City-Scale Climate Planning Model for the San Diego Region

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Western Energy Policy Research Conference
Portland Oregon

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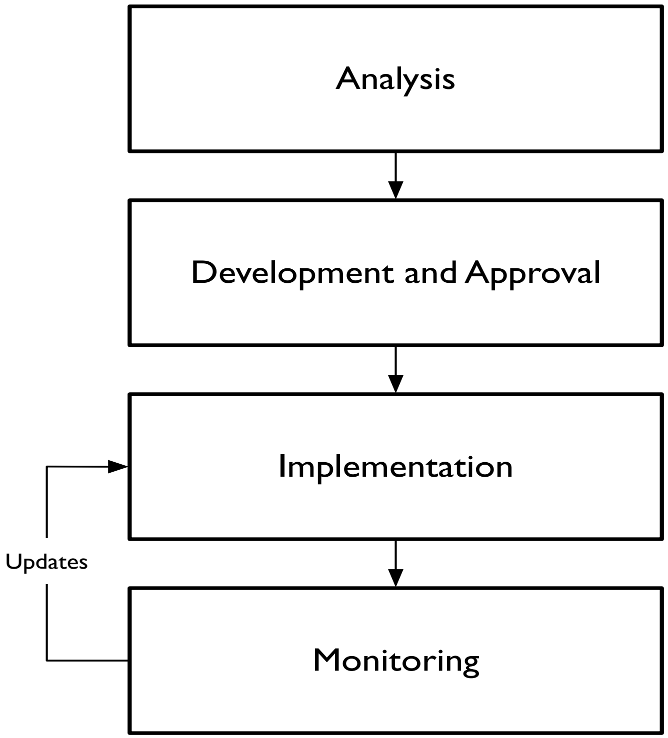
Presentation Overview

Overview of the City Climate Planning Process

Regional Climate Planning Progress in the San Diego Region

EPIC Climate Planning Tool

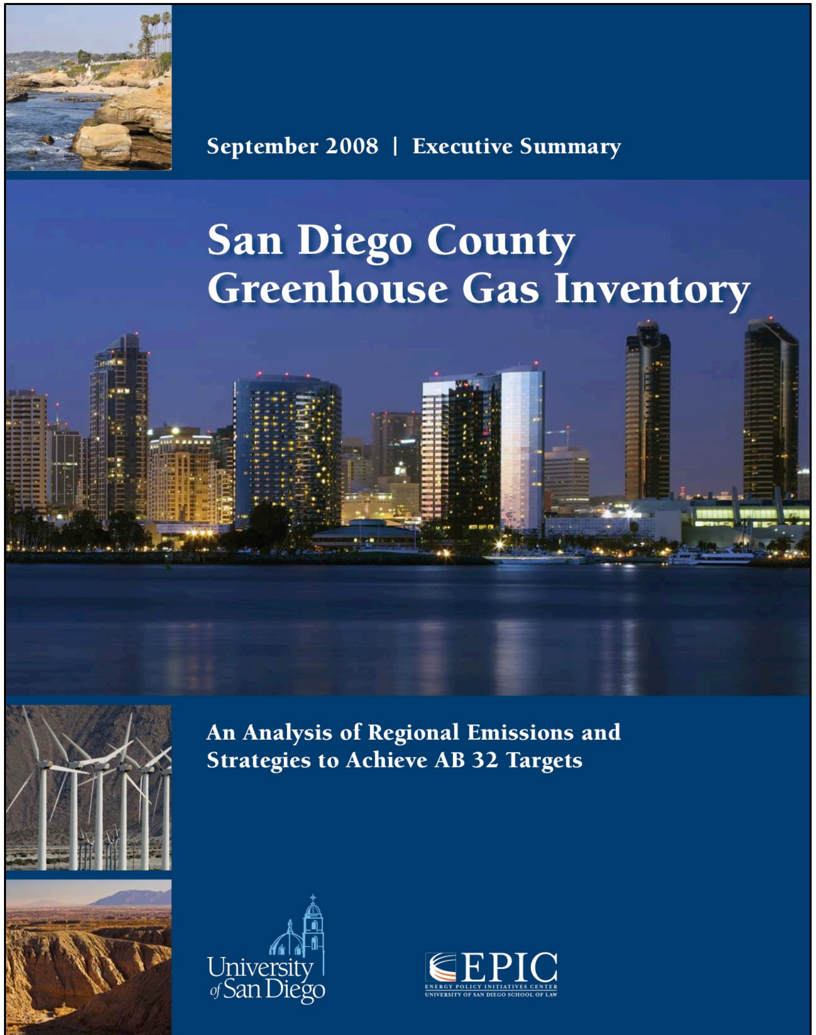
Climate Planning Overview

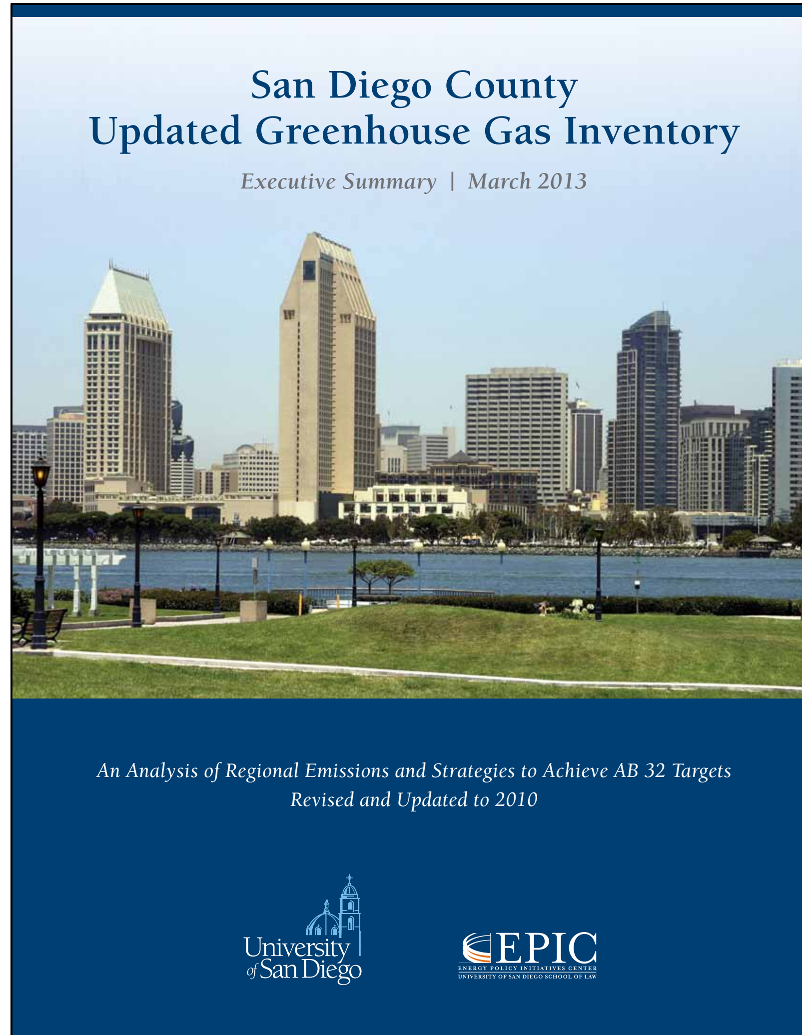


	Complete GHG Inventory	Develop Targets for Reductions	Developing Climate Action Plan	Adopted Climate Action Plan	Implement	Monitor
City of Chula Vista	x	x		x	x	x
City of San Diego	x	x		x	x	x
City of Encinitas	x	x		x	x	
City of National City	x	x		x	x	
City of Del Mar	x		x			
County of San Diego	x	x		x		
City of Solana Beach	x		x	x		
City of Carlsbad	x					
City of Coronado	x					
City of Escondido	x		x			
City of Imperial	x					
City of Santee	x		x			
City of Vista	x		x			
City of El Cajon	x					
City of La Mesa	x					
City of Lemon Grove	x					
City of Oceanside	x					
City of Powa	x					
City of San Marcos	x					

Source: The San Diego Foundation

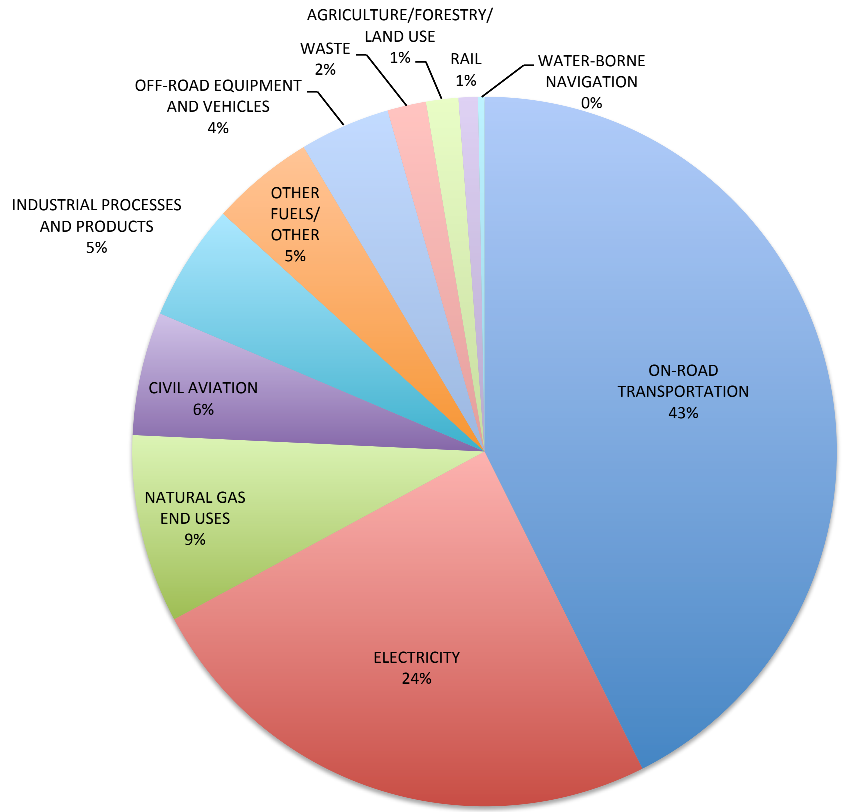
Regional GHG Inventory



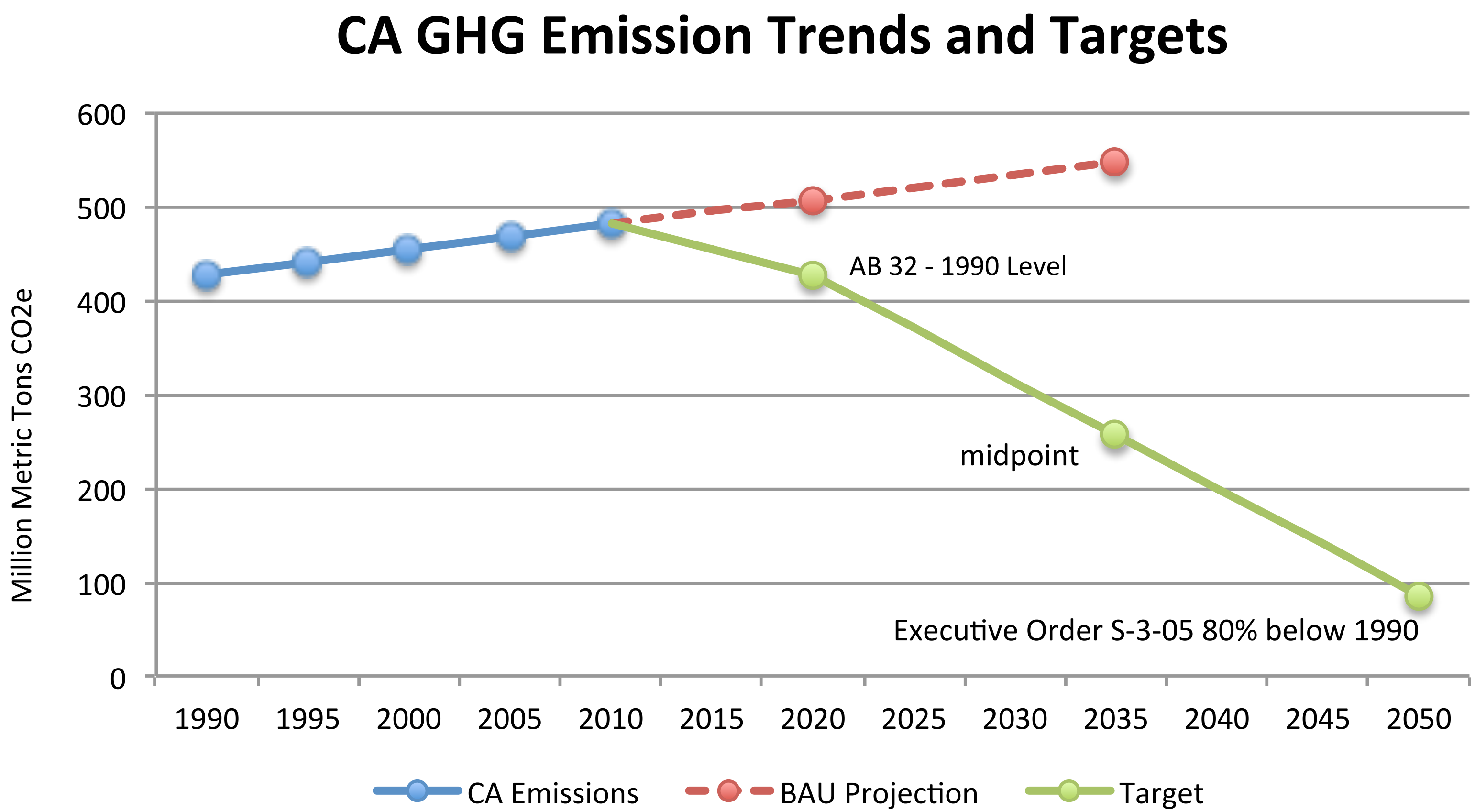


Regional GHG Inventory

San Diego County GHG Emissions by Category (2010)



The Challenge



EPIC Climate Planning Tool

Project Partners

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Funding Support

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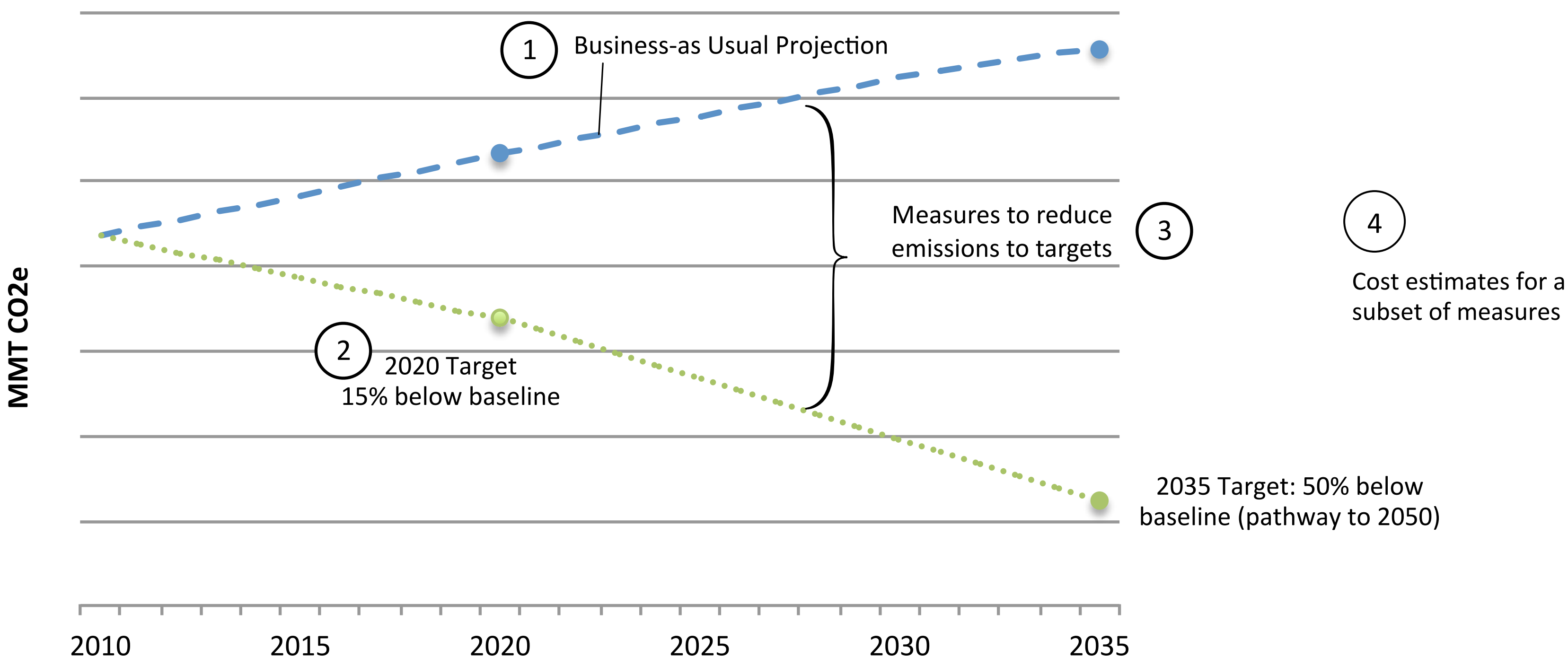
Main Elements of Climate Planning Tool



EPIC Climate Planning Tool

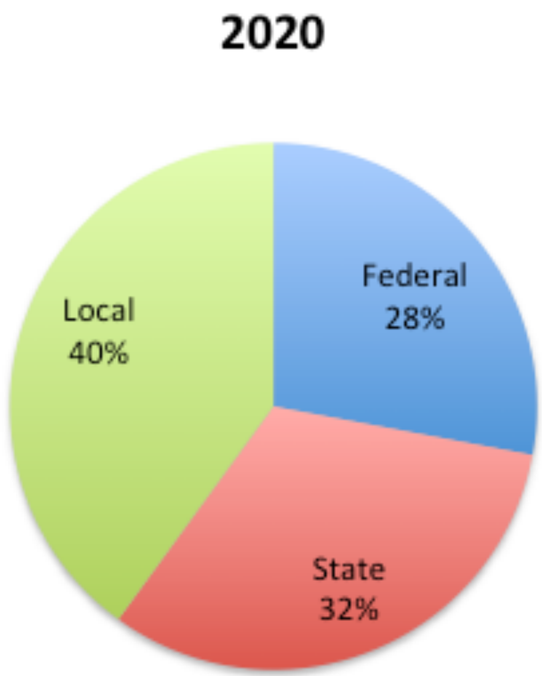
Dynamic and integrated

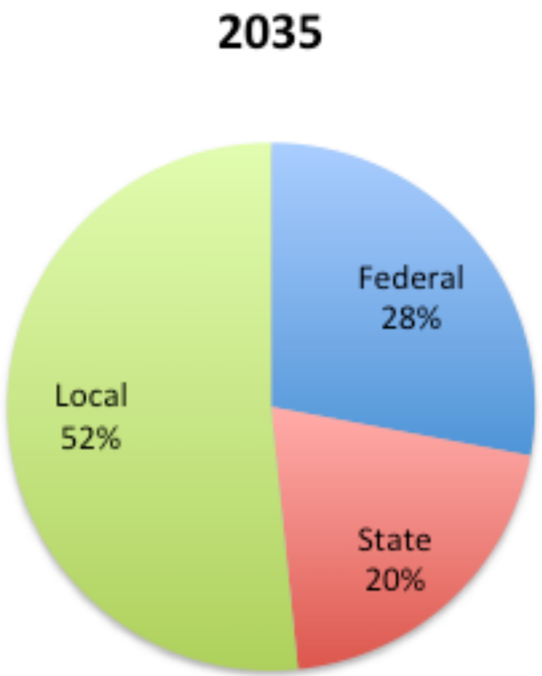
- e.g., electric vehicles reduce GHG from transport but increase electricity use

Two key rates dynamically calculated

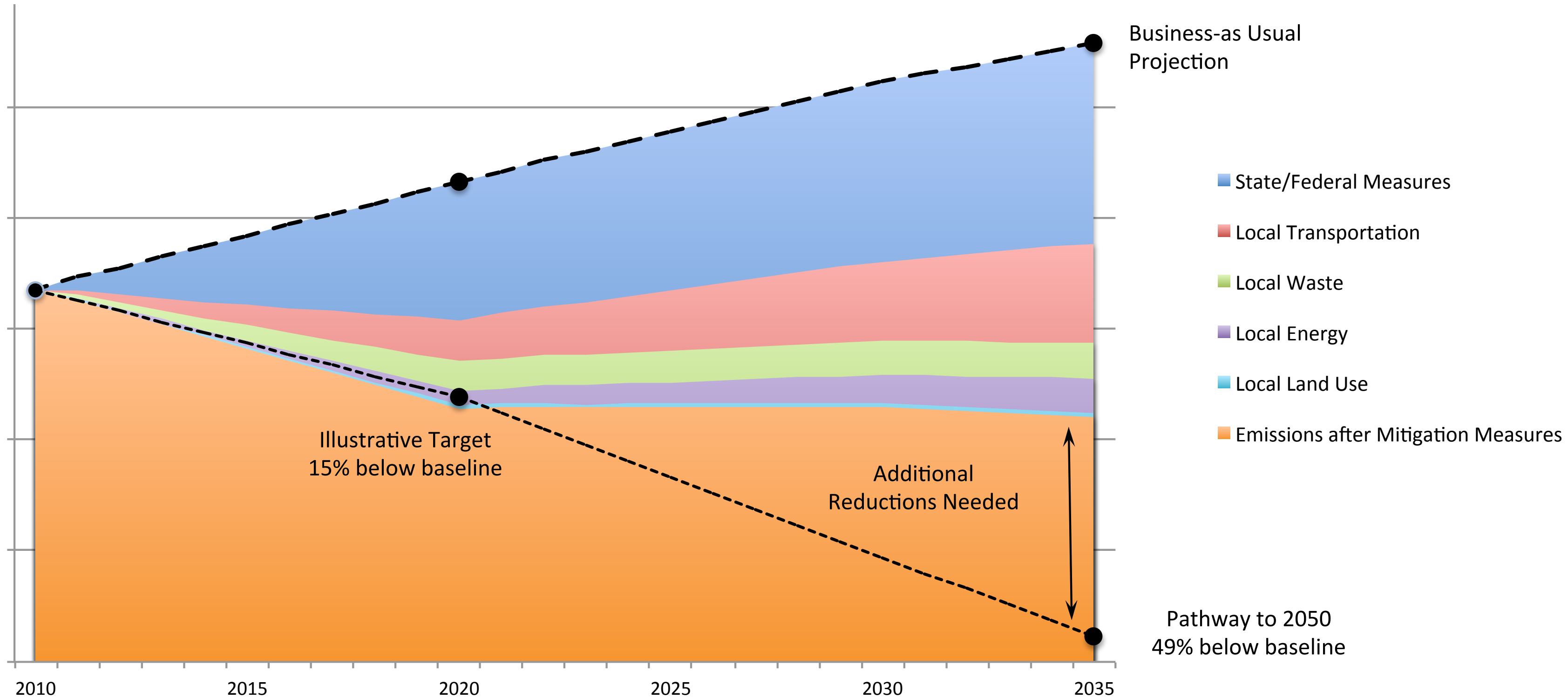
- Electricity: CO_2e/unit of electricity
- Transportation: CO_2e/mile driven

Effects of State and Federal Measures

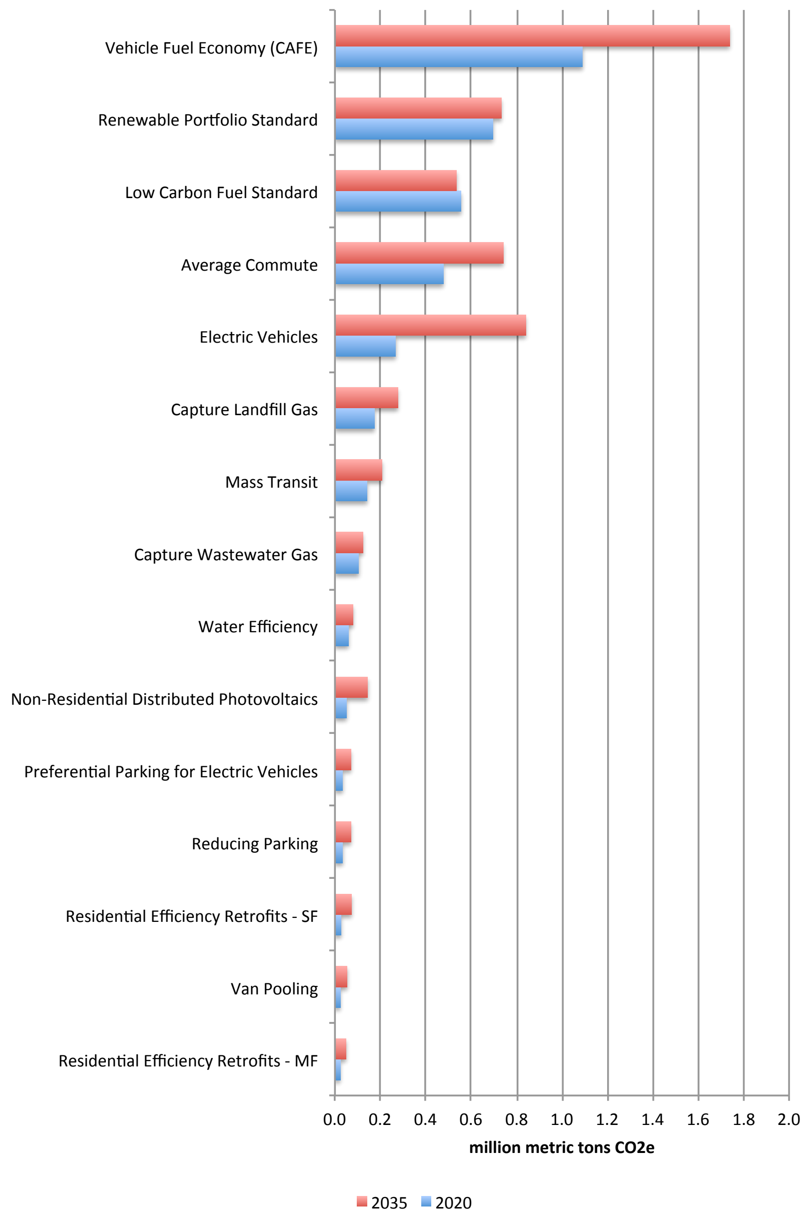




Effects of State and Federal Measures

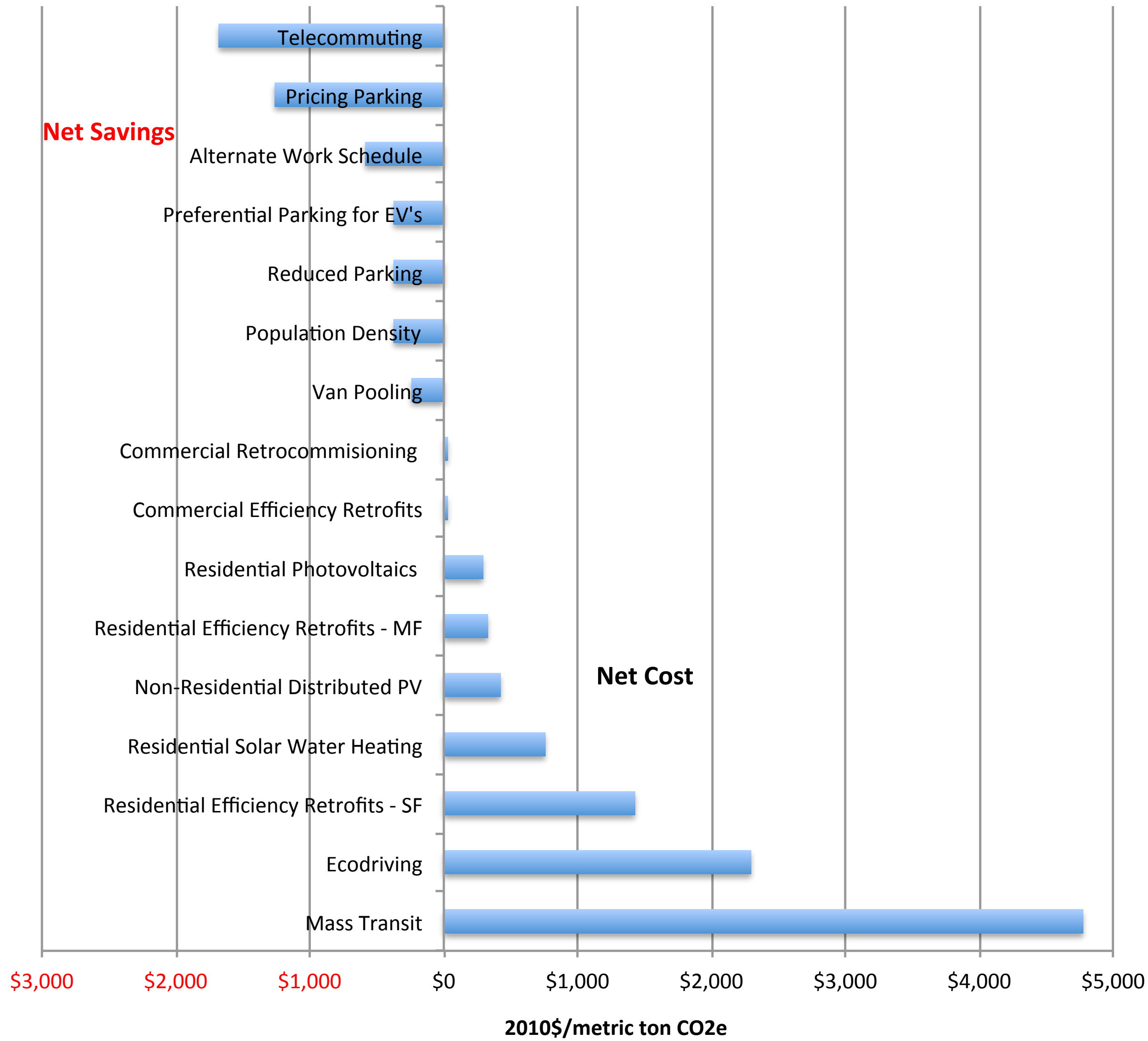


Illustrative Emission Reductions from Selected Mitigation Measures



Mitigation Measure	GHG Reductions MMT COE 2020	2035	Category	Jurisdiction
Vehicle Fuel Economy (CAFE)	1.09	1.74	Transportation	Federal
Renewable Portfolio Standard	0.69	0.73	Electric/Natural Gas	State
Low Carbon Fuel Standard	0.56	0.54	Transportation	State
Average Commute	0.48	0.74	Transportation	Local
Electric Vehicles	0.27	0.84	Transportation	Local
Capture Landfill Gas	0.17	0.28	Solid Waste	Local
Mass Transit	0.14	0.21	Transportation	Local
Capture Wastewater Gas	0.10	0.12	Wastewater	Local
Water Efficiency	0.06	0.08	Water	Local
Non-Residential Distributed Photovoltaics	0.05	0.14	Electric/Natural Gas	Local
Reducing Parking	0.03	0.07	Transportation	Local
Preferential Parking for Electric Vehicles	0.03	0.07	Transportation	Local
Residential Efficiency Retrofits - SF	0.03	0.07	Electric/Natural Gas	Local
Van Pooling	0.02	0.05	Transportation	Local
Residential Efficiency Retrofits - MF	0.02	0.05	Electric/Natural Gas	Local
Commercial Efficiency Retrofits	0.02	0.05	Electric/Natural Gas	Local
Commercial Retrocommissioning	0.02	0.05	Electric/Natural Gas	Local
Ecodriving	0.019	0.047	Transportation	Local
Residential Solar Water Heaters	0.02	0.06	Electric/Natural Gas	Local
Bicycle Strategy	0.016	0.038	Transportation	Local
Residential Photovoltaics	0.01	0.08	Electric/Natural Gas	Local
Alternate Work Schedule	0.010	0.014	Transportation	Local
Telecommuting	0.009	0.038	Transportation	Local
Cogeneration	0.008	0.039	Electric/Natural Gas	Local
Commercial Solar Water Heaters	0.004	0.049	Electric/Natural Gas	Local
Population Density	0.002	0.003	Transportation	Local
New Construction Efficiency	0.002	0.007	Electric/Natural Gas	Local
Pricing Parking	0.001	0.001	Transportation	Local

Illustrative Cost Estimates for Selected Mitigation Measures



Key Findings

State and Federal Measures Provide Large GHG Reductions

- Corporate Average Fuel Economy standards
- California Renewable Portfolio Standard

2035 Targets are Difficult to Reach

- As electricity is more renewable and miles driven are cleaner, other measures yield smaller reductions
- Need high levels of all measures to reach 2035 target

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Other Resources

EPIC Mitigation Model Documents (via EPIC Website)

- Excel Model
- Documentation
- User Guide and Instructional Videos

EPIC Regional GHG Inventory

- See http://catcher.sandiego.edu/items/usdlaw/EPIC-GHG-2013.pdf

Full Paper Attached

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About the Energy Policy Initiatives Center

The Energy Policy Initiatives Center (EPIC) is a non-profit research center of the USD School of Law that studies energy policy issues affecting California and the San Diego region. EPIC integrates research and analysis, law school study, and public education, and serves as a source of legal and policy expertise and information in the development of sustainable solutions that meet future energy needs.

For more information on the Energy Policy Initiatives Center, see www.sandiego.edu/epic.

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1 Introduction

In the absence of federal action on climate change, subnational governments have adopted policies to reduce greenhouse gas emissions in their jurisdictions. California is a national leader in adopting and implementing policies to reduce greenhouse gases. The state has adopted two significant emission reduction targets: state law (AB 32) seeks to reduce emissions to 1990 levels by the year 2020 and Executive Order S-3-05 sets forth long-term reduction targets of 80% below 1990 levels by the year 2050. These two targets are the mileposts by which to measure California's climate policies.

Driven by state law, local public agencies have developed climate action plans in recent years in California. The process requires significant analysis of federal, state, and local measures to reduce emissions. The Energy Policy Initiatives Center (EPIC) has developed a City-Scale Climate Planning Model to assist local jurisdictions in this endeavor. It allows users to project emissions, select targets, chose from a range of reduction measures to reduce emissions, and estimate costs for a subset of measures. The tool is designed to account for the inter-related nature of certain policy measures. For example, an increase in electric vehicles will increase electrical use but reduce emissions from the transportation sector.

In California and in San Diego County, the majority of greenhouse gas emissions come from cars and trucks (40%) and the energy use associated with buildings (30%). Two critical factors drive emissions in these categories: the emissions intensity of a mile driven (metric tons of carbon-dioxide equivalent (CO2e) per mile) and a unit of energy produced (tons of CO2e per megawatt-hour). These rates also are used to calculate the emissions reductions expected from measures associated with cars and trucks.

The paper will discuss California greenhouse gas reduction laws; climate planning progress in the San Diego region (18 cities and the unincorporated county); the role of federal, state, and local measures in reaching long-term targets; the main components of the model; estimates for greenhouse gas reduction potential and cost for a range of measures; illustrative examples of how realistic it is for local jurisdictions to meet 2020 and 2035 targets; and, the cost of a range of measures to reduce emissions.

1.1 Paper Overview

Section 2 provides a short background on the San Diego region, the overall climate planning process, climate planning progress in the region, results of a region wide inventory, and California's climate policy framework. Section 3 provides an overview of the City-Scale Climate Planning Model, including a summary of the main elements of the model, including estimating a business-as-usual projection, calculating targets, and estimating the emissions reductions associated with a range of mitigation measures. In Section 4, we provide illustrative results based on analysis for one city in the San Diego region. A brief conclusion is provided in Section 5 and Section 6 is the appendix.

2 Background

This section provides a brief overview of the San Diego region, the climate planning process typically used by local governments, and a summary of the climate planning progress in the region.

2.1 The San Diego Region

The San Diego region is located on the far southwest corner of the United States, bordered by Mexico to the South, Orange and Riverside Counties to the north, and Imperial County to the east. It comprises 18 cities and the unincorporated areas of the County of San Diego. All 19 jurisdictions are within the boundaries of San Diego County, which covers 4500 square miles, about the size of Connecticut. Based on the results of the 2010 Census, the population of San Diego County is just over 3 million residents. The San Diego Association of Governments (SANDAG) is a metropolitan planning organization comprised of all local governments in the region. SANDAG is the principal regional land use and transportation planning agency in the region.

2.2 Climate Planning Process

Local governments conduct climate planning on two separate levels: municipal operations and community wide. Planning for municipal operations covers all activities within the local government enterprise, such as government buildings, transportation fleet, and waste management. Community wide climate planning includes all activities within the local governments boundaries, including government operations. Typically, emissions from local governments operations represent 1-2% of overall community wide emissions. For example, emissions from the City of San Diego's municipal operations accounted for 1.2% of total emissions in 2007, 1.1% in 2008 and 2009. This paper focuses on the broader, community wide climate planning activities.

Climate planning at the local level typically follows a general framework of (1) greenhouse gas emissions analysis, including an inventory and emissions projection; (2) plan development, including policy development; (3) implementation; and (4) monitoring and updating the plan. Figure 1 below provides a simplified diagram of this process. Figure 2 provides a more detailed flow chart that describes these steps and their relations to each other. This paper provides an overview of a tool developed by the Energy Policy Initiatives Center to support local governments complete the analysis phase.

Figure 1 Simplified Climate Action Planning Process Diagram

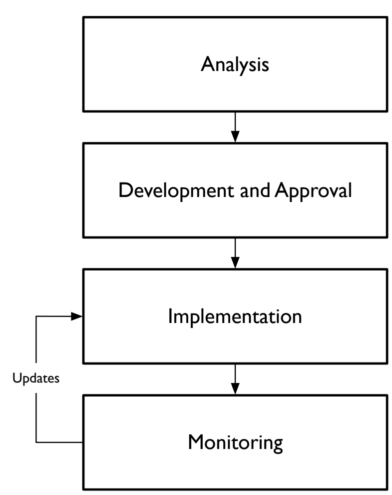
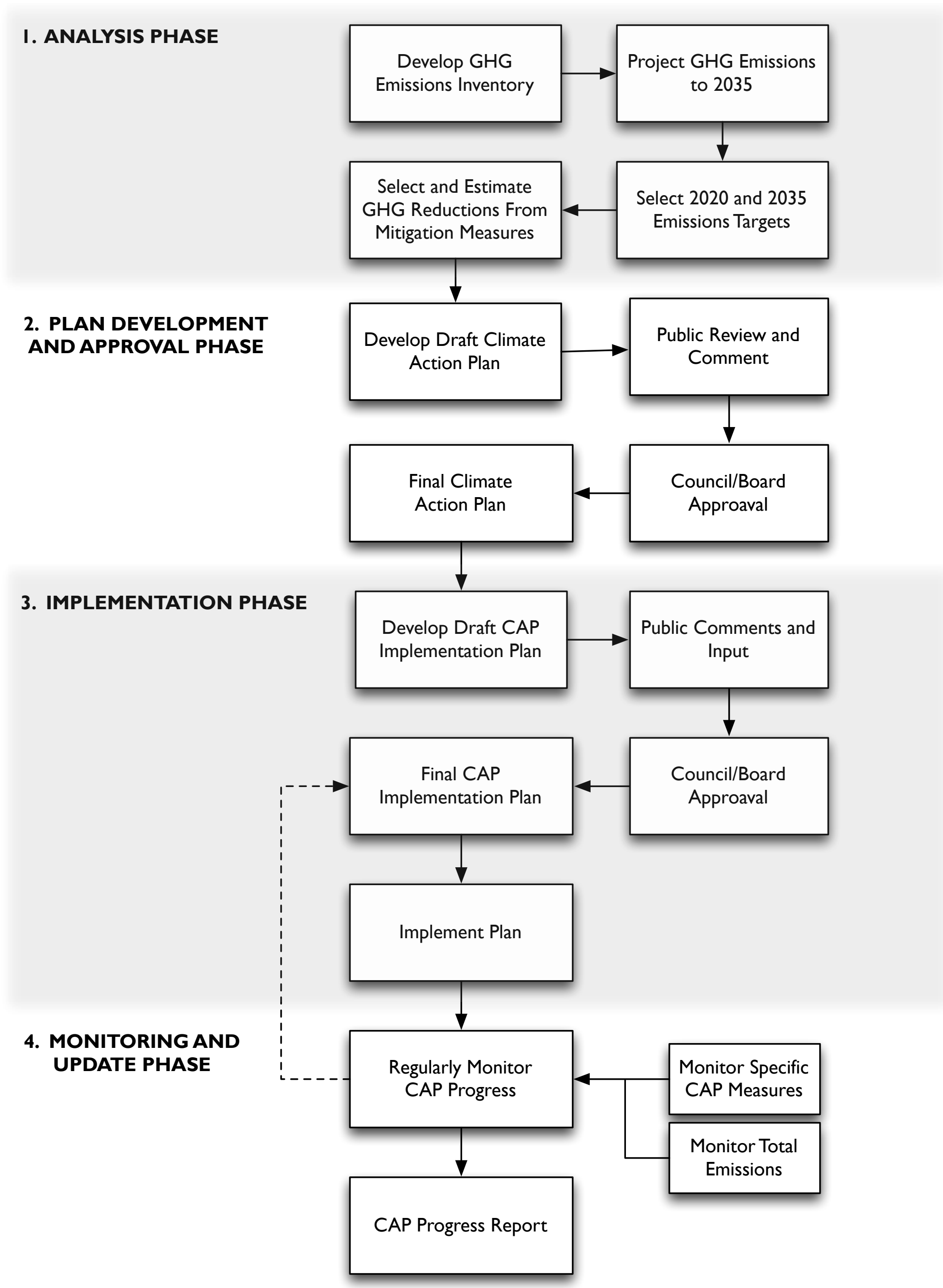


Figure 2: Local Government Climate Action Plan (CAP) Development Process



2.3 Climate Planning Progress in the San Diego Region

Local governments in the San Diego region have been conducting aspects of climate planning for over a decade. Table 1 below provides a summary of the most recent actions completed by local jurisdictions in the San Diego region, using a similar framework to that provided in Figure 1 above. All local jurisdictions have completed greenhouse gas inventories and a subset of those have begun or completed a climate action plan. The City of Chula Vista and City of San Diego have been leaders in climate action and have completed the entire planning cycle and are currently updating their inventories and plans.

Table 1 Climate Planning Progress in the San Diego Region[1]

	Complete GHG Inventory	Develop Targets for Reductions	Developing Climate Action Plan	Adopted Climate Action Plan	Implement	Monitor
City of Chula Vista	x	x		x	x	x
City of San Diego	x	x		x	x	x
City of Encinitas	x	x		x	x	
City of National City	x	x		x	x	
City of Del Mar	x		x			
County of San Diego	x	x		x		
City of Solana Beach	x		x	x		
City of Carlsbad	x					
City of Coronado	x					
City of Escondido	x		x			
City of Imperial	x					
City of Santee	x		x			
City of Vista	x		x			
City of El Cajon	x					
City of La Mesa	x					
City of Lemon Grove	x					
City of Oceanside	x					
City of Powa	x					
City of San Marcos	x					

Source: The San Diego Foundation

2.4 Regional Greenhouse Gas Inventory

EPIC conducted a regional greenhouse gas inventory for the San Diego Region in 2008[2] and 2010.[3] Based on the 2010 inventory, estimated emissions were 32 million metric tons of carbon dioxide equivalent (MMT CO2e) – about 9% more than in 1990.[4] Figure 2 shows San Diego County greenhouse gas emissions from 1990 through 2010.

Key findings of the 2010 Inventory, including the following:

- In 2010, per-capita emissions for San Diego County were approximately 10 MMT CO2E.
- In 2010, emissions from cars and light-duty trucks represented about 44% of total greenhouse gas emissions in San Diego County, approximately the average of the years 2005-2010.

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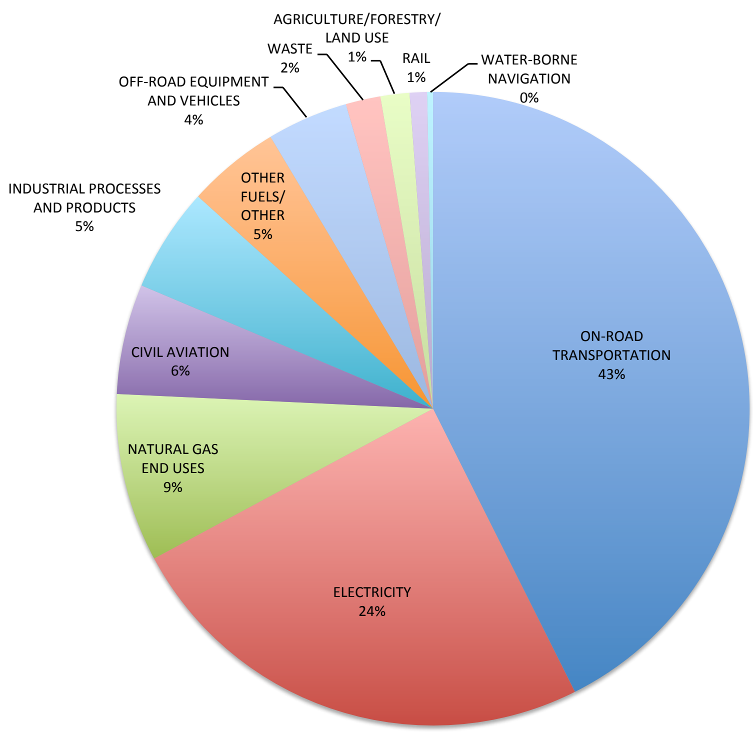
[1] Climate Action Planning Progress in the San Diego Region, The San Diego Foundation, 2013. See http://www.sdfoundation.org/Portals/0/Newsroom/PDF/Reports/ClimateActionPlanning.pdf.
[2] See http://catcher.sandiego.edu/items/epic/GHGReportAllSections.pdf.pdf for results and methodology.
[3] See http://catcher.sandiego.edu/items/usdlaw/EPIC-GHG-2013.pdf for a summary of results of the 2010 inventory.
[4] Carbon dioxide equivalent includes the sum of all greenhouse gases converted to the global warming potential (GWP) of carbon dioxide. For example, the GWP for methane is 21. This means that 1 million metric tons of methane is equivalent to emissions of 21 million metric tons of carbon dioxide.

- Electricity and natural gas end-use consumption accounted for a combined 33% of total emissions in 2010.
- The projection for 2020 – assuming no change in policy from 2009 – is about 37 MMT CO2e, significantly lower than the previous (2008) projection of 43 MMT CO2e, due in large part to the economic downturn.

Figure 3 Greenhouse Gas Emissions - San Diego County (2010)



2.5 California Policy Framework

California has been a leader in statewide action to reduce greenhouse gas emissions. California's climate strategy comprises three main elements: the Global Warming Solutions Act (AB 32) of 2006, Executive Order S-3-05, and Senate Bill 375 (2009). In 2006, California Governor Arnold Schwarzenegger signed into law the Global Warming Solutions Act (AB 32), establishing statutory limits on greenhouse gas emissions in California. AB 32 seeks to reduce statewide emissions to 1990 levels by the year 2020. While AB 32 does not specify reduction targets for specific sectors or jurisdictions, it is often used as a benchmark for regions and local governments when considering greenhouse gas reduction targets.

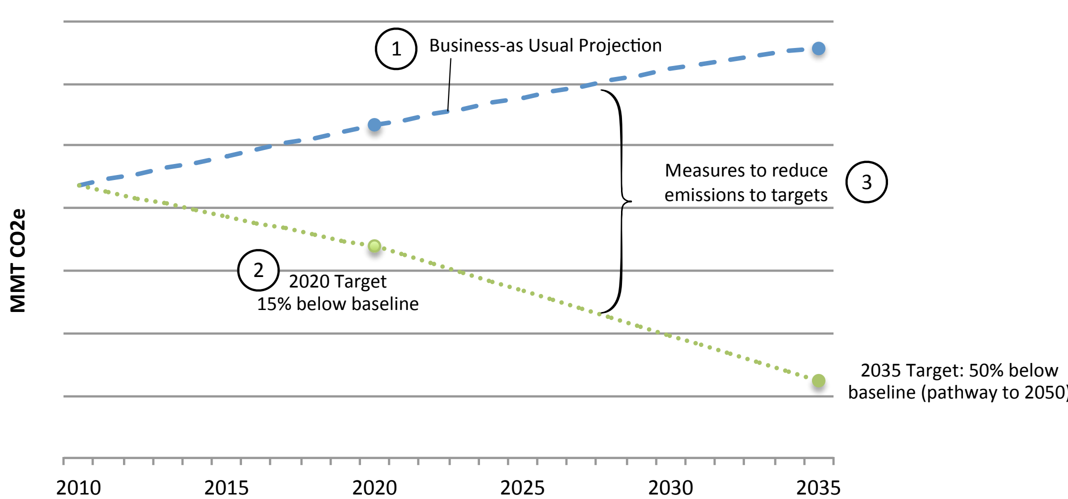
In 2005, Governor Schwarzenegger signed Executive Order S-3-05, which establishes long-term targets for greenhouse gas emissions reductions to levels 80% below 1990 levels in 2050. While this reduction target is not mandatory, it is generally accepted as the long-term target for emissions in California and influences state regulation.

In 2009, California Senate Bill 375 (SB 375) took effect as another regulatory tool to help California achieve its greenhouse gas reduction targets. SB 375 requires regional planning agencies to achieve greenhouse gas emissions reductions through land use and transportation policy, specifically requiring a target for these emissions in 2020 and 2035.

3 Overview of the City-Scale Climate Planning Model

In response to an increase in climate planning in the San Diego region, EPIC developed the City-Scale Climate Planning Model to assist local governments with the quantitative analysis required to develop a climate action plan. The model, which is intended to assist with city-scale climate planning, allows users to do the following: (1) estimate a business-as-usual projection through 2035, (2) calculate reduction targets, and (3) estimate the emissions reductions associated with nearly 30 emissions reductions measures. Using illustrative values, Figure 3 depicts the main elements of the model graphically. The model also provides cost estimates for a subset of mitigation measures.

Figure 4 Three Main Elements of the Greenhouse Gas Mitigation Model



3.1 Business-as-usual Projection

The City-Scale Climate Planning Model generates a business-as-usual (BAU) emissions projection (number 1 in Figure 3) between 2010 and 2035 for any of the 19 jurisdictions in the San Diego region, or for the region as a whole. It is the baseline from which all emissions reductions are subtracted in the model. The BAU projection is derived by taking all existing conditions in the base year and projecting them forward assuming not major policy changes using relevant factors like population, vehicle miles traveled, and electric consumption. For example, California's Renewable Portfolio Standard requires electric utilities to provide 33% of their sales from renewable resources. If in 2010, a given utility had only achieved a 10% renewable content, then emissions from electricity consumption would be projected at an emissions rate commensurate with 10% renewable supply. This same principle was applied to all other emissions categories. Assumptions included in a typical BAU projection for a city are included in Section 6.1 of the Appendix.

3.2 Emission Reduction Targets

The model allows users to select emission reduction targets for 2020 and 2035, the two milestone years for climate planning in California. The year 2020 is important because it is the target year for AB 32 reductions and 2035 is the halfway point to the level needed to achieve the 2050 target included in Executive Order S-3-05. Also, many cities develop a climate plan in connection with a General Plan update, which typically have a planning horizon on the 2035 timeframe. Targets can be based on a percentage reduction from a defined baseline year or a specific reduction amount. The model calculates the targets and compares the emissions trajectory needed to meet these targets with the trajectory needed to meet the statewide 2020 and 2035 targets.

3.3 Emissions Reduction Measures

The most significant element of the model is the ability to estimate the emissions reductions of a range of measures, such as vehicle efficiency improvements and residential building efficiency retrofits. Table 2 provides a list of the mitigation measures currently included in the model. We forego a detailed discussion of the methodology used for each mitigation measure; a detailed overview of the methods used are available on the EPIC website.[5] Mitigation measures are divided into the categories of Transportation, Electricity and Natural Gas, and Waste & Water, which match the categories of a typical emissions inventory. Each measure calculates expected emissions reductions resulting from user defined input variables. Where possible, feasible default values based on actual trends are provided to the user as a guide for selecting realistic input values for each measure. The results from each individual mitigation measure are aggregated to determine the total greenhouse gas reductions for the selected jurisdiction.

Table 2 Greenhouse Gas Mitigation Measures Included in the EPIC Model

Electric and Natural Gas (Built Environment)	Transportation	Waste/Wastewater/Water
Renewable Portfolio Standard	Vehicle Efficiency Standards	Landfill Gas Captured
Residential Photovoltaics	Low Carbon Fuel Standard	Wastewater Emissions Captured
Non-Residential Distributed Photovoltaics	Electric Vehicles	Per Capita Consumption
Cogeneration	Average Commute	
Residential Efficiency Retrofits - Single Family	Alternate Work Schedule	
Residential Efficiency Retrofits - Multi-Family	Telecommuting	
Commercial Efficiency Retrofits	Mass Transit	
Commercial Retrocommisioning	Van Pooling	
Residential New Construction	Ecodriving	
Commercial New Construction	Pricing Parking	
Residential SHW Installs (New Con. & Retrofits)	Reduced Parking	
Commercial SHW Installs (New Con. & Retrofits)	Preferential Parking for EV's	
	Population Density	
	Bicycle Strategy	

Emission reductions for each measure are dependent on the values assumed for key variables in the calculation. Most mitigation measures require several measure-specific variables in order to calculate emissions reductions, however users typically need only enter one or two. Section 6.2 of the Appendix provides a list of the main assumptions used to calculate the illustrative emissions reduction values presented in Section 4 below. For example, for residential solar photovoltaics, the user can provide input values for total capacity in kilowatt (kW) and the installed cost in dollars per watt. With these values, the model will estimate the greenhouse gas reductions and cost effectiveness of those inputs. It is possible to modify several other variables for residential solar photovoltaic, including decline in energy production in percent per year, capacity factor, operations and maintenance costs in dollars per kilowatt-hour, inverter costs for 2010/2020/2030, and the discount rate. This allows the user more control over the assumptions used in the overall calculations for measures.

It is important to note that many of the mitigation measures are inter-related, so changing the input values for one measure can effect on the greenhouse gas emissions reductions of other mitigation measures. For example, adjusting the number of miles driven by electric vehicles will increase electric consumption. Another example is percentage of electricity supplied by renewable energy (Renewable Portfolio Standard). As the percentage of renewable energy increases, the amount of emissions reductions that can be expected from energy efficiency measures decreases. Taken to the logical extreme to demonstrate the relationship, if electricity were 100% greenhouse gas emissions free, then efficiency would not yield any emissions

[5] See http://www.sandiego.edu/documents/climate/TechnicalDocumentationandMethodology.pdf

reductions. Similarly, if all miles traveled were by 100% emissions-free electric vehicles, measures to reduce miles driven, like increasing mass transit, would yield no savings.

The models inter-related structure relies in part on two dynamically calculated rates: the greenhouse gas intensity of a mile driven in metric tons of CO2e per mile driven and the pounds of CO2e per megawatt hour (MWh) of electricity consumed. These two rates drive many of the other calculations in the model and are dynamically updated as other inputs in the model change. In the example given above, as the percentage of renewable energy supplied increases, the pounds of CO2e per MWh rate drops, thus reducing the effects of any energy related measure from that point forward. Similarly, as the CAFE standards phase in through 2025, the rate of CO2e per mile drops, which in turn affects all transportation measures that are linked to miles driven (e.g., mass transit, telecommuting, etc.). This dynamic makes it increasingly difficult for California and local jurisdictions to demonstrate how they will meet their long-term targets for 2035 and beyond, which could require significantly higher renewable electricity supply and a dramatic reduction in the emission per mile of passenger vehicles, possibly by shifting to high-content renewable electricity as the main transportation fuel.

The model distinguishes mitigation measures as either federal, state, or local measures based on jurisdiction and authority. This is important to help local governments understand the magnitude of emissions reductions resulting from activities at these different levels, particularly those within their jurisdiction and authority. Federal measures, such as the Corporate Average Fuel Economy (CAFE) standards, are measures adopted by the federal government. State measures, such as the Renewable Portfolio Standard, are those adopted by the state. Local mitigation measures are controlled or influenced by action taken at the local city government level. In many cases, the distinction between local and state or federal measures is very clear. In other instances, it is not as clear - for example, residential energy efficiency. California investor-owned utilities are mandated to develop and implement energy efficiency programs and often provide financial rebates and incentives for energy reduction. These activities, while implemented locally, occur under the auspices of the California Public Utilities Commission's regulatory authority over investor-owned utilities and support statewide policy to enhance building efficiency. However, local governments have the ability to influence energy efficiency measures through their permitting authority. In such cases we classify the measure as local.

4 Illustrative Results

This section provides illustrative results based on analysis for one city in the San Diego region. These values are intended to show results based on a set of assumptions and inputs and should not be interpreted as representative of these measures for any particular city. As mentioned above, model results are heavily influenced by user inputs, so results can vary widely depending on assumptions used.

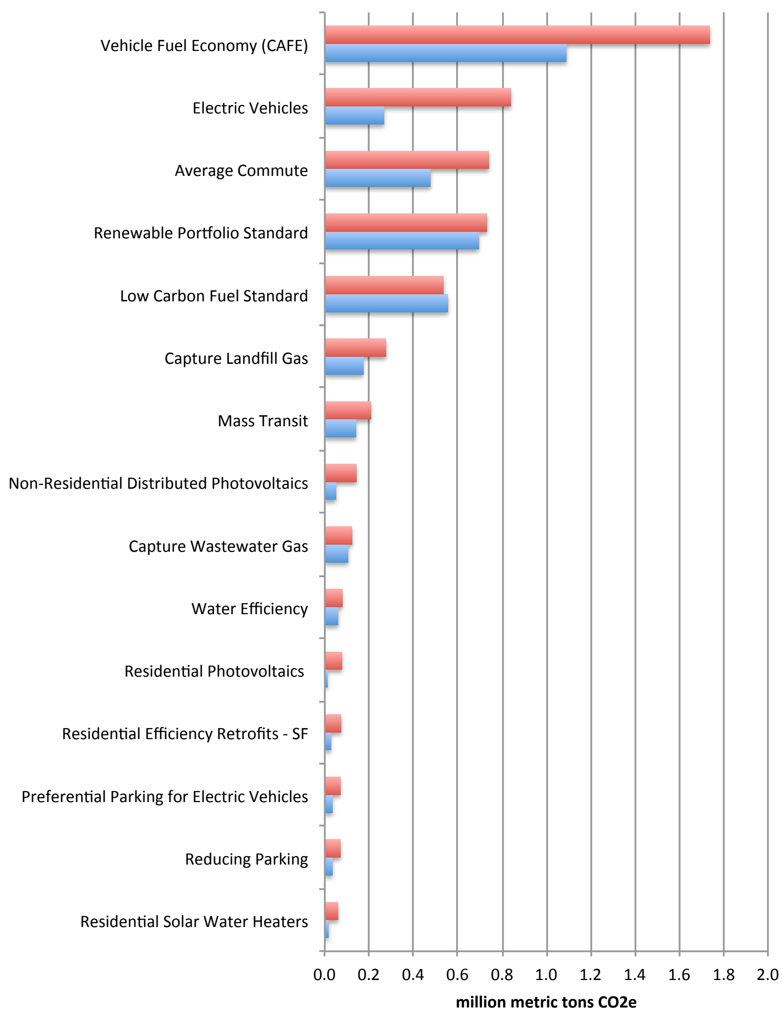
4.1 Greenhouse Gas Reductions

Figure 4 provides a comparison of the estimated greenhouse gas reductions expected from selected measures included in the model. A summary of greenhouse gas reductions for all measured included in the model is included in Section 6.2 in the Appendix. These illustrative results are based on the assumptions listed in Section 6.2 of the Appendix. In Section 2.4, we presented results of the regional inventory for the year 2010, which showed that on-road transportation – largely passenger cars and trucks – account for the largest proportion of greenhouse gas emissions in the region, followed by electricity and natural gas – largely associated with energy use in buildings. Therefore it is no surprise that the measures four of the five largest estimated reductions are those affecting transportation.

Of the measures included in the model, the largest reductions are associated with federal vehicle efficiency standards (CAFE standards). These standards result in significant reductions in the model for two important reasons. First, fuel economy standards for the fleet of new cars will increase to 54.5 miles per gallon (MPG) by 2025, a significant increase over the previous goal of 35 mpg by 2016. Second, as the fuel efficiency standards phase in and the entire fleet of vehicles turns over, an increasing proportion of miles driven in the region associated with higher fuel economy. It is important to note that 4 of the top 5 measures with the highest emissions reductions are associated with on-road transportation.

The highest non-transportation measure is the Renewable Portfolio Standard, or the percentage of electricity supplied from renewable resources. This will increase from about 10% in 2010 to 33% in 2020. This thirteen percentage point increase is significant and also affects nearly all of the electricity use in the region.

Figure 5 Greenhouse Gas Reductions from Selected Mitigation Measures (Sorted by 2035 Values)



As mentioned in Section 3.3, we distinguish between state and federal measures that local governments may not have any authority to control or influence and local measures for which they have some authority to control or influence. Figure 5 presents a comparison of how much federal, state, and local measures contribute to the total reduction estimated in the model. Nearly 30% of the total reduction in 2020 and 2035 are provided by federal action on vehicle fuel economy (CAFE). Figure 6 provides an illustrative summary of the results and the respective contributions to the overall reductions. The blue wedge represents all state and federal measures and represents about 60% of the total reductions needed to reach the targets in 2020 and just over half of those needed in 2035. Based on the assumptions used, the measures in the model would meet the 2020 target but they would fall significantly short in 2035. One significant reason that the emissions reductions level off after 2020 is that based on guidance by the Governor's Office of Planning and Research, California cities cannot assume higher levels of state and federal activities in their climate plans. As a result, because CAFE standards and the Renewable Portfolio Standard are held constant after the timeframe of their current requirements; that is, the emissions rates used for CO2e per mile in 2025 and pounds per MWh in 2020 are held constant into the future and only expected growth in miles traveled and electricity consumption cause an increase between 2020 for the RPS and 2025 for CAFE.

Figure 6 Effects of Local and Non-Local Measures

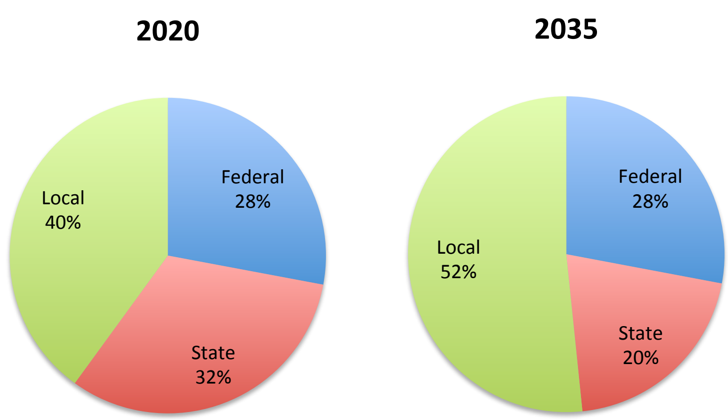
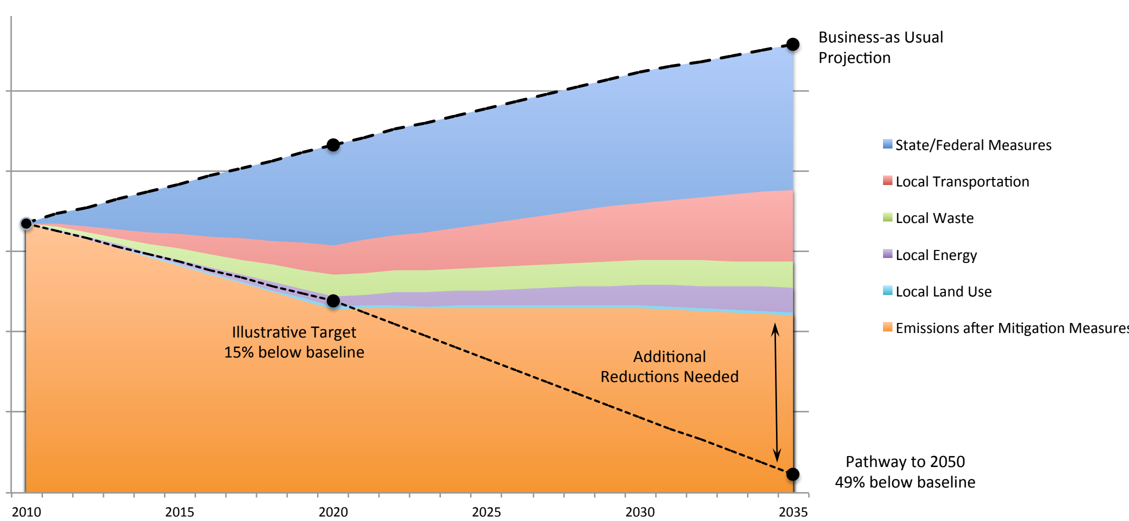


Figure 7 Summary of Projection, Targets, and Effects of Mitigation Measures[6]



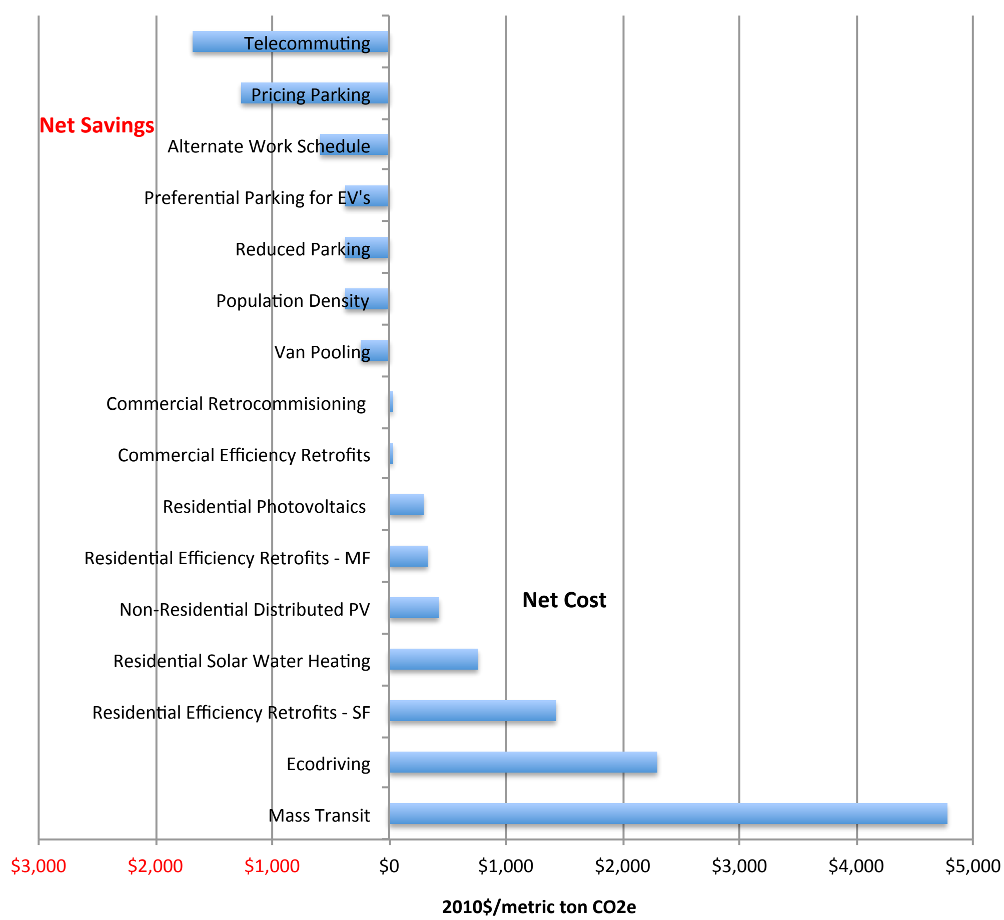
[6] Note that this chart is an illustrative breakdown of emissions reduction categories and does not necessarily reflect the emissions reduction totals in Table 4 (Section 6.3 of the Appendix).

4.2 Cost Effectiveness

In addition to estimating expected greenhouse gas reductions associated with a range of mitigation measures, the EPIC model also provides cost estimates for a subset of measures. Figure 7 provides a summary of these cost estimates. The measures with a negative cost (bars left of zero dollars) have a net savings; that is, the cost of implementation is more than offset by the benefits over the life of the project. Those represented with bars greater than zero have a net cost; that is the cost of implementation is never offset by benefits. Cost is an important factor in prioritizing climate action, but it is important to consider cost in conjunction with emissions reduction potential. Certain measures, like telecommuting are relatively cost effective, but have a relatively small potential to reduce emissions. On the other hand, residential single-family retrofits have a relatively high cost but also a relatively high potential to reduce emissions. It may be possible to use cost as a way to prioritize action to reach 2020 targets, but achieving the level of reductions by 2035 to be on a pathway to the deeper 2050 reductions may require a comprehensive approach that includes some level of activity among all the measures included in the model.

Also, there are other considerations related to cost effectiveness that are more difficult to quantify, including the health impacts and other environmental benefits. While we acknowledge these, we did not quantify the magnitude of their benefits.

Figure 8 Cost Estimates for Selected Mitigation Measures in 2010



5 Conclusion

California local governments are increasingly conducting climate planning. In response to a need for technical assistance, EPIC developed a model to provide the quantitative building blocks of local climate planning: business-as-usual projection, target selection, and emissions reductions from mitigation measures. As a result of work conducted with cities in the San Diego region, it appears that a suite of measures could reduce emissions sufficient to meet 2020 targets, though these reductions are significantly affected by state and federal measures – such as the federal Corporate Average Fuel Economy standards and California Renewable Portfolio Standard, which are beyond the control of local jurisdictions. However, longer-term reductions by 2035 that are consistent with California's overarching goal of reducing emissions 80% below 1990 levels by 2050 could be much harder to achieve. To achieve these reductions, vehicle fleet efficiency and the energy intensity of electricity would have to increase beyond the currently planned levels of 54.5 miles by 2025 and 33% renewable electricity supply by 2020. Also, as emissions from vehicles and electricity decreases, the potential to reduce emissions from measures to reduce vehicle miles traveled, such as mass transit or telecommuting, and measures to reduce electric consumption, such as building retrofits, also decreases.

6 Appendix

6.1 Assumptions Used in the Business-as-Usual Projection

6.1.1 Electricity Assumptions

The model uses an electricity forecast for the San Diego Gas & Electric service territory developed by the California Energy Commission.[7] The following assumptions are embedded in the forecast.

- Percentage of Electricity Supplied by Renewable Sources – 11.9% of retail electricity sales in 2010
    - Greenhouse gas Intensity of electricity 722 pounds of CO2e per megawatt-hour
    - Assumes direct access providers have the same greenhouse gas intensity
- New Residential Building Standards – 2005 Title 24 (effective 10-1-05)
- New Commercial Buildings Standards – 2008 Title 24 (effective 1-1-10)
- Appliance Standards – those in effect in 2010
- AB 1109 Lighting Standards – electric savings through 2020
- Utility Energy Efficiency Programs – electric savings from 2010-2012 program cycle

6.1.2 Natural Gas Assumptions

Similarly, the model uses a natural gas forecast for the San Diego Gas & Electric service territory developed by the California Energy Commission.[8] The following assumptions are embedded in the forecast.

- New residential building standards are 2005 Title 24 (effective 10-1-05)
- New commercial buildings standards are 2008 Title 24 (effective 1-1-10)
- Appliance standards in effect in 2010
- Utility Energy Efficiency Program therms savings from 2009-2012 program cycle

6.1.3 Transportation

The model uses the following assumptions for projecting on-road transportation emissions, depending on the city.

- Vehicle efficiency standards as included in EMFAC 2009[9]
- Statewide CARB Tire Pressure Program reductions applied to local government, if applicable

6.1.4 Waste Assumptions

For the waste sector, depending on the city, assumptions could include.

- 55% capture rate of landfill methane gas in 2010
- 71% capture rate of wastewater treatment gases in 2010

[7] Kavalec, Chris, Nicholas Fugate, Tom Gorin, Bryan Alcorn, Mark Ciminelli, Asish Gautam, Glen Sharp, and Kate Sullivan. 2012. California Energy Demand Forecast 2012-2022 Volume 1: Statewide Electricity Demand and Methods, End-User Natural Gas Demand, and Energy Efficiency. California Energy Commission, Electricity Supply Analysis Division. Publication Number: CEC-200-2012-001-CMF-VI.

[8] See note 5.

[9] See California Air Resources Board http://www.arb.ca.gov/msei/modeling.htm.

6.2 Input Assumptions for Mitigation Measures

Table 3 provides a summary of the key assumptions used to estimate illustrative emissions reductions for the measures in the model.

Table 3 Input Assumptions for Mitigation Model Illustrative Results

Local Measures - Electric Natural Gas	2020	2035
Residential Photovoltaics		
Total Capacity (MW)	50	200
Non-Residential Distributed PV		
Total Capacity (MW)	150	350
Cogeneration		
Total Capacity (MW)	150	250
Residential Efficiency Retrofits - SF		
Energy Reduction (%/Unit)	30%	30%
Percent of Units Retrofit	10%	25%
Residential Efficiency Retrofits - MF		
Energy Reduction (%/Unit)	20%	20%
Percent of Units Retrofit	15%	30%
Commercial Efficiency Retrofits		
Energy Reduction (% per Square Foot)	15%	15%
Area Retrofit (% of Total Square Feet)	10%	25%
Commercial Retrocommisioning		
Energy Reduction (% per Square Foot)	15%	15%
Area Retrofit (% of Total Square Feet)	10%	25%
New Construction		
Improvement over T20 (%)	0%	0%
Improvement over Federal Standards (%)	0%	0%
Improvement over T24 (%)	15%	30%
Residential SHW Installs (New Con. & Retrofits)		
Systems Installed (% Existing Homes Retrofit)	5%	15%
Systems Installed (% of New Construction)	50%	100%
Commercial SHW Installs (New Con. & Retrofits)		
Reduction in Water Heating Energy	50%	50%
% Commercial Water Heating Energy Affected	5%	15%

Local Measures - Transportation	2020	2035
Average Commute		
Daily Miles, Round-trip	20	18
Alternate Work Schedule		
% Workforce Participating	5%	8%
Days in Work Week for Participating Jobs	4	4
Miles Driven in Off-Days	10	10
Telecommuting		
% Telecommutable Jobs	12%	33%
% of Eligible People Who Telecommute	10%	10%
Days Per Week Telecommuted	2	3
Mass Transit		
Commuter Ridership (%)	7.8%	0.1%
Van Pooling		
Average Van Pool Size	10	15
Ridership (%)	3%	5%
Ecodriving		
% Drivers Trained	5%	10%
Pricing Parking		
Cost per Parking Space	$22.00	$24.00
Reduced Parking		
% of Spaces Removed	10%	20%
Preferential Parking for EV's		
% of Spaces Reserved	10%	20%
Population Density		
Increase in Population Density vs. 2010	13%	30%
Bicycle Strategy		
Bicycle Lane Miles/Square Mile	4	8

Local Measures - Solid Waste and Wastewater	2020	2035
Landfill Waste		
Landfill Waste Emissions Captured (%)	80%	80%
Wastewater		
Water Emissions Reductions (%)	98%	98%

Local Measures - Water	2020	2035
Per Capita Consumption		
Gallons per Capita per Day	120	113
Gallons per Capita per Day % Reduction	15%	20%
Supply and Conveyance		
GHG Intensity of Water (lbs CO2e/MWh)	494	494
% Reduction from Expected GHG Intensity of Water	8%	8%
Energy Intensity (kWh/million gallons)	8,949	8,949
% Reduction of Energy Intensity	8%	8%
Water Treatment		
GHG Intensity of Water (lbs CO2e/MWh)	494	494
% Reduction from Expected GHG Intensity of Water	8%	8%
Energy Intensity (kWh/million gallons)	102	102
% Reduction of Energy Intensity	8%	8%
Water Distribution		
GHG Intensity of Water (lbs CO2e/MWh)	494	494
% Reduction from Expected GHG Intensity of Water	8%	8%
Energy Intensity (kWh/million gallons)	1,170	1,170
% Reduction of Energy Intensity	8%	8%

State/Federal Measures	2020	2035
Renewable Portfolio Standard		
% of Sales Supplied by Renewable Sources	33%	33%
Vehicle Emissions Efficiency (Pavley I and CAFE)		
User Defined **Total Fleet** CO2e/Mile (Grams/Mile)	382	347
Low Carbon Fuel Standard (LCFS)		
Emissions Reduction Factors	10%	10%
Electric Vehicles		
% of Total VMT Driven By Electric Vehicles	4.0%	11.0%
Pump Price of Gasoline		
Pump 2010$/Gallon	$3.85	$4.00

6.3 Greenhouse Gas Reduction Estimates for All Measures

Table 4 provides a summary of the greenhouse gas reductions associated with all the measures currently included in the model.

Table 4 Greenhouse Gas Reduction Estimates for All Measures in the Model (MMT CO2e)

Mitigation Measure	2020	2035	Category	Jurisdiction
Vehicle Fuel Economy (CAFE)	1.09	1.74	Transportation	Federal
Electric Vehicles	0.27	0.84	Transportation	Local
Average Commute	0.48	0.74	Transportation	Local
Renewable Portfolio Standard	0.69	0.73	Electric/Natural Gas	State
Low Carbon Fuel Standard	0.56	0.54	Transportation	State
Capture Landfill Gas	0.17	0.28	Solid Waste	Local
Mass Transit	0.14	0.21	Transportation	Local
Non-Residential Distributed Photovoltaics	0.05	0.14	Electric/Natural Gas	Local
Capture Wastewater Gas	0.10	0.12	Wastewater	Local
Water Efficiency	0.06	0.08	Water	Local
Residential Photovoltaics	0.01	0.08	Electric/Natural Gas	Local
Residential Efficiency Retrofits - SF	0.03	0.07	Electric/Natural Gas	Local
Reducing Parking	0.03	0.07	Transportation	Local
Preferential Parking for Electric Vehicles	0.03	0.07	Transportation	Local
Residential Solar Water Heaters	0.02	0.06	Electric/Natural Gas	Local
Van Pooling	0.02	0.05	Transportation	Local
Commercial Efficiency Retrofits	0.02	0.05	Electric/Natural Gas	Local
Commercial Retrocommissioning	0.02	0.05	Electric/Natural Gas	Local
Residential Efficiency Retrofits - MF	0.02	0.05	Electric/Natural Gas	Local
Commercial Solar Water Heaters	0.00	0.05	Electric/Natural Gas	Local
Ecodriving	0.02	0.05	Transportation	Local
Cogeneration	0.01	0.04	Electric/Natural Gas	Local
Bicycle Strategy	0.02	0.04	Transportation	Local
Telecommuting	0.01	0.04	Transportation	Local
Alternate Work Schedule	0.01	0.01	Transportation	Local
New Construction Efficiency	0.00	0.01	Electric/Natural Gas	Local
Population Density	0.00	0.00	Transportation	Local
Pricing Parking	0.00	0.00	Transportation	Local