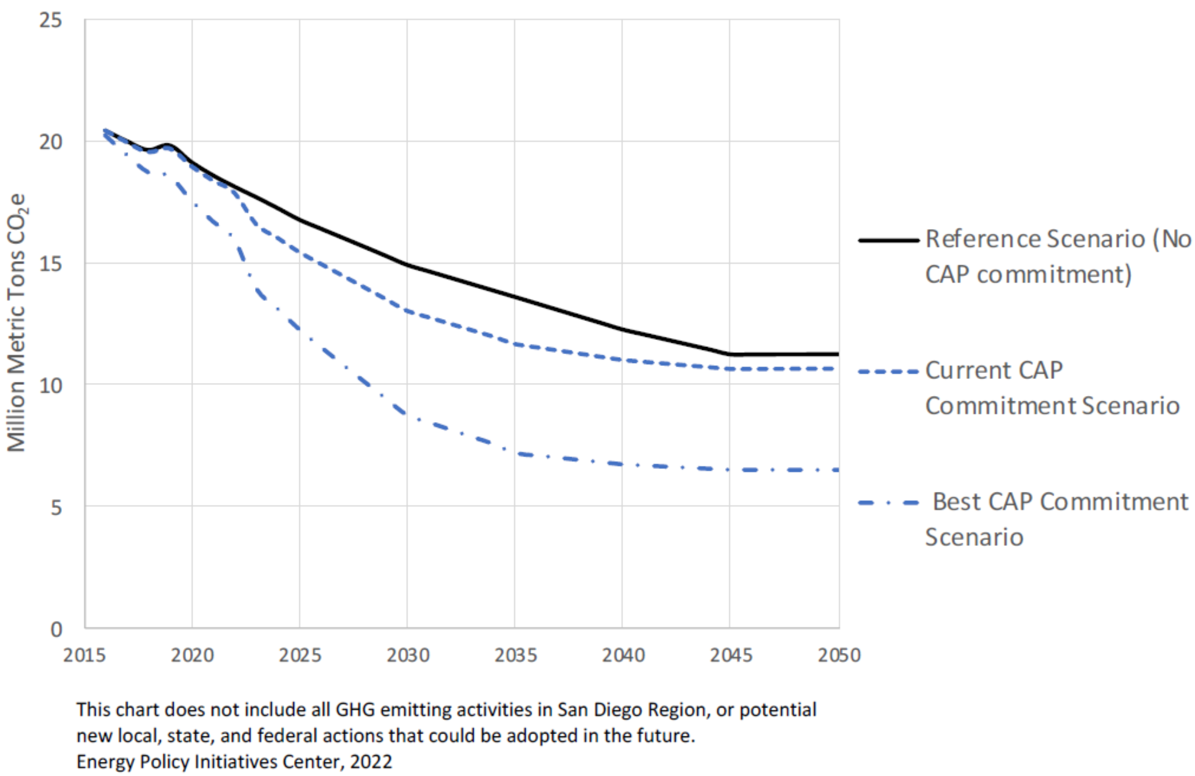

Figure 12. This graph shows the projected GHG emissions in the San Diego region from electricity, natural gas, and on-road transportation in each of the scenarios analyzed. The reference scenario, where there are no CAP commitments, only shows reductions based on State and federal laws, mandates, actions, and goals. The Current CAP Commitments scenario shows the remaining GHG emissions from a subset of total emissions if all current CAPs were applied in full as written. The Best CAP Commitment Scenario shows the remaining GHG emissions if the best CAP commitment from each policy category is applied to every jurisdiction in the region, regardless of current CAP commitments. This graph shows that no analyzed scenario will allow the region to reach net zero emissions by 2050. Note that these analyses assume no new State and federal laws, mandates, actions, and goals, and that current ones do not change at any point in this period. Further, these analyses do not include all GHG emissions for the region.

[xxii] See section 8.2 and Appendix B for a more detailed discussion of authority.

Opportunities exist for more jurisdictions to adopt additional CAP measures and strengthen existing measures. Based on the comparative analysis of CAPs, there is an opportunity for more jurisdictions to adopt CAP measures that are already adopted by some jurisdictions in the region. Similarly, based on the scenario analysis of the combined GHG impacts of CAP measures, there is an opportunity for most jurisdictions to strengthen their existing CAP measures, especially in the transportation and building sectors. These sectors produce large GHG emissions (Figure 13, right), but on average represent disproportionately low emissions reductions in CAPs in 2035 (Figure 13, left).

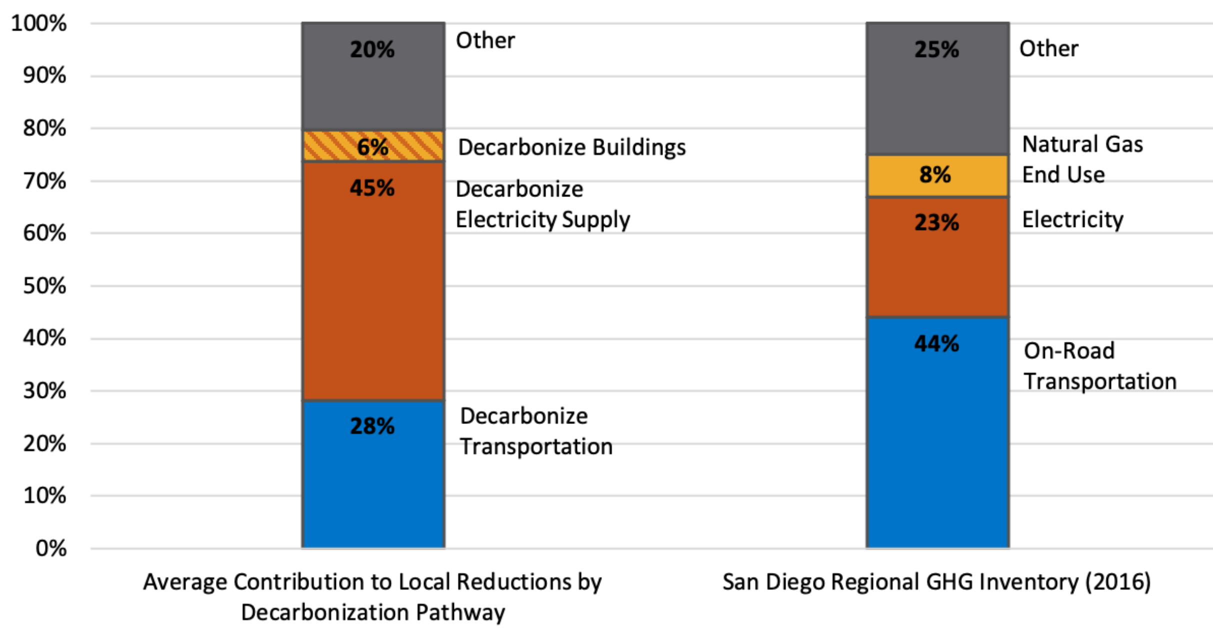

Figure 13. This graph shows the average contribution of each decarbonization pathway to the total GHG reduction from local CAP measures in 2035 (left) and the distribution of 2016 regional emissions by emission source (right). It shows that emissions from transportation (blue, right side) account for nearly half of regional emissions, but on average corresponding reductions from CAP commitments only represent slightly more than a quarter of local GHG reductions in CAPs (blue, left side). Similarly, electricity accounts for about a quarter of regional emissions (dark orange, right side) but associated reductions contribute on average just under half of GHG reductions from CAP commitments. Note that because emissions associated with buildings come from both onsite natural gas combustion and electricity production, the building decarbonization portion of the bar is shaded to show both light and dark orange to correspond with both natural gas buildings (light orange) and the electricity supply (dark orange).

Additional work would be needed to integrate social equity into climate planning. Based on a preliminary review, the integration of social equity in adopted and pending CAPs is limited, inconsistent, and lacks specificity. Additional work would be needed to develop the capacity and tools to understand and address the equity implications of all decarbonization policies in the San Diego region, including data collection and analysis; regional guidance documents; and regional working groups to coordinate, advise, track, and monitor how equity is being addressed in climate planning.

The San Diego Region as a Model

Although the San Diego region only accounts for 0.08% of global emissions, the decarbonization efforts undertaken by the region can have a measurable impact on global emissions by generating followership among others and sharing durable innovations that can be expanded and replicated. San Diego should actively seek to make its efforts visible and communicate lessons learned in national and international fora. The creation of the San Diego Regional Decarbonization Framework can serve as a case study for other jurisdictions across the U.S. and globally to learn from and adapt in their own long-term decarbonization planning endeavors. In addition to showcasing this effort alongside various national and international fora,[xxiii] the UN Sustainable Development Solutions Network (SDSN) is producing a Guidebook that will serve as a toolkit for other municipalities, universities, and communities to follow the process undertaken by the County of San Diego in their own decarbonization processes.

SDSN is working to share the RDF within three horizontal levels across its networks. SDSN will share the RDF and its key findings in national meetings and fora in the United States, international groups and consortiums, and the United Nations. For example, the project was presented during the Innovate4Cities Conference in October 2021 and the inputs of this event will serve to inform the 2022 IPCC Sixth Assessment Report on impact, adaptation, and vulnerability to global climate change. These global consortiums provide an opportunity to showcase the results of this project and San Diego as a model to the world. With access to these audiences, the RDF can help inform global roadmaps and pathways to net zero.

A Guidebook for Regional Decarbonization is being prepared for use by local jurisdictions to aid in creating unique decarbonization frameworks. This Guidebook will provide background information as well as specific steps and advice on logistics, methodology, stakeholder engagement, long-term planning, and more. Although the resources within this Guidebook are relevant and applicable to decarbonization framework project teams beyond the US, frameworks being created in the context of emerging economies will likely use different approaches, perspectives, and strategies in climate action planning. This Guidebook will be free and available online at UC San Diego's SDG Policy Initiative's website (http://sdgpolicyinitiative.org/guidebook/) as a way to facilitate the creation of regional decarbonization frameworks and provide a practical roadmap for jurisdictions to work toward net-zero goals.

[xxiii] Chapter 9 and Appendix C present extensive lists of US and global consortiums that San Diego County and other jurisdictions with decarbonization frameworks can connect with, attend, and join the networks of in order to disseminate their findings across different scales.