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Reducing Greenhouse Gases from Electricity and Natural Gas Use in San Diego County Buildings

An Analysis of Local Government Policy Options

EPIC
ENERGY POLICY INITIATIVES CENTER
UNIVERSITY OF SAN DIEGO SCHOOL OF LAW

Author

Scott J. Anders
Director, Energy Policy Initiatives Center, University of San Diego School of Law

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Key Findings

- To achieve 1990 levels of regional greenhouse gas (GHG) emissions by 2020, it would be necessary to reduce electric consumption by 10%, reduce natural gas use by 8%, and increase total distributed photovoltaics to 400 megawatts (MW) in the San Diego Region, according to the San Diego Greenhouse Gas Inventory report.

- If local governments do not adopt any policies relating to reducing electric and natural gas usage and increasing use of photovoltaics, a certain level of greenhouse gas (GHG) reductions will occur as a result of statewide programs and policies.

    - Projected GHG emissions reductions from statewide appliance and buildings standards and utility energy efficiency programs could achieve about 0.7 million metric tons of carbon dioxide equivalent (MMT CO_2E), 73% of the amount needed (0.9 MMT CO_2E) from measures to reduce electric and natural gas consumption to achieve the hypothetical regional target of 1990 emissions levels by 2020.

    - Similarly, projected GHG emissions reductions from statewide programs to promote photovoltaics could achieve about 0.1 MMT CO_2E, about 50% of the amount needed (0.2 MMT CO_2E) from measures to increase use of photovoltaics to achieve the 2020 target.

    - Expected emissions reductions from statewide electric and natural gas policies combined with photovoltaics measures could achieve 0.8 MMT CO_2E, about 70% of the level needed to reach the 2020 target.

- Local government policies related to energy efficiency and photovoltaics could help to contribute to the remaining emissions reductions needed to meet the 2020 targets (after counting the effects of statewide measures).

- A range of policy options exists within the authority of local governments to reduce community-wide greenhouse gas emissions.

- All policies analyzed for this report can be developed and implemented in the short term (1-2 years).

- One or more local governments in California or the U.S. have adopted most of the policies assessed.

- Based on the assumptions used, preliminary quantitative analysis suggests that five local policies have a high potential to reduce GHG emissions in the San Diego region: (1) residential and (2) commercial efficiency retrofits in a percentage of all existing buildings[1], (3) residential photovoltaics in all new homes, (4) solar water heating retrofits in a percentage of all homes, and (5) residential efficiency retrofits that target a percentage of ***buildings built prior to 1980.***

- Among the policies with high potential to reduce GHG emissions, only one policy – efficiency retrofits in commercial buildings[2] – also has a relatively low cost per unit of greenhouse gas reduction (dollar/metric ton CO_2 equivalent).

1. For existing building policies, we calculate potential greenhouse gas reductions assuming the policy is applied both to a percentage of all buildings as of 2010 *and* as a percentage of buildings built prior to 1980, about when California adopted building energy standards.
2. "Commercial building" as used here means all non-residential and non-industrial buildings and would include government buildings.

- Retro-commissioning[3] in commercial buildings also has a low cost of implementation and a medium to low potential to reduce emissions, depending on the population of buildings targeted. Another policy – requiring Energy Star appliances in new homes – also has a low cost per unit of GHG reductions, though it has a relatively low potential to reduce emissions.

- Of the local energy efficiency policies assessed, those targeting existing buildings have a higher potential to reduce GHG emissions than those targeting new construction or solar photovoltaics. Emission reductions from policies that focus on efficiency in existing buildings represent 0.3 to 0.5 MMT CO_2E, about 72% to 85% of the total potential, respectively, depending on the population of buildings targeted.

Of the local energy efficiency policies assessed, those targeting existing buildings have a higher potential to reduce GHG emissions than those targeting new construction or solar photovoltaics.

- If every local jurisdiction in the region adopted the efficiency and photovoltaics policies assessed in this report the emission reductions associated with the medium scenario[4] would be approximately 0.6 MMT CO_2E, about 60% of the estimated levels needed for the region to meet the hypothetical 2020 target; however, the combined emission reductions of these local policies and state building and appliance standards and utility energy efficiency programs would be significantly higher and likely would meet the hypothetical 2020 targets.

- Looking beyond 2020, it appears that more aggressive local policy actions could be necessary to achieve significant reductions of 80% below 1990 levels by 2050.

Report Overview

In September 2008, the Energy Policy Initiatives Center (EPIC) released a study that estimated the San Diego region's greenhouse gas emissions and analyzed strategies to reduce regional emissions to 1990 levels by 2020. While a necessary step in the mitigation process, that report did not provide any specific analysis to help decision makers understand which policy actions would achieve the savings identified. Nor did it provide any way to prioritize activities and policies. This report conducts more detailed analysis on a selection of those strategies related to electric and natural gas consumption and distributed photovoltaics. The purpose of this study is to assess policy options based on their potential to reduce greenhouse gases, cost and time to implement, and experience by other jurisdictions to help decision makers evaluate and prioritize mitigation actions. In nearly all cases, the time to implement was relatively short term, in the 1-2 years range; therefore, we omit that variable from the summary information presented here.

This report is not intended to be a detailed cost effectiveness or GHG reduction analysis; rather, the results should be viewed as preliminary information to communicate to decision makers relative cost and GHG reduction potential of the policies assessed. In many cases, we provide quantitative analysis, but in cases where policies either will not have a direct GHG effect or where it is difficult to ferret out the potential effect of a specific policy, we did not include any these estimates. This summary includes the results of the analysis to

3. The California Energy Commission defines retro-commissioning as the process of "systematically investigat[ing] the operation of a building's energy consuming equipment to detect, diagnose, and correct faults in the installation and operation of commercial building energy systems." Retro-commissioning is typically only done in commercial buildings.
4. For each policy, we calculated potential greenhouse gas reductions based on varying assumptions to yield a low, medium, and high estimate. All values presented here represent the medium scenario unless otherwise noted.

Table 1. Summary of Policies Assessed in This Report

POLICY OR MEASURE	GHG REDUCTION AND COST ESTIMATE	JURISDICTIONS THAT HAVE ADOPTED THE POLICY OR MEASURE
Energy Efficiency		
Regional or Citywide Building Assessment	N	N/A
Regional or Citywide Energy Efficiency Target (Existing)	N	Palm Desert (CA), San José (CA)
Regional or Citywide Existing Building Efficiency Task Force	N	Austin (TX), Seattle (WA)
Energy Rating and Disclosure (Existing)	Y	Austin (TX), Montgomery County (MD), European Union
Efficiency Retrofits	Y	Berkeley (CA), San Francisco (CA), Austin (TX), Wisconsin, New York City (*proposed*)
Retro-Commissioning for Commercial Buildings	Y	New York City *(proposed)*
Solar Water Heating (New and Existing Buildings)	Y	Spain
Enhanced New Construction Building Energy Standards	Y	San Francisco (CA), City of Santa Barbara (CA), Palm Desert (CA), Marin County (CA), 10 other CA Cities
Energy Efficiency Appliances (New Buildings)	Y	Santa Barbara (CA)
Energy Rating and Disclosure (New Buildings)	N	Kansas, South Dakota
Pre-Plumb for Solar Water Heating (New Buildings)	Y	Chula Vista (CA), Carlsbad (CA)
Photovoltaics		
Regional or Citywide Rooftop Photovoltaics Target	N	San Diego (CA) San Francisco (CA), Sonoma (CA)
Pre-wire for Photovoltaics	Y	Chula Vista (CA), Palm Desert (CA)
Photovoltaics on New Buildings - Commercial	Y	Culver City (CA)
Photovoltaics on New Buildings - Residential	Y	N/A

estimate the potential for each policy to reduce GHG emissions and the associated cost of such reductions. Table 1 provides a list of the policies assessed, the ones for which we provided quantitative analysis, and jurisdictions that have adopted the policy.

Several points of clarification will help the reader to understand the reasons for including or excluding certain topics. First, we recognize that while GHG emissions are an important barometer, they are but one piece of the larger question of sustainability and that it is important to consider a broader, comprehensive perspective when assessing policy actions. Other important considerations include air quality, waste reductions, economic and workforce development, and national security. Nonetheless, this report focuses on the issue of GHG emissions as a potential driver of negative outcomes in many of these other areas.

Second, this study focuses on policies to mitigate existing emissions. There is a growing debate about the relative roles of mitigation, reducing GHG emissions, and adaptation, changing the way we plan and live to adapt to a future altered by climate change. Adaptation is an important topic that warrants serious discussion but is outside the purview of this report.[5]

5. For more on the potential regional effects of climate change, see San Diego's Changing Climate: A Regional Wake-Up Call – A Summary of the Focus 2050 Study Presented by the San Diego Foundation, *available at* http://www.sdfoundation.org/news/pdf/Focus2050glossySDF-ClimateReport.pdf.

This study evaluates policies that local governments can adopt because their jurisdiction allows them to directly regulate an area or to influence implementation of state and federal policies and programs and that could reduce GHG emissions across the entire population of a city or county. Finally, this study focuses on community-wide emissions because even though cities have direct control over their own operations, emissions resulting from city operations only account for a small percentage of total emissions within a given jurisdiction. For example, GHG emissions from the City of San Diego constitute approximately 1% of the all the GHGs emitted within the City boundaries. So even if the City of San Diego eliminated its emissions completely, it would only account for a very small portion of overall citywide emissions. All emissions reduction and cost estimates included in this study show region wide totals and assume that all jurisdictions adopt the policies.

This summary report is intended as an overview of the findings, and no discussion of methods is included. It provides a brief overview of the San Diego County Greenhouse Gas Inventory and its connection to this study, information about the potential for energy efficiency in the region, findings for our analysis of policies directed toward existing and new buildings, and a comparison of all the policies assessed in the study. Detailed analysis for each policy, including cost considerations, examples of other jurisdictions, and options for developing similar policies, and information about the methods used for GHG emissions savings and costs estimates are provided in the main project report available for download on the Energy Policy Initiatives Center Website.[6]

San Diego County Greenhouse Gas Inventory

To understand the context of this study, it is helpful to realize its relationship to the San Diego Greenhouse Gas Inventory project[7], which developed a greenhouse gas inventory for San Diego County and identified strategies to reduce emissions to 1990 levels by 2020 —the statewide statutory target under AB 32.[8] The inventory showed that electricity accounted for 25% of regional emissions and natural gas 9%.

Table 2. Emission Reduction Strategies - Electric/Natural Gas

Emissions Category / Strategy	Reduction Amount (MMT CO_2E)	Percentage of Total Reduction
ELECTRICITY	**3.8**	**28%**
Renewable Portfolio Standard 20%	1.2	8%
Reduce Electricity Consumption 10%	***0.7***	***5%***
Renewable Portfolio Standard 33% (Incremental)	0.7	5%
Cleaner Electricity Purchases (≤1100 lbs/MWh)	0.6	4%
Replace Boardman Contract (Coal)	0.3	2%
Increase Distributed Photovoltaics to 400 MW	***0.2***	***1%***
Increase combined heat and power by 200 MW	0.2	1%
NATURAL GAS END-USE	**0.3**	**2%**
Reduce Natural Gas Consumption 8%	***0.3***	***2%***

The GHG inventory project also identified 19 emissions reduction strategies that in combination could reduce regional GHG emissions to 1990 levels by 2020. Table 2 presents the strategies related to electricity and natural gas. This study focuses on three broad strategies – reducing electric consumption, reducing natural gas consumption, and increasing distributed photovoltaics – that taken together equal about 8% of the total GHG emissions reductions needed

6. Electronic copies are available on the EPIC Website at http://www.sandiego.edu/epic/ghgpolicy.
7. Electronic copies of the executive summary and 8 supplements sector reports are available on the EPIC website at http://www.sandiego.edu/epic/ghginventory/.
8. To do this, we adapted the well-know approach used by Pacala and Socolow. See Pacala, S. and Socolow, R., Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies, Science, 305, 968-972 (2004).

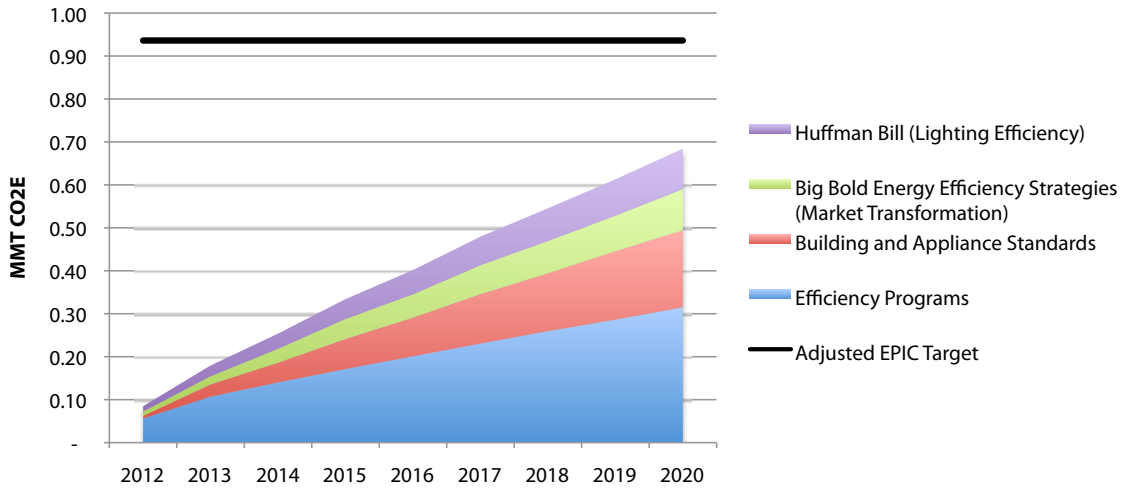
to lower regional emissions to 1990 levels by 2020.[9] The total emissions reduction target from energy efficiency activities – both electric and natural gas – is 0.9 million metric tons of carbon dioxide equivalent (MMT CO_2E).[10] Increasing distributed photovoltaics to 400 MW region wide could reduce emissions by 0.2 MMT CO_2E.

Energy Efficiency Potential in the San Diego Region

California has used three primary policy approaches to reduce electric and natural gas usage in the state: energy efficiency programs regulated by the California Public Utilities Commission (CPUC) and administered by utilities and building and appliance standards promulgated by the California Energy Commission (CEC). The combination of these statewide policies has significantly reduced statewide energy consumption since the 1970s. The CEC estimates that between 1975 and 2003, the cumulative energy savings from efficiency programs and standards is equivalent to about 15% of total electricity consumption in 2003.[11]

Estimates vary on what level of future energy reductions will be attributed to efficiency programs and standards over the next decade, depending on the assumptions used. Figure 1 presents the GHG emissions reduction implications from the CPUC estimates of future energy savings for the San Diego region.[12] This combination of savings falls short of the adjusted EPIC target of 0.9 MMT CO_2E for energy efficiency by about 30%, which highlights a potential role for local government policy in reducing GHG emissions.

Figure 1. GHG Reductions from CPUC Estimate of Future Electric and Natural Gas Efficiency



To determine the remaining potential for energy efficiency programs in California, Itron Inc. conducted a detailed, bottom-up study that estimates efficiency potentials through 2016 with a long-term projection for 2026.[13] The study identifies energy savings potential for programs in the residential, commercial, and industrial sectors both for new construction and existing buildings. For purposes of this study, Itron's results provide a reasonable proxy of remaining potential that local government policies could affect.

The Itron study results show that the residential sector has the highest remaining potential for energy program

9. Results for several electricity related strategies have been modified due to a refined methodology and updated energy forecast. For instance, the amount of GHG emissions expected from energy efficiency has been revised down to 0.68 MMT CO_2E from 1.1 MMT CO_2E. The total amount of GHG reductions from the electricity sector still meets the 1990 target by 2020. Also, the natural gas value has been revised down to 0.26 MMT CO_2E from 0.3 MMT CO_2E.
10. 1 million metric tons of CO_2E is roughly equivalent to the emissions of 83,000 typical San Diego residents. 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.
11. California Energy Commission, Options for Energy Efficiency in Existing Buildings, p. iii (Dec. 2005).
12. California Public Utilities Commission Rulemaking 06-04-010 D.08-07-047 Table A-6, Available at: http://docs.cpuc.ca.gov/WORD_PDF/FINAL_DECISION/85995.DOC.
13. Itron, Inc., California Energy Efficiency Potential Study- CALMAC Study ID: PGE0264.01, (Sept. 2008).

The Itron study results show that the residential sector has the highest remaining potential for energy program reductions...

reductions, representing 49% of the total potential, followed by the commercial (34%) and industrial (17%) sectors. Existing buildings represent 89% of the energy reduction estimate, while new construction represents 11%.

The residential existing building sector represents about 48% of the entire efficiency potential identified in the analysis. Existing commercial buildings have the second highest potential for energy reductions at 24% of total and existing industrial buildings account for about 17% of the total.

Figure 2 presents the breakdown of greenhouse gas emissions associated with energy reductions in each of the sectors covered for both electricity and natural gas.[14]

Figure 2. Projected GHG Reductions from Efficiency Program Potential (San Diego County, 2020)

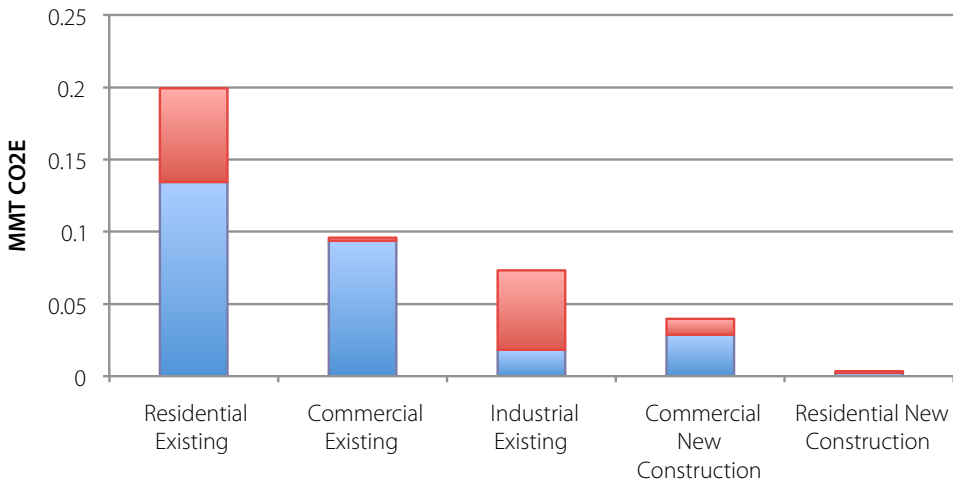


Table 3 provides a summary of Itron's natural gas and electric energy savings estimates and their corresponding greenhouse gas reduction potential. The total GHG emissions reductions associated with the energy savings from programs is 44% of the revised EPIC target for GHG reductions from the electric and natural gas categories (0.9 MMT CO_2E). It is possible that building and appliance standards could account for the remaining 56% of emission reductions, nonetheless these data suggest a role for local government policy actions to supplement state policies and programs.

Table 3. Summary of Efficiency Program Potential Study (San Diego County, 2020)

Sector	Natural Gas (MM Therms)	Natural Gas MMT CO_2E	Electric (GWh)	Electric MMT CO_2E	Total MMT CO_2E
Commercial Existing	0.4	0.002	352	0.1	0.1
Commercial New Construction	2.0	0.01	108	0.03	0.04
Industrial Existing	10.2	0.06	69	0.02	0.1
Industrial New Construction	n/a	n/a	2	0.001	0.001
Residential Existing	12.0	0.1	505	0.1	0.2
Residential New Construction	0.2	0.00	9	0.002	0.003
Total	**24.8**	**0.13**	**1045**	**0.28**	**0.41**

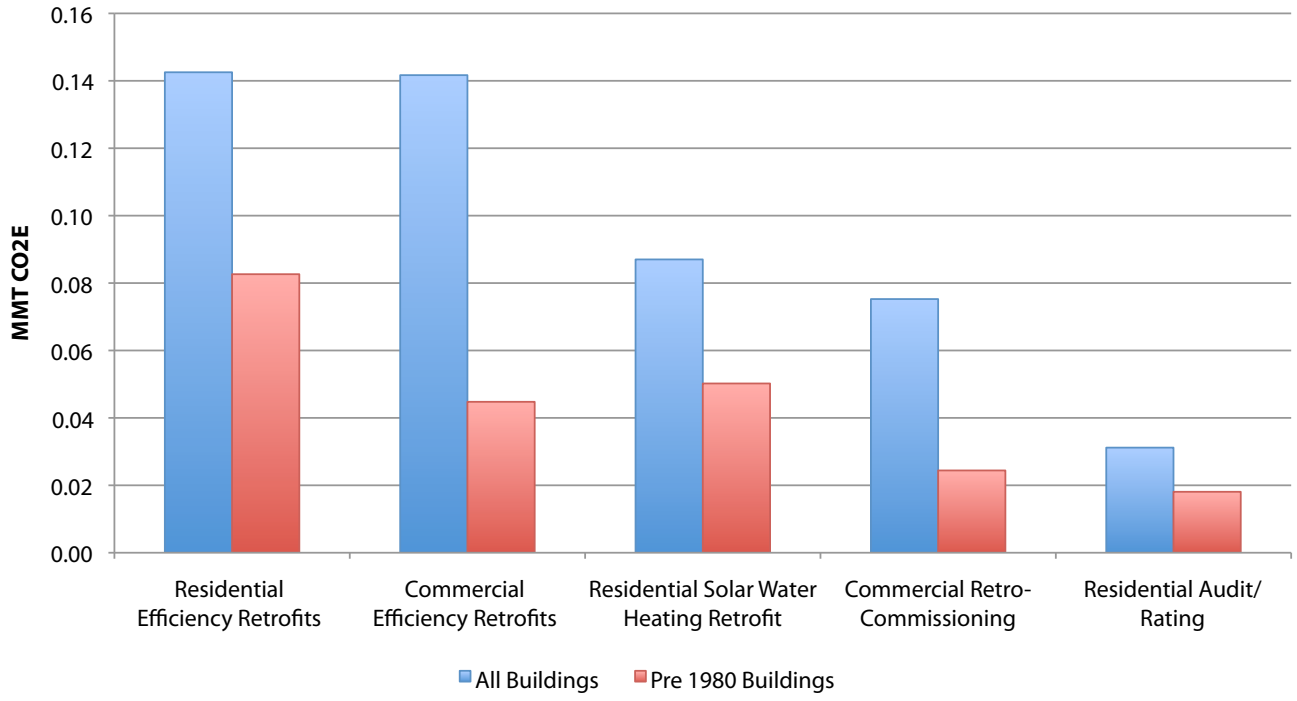
14. The values presented in Figure 2 represent the results of the mid-restrict scenario.

Existing Building Policies

Given the current building stock and future trends, it is very likely that a significant proportion of building that will be in place in 2050 already exists today; therefore, any strategy to reduce regional GHG emissions from electricity and natural gas use must include measures to improve the energy performance of existing buildings. This report estimates the potential GHG reductions associated with a range of policies that target existing buildings.

Improving the energy efficiency of existing residential and commercial buildings has the greatest potential of all the policies assessed in this report – both for existing buildings and new construction – to reduce energy and GHG emissions in the region. This is due primarily to the number of existing buildings compared to the number of buildings constructed each year. Also, 60% of the residential and 40% of the commercial buildings in the region were built before new building energy standards were fully implemented in California. To differentiate between buildings built before and after adoptions of statewide building efficiency, we calculated the emission reduction potential of policies assuming a percentage of the pre-1980 building stock *and* of the entire building stock. The results of these two approaches are included in the results below. Figure 3 shows the GHG reduction potential of policies that would target existing buildings.

Figure 3. GHG Reductions - Existing Building Policies
(Medium Scenario, 2020)



Based on preliminary cost estimates, a local policy to encourage or require commercial efficiency retrofits has both high potential to reduce GHG emissions and low cost of implementation.[15] On the other hand, a policy to encourage residential energy retrofits, which has the highest potential for reductions, was just below average in terms of cost. Policies to encourage residential solar water heating (medium cost) and commercial retro-commissioning (low cost) also could achieve significant GHG savings in the region.

15. Cost used here means total cost to implement and does not take into account any financial incentives that might reduce the final cost to the customer.

Requiring residential building owners to conduct an energy audit and disclose the results could have a relatively high cost. This is because if no efficiency retrofit is required it is assumed that only a fraction of the homes audited will actually conduct efficiency retrofits. Nonetheless, energy rating and disclosure policies may be an effective way to raise awareness about building energy performance, provide a benchmark and rating system for future efficiency retrofit policies, and to help jumpstart the energy rating and building performance industry. Table 4 presents a summary of results for existing building policies.

Table 4. GHG and Cost Summary - Existing Buildings (2020)

GHG Reduction Policy Option	GHG Reduction Potential[1] (MMT CO_2E)	Cost per Unit of GHG Reduction[1] ($/MT CO_2E)
Residential Efficiency Retrofits (ALL)[2]	H	M
Commercial Efficiency Retrofits (ALL)	H	L
Residential Solar Water Heating Retrofit (ALL)	H	M
Residential Efficiency Retrofits (Pre-1980)[3]	H	M
Commercial Retro-Commissioning (ALL)	M	L
Residential Solar Water Heating Retrofit (Pre-1980)	M	M
Commercial Efficiency Retrofits (Pre-1980)	M	L
Residential Audit/Rating (ALL)	M	H
Commercial Retro-Commissioning (Pre-1980)	L	L
Residential Audit/Rating (Pre-1980)	L	H
Residential Pre-Plumb (New)	L	H

[1] L=Low M=Medium H=High

[2] "All" means policy targets a percentage of all buildings.

[3] "Pre-1980" means policy targets a percentage of buildings built before 1980.

A policy to encourage or require commercial efficiency retrofits has both high potential to reduce GHG emissions and low cost of implementation.

Table 5. Jurisdictions with Existing Building Policies

Policy	Jurisdiction
Residential Efficiency Retrofits	San Francisco (CA), Berkeley (CA), Burlington (VT), Wisconsin, Austin (TX)
Commercial Efficiency Retrofits	Berkeley (CA), New York City *(pending)*
Commercial Retro-Commissioning	New York City *(pending)*
Residential Solar Water Heating Retrofit	Barcelona (Spain)
Residential Audit/Rating	Austin (TX), Montgomery County (MD), European Union

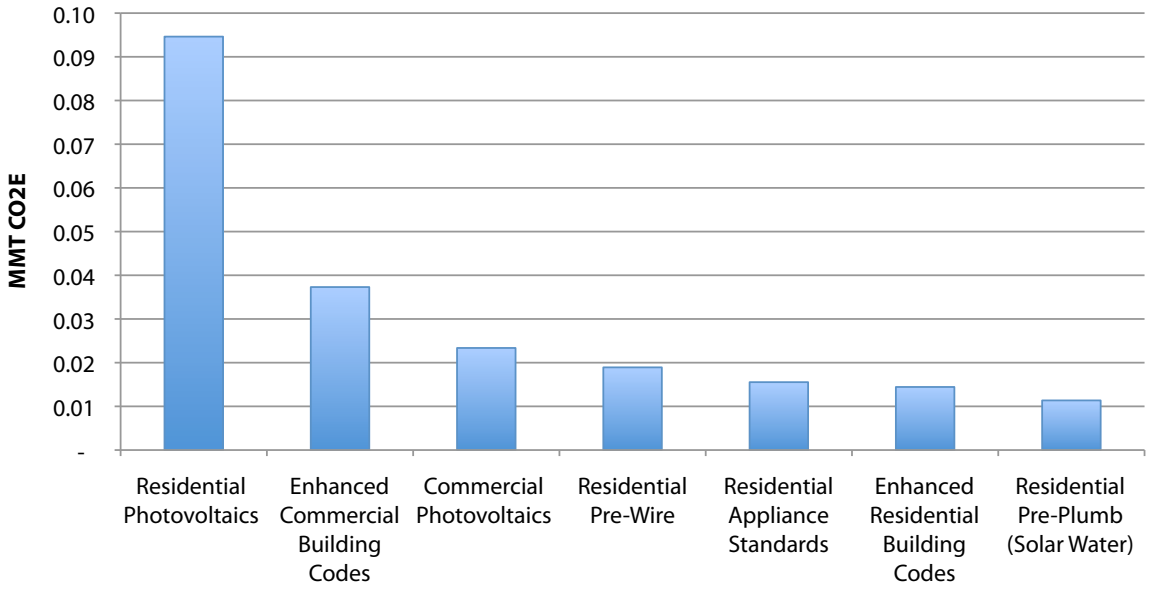
Table 5 shows the jurisdictions that have adopted the existing building policies assessed here.

New Construction Policies

In general policies that focus on new construction have a relatively low potential to reduce GHG emissions in the region compared to policies that focus on existing buildings. Emission reductions from the new construction policies could achieve between 15-30% of the total GHG savings from all the policies evaluated in this report, depending on the population of buildings captured and whether the emission reductions associated with photovoltaics are included. This difference exists because on average only a small percentage of the total building stock is built new each year. Also, policies seeking to increase efficiency in new homes and commercial buildings by strengthening requirements of California's building energy standard yield relatively low GHG reductions because in some cases – particularly residential – Title 24 regulates a relatively small proportion of overall energy usage.

Of all the new construction policies assessed, a measure to encourage or require photovoltaics on all new homes has the greatest GHG reduction potential and a medium cost of implementation. It is not clear whether local government policies to encourage photovoltaics would lead to net GHG reductions in the short run as investment in this technology is heavily dependent upon subsidies and the market may grow only as fast and large as incentives will allow; however, after current subsidies expire (2016), local policies to encourage photovoltaics could be more important. Requiring new commercial buildings to exceed Title 24 building energy requirements has a moderate potential to reduce emissions, though it could have a relatively low cost of implementation. Similar policies for new residential buildings have a much lower GHG reduction potential and relatively high cost. Two policies to make all new homes "solar ready" to accommodate later installation of solar photovoltaics or solar water heating have relatively low potential to reduce GHG, mainly because it is not clear that buyers of solar ready homes would install solar technologies. Figure 4 presents the GHG emission reduction potential of the new construction policies assessed in the study.

Figure 4. GHG Reductions - New Construction Policies
(Medium Scenario, 2020)



Among the new construction measures that focus on energy efficiency, two policies have a low cost of implementation. Requiring new commercial buildings to meet building energy standards that exceed California Title 24 has moderate potential to reduce GHG emissions and a relatively low cost of implementation. A policy to require that all new homes have Energy Star appliances has a relatively low cost of implementation, though it is among the lowest in terms of GHG reductions. Regardless of any GHG benefit that might result, requiring use of Energy Star appliances in new residential construction could be justified completely in terms of cost effectiveness. Table 6 presents a summary of the GHG reduction potential, costs, and jurisdictions that have adopted the new construction policies analyzed in this study.

In general policies that focus on new construction have a relatively low potential to reduce GHG emissions in the region compared to policies that focus on existing buildings.

Regardless of any GHG benefit that might result, requiring use of Energy Star appliances in new residential construction could be justified completely in terms of cost effectiveness.

Table 6. GHG and Cost Summary for New Construction Policies (Medium Scenario, 2020)

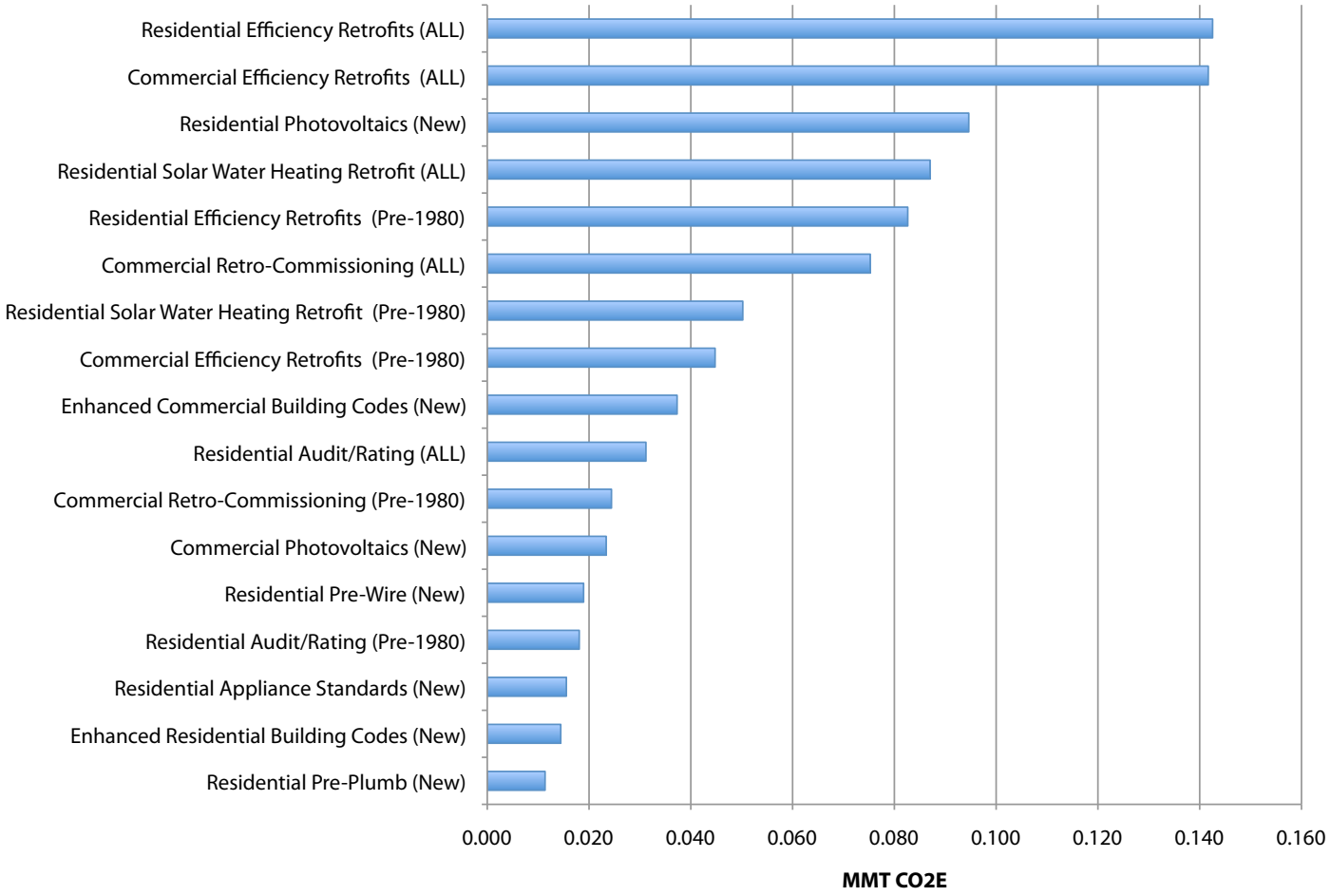
GHG Reduction Policy Option	GHG Reduction Potential (MMT CO_2E)[1]	Cost per Unit of GHG Reduction ($/MT CO_2E)[1]	Examples of Jurisdictions that Have Adopted Policies
Residential Photovoltaics	H	M	N/A
Enhanced Commercial Building Codes	M	L	San Francisco (CA), City of Santa Barbara (CA), Palm Desert (CA), others
Commercial Photovoltaics	L	M	Culver City (CA)
Residential Pre-Wire	L	M	Chula Vista (CA), Palm Desert (CA)
Residential Appliance Standards	L	L	Santa Barbara (CA)
Enhanced Residential Building Codes	L	H	San Francisco (CA), City of Santa Barbara (CA), Palm Desert (CA), Marin County (CA), others
Residential Pre-Plumb	L	H	Chula Vista (CA), Carlsbad (CA)

[1] L=Low M=Medium H=High

Overall Findings

This section provides a summary of the overall findings of the study. When all local policy measures assessed in this report are combined, it is possible to compare the relative GHG reduction potential and implementation cost and to assess their combined impact. Of the policies included in this report, residential and commercial efficiency retrofits targeting a percentage of all buildings have by far the highest GHG reduction potential, followed by a requirement to install solar photovoltaics on new homes and a policy to install solar water heating systems on existing homes (Figure 5). Also, the vast majority of potential GHG reductions from the policies evaluated – between 72% and 85%, depending on the building population addressed – result from policies that target existing buildings.

Figure 5. GHG Reduction Potential (Medium Scenario, 2020)



There are 6 policies that have high potential to reduce GHG emissions in the region. None of these have high implementation costs and only one policy – requiring commercial energy retrofits in a percentage of all buildings – also has a relatively low cost of implementation. Three policies – (1) requiring commercial retro-commissioning in a percentage of all buildings, (2) commercial efficiency retrofits in buildings built prior to the adoption of energy codes, and (3) a local policy to require new commercial buildings to be more energy efficient than mandated by state law – also have a low cost of implementation but they all have a medium potential to reduce emissions. Table 7 provides a summary of the GHG reduction potential and the associated cost for the policies evaluated in this study. The information presented in Table 7 is sorted in order of GHG potential from high to low.

Table 7. GHG Reduction Potential and Cost - All Policies

GHG Reduction Policy Option	GHG Reduction Potential[1] (MMT CO_2E)	Cost per Unit of GHG Reduction[1] ($/MT CO_2E)
Residential Efficiency Retrofits (ALL)[2]	H	M
Commercial Efficiency Retrofits (ALL)	H	L
Residential Photovoltaics (New)[3]	H	M
Residential Solar Water Heating Retrofit (ALL)	H	M
Residential Efficiency Retrofits (Pre-1980)	H	M
Commercial Retro-Commissioning (ALL)	M	L
Residential Solar Water Heating Retrofit (Pre-1980)	M	M
Commercial Efficiency Retrofits (Pre-1980)	M	L
Enhanced Commercial Building Codes (New)	M	L
Residential Audit/Rating (ALL)	M	H
Commercial Retro-Commissioning (Pre-1980)	L	L
Commercial Photovoltaics (New)	L	M
Residential Pre-Wire (New)	L	H
Residential Audit/Rating (Pre-1980)	L	H
Residential Appliance Standards (New)	L	L
Enhanced Residential Building Codes (New)	L	H
Residential Pre-Plumb (New)	L	H

[1] L=Low M=Medium H=High

[2] "All" means policy targets a percentage of all buildings.

[3] "Pre-1980" means policy targets a percentage of buildings built before 1980.

For the San Diego region to reach AB 32 targets, EPIC estimated that it would be necessary to reduce GHG emissions from electric and natural gas consumption by 0.9 MMT CO_2E and 0.2 MMT CO_2E from increased use of solar photovoltaics (PV). To determine the combined effect of the policies assessed here, we created four scenarios that vary based on the target population of existing buildings and whether emission reductions from PV are included. As mentioned above, it is unclear how much net GHG reductions between now and 2016 will be realized by local policies that target photovoltaics. These four scenarios are:

- Scenario 1: Efficiency Only (All Buildings) – existing building policies target a percentage of the entire building stock annually and GHG reductions from solar photovoltaics are not included.
- Scenario 2: Efficiency Only (Pre-1980 Buildings) – existing building policies target a percentage of the pre-1980 buildings annually and GHG reductions from solar photovoltaics are not included.

- Scenario 3: Efficiency (All Buildings) + PV - existing building policies target a percentage of the entire building stock annually and GHG reductions from solar photovoltaics are included. Because PV is included the target for scenarios 3 and 4 is 1.1 MMT CO_2E.

- Scenario 4: Efficiency (Pre-1980 Buildings) + PV - existing building policies target a percentage of the pre-1980 buildings annually and GHG reductions from solar photovoltaics are included.

For each of these four scenarios we show a range of emissions reductions (low, medium, and high) based on the adoption rate or assumed level of savings. If adopted region wide, no scenario of local efficiency policies (Scenarios 1 and 2) could achieve the 0.9 MMT CO_2E target alone. Similarly, no scenario of policies that combines efficiency and solar photovoltaics (Scenarios 3 and 4) can meet the combined target of 1.1 MMT CO_2E. However, in both cases, combining estimated emission reductions from local policies with those projected from statewide policies and programs, it could be possible to achieve the target by 2020.

Figure 6 shows a range of GHG emission reductions from 4 scenarios, including a low, medium, and high estimate for each scenario.

Figure 7 shows the medium level of savings for each scenario and the amount of reductions that would be needed to reach the revised hypothetical EPIC target.

Figure 6. Comparison of Policy Scenarios (2020)

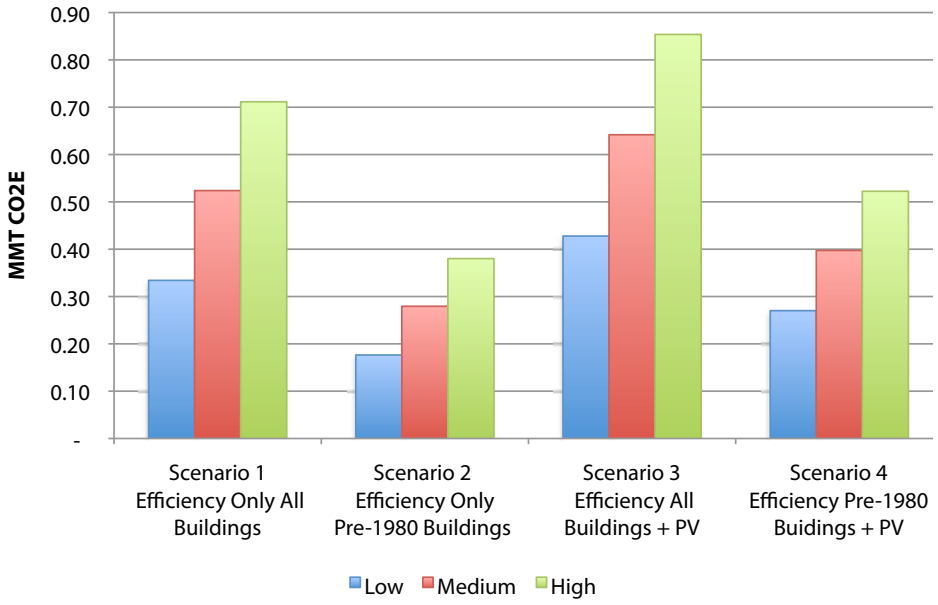


Figure 7. Estimated GHG Reductions for Policy Scenarios (Medium Scenario, 2020)

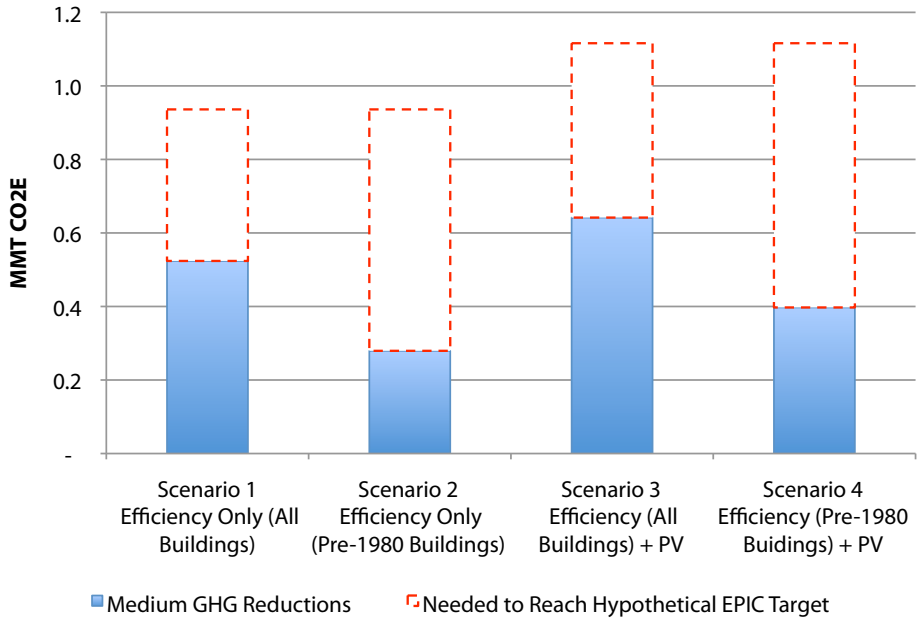


Table 8 presents the estimated GHG reduction potential for each policy and the values used for the four policy scenarios.

Table 8. Summary of GHG Reduction Estimates (MMT CO_2E, 2020)

Existing Buildings - All[1]	**Low**	**Medium**	**High**
Residential Efficiency Retrofits (ALL)	0.10	0.14	0.19
Residential Solar Water Heating Retrofit (ALL)	0.07	0.09	0.11
Commercial Retro-Commissioning (ALL)	0.04	0.08	0.11
Commercial Efficiency Retrofits (ALL)	0.09	0.14	0.19
Total	**0.29**	**0.45**	**0.60**
Existing Buildings - Pre 1980[1]	**Low**	**Medium**	**High**
Residential Efficiency Retrofits (Pre-1980)	0.06	0.08	0.11
Residential Solar Water Heating Retrofit (Pre-1980)	0.04	0.05	0.06
Commercial Retro-Commissioning (Pre-1980)	0.01	0.02	0.04
Commercial Efficiency Retrofits (Pre-1980)	0.03	0.04	0.06
Total	**0.13**	**0.20**	**0.27**
New Construction[2]	**Low**	**Medium**	**High**
Enhanced Residential Building Codes	0.01	0.01	0.02
Residential Appliance Standards (New)	0.01	0.01	0.02
Residential Photovoltaics (New)	0.08	0.09	0.11
Residential Pre-Plumb (New)	0.01	0.01	0.01
Enhanced Commercial Building Codes (New)	0.02	0.04	0.06
Commercial Photovoltaics (New)	0.01	0.02	0.04
Total New Construction - no SOLAR	**0.04**	**0.08**	**0.11**
Total New Construction - with SOLAR	**0.14**	**0.20**	**0.25**
Scenario 1 - Efficiency Only All Buildings	0.33	0.52	0.71
Scenario 2 - Efficiency Only Pre-1980 Buildings	0.18	0.28	0.38
Scenario 3 - Efficiency All Buildings + PV	0.43	0.64	0.85
Scenario - 4 Efficiency Pre-1980 Buildings + PV	0.27	0.40	0.52

[1] Auditing and disclosure policy totals eliminated to avoid double counting with efficiency retrofits.

[2] Photovoltaic pre-wire policy eliminated to avoid double county with residential requirement.

Conclusion

Many policy options exist within the authority of local governments that can reduce community-wide GHG emissions. Of the policies analyzed in this study, all can be developed and implemented in the short term (1-2 years), most of the policies have been adopted by one or more local governments in California or the U.S., and several policies with a relatively low cost per metric ton of GHG reduction.

Based on preliminary quantitative analysis, one policy – commercial efficiency retrofits targeted at a percentage of all buildings – has a high potential to reduce emissions and a relatively low cost per unit of GHG reduction. Several policies have a moderate potential to reduce emissions and have a low implementation cost. These include: commercial retro-commissioning in a percentage of all buildings, commercial efficiency retrofits in buildings built prior to 1980, and enhanced new construction energy standards in commercial buildings. Another policy – requiring Energy Star appliances in all new homes – has also has a low cost per unit of GHG reductions, though it has a relatively low potential to reduce emissions.

With the exception of one policy with high potential for GHG reductions, all would target existing buildings. Further, of the energy efficiency policies assessed, those targeting existing buildings have a higher potential to reduce GHG emissions than those targeting new construction or solar photovoltaics.

Regardless of the relative cost of individual policy measures, to attain the levels of emissions reductions necessary to meet the hypothetical target of 1990 levels by 2020, it would be necessary to implement all policy options region wide or achieve similar reductions by other methods such as enhanced statewide building and appliance standards and expanded utility-administered energy efficiency programs. By extension, even more aggressive actions would be necessary to achieve significant reductions by 2050.

Regardless of the relative cost of individual policy measures, to attain the levels of emissions reductions necessary to meet the hypothetical target of 1990 levels by 2020, it would be necessary to implement all policy options region wide or achieve similar reductions by other methods.

Recommendations for Further Research and Analysis

- Conduct a detailed analysis of the existing building stock in San Diego County to validate and refine the estimates developed in this report. At a minimum, it would be necessary to characterize the building stock by type (single family, multi-family, etc.), vintage, climate zone, etc.
- Conduct a more detailed cost analysis to validate and refine preliminary estimates and to account for any unique characteristics that may exist.
- Conduct analysis on the implications for regional electric and natural gas use of reducing regional emissions 80% below 1990 levels by 2050. This is the level of emissions reductions contained in California Executive Order S-3-05 and contemplated by federal legislation.
- Develop model policy language and supporting documentation for a subset of feasible policy options.

About the Energy Policy Initiatives Center (EPIC)

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

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University of San Diego
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School of Law
5998 Alcalá Park
San Diego, CA 92110-2492

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