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

An Analysis of Local Government Policy Options

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About EPIC

The Energy Policy Initiatives Center (EPIC) is a nonprofit academic and research center of the USD School of Law that studies energy policy issues affecting the San Diego region and California. EPIC integrates research and analysis, law school study, public education, and 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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1. INTRODUCTION

Reducing greenhouse gases (GHG) to sustainable levels will require action from international, federal, state, and local governments and organizations. Each level of government has specific jurisdiction and potential to affect emissions levels. Local governments can play a significant role due in part to their role in land use planning, zoning, and permitting. In some cases local governments have direct control over certain areas like land use and in others local governments are implementing state policies, such as California's statewide building energy standards.

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, our first report did not provide any specific analysis to help decision makers understand which policy actions could achieve the savings identified nor did it provide any way to prioritize activities and policies. 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.

This report is not intended to be a detailed cost effectiveness or GHG reduction analysis; rather, the results included here are intended as preliminary information to communicate to decision makers relative cost and GHG reduction potential. In many cases, we provide quantitative analysis, but in cases where policies either would 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 quantitative treatment. Table 1 provides a list of all the policies evaluated in this report, indicates whether quantitative GHG emissions and cost analysis was conducted, and includes a sample of jurisdictions that have adopted a version of the policy or measure listed.

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, and economic and workforce development. Nonetheless, this report focuses on the issue of GHGs 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, or reducing GHG emissions, and *adaptation*, changing the way we plan and live in order to adapt to an altered future because of climate change. Adaptation is an important topic that warrants serious discussion but is outside the purview of this report.[1]

This report also focuses on policies that local governments can adopt because their jurisdiction allows them to directly regulate an area or to influence state and federal policies. An example would be a local government requiring all new homes to install Energy Star appliances. Appliance standards are the jurisdiction of the federal and state governments, but by exercising local jurisdiction, a local government can influence the effectiveness of a state or federal appliance standard.

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[1] 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.

Table 1 Summary of Policies Evaluated

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

Finally, this report focuses on policies that can reduce GHG emissions across the entire population of a city or county. Local government GHG emissions inventories are often broken into two categories: city operations and the entire community. We chose to focus on community-wide emissions in part because even though cities have direct control over their own operations, these emissions 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 GHG 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. Instead this report seeks to provide information and analysis on policy options to reduce GHG emissions throughout an entire jurisdiction.

1.1. 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 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[2], (3) residential photovoltaics in all new homes, (4) solar water heating retrofits in a percentage of all homes, and (5) residential 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[3] – also has a relatively low cost per unit of greenhouse gas reduction (dollar/metric ton CO_2 equivalent).
- Retro-commissioning[4] 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

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[2] 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.

[3] "Commercial building" as used here means all non-residential and non-industrial buildings and would include government buildings.

[4] 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.

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.

- 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[5] 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.
- Recommendations for further research and analysis include the following:
    - 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.

1.2. Organization of the Report

The report is organized into the following sections.

- In Section 2, we provide background information necessary to provide a context for the subsequent policy analysis. This section includes a brief overview of the San Diego County Greenhouse Gas Inventory study and the connection to the material covered in this report.
- A discussion of policies to encourage energy efficiency policies for existing buildings and new construction is covered in Section 3. This section includes evaluation of policies such as energy auditing and disclosure, residential and commercial retrofits, and commercial retro-commissioning.
- Section 4 includes a discussion of policies to encourage use of distributed solar photovoltaics, including pre-wiring to make new homes solar ready and requirements to include photovoltaics on all new residential and commercial buildings.
- The report's overall findings are presented in Section 5.
- General conclusions are presented in Section 6, which includes an overview of areas for further study.

[5] 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.

- Section 7 is the Appendix, which includes information about the methodology used to estimate GHG emission reductions and implementation costs.

2. BACKGROUND

2.1. Regional Greenhouse Gas Inventory Results

The Energy Policy Initiatives Center's (EPIC) San Diego Greenhouse Gas Inventory project developed a GHG inventory for San Diego County to better understand the emissions sources in the region.[6] The project team calculated historical GHG emissions from 1990 to 2006 using the best available data, and then estimated future emissions to 2020. Using emissions reduction targets codified in California's Global Warming Solutions Act of 2006 (AB 32) as a guide, the study also sought to establish emissions reductions targets for the region. Although AB 32 does not require individual sectors or jurisdictions (e.g., cities and counties) to reduce emissions by a specific amount, the study calculated the theoretical emissions reductions necessary in each emissions category (e.g., transportation, electricity, etc.) for San Diego County to reduce emissions to 1990 levels by 2020—the statewide statutory target under AB 32.[7]

2.1.1. Key Findings from the San Diego Regional Greenhouse Gas Inventory

The following are among the key findings from the San Diego regional greenhouse gas inventory:

- San Diego County emitted 34 million metric tons of carbon dioxide equivalent (MMTCO_2E) in 2006 – an 18% increase over 1990 levels, commensurate with population growth during the same period.
- In 2006, per-capita emissions for San Diego County were 12 metric tons CO_2E, which is slightly lower than California as a whole (13) and significantly lower than the U.S. levels (24). California's lower per capita emissions can be attributed mostly to weather but also include the effects of the state's comparatively aggressive efficiency programs since the 1970s.[8]
- In 2006, emissions from cars and light-duty trucks represented 46% of total greenhouse gas emissions in San Diego County.
- By 2020, under a business-as-usual scenario, regional GHG emissions are expected to be 43 MMT CO_2E, an increase of 9 MMT CO_2E (26%) over 2006 levels and 14 MMT CO_2E (48%) over 1990 levels.
- To meet AB 32 emissions reduction targets (1990 levels by 2020), San Diego County would have to reduce emissions by 14 MMT CO_2E (33%) below projected business-as-usual levels in 2020.

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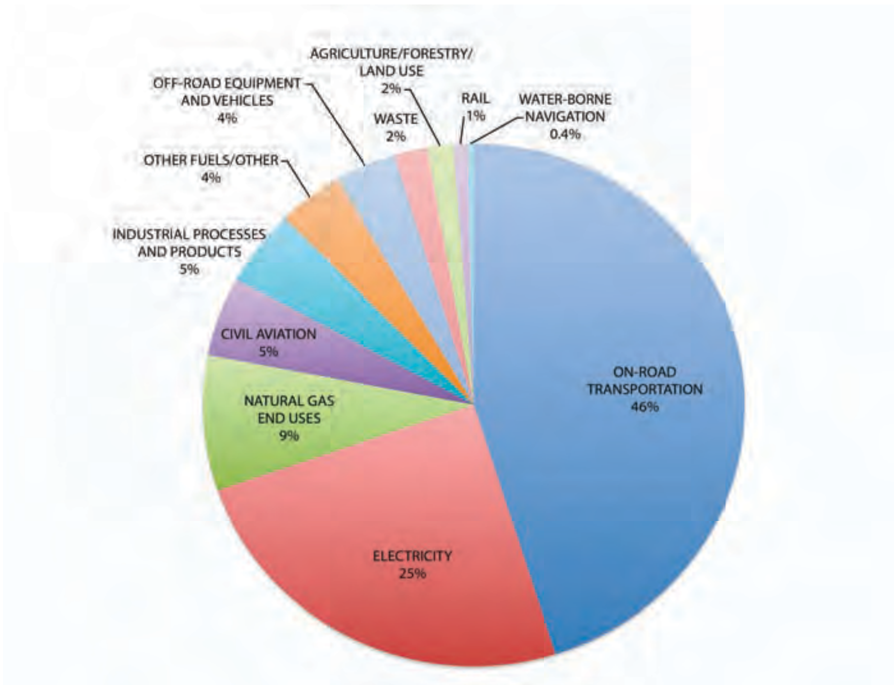
[6] Electronic copies of the executive summary and 8 supplements sector reports are available on the EPIC website at http://www.sandiego.edu/epic/ghginventory/.

[7] 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).

[8] The gap between California and the US average presented here have not been adjusted for weather, but it has been shown that the lower per capita energy use in California is due to about 2/3 climate advantages and 1/3 to state energy efficiency measures since the 1970s. See Schipper, L and McMahon, J., Energy Efficiency in California: A Historical Analysis (1995).

Figure 1 summarizes the results of the San Diego regional greenhouse gas inventory. It shows the relative contribution of emissions from each sector analyzed. Electricity (25%) and natural gas (9%), the focus of this report, account for about 34% of all regional emissions.

Figure 1. San Diego County GHG Emissions by Category (2006)



The GHG inventory project also identified 19 broad 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 use. Several strategies – renewable portfolio standards, cleaner electricity purchases, replacing Boardman contract (coal), increasing use of combined heat and power – are either not within the purview of local governments or there are limited local barriers to implementation and are therefore not considered here. This report focuses on three broad strategies – reducing electric and natural gas consumption and increasing distributed photovoltaics – that taken together equal about 7% of the total GHG emissions reductions needed to lower regional emissions to 1990 levels by 2020. The total emissions reduction target from energy efficiency activities – both electric and natural gas – is 0.9 MMT CO_2E, and 0.2 MMT CO_2E from increased use of photovoltaics. The analysis below will compare potential GHG reductions of specific policies and groups of policies to these values.

Table 2. Emissions Reduction Strategies for the Electricity and Natural Gas Categories[9]

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%***

2.2. Cost Considerations of Mitigation Strategies

The San Diego Greenhouse Gas Inventory study did not include any discussion of cost; rather, it was intended simply as an accounting of emissions and analysis of how the region could meet AB 32 targets. An obvious question remains: what are the most cost effective mitigation strategies? This report seeks to provide a preliminary answer by providing cost estimates for local policies that can reduce emissions in the San Diego region.

Two studies are helpful in providing background on the cost of GHG mitigation strategies. The first study is a well-known study by McKinsey & Company that estimates the abatement costs of reducing GHG reduction measures in the U.S.[10] It shows that a range of mitigation technologies have a *negative* abatement cost ($/ton GHG); that is, their lifecycle cost is below zero. Another way to put this is that the money saved over time by implementing such measures is greater than the installation cost. The study shows that in general but not exclusively, many of the measures with negative abatement costs are related to efficiency. For example, improvements in lighting efficiency – both for the residential and commercial sectors – have significant potential to reduce emissions and have very low (negative) abatement costs. Further, improvements to new building shell efficiency also have similar potential and costs. Costs associated with improving the energy performance of the residential building shell in existing buildings has a slightly positive abatement cost and a relatively small potential for emissions reductions. Distributed

[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 3.0 MMT CO_2E.

[10] Jon Creyts et al., Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?, McKinsey & Company and The Conference Board (Dec. 2007).

photovoltaics have a relatively high cost and potential, according to the McKinsey & Company study. Efficiency improvements to residential and commercial heating, ventilation, and air conditioning equipment (HVAC) have a relatively high abatement cost but also have a relatively high emissions reduction potential.

A similar study was conduced by the Precourt Institute for Energy Efficiency at Stanford University to assess the marginal abatement costs of a set of measures to meet California's statutory GHG targets.[11] The results are very similar to the McKinsey & Company report, with a few exceptions. Energy efficiency is shown to be a negative cost measure; however, the Precourt study shows photovoltaics as having a negative cost lower than that of energy efficiency, though photovoltaics is shown to have a relatively small potential to reduce GHG emissions. Unlike the McKinsey & Company report, the Precourt report shows that it would require nearly all the measures being considered to meet the stated targets.

As mentioned in the introduction, this report is not intended to be a detailed cost effectiveness study; rather, this report seeks to provide preliminary information to compare the GHG reduction potential against the potential cost of implementation. For nearly each policy evaluated in this report, we provide a discussion of compliance costs, including data from published reports and studies. We estimate life-cycle costs and GHG reductions to create a metric (dollars per ton of MMT CO_2E reduction) that normalize the cost and allows comparisons among policies. Details on the assumptions used to estimate GHG reduction and cost are included in Section 7.

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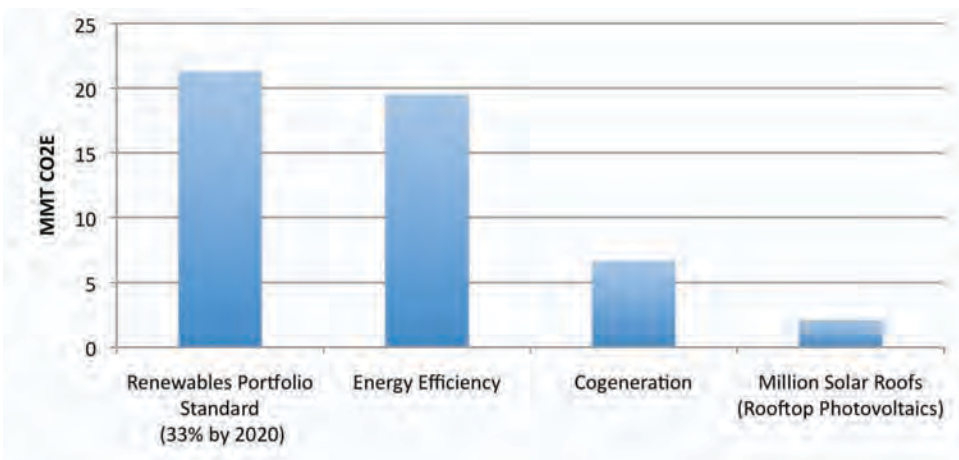
[11] Jim Sweeney, John Weyant, et al., Analysis of Measures to Meet the Requirement of California's Assembly Bill 32, Precourt Institute for Energy Efficiency, Stanford University (Sept. 27, 2009).

3. ENERGY EFFICIENCY

In the San Diego Region 34% of emissions are associated with electricity and natural gas use.[12] While strategies targeting supply, such as a renewable portfolio standard, likely will significantly reduce emissions, reducing consumption through efficiency will play an important role. In the San Diego County Greenhouse Gas Inventory report, we estimated the GHG reduction impacts of 19 strategies, including energy efficiency. As part of a suite of strategies to meet AB 32 targets, electric and natural gas efficiency in the san Diego region could account for 0.9 MMT CO_2E, about 6% of the overall GHG reductions needed.[13] Energy efficiency plays an even more significant role in California's plans to reduce greenhouse gas emissions to 1990 levels by 2020. The California Air Resources Board (CARB) proposes to reduce electric energy consumption by 32,000 gigawatt-hours and natural gas use by 800 million therms by 2020.[14] These levels of energy reduction in addition to expanded combined heat and power, are expected to account for 26 MMT CO_2E (15%) of all the estimated GHG reductions outlined in the CARB's Climate Change Scoping Plan, second in magnitude only to reductions associated with light-duty vehicle emissions controls, which account for 32 MMT CO_2E (18%).[15] Figure 2 presents the expected GHG reduction sources from the electricity and natural gas sector contained in the CARB Scoping Plan.

Figure 2 Role of Efficiency in the CA Air Resources Board Scoping Plan



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[12] Scott Anders et al., San Diego County Greenhouse Gas Inventory: An Analysis of Regional Emissions and Strategies to Achieve AB 32 Targets. University of San Diego – Energy Policy Initiatives Center (Sept. 2008).

[13] Estimated GHG reduction potential for a 10% decrease in electricity consumption was revised down due to refinements in the calculation methodology and a new California Energy Commission electricity forecast.

[14] California Air Resources Board. Climate Change Scoping Plan: a framework for change, DECEMBER 2008. p. 41. *Available at* http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf.

[15] *Id.* at 17.

Other state policies underscore the importance of energy efficiency. On Sept. 18, 2008, the CPUC adopted its Long-Term Energy Efficiency Strategic Plan ("Plan").[16] The Plan outlines strategies and actions between 2009 and 2020 to achieve maximum energy savings in California. The CPUC Plan includes aggressive efficiency goals, including that:

- By 2020, all new homes are net zero energy.
- By 2020, energy consumption in existing homes will be reduced by 40%.
- By 2030, all new commercial buildings will be net zero energy.
- By 2030, 50% of existing commercial buildings will be retrofit to net zero energy.

This section provides background information on energy efficiency, including a discussion of local government jurisdiction in the area of electric and natural gas efficiency, the regional building stock, the remaining potential for efficiency in the San Diego region, and a range of local government policies to reduce greenhouse gases. Each policy is described in detail including information about its potential to reduce GHG emissions, experience from other jurisdictions, cost, time to implement, and policy considerations for local governments considering such policies.

3.1. Background on Energy Efficiency

3.1.1. The Role of Local Government in Energy Efficiency

In general, matters of energy efficiency are regulated by state and federal agencies. In California, state agencies have significant control over energy efficiency. The California Public Utilities Commission (CPUC), which regulates the investor-owned electric and natural gas utilities (IOU), administers the portion of the public good monies used to fund energy efficiency programs. The CPUC establishes energy efficiency targets for IOUs and approves all energy efficiency funding expenditures. The California Energy Commission (CEC) promulgates new building energy standards, known as Title 24, and appliance standards. Despite state regulation of electric and natural gas efficiency in California, local governments can play an important role in promoting efficiency either through direct local regulation or by adopting local policies that support or influence state policy.

An example in which local governments exert direct control is an ordinance to require certain energy efficiency upgrades at the time a building is sold. There is no commensurate state authority within the agencies that regulate energy efficiency in California, though such a requirement could be adopted by statute. An example of where local government can use its authority to influence a state policy is to require all new homes to have Energy Star appliances. Local governments do not promulgate appliance standards but by requiring Energy Star appliances, such a policy would support California's appliance standards, which are typically more aggressive than federal standards.

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[16] California Public Utilities Commission. California Long-tem Energy Efficiency Strategic Plan: Achieving Maximum Savings in California for 2009 and beyond. *Available at*, http://www.californiaenergyefficiency.com/docs/EEStrategicPlan.pdf.

The CPUC's Long-Term Energy Efficiency Strategic Plan specifically addresses the role of local governments in promoting energy efficiency and includes the following specific recommendations for implementing energy savings targets.[17]

- At least 5 percent of California's local governments (representing at least 5 percent of CA total population) each year adopt "reach" (enhanced energy efficiency) codes.
- By 2020, the majority of local governments have adopted incentives or mandates to achieve above-code levels of energy efficiency (or DSM) in their communities, or have led statewide adoption of these higher codes.
- The current rate of non-compliance with codes and standards is halved by 2012, halved again by 2016, and full compliance is achieved by 2020.
- By 2015, 50 percent of local governments have adopted energy efficiency/sustainability/climate change action plans for their communities and 100 percent by 2020, with implementation and tracking of achievements.

The Plan also identifies the following areas where local government authority can reduce energy use in new and existing buildings.[18]

- Ensuring compliance and enforcement of the Title 24 energy code for residential and commercial buildings.
- Adopting building codes beyond Title 24's energy requirements (and potentially other "green" requirements).
- Supporting highly efficient projects that voluntarily exceed minimum energy codes through favorable fee structures, fast-tracked permitting and other innovative and locally appropriate approaches.
- Enacting ordinances with point-of-sale or other approaches that spur efficiency actions in existing, privately-owned buildings.
- Applying efficiency-related "carrots" and "sticks" using local zoning and development authority.

These and other policy options for local governments to encourage energy efficiency are discussed in detail in Section 4.2 and 4.3.

3.1.2. Data on San Diego Building Stock

While cars and trucks are the primary emitters of GHGs in the San Diego region, buildings are the next largest category of emitters. Approximately 80% of GHG emissions in the electricity category and 90% of emissions in the natural gas category are associated with buildings. Overall, electric and natural gas use associated with buildings accounts for about 28% of all greenhouse gas emissions in the region. Understanding from a broad perspective some information about the San Diego region's building stock can be very helpful on determining how to reduce its energy consumption.

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[17] *Id*. at 11.

[18] *Id*. at 89.

Residential Buildings

According to the San Diego Association of Government housing stock data, in 2008 there were 1,147,900 housing units in the region, including single family, multi-family, and mobile homes. Just over 60% of all housing units (over 700,000) were built prior to 1980, about when building energy efficiency standards came into force in California (Table 3).

Table 3 San Diego Region Housing Units by Type for Selected Years[19]

Year	Single Family	Multi Family	Mobile Home	Total	Percentage of 2008 Total
1980	440,794	245,290	37,907	723,991	63%
1985	485,403	274,715	41,466	747,339	65%
1990	554,023	346,414	45,803	946,240	82%
1995	591,621	355,724	46,360	993,705	87%
2000	628,652	364,636	46,861	1,040,149	91%
2005	678,221	384,242	46,037	1,108,500	97%
2008	699,004	403,094	45,802	1,147,900	100%

On average between 1990 and 2008, just over 1% of the entire residential building stock was built new each year and about 3.5% was sold annually (Figure 3).[20] These proportions correspond roughly to statewide numbers, which estimate that roughly 3 times as many homes are sold in California each year than built new.[21] Though not enough data is publicly available to assess trends, limited data suggests that alterations and additions that receive permits account for about 1% of all existing buildings.[22] The CPUC estimates that the balance of renters to homeowners in California is about 42% to 58%, respectively.[23]

[19] Housing Data from the San Diego Association of Governments.

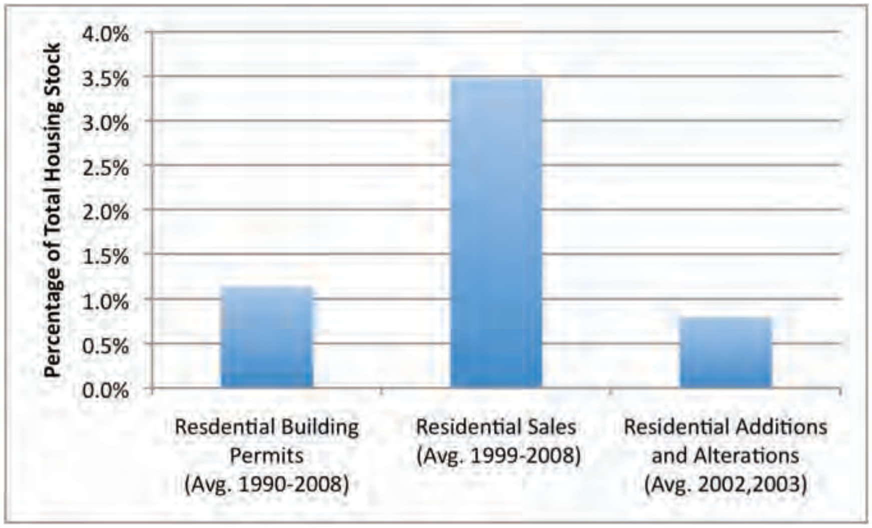
[20] Residential housing stock data provided by San Diego Association of Governments, residential permit data provided by the Construction Industry Research Board.

[21] California Energy Commission, Options for Energy Efficiency in Existing Buildings, p.21 (Dec. 2005).

[22] Rachel Roth. Using Additions and Alterations Permits to Estimate Remodeling Activity in Metropolitan Areas. Harvard University Joint Center for Housing Studies. (Oct. 2004).

[23] California Public Utilities Commission, California Long Term Energy Efficiency Strategic Plan, p.9 (Sept. 2008).

Figure 3 Residential Housing Trends, San Diego County



Efficiency policies that require efficiency upgrades typically have "trigger points" for compliance. In 2008, the California legislature considered but did not pass legislation that would have targeted certain efficiency policies at existing buildings at the time of sale. In the San Diego region, this would capture on average 3.5% of the existing building stock each year. In 10 years, assuming a home sells only once, this would capture 35% of the building stock. Policies targeted at new construction would capture less of the overall building stock. New construction standards only affect 1% of the entire building stock and such standards do not regulate all the energy consumed in the building.

<u>Commercial Buildings</u>

According to data from the CEC, the San Diego region had a total of 537 million square feet of commercial real estate space in 2008. Unlike residential buildings in the region, significant commercial development occurred between 1980 and the present. In 1980, only about 40% of today's commercial building space was already constructed. Table 4 presents the trends of commercial building space, including building space as a percentage of the total that existed in 1980.

Table 4 Commercial Buildings Square Footage for Selected Years[24]

Year	Total Square Footage (MM SF)	Percentage of 2008 Total
1980	208	39%
1985	263	50%
1990	337	64%
1995	388	74%
2000	436	83%
2005	500	95%
2008	528	100%

The type of lease arrangement and term of the lease can be an important factor to determine the building occupant will invest in energy efficiency improvements. In a report on options to reduce energy use in existing buildings, the CEC estimates that in California 23% of commercial floor space is leased. Of that percentage, about 50% are net leases, in which the tenant pays many of the property expenses, including electric and natural gas utility costs.[25] These data on leasing in California indicate that the split incentive problem, where energy efficiency retrofits are not conducted because the building owner does not pay utility expenses and the building occupant does not own the building, remains a significant challenge.

3.1.3. Energy Efficiency Potential in the San Diego Region

There are several primary policy approaches that have been used to reduce energy consumption in California: energy efficiency programs, building standards, and appliance standards. The combination of these has yielded significant energy reductions in California since the 1970s. The CEC estimates that between 1975 and 2003, the cumulative energy savings from efficiency programs and standards are 40,000 GWh, which is equivalent to about 15% of total electricity consumption in 2003.[26]

In this case, energy efficiency programs are defined as those administered by the IOU and funded by the public purpose program charge paid by electric and natural gas utility customers. In 2006, this charge was $0.0585 per kilowatt-hours and represented approximately 4% of the typical San Diego Gas & Electric customer bill.[27]

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[24] California Energy Commission. Final Staff 2009-2020 Forecast (Sept. 2009). Form 2.2 - SDG&E Planning Area California Energy Demand 2008-2018 Staff Revised Forecast Planning Area Economic and Demographic Assumptions.

[25] California Energy Commission. Technical Assistance in Determining Options for Energy Efficiency in Existing Buildings-Appendices, p. F-47 (Dec. 2005).

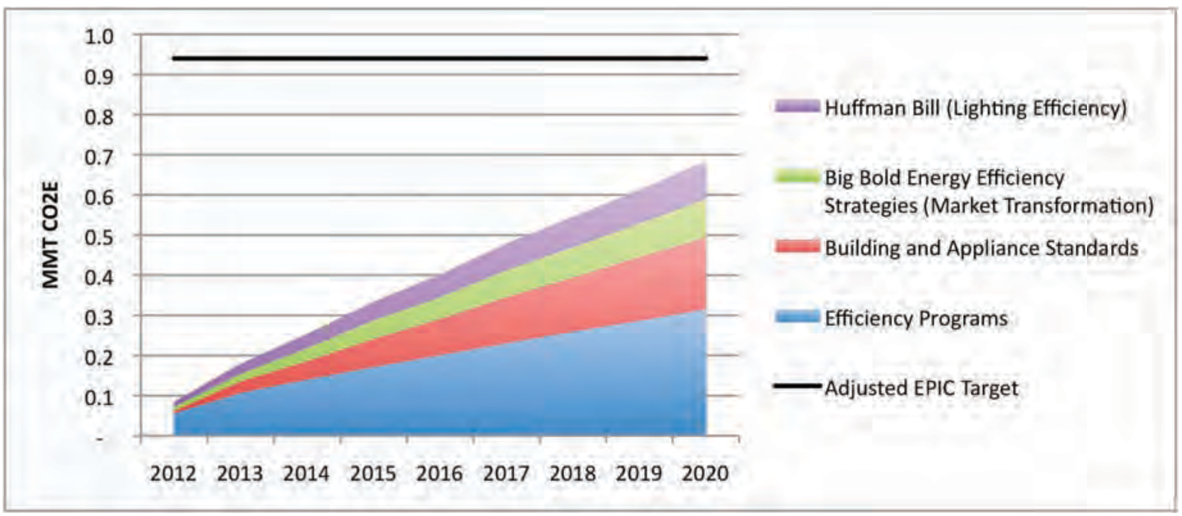
[26] California Energy Commission, Options for Energy Efficiency in Existing Buildings, p. iii (Dec. 2005).

[27] Kuduk, Adi, and Anders, Scott. Following California's Public Goods Charge: Tracking Contributions and Expenditures of the Renewable Energy Program and the PIER Program. Energy Policy Initiatives Center University of San Diego School of Law (Sept. 2006).

California's residential and nonresidential energy efficiency standards for buildings are contained in Title 24, Part 6, of the California Code of Regulations.[28] The standards, which were established in 1978 in response to a legislative mandate to reduce California's energy consumption, are updated regularly to allow for incorporation of new energy efficiency technologies and techniques. The latest iteration of California's building efficiency standards (2008 version) will take effect in October 2009.[29] California's Appliance Standards, which are contained in Title 20 of the California Code of Regulations, were adopted in 1976 and are periodically updated.[30]

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. The CPUC estimates that in the San Diego region, efficiency programs will achieve gross savings of 1,514 GWh and 52 million therms between 2012 and 2020, the largest contributor to energy reductions over this period.[31] Figure 4 presents the GHG emissions reduction implications from the CPUC estimates of future energy savings for the San Diego region. 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 the role of local government policy in reducing GHG emissions.

Figure 4 GHG Reductions from CPUC Estimate of Future Electric and Natural Gas Savings[32]



Energy Efficiency Program Potential

Itron Inc. conduced a detailed, bottom-up study of energy efficiency program potential in San Diego County through 2016 with a long-term projection for 2026.[33] "The primary objective of

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[28] CCR Title 24, Part 6.

[29] 2008 Building Energy Efficiency Standards, *available at* http://www.energy.ca.gov/title24/2008standards/.

[30] California's Appliance Efficiency Program, *available at* http://www.energy.ca.gov/appliances/.

[31] Decision 08-07-047 (Table A-6), issued July 31, 2008 in Rulemaking 06-04-010.

[32] 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.

the work underlying this report was to produce estimates of remaining potential energy savings that might be obtainable in the near (2007-2016) and foreseeable (2017-2026) future through *publicly funded energy efficiency programs* in the existing and new residential, industrial, and commercial sectors"(emphasis added).[34] The purpose of the study was to identify energy savings potential in the residential, commercial, and industrial sectors both for new construction and existing buildings. As noted above, there are other sources of energy reductions; however, the Itron values provide a reasonable proxy of remaining potential and can help local governments target GHG mitigation efforts.

The Itron analysis includes three basic scenarios: (1) base incentive scenario, which includes measures that received incentives in the 2004-2005 energy efficiency program cycle but sets incentive levels to those available in 2006 (this is effectively business as usual); (2) mid incentive, which includes the same measures as the base incentive scenario but sets incentive levels halfway between those available in 2006 and the full incremental cost; (3) full incentive, which sets incentives for all measures to the full incremental cost.[35]

Each of these scenarios were then restricted by allowing only measures that had a total resource cost (TRC) equal to or greater than 0.85; that is, for every dollar invested in an efficiency measure or program, the total benefits to the participant and society would be no less than $0.85. A broad portfolio would have measures above this level and the overall goal is to have a total portfolio TRC over 1, so that the portfolio breaks even in terms of initial costs and long-term societal benefits. The higher the TRC value is above 1 the more cost effective the portfolio.

For purposes of analyzing the GHG implications of future energy efficiency programs and policies in the region, the mid-restrict scenario is a reasonable target and is the basis for the energy efficiency program analysis included here. Table 5 shows the energy savings estimates for the three restricted scenarios for electric and natural gas energy savings. It shows that the energy savings estimates for the mid-restrict scenario for electric efficiency represents just over 4% of the projected 2020 consumption levels. The mid-restrict scenario for natural gas is equivalent to 4% of the 2020 projection. By comparison, EPIC estimates that it would be necessary to reduce electric consumption by 10% and natural gas consumption by 8% to realize sufficient GHG reductions from energy efficiency to reach the hypothetical target of 1990 level emissions in the region by 2020. Additional energy savings is likely to come from statewide building and appliance standards.

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[33] Itron, Inc., California Energy Efficiency Potential Study- CALMAC Study ID: PGE0264.01, (Sept. 2008).

[34] *Id.* at p. ES-2. The report states that "Market potential denotes the energy savings that can be expected to result from specific scenarios relating to program designs and market conditions. Market potential was estimated under 10 scenarios relating to incentive levels, market awareness, cost effectiveness, and the base lighting technology."

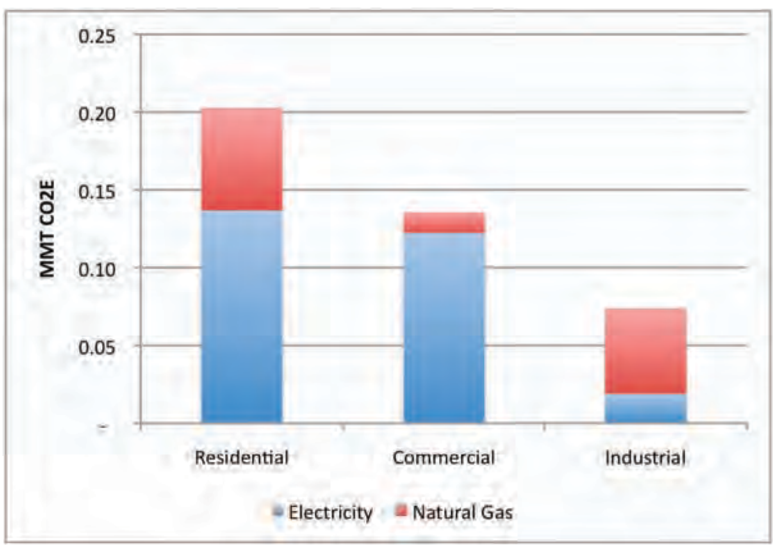
[35] *Id.* at p. 4-2.

Table 5 Projected Energy Reductions from Efficiency Programs (San Diego County, 2020)[36]

ITRON Scenario	Gross Electric Savings (GWh)	Percentage of 2020 Electric Consumption	Gross Natural Natural Gas Savings (MMTherms)	Percentage of 2020 Natural Gas Consumption
Base Restrict	843	3.5%	14	2%
Mid Restrict	1045	4.3%	25	4%
Full Restrict	1140	4.7%	31	5%

The Itron study results show that the residential sector has the highest remaining potential for energy program reductions, representing 49% of the total potential, followed by the commercial (34%) and industrial (17%) sectors. Figure 5 shows the greenhouse gas reductions associated with Itron's estimates. Existing buildings represent 89% of the energy reduction estimate, while new construction represents 11%. The residential existing building sector represents over 48% of the entire efficiency potential identified in the analysis. Commercial existing 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 6 presents the breakdown of GHG emissions associated with energy reductions in each of the sectors covered.

Figure 5 Projected GHG Reductions from Energy Efficiency Potential - Itron Mid-Restrict (San Diego County, 2020)



[36] Values represent incremental energy efficiency potential between 2009-2020. Electric energy projection for San Diego County.

Figure 6 Projected GHG Reductions from Efficiency Programs (San Diego County (2020)

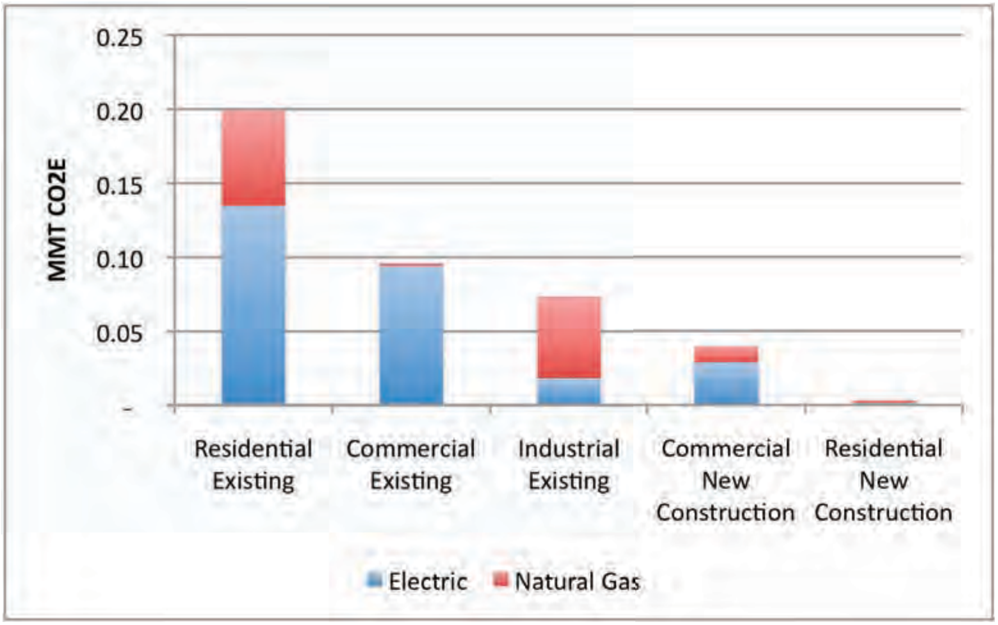


Table 6 provides a summary of the natural gas and electric energy savings estimates and their corresponding greenhouse gas reduction potential. The total GHG emissions reductions associated with the energy savings from programs is 44% of the revised EPIC target for electric and natural gas reductions (0.94 MMT CO_2E).

Table 6 Summary of the Itron 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**

3.2. Policy Options for Reducing Energy In Existing Buildings

Based on results from Itron's energy efficiency potential study, it is clear that the existing building sector has the highest non-standards-based energy savings potential, particularly in the residential sector, and likely should be a priority of regional and citywide policies to reduce greenhouse gases. Challenges exist to reduce energy use in the existing building sector. For example, many residential renters or commercial entities leasing property have no incentive to reduce energy costs because they do not own the building and the owner does not have an incentive because she does not pay the energy bills – this dilemma is known as the "split incentive." Also, the retrofitting needs of each building or home can be different and more costly, customized approaches may be necessary.

As mentioned above, the CPUC has established ambitious energy efficiency targets to reduce the state's energy use in existing homes. It seeks to reduce energy consumption in existing homes by 20% by 2015 and 40% by 2020.[37] To reach these targets would require over 1 million retrofit projects annually until 2020 – about 3,400 projects a day until 2020. In San Diego County, retrofitting all 1.15 million homes would require over 300 retrofits a day until 2020. Table 7 provides a range of penetration and energy savings rates that would be required to reach the electric energy efficiency potential identified by Itron for the San Diego region's existing residential building sector by 2020. For example, it would be possible to reach the 505 GWh energy savings number if 25% of all the homes that existed in San Diego County in 2009 reduced electricity use by about 30%. The table provides values for reductions in all buildings in 2009 and only for buildings that were built in 1980 or earlier.

Table 7 Penetration and Energy Savings Rates to Reach Itron's Electric Efficiency Program Potential Estimate in Existing Residential Homes by 2020 (San Diego County)

	Total	Annual	Monthly	Weekly	Daily	Electricity Reduction Needed (kWh/unit)	Reduction as Percentage of Median Residential Consumption
All 2009 Residential Units	1,151,296	104,663	8,722	2,180	363	439	7%
All Pre-1980 Residential Units	723,991	65,817	5,485	1,371	229	698	11%
50% of 2009 Residential Units	575,648	52,332	4,361	1,090	182	878	13%
50% of Pre-1980 Residential Units	361,996	32,909	2,742	686	114	1,396	21%
25% of 2009 Residential Units	287,824	26,166	2,180	545	91	1,756	27%
25% of Pre-1980 Residential Units	180,998	16,454	1,371	343	57	2,792	42%
10% of 2009 Residential Units	115,130	10,466	872	218	36	4,389	66%
10% of Pre-1980 Residential Units	72,399	6,582	548	137	23	6,979	106%

The CPUC Strategic Plan also has established aggressive targets for existing commercial buildings. According to the plan, "50 percent of existing buildings will be equivalent to zero net energy buildings by 2030 through achievement of deep levels of energy efficiency and clean distributed generation."[38] This would be equivalent to retrofitting about 250 million square feet (1/20th of existing space) per year through 2030.

This section provides analysis on a range of local policies to reduce energy use in existing buildings, including information on the purpose, cost, GHG impacts, lessons from other jurisdictions, policy considerations, and pros and cons of each. A list of the policies and measures discussed in this section and examples of jurisdictions that have adopted similar policies is included in Table 8.

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[37] California Public Utilities Commission, California Long Term Energy Efficiency Strategic Plan. Section 2, page 11.

[38] *Id*. at p. 31.

Table 8 Existing Building Policies and Measures

POLICY OR MEASURE	JURISDICTIONS THAT HAVE ADOPTED THE POLICY OR MEASURE
Regional or Citywide Building Assessment	N/A
Regional or Citywide Energy Efficiency Target (Existing)	Palm Desert (CA), San José (CA)
Regional or Citywide Existing Building Efficiency Task Force	Austin (TX), Seattle (WA)
Energy Rating and Disclosure (Existing)	Austin (TX), Montgomery County (MD), European Union
Efficiency Retrofits	Berkeley (CA), San Francisco (CA), Austin (TX), Wisconsin, New York City (*proposed*)
Retro-Commissioning for Commercial Buildings	New York City (*proposed*)

3.2.1. Strategic Jurisdiction-Wide Building Assessment

One of the barriers to realizing the energy savings in existing buildings is the relative lack of information and understanding about the regional building stock. A strategic assessment of all the buildings within a jurisdiction or the entire region, could help cities direct services and programs. This analysis could be done using the Geographical Information System (GIS), which can integrate and process data sets (layers) in a spatial format. For example, the first layer could be a map of every building within a given geographical area (e.g., city, region, utility service territory). The second layer of information could be the general building characteristic data (e.g. age, type, floor space). These two layers would allow a preliminary analysis to determine the age of neighborhoods and concentrations of building types. A final layer of electric and natural gas billing data could produce an energy-intensity (kWh/square foot) for every building in a specific area. Given the strong connection between energy and water, it may also be useful to integrate water billing data, though the number of water agencies in the region may make this difficult.

This analysis likely would have to be conducted in partnership with the local electric or natural gas utility and due to the confidential nature of utility billing data, no data could be released about individual customers. Utilities could use the results of such an analysis to target its own energy efficiency programs and services, but releasing the data to the public in a way that does not compromise confidentiality would help energy retrofit companies target their services to the areas that had the highest energy reduction potential. It may be possible to aggregate the data in a way that obscures individual customer confidentiality in order to release data to the public, particularly the private sector energy efficiency providers who might use the information to more effectively target their services. For example, if groups of single-family homes fall within a range of energy intensity, neighborhoods could be depicted as high users.

3.2.2. Regional and/or Citywide Target Energy Efficiency in the Existing Building Sector

As noted above, California has established aggressive statewide efficiency targets. Several local jurisdictions in California have established specific energy reduction targets as part of their climate action or sustainability planning. For example, the City of Palm Desert has developed a partnership with Southern California Edison, Southern California Gas Company, and the Energy Coalition, called Set to Save, which has established a goal of reducing energy use citywide by 30% by the end of 2011.[39] In its Green Vision, the City of San Jose seeks to reduce per capita energy consumption by 50% in 15 years.[40]

3.2.3. Regional and/or Citywide Existing Building Energy Reduction Task Force

Since existing buildings could play such a significant role in meeting the region's GHG reduction targets, convening a Task Force to assess policy options can be an effective approach. One advantage to this approach is that broad participation from relevant stakeholders can yield policy recommendations that are politically feasible. It might be more efficient to convene a regional Task Force rather than convening city level groups and some level of coordination and harmonization across the region could be helpful. Alternatively, it might be feasible for the larger cities in the region to convene their own Task Forces and the medium to small sized cities to form sub-regional groups.

There are three prominent examples of city-based Existing Building Efficiency Task Forces or Committees. The Austin City Council established by resolution the Energy Efficiency Retrofit Task Force to "make recommendations for development of an ordinance relating to energy efficiency upgrades and retrofits for existing homes and commercial buildings."[41] The language of the resolution bound the task force to consider energy efficiency mandates when a homeowner attempts to sell an existing home. It also provided for guidance on the membership, specifying the stakeholder groups that would comprise the Task Force.[42] The City of Austin adopted a mandatory auditing and disclosure policy (See Section 3.2.4).

Seattle Mayor Mike Nichols established the Green Building Task Force to "provide guidance on appropriate policy mechanisms that the City can employ to achieve…" goals to reduce energy consumption in new and existing buildings.[43] The Task Force Charter sets up two committees: New Buildings Committee and Existing Building Committee. The charter also set forth policy options for consideration by the committees. The Existing Building Committee was charged with assessing two broad categories of polices. The first category consists of policies that provide financing and incentives that make energy efficiency upgrades cost effective and attractive to consumers. Options in this category could include public or private financing (including utility bill financing), expanded conservation programs, or energy efficiency tax credits. The second category includes policies that require increases in building energy

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[39] Palm Desert's 30% savings target is equivalent to 214.7 M kWh, 48,748 kW peak demand, and 5.7 M Therms Natural Gas, See http://www.settosave.com/.

[40] San Jose Green Vision – Energy Efficiency, *available at*, http://www.sanjoseca.gov/greenvision/EnergyEfficiency.asp.

[41] City of Austin Energy Efficiency Retrofit Task Force information *available at* http://www.ci.austin.tx.us/council_meetings/wams_item_attach.cfm?recordID=8560 (last visited May 19, 2009).

[42] Board of Realtors, "Green" Realtors, Real Estate Inspectors, Real Estate Appraisers, Mortgage Brokers, Mortgage Lenders, "Green" Lenders, Title Companies, County Clerks, Austin Multiple Listing Service, Energy Efficiency Auditors, Home Performance Contractors, The Resource Management Commission, The Electric Utility Commission, Affordable Housing Advocates, Consumer Protection Advocates, Energy Efficiency Advocates, Environmental Justice Advocates, The Austin Apartment Association, The Austin Tenants' Council, Small Multifamily Property Owners, The Building Owners and Managers Association, The International Facility Management Association, The U.S. Green Building Council Central Texas-Balcones Chapter, and The American Institute of Architects.

[43] City of Seattle Green Building Task Force Charter, *available at* http://www.seattle.gov/environment/documents/GBTF_Charter_revdraft8-26-08.pdf.

efficiency, including requiring disclosure of energy use history, energy efficiency audits, energy efficiency upgrades at the point of sale, or enhanced energy codes and standards. The Charter also specified the approximately 25 stakeholder groups that would comprise the Existing Building Committee.[44]

In early 2009 San Francisco Gavin Newsom convened a task force to make recommendations on how the city could reduce the energy use of its existing commercial building stock.[45] The Existing Buildings Efficiency Initiative task force comprises 19 key stakeholders from San Francisco's building ownership, developer, financial, architectural, engineering, legal, utility, and construction communities, who the Mayor selected for their knowledge and experience of the building industry.[46]

Cost to Implement a Stakeholder Existing Building Committee

The cost of a stakeholder committee depends on several factors including the scope of topics to be considered, whether or not consultants are used to conduct analysis, and the level of involvement of local government staff. The City of Seattle estimates that it cost approximately $250,000 to implement its Existing Building Committee.[47] This total includes $150,000 in consultant fees, which was used for policy analysis and facilitation, the time incurred by two city staff members, and administrative costs such as room fees and copying.

Time to Implement

The time needed to implement the committee process varies by the same factors considered above for cost to implement a committee. The City of Seattle's Green Building Task Force (GBTF) provides a representative example of the time necessary. Seattle's Mayor announced the GBTF in February 2008. It met monthly from June 2008 to January 2009 and completed its

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[44] American Society of Home Inspectors, Atmosphere IEM, Inc. (Energy Efficiency Contractors - Residential), BOMA Seattle-King County, Certified Sustainable Development Professional (CSDP), Greenworks Realty ("Green" Realty), Historic Seattle, HomeStreet Bank, International Facility Managers Association, Kennedy Associates (Real Estate Investment Advisors), Keithly Barber Associates (Commissioning Agent), King County Executive's Office, McKinstry (Energy Service Contractors), Northwest Energy Efficiency Alliance, Northwest Energy Coalition (Environmental Advocate), Pacific Northwest Council of Carpenters, Puget Sound Energy, Seattle King-County Association of Realtors, Seattle Housing Authority, Seattle Steam, ShoreBank Enterprise Cascadia (Community Development Financial Institution), Sound Alliance (Social Change Advocate), Tenant's Union of Washington State, University Mechanical Contractors(Energy Efficiency Contractors, Commercial), Washington Land Title Association, and Washington Oil Marketers Association / Genesee Fuel & Heating.

[45] Mayor Launches Task Force to Green Existing Buildings (Feb. 13, 2009), *available at e* http://www.sfenvironment.org/our_sfenvironment/press_releases.html?topic=details&ni=448.

[46] Alexander Hamilton of the law firm MBV; Property manager Angelica Steinmeier; Barry Giles of Building Wise; Greg Cunningham, Enovity; Jeff Palmer, Able Engineering; Jim Smith, Cushman & Wakefield; Jim Cantrell, Cantrell Harris & Associates engineers; Kari Aycock, Hines; Kathy Diehl, US EPA; Laura Rodormer, Swinerton Management & Consulting; Lisa Galley, Galley Eco Capital; Panama Bartholomy, California Energy Commission; Peter Turnbull, PG&E; Peter Liu, New Resource Bank; Phil Williams, Webcor Builders; Raphael Sperry, Simon & Associates; Robin Bass, Hunstman Architectural Group; Steven Ring, Cushman & Wakefield; and William Young, Shorenstein Realty Services.

[47] Personal conversation with Jaimey Boawn, City of Seattle Sustainability and Environmental Department (June 12, 2009).

final policy recommendations report in April 2009.[48] The Existing Building Committee of the GBTF met between September and November 2008.[49] As noted above, the City of Seattle hired consultants to conduct policy assessments, which may have expedited the overall time needed to complete the process.

3.2.4. Energy Ratings and Disclosure

Rating and disclosure policies encourage or require building owners to hire a professional energy auditor or rater to assess the energy performance of the building. Typically an audit is conducted and the building is given an energy performance score using an accepted rating protocol such as the California Home Energy Rating System (HERS) and recommendations on how to improve energy performance. The purpose of rating policies is to disclose the projected energy use of the building to prospective occupants, analogous to the miles-per-gallon sticker on new cars or the energy consumption estimates on new appliances.

In 2008, the California Legislature considered but did not approve AB 2678 (Nuñez), which upon introduction proposed that the CEC develop requirements for energy audits of residential and commercial buildings at the time of sale.[50] The bill was amended and broadened to require the CEC to establish a regulatory proceeding to develop a comprehensive program to reduce energy use in California's residential and commercial buildings. In 2009, the California Legislature adopted AB 758, which has similar provisions as the amended version of AB 2678.[51]

In 2007, California enacted legislation to require commercial buildings staring January 1, 2010 to benchmark energy use through the United States Environmental Protection Agency's Energy Star Portfolio Manager and to disclose this information to prospective buyer, lessee, or lender.[52]

Several cities and the European Union have adopted residential rating and disclosure policies. In November 2008, the City of Austin Texas adopted the Conservation and Disclosure Ordinance.[53] The policy, which took effect June 1, 2009, requires all commercial, residential or multi-family facilities to receive an energy audit if they are 10 years or older, receive services from the Austin Electric Utility, and are for sale, lease, or rent. Building owners must disclose the audit results to current and prospective tenant and buyers. For most consumers, efficiency retrofits remain voluntary; however, multi-family facilities that have an average per-square-foot energy usage exceeding 150% of the average for similar facilities within the Austin Electric Utility service territory are required to undergo mandatory energy efficiency upgrades.

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[48] City of Seattle Office of Sustainability and Environment Website, *available at* http://www.seattle.gov/environment/GBTaskforce.htm.

[49] *Id*.

[50] *See* the California Legislative Information Website, *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_2678&sess=PREV&house=B&author=nunez.

[51] *See* the California Legislative Information Website *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_758&sess=CUR&house=B&author=skinner (last visited 9-19-09).

[52] California Public Resources Code Section 25402.10, *available at* http://www.leginfo.ca.gov/cgi-bin/postquery?bill_number=ab_1103&sess=PREV&house=B&author=saldana. AB 531 was introduced in 2009 to exempt an electric or gas utility from existing customer information disclosure prohibitions when the electric or gas utility is uploading the energy consumption data for the account specified for a building to the US EPA's ENERGY STAR Portfolio Manager.

[53] Ordinance No. 20081106-0467, *available at* http://www.cityofaustin.org/edims/document.cfm?id=123737.

In April 2008, the Montgomery County, Maryland enacted a law to require sellers in single-family homes to disclose certain information about energy use.[54] Under the law, before signing a contract for the sale of a single-family home, the seller must provide the buyer with information about home energy efficiency improvements, including the benefit of conducting a home energy audit; and two copies of the electric, gas, and home heating oil bills or cost and usage history for the single-family home for the immediate prior 12 months.

In December 2002, the European Union adopted the Directive on the Energy Performance of Buildings. It required, among other things, that member states "ensure that, when buildings are constructed, sold or rented out, an energy performance certificate is made available to the owner or by the owner to the prospective buyer or tenant…."[55] Certificates are valid for ten years and must include benchmarks to allow consumers to compare and assess the energy performance.

Cost Considerations of Energy Rating and Disclosure Policies

There are several costs that residents or building owners must bear to comply with rating and disclosure policies, including fees to file with the local jurisdiction, costs of energy audits, and any ensuing upgrades. Cost estimates for an audit and accompanying report with recommendations range from $150-$700, depending on complexity and who conducts the audit.[56] Several possibilities exist to reduce the cost to the resident or building owner, such as capping the cost to comply with the policy. The City of Austin has enacted a policy to require rating and disclosure that caps audits at $300. Another option is to coordinate home energy audits with traditional home inspections. A significant portion of homes - up to 75% - are inspected as part of a sale.[57] Home inspectors could perform an audit or could collect requisite data that would then be analyzed by a qualified rating organization.

There also may be costs associated with any efficiency retrofits installed as a result of an audit and rating. Levels of energy savings and the associated costs would vary by home, but as a rule of thumb, in calculating the cost effectiveness for this policy, we assume that an the cost of an audit is $500 and that an efficiency improvement of 8% would cost $1,000.[58]

GHG Impact

It is unclear how much energy would be reduced by a rating and disclosure policy alone. It is likely that some building owners would execute recommended efficiency measures included in the audit report; however, it is unclear how many retrofits would occur. The effectiveness of a

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[54] Montgomery County Code Chapter 40, real Property Section [[40-13A]] 40-13B.

[55] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the Energy Performance of Buildings.

[56] *Id.*, City of Austin Energy Efficiency Upgrades Task Force Final Report p. 4. (Sept. 2008).

[57] California Energy Commission. Technical Assistance in Determining Options for Energy Efficiency in Existing Buildings -Final Report Appendices, P. A-39 (Dec. 2005). *See also*, GeoPraxis Time-of-Sale (TOS) Home Inspection Program Evaluation, prepared by Robert Mowris and Associates (2004), *available at* www.calmac.org.

[58] This value is based in part on several sources: pro-rated estimates by Sustainable Spaces ($11,000 for $25% reduction in GHG emissions), Consol's estimate savings in the Berkeley RECO program (16%) and for deep retrofits ($10,000 for a 30% energy reduction), Berkeley's cost cap applied to San Diego (~$2,500), and San Francisco's RECO cost cap ($1,300). Average for 15% reduction is about $3,000. Taking only the Berkeley and San Francisco caps, the average cost would be about $1,900.

rating system could be increased when coupled with other programs and policies, such as required efficiency upgrades (Section 3.2.5).

The CEC estimates that a rating and disclosure program at the time of sale could reduce annual residential energy use on average by 535 kWh and 26 therms in California households.[59] To determine emissions reductions from this policy, we reduced these values slightly to reflect San Diego County's slightly lower electricity and natural gas consumption levels. Also, our estimates assume that 25% of audited homes would reduce total energy consumption by 8% total energy reduction, though it may be possible to increase these numbers with customer education. Nonetheless, based on our assumptions, GHG savings would be 0.03 MMT CO_2E if a policy were applied to all residential buildings at the time of sale and 0.02 MMT CO_2E if applied only to buildings built in 1980 or earlier (Table 9). A policy required at time of sale in San Diego County would capture about 3.5% of homes annually and assuming homes only sell once, it would take 30 years to capture all homes. If it were possible to capture more homes annually by having more trigger points for audits total GHG reductions would increase and occur faster.

Table 9 GHG Reductions from Rating and Disclosure Policy (San Diego County, 2020)

Building Population	GHG Reduction (MMT CO2E)	% of ITRON Existing Residential Total	% of EPIC Energy Reduction Target
All Buildings	0.03	16%	3%
Pre 1980	0.02	9%	2%

Policy Considerations

There are several key options that must be considered when developing a rating and disclosure policy.

Rating System. One of the most important aspects is the rating system used to measure energy performance. Several systems exist, including the California version of the Home Energy Rating System and Energy Star for Home Performance. The CEC was required by legislation to establish regulations for a Home Energy Rating System (HERS) Program to certify home energy rating services in California.[60]

Trigger Points. When to require an audit is another important consideration. Trigger points should be sufficient to cycle through the building stock in a reasonable timeframe. Options for trigger point include the time-of-sale. Homeowners would be required to conduct and audit and disclose to potential buyers the energy performance of the home for sale. Another approach would be to require audits by a specific date, which can more systematically cycle through all homes in a jurisdiction. For example, a policy could require homes built in a certain year or range of years to conduct audits within a specified timeline. A similar option would put an expiration date on the energy rating certificate (e.g., 10 years), so homes would have to be audited in regular intervals, depending on the level of efficiency retrofits completed. Other

[59] California Energy Commission, Options for Energy Efficiency in Existing Buildings, p.54 (Dec. 2005).

[60] Public Resource Code Section 25942. See also California Code of Regulations, Title 20, Chapter 4, Article 8, Sections 1670 to 1675.

possible trigger points include rental, lease, other transfers, major retrofits, new electrical accounts, and reappraisals. Each of these would increase the total number of residential units captured by the policy.

Buildings Covered. Which buildings are covered by or exempt from rating and disclosure policies is an important policy choice. Since building codes began in 1978 in California, one option is to limit the policy to buildings built before 1980 or some other date. Austin's policy captures buildings older than 10 years. The CEC proposed a phased approach beginning with a pilot, followed by the first phase in which audits were mandatory only for pre-1980 buildings, and the second phase in which all residential units were required to receive an audit.[61] In addition, exemptions for historic buildings, mobile homes, and homes that have already participated in energy reduction programs should be considered.

Enforcement. How a policy is enforced and penalties for non-compliance are other important issues. As mentioned above, the City of Austin fines residents between $500 and $2,000 for building owners who do not comply with the ordinance.

Advantages and Disadvantages of Rating and Disclosure Policies

Rating and disclosure policies have several advantages. By requiring residential building owners to disclose the energy performance to renters, buyers, and lessors, such policies can increase awareness of building energy performance and could encourage energy efficiency retrofits. Also, once in place, the energy rating systems used for a rating and disclosure policy could be the basis for future requirements for energy efficiency retrofit policies (see 3.2.5 below). Because several energy rating systems exist, including California's Home Energy Rating System, local governments would not have to develop such systems in order to require rating and disclosure.

Rating and disclosure policies also have several disadvantages. Although building owners would be required to disclose energy performance, absent a requirement to increase buildings efficiency there is no guarantee that building owners, renters, or lessors would conduct efficiency retrofits; therefore, it is not clear how much energy and GHG reduction would result from adopting such a policy. A rating and disclosure policy would require a significant number of qualified home energy raters and building performance contractors and other businesses required to conduct retrofits, which currently do not exist. Unless the number of qualified building energy auditors increases, it could be difficult to scale up to significant penetrations of existing buildings in the region. Finally, opposition from stakeholders, particularly the real estate community if a policy uses time of sale as a trigger point, could make adoption of such policies difficult.

3.2.5. Efficiency Retrofit Policies

Efficiency retrofit polices, sometimes called "energy conservation ordinances," require building owners to conduct energy efficiency retrofits at defined trigger points. Examples of these policies include Residential Energy Conservation Ordinances (RECO) and Commercial Energy Conservation Ordinances (CECO). These policies are analogous to policies adopted to increase water efficiency. For example, the City of San Diego Municipal Code (SDMC) 147.04 requires all buildings to install water-conserving plumbing fixtures prior to a change in property

[61] California Energy Commission. Options for Energy Efficiency in Existing Buildings (Dec. 2008).

ownership.[62] City of San Francisco Housing Code Chapter 21A also contains a similar requirement. An overview of existing efficiency upgrade policies is presented below followed by more detailed discussion of the elements of such policies.

Overview of Existing Efficiency Retrofit Policies

The City of San Francisco adopted a Residential Energy Conservation Ordinance in 1982. It requires certain residential property owners constructed before 1978 to make prescribed energy and water efficiency upgrades prior to sale of the property. Owners of single- and two-family dwellings, apartment buildings, and residential hotels must comply at the time of sale. Conversion of a unit from the master meter to an individual meter, major renovation, and condominium conversions also must comply as part of the city approval process. To comply with the RECO, residential property owners who plan to sell their property, must obtain a valid energy inspection, install certain energy and water conservation measures and then obtain a certificate of compliance. Completion of this procedure must occur prior to transfer of title and the seller must provide a copy of the compliance certificate to the buyer prior to title transfer.[63]

The City of Berkeley enacted its RECO in 1987 and a similar Commercial Energy Conservation Ordinance in 1994. Like San Francisco's policy, Berkeley's RECO requires residential property owners that seek to sell, exchange, or substantially renovate their facility to install the required energy efficiency measures (up to cost caps), receive an inspection, and provide a copy of the compliance certification to prospective buyers or in the case of a renovation project, submit a copy to the City's Building Department.[64]

Under Berkeley's CECO, whenever a building is sold, transferred, or undergoes a major renovation, the building owner or responsible party must obtain an energy audit for the building for the purpose of ascertaining the costs and energy savings of each required energy conservation measures, submit the audit findings with proper city department, install all required energy efficiency, obtain a final energy inspection, and file the results with city to demonstrate compliance.

As noted above, the City of Austin has adopted a rating and disclosure policy. Most buildings are not required to install energy efficiency measures; however, in certain cases, owners of all multi-family facilities that are ten years old or older must have an energy audit performed and install efficiency measures. The owner must post and provide to current and prospective tenants the results of the audit in a manner prescribed by rule, and must provide a copy to the director of the Austin Electric Utility within 30 days of its completion. Regardless of age of the building, the director can designate certain facilities as "High Energy Use" if it has an average per-square-foot energy usage exceeding 150% if of the service area average. Owners of these facilities must implement enough efficiency measures to bring it within 110% of service area average within 18 months.[65]

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[62] City of San Diego Plumbing Retrofit Ordinance Compliance, *available at,* http://www.sandiego.gov/water/conservation/selling.shtml.

[63] San Francisco Department of Building Inspection, What You Should Know About the Residential Energy Conservation Ordinance (RECO). November 2007, *available at*, http://www.sfgov.org/site/uploadedfiles/dbi/Key_Information/19_ResidEnergyConsBk1107v5.pdf.

[64] Berkeley Municipal Code Chapter 19.16 §19.16.070.

[65] Austin Municipal Code Chapter 6-7 §6-7-21 et seq.

In 1997, the City of Burlington, VT enacted its Minimum Rental Housing Energy Efficiency Standards Ordinance, which seeks to improve the efficiency of rental housing. It requires that "[u]pon transfer of rental property where there is a deed recorded, an inspection report, signed by a Vermont-licensed mechanical engineer or an inspector certified by the program administrator, must be filed with the city clerk when the deed is recorded in the land records. The inspection report shall either include a certificate of energy efficiency compliance, if the standards of this article are met, or list the standards not met and inform the property owner that the recruited energy improvements must be made within one year of the date of transfer."[66]

The State of Wisconsin adopted its Rental Weatherization Program in 1985, which requires efficiency upgrades in rental properties. Under the policy, a property owner must obtain an inspection by a certified inspector or the Department of Commerce to determine whether the rental unit meets the energy efficiency requirements of the rule. If the property meets the requirements, the inspector issues the owner a certificate of compliance and file a copy with the Department within 15 days. If the property fails, the inspector must notify the owner within 10 days of the reason, defects, and measures required to comply. The owner must then bring the property into compliance (within 1 year if a purchaser "stipulation" applies) and obtain a final re-inspection inspection. Once the owner is given a certificate of compliance (or waiver, stipulation, etc), he must then present it as a precondition of recordation at the time the deed transfer is recorded with the register.[67]

New York City is also considering a policy to require efficiency retrofits in certain buildings.[68] INT 0967-2009 would require buildings over 50,000 gross square feet is required to perform an energy audit and make all retro-commissioning and efficiency retrofit upgrades that have a simple payback of 7 years.

Cost Considerations of Efficiency Retrofit Policies

Efficiency retrofit policies typically include several costs to residents or building owners, including filing fees, inspection fees, and the cost of making the efficiency upgrades. The City of Berkeley Residential Energy Conservation Program (RECO) has a $20 filing fee, $150 in inspection fees, and caps the cost of efficiency upgrades at 1-2 family facilities at 0.75% of the final sale price and $0.50 per square foot when any one structure with three or more housing units is sold. Renovation projects, which are triggered for projects that cost more than $50,000, are capped at 1% of project costs. In addition to these caps, the Berkeley RECO provides for the right to appeal if the resident believes that complying with the ordinance would be unreasonable.[69] Assuming San Diego's median residential housing value is $325,000, the cap for 1-2 family facilities would be $2,500. The City of San Francisco's RECO program also

[66] City of Burlington Code of Ordinances Article VII, Sec 18-503.

[67] Wisconsin Administrative Code, Department of Commerce. Chapter Comm 67 Subchapter III, §Comm 67.05 et seq.

[68] INT 0967-2009. The New York City Council Web Site *available at* http://webdocs.nyccouncil.info/textfiles/Int%200967-2009.htm?CFID=381204&CFTOKEN=24968752.

[69] City of Berkeley. Residential Energy Conservation Ordinance (RECO): A Compliance Guide for Berkeley's Residential Property Owners and Sellers. July 2008. *Available at* http://www.ci.berkeley.ca.us/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Residential%20Energy%20Conservation%20Ordinance%20Compliance%20Guide%202008.pdf.

requires facility owners to pay the cost of inspection and fees related to the program.[70] Program compliance costs are capped at the greater of 1% of the purchase price or 1% of the assessed value for buildings that contain 3 units or more. In the case of single 1 and 2 family units, the cap is $1,300.[71]

The City of Berkeley's Commercial Energy Conservation Ordinance also has cost caps. In the case of facilities that enter the program due to sale, the cap is the lesser of 1% of the value or $150,000. In the case of renovation, the cap is the lesser of 5% of the cost of the renovation or 1% of the value of the facility.

The City of Burlington's policy provides for cost caps for efficiency measures. The ordinance states that "no property owner shall be required to make any specific energy improvement where the cost of making the improvement is greater than seven times the calculated first year savings in energy costs attributable to the improvement."[72] In addition, the cost of energy improvements required under this the policy cannot exceed the lesser of 3% of the sale price of the property or $1,300 per rental unit.[73]

The state of Wisconsin program sets cost caps for inspections at $250. For facilities with 3-8 Rental units the cap is $50 for each additional unit over 2, and for facilities over 8 rental units, $25 for each additional unit after 8.

Cost estimates vary for comprehensive residential retrofit projects. On the lower end of the range, the City of San Francisco's RECO program has a cost cap of $1,300 and has reduced energy use by 10% on average. Achieving higher energy reductions could cost significantly more. For example, upgrading an air conditioner, furnace, sealing ducts, and increasing ceiling insulation to reduce overall energy use by 30% could cost more than $10,000. For our preliminary cost effectiveness calculations, we assume $2,500 for a 15% reduction.[74] This value is based on the assumption that it is less expensive to reduce lower amounts of energy than it would be for a deep retrofit yielding significant savings.

To determine average commercial retrofit implementation costs, we analyzed actual project cost data from SDG&E's Standard Performance Contract Program.[75] Based on data from 2006-2007, the average cost for energy reductions (including lighting, HVAC, and other measures) is $0.75 per kilowatt-hour and $4.35 per therm, which would be equivalent to $1.22 per square foot when combined and applied to the estimated energy reductions in the region. To be conservative, our projected energy savings associated with a commercial efficiency retrofit policy are based on an average cost of $1.50 per square foot.

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[70] Except for condo conversions in which case the inspection will be performed in conjunction with the total conversion inspection already required.

[71] San Francisco Housing Code Chapter 12 §1209.

[72] City of Burlington Code of Ordinances Article VII Sec 18-503.

[73] *Id*.

[74] This value is based on several sources: pro-rated estimates by Sustainable Spaces ($11,000 for $25% reduction in GHG emissions), Consol's estimate savings in the Berkeley RECO program (16%) and for deep retrofits ($10,000 for a 30% energy reduction), Berkeley's cost cap applied to San Diego (~$2,500), and San Francisco's RECO cost cap ($1,300). Average for 15% reduction is about $3,000. Taking only the Berkeley and San Francisco caps, the average cost would be about $1,900.

[75] San Diego Gas & Electric 2008 Energy Efficiency Quarterly Report for Standard Performance Program (SPC) *available at* http://www.sdge.com/regulatory/energyEfficiency.shtml.

GHG Impact of Efficiency Retrofit Policies

The overall GHG reduction impact from an efficiency upgrade policy depends largely on three factors: the number of buildings that are captured each year by the policy, the energy upgrades required, and the cap on efficiency upgrade costs. Estimates vary about how much energy such a policy would reduce. The City of Berkeley estimates that energy savings from their RECO program range from 10-20% per building.[76] Another estimate of the Berkeley RECO program estimates savings at 16%, just about in the middle of Berkeley's estimate.[77] Assuming an annual penetration rate of 2% and that each residential unit reduces its energy consumption by 15%, a residential efficiency upgrade policy in the San Diego region would reduce GHG emissions by 0.14 MMT CO_2E if applied to all 2010 buildings and 0.09 MMT CO_2E if applied only those built prior to 1980. Table 10 shows the emissions reductions for efficiency retrofit policies and how they compare to Itron's estimate for energy reductions from existing residential and the revised EPIC energy reduction target.

Another important factor in estimating emissions reductions from energy efficiency policies is the GHG intensity of electricity. Assuming implementation of a renewable portfolio that requires electric utilities to provide 33% renewable energy by 2020, the GHG content of electricity would decline over time, therefore reducing the GHG impact of energy efficiency. For purposes of estimating GHG emissions reductions associated with energy efficiency policies, we have assumed that all the reduction strategies contained in the San Diego County Greenhouse Gas Inventory report are implemented and that the GHG intensity of electricity declines steadily between now and 2020.

Table 10 GHG Reductions from Residential Efficiency Upgrade Policy, San Diego County (2020)

Building Population	GHG Reduction (MMT CO2E)	% of ITRON Existing Residential Total	% EPIC GHG Reduction Target
All Buildings	0.14	71%	15%
Pre 1980	0.08	41%	9%

A commercial program could have significant GHG reductions. Berkeley estimates that their CECO program on average reduces energy usage 10-15%. Assuming a 2% annual penetration rate and a 15% average electricity savings per facility, a similar program in the San Diego region would reduce GHG emissions by 0.14 MMT CO_2E if applied to all buildings and 0.04 MMT CO_2E if applied to pre-1980 buildings by 2020 (Table 11). The level of energy savings and emissions reductions from a policy that would target all commercial buildings is higher than the estimated mid-range potential identified by Itron.

[76] City of Berkeley, Climate Action Plan April 2009 (3rd DRAFT), p. 51.

[77] Consol, Meeting AB 32 – Cost-Effective Green House Gas Reductions in the Residential Sector, p. 10 (Aug. 2008).

Table 11 GHG Reductions from Commercial Efficiency Upgrade Policy, San Diego County (2020)

Building Population	GHG Reduction (MMT CO2E)	% of ITRON Existing Commercial Total	% EPIC GHG Reduction Target
All Buildings	0.14	142%	15%
Pre 1980	0.04	45%	5%

Policy Considerations

Trigger Point. Like audit and disclosure policies, what actions trigger the requirements of an energy efficiency upgrade policy is an important consideration. The City Berkeley RECO Program requires compliance upon sale, transfer, renovation that cost more than $50,000, and participation in Berkeley First Program, which provides financing for solar photovoltaics projects. Trigger points are the same for the CECO program with the exception that renovation projects that increase total heated or cooled square footage by more than 10% must also comply with the program requirements.[78]

San Francisco's RECO requires efficiency retrofits at the following triggers points: sale, meter conversion (moving one or more units from a master meter to an individual meter), condominium conversions, and major improvements. In the case of major improvements, for 1 and 2 family units the cost of improvements must be greater than $6,000, for facilities of 3 or more units the improvements must be greater than $6,000 per unit, and for residential hotels $1,300 per unit. Other possible trigger points include lease, property tax assessments, and date certain, which would require certain buildings to meet efficiency upgrade requirements by a specific date. Another approach is to have assessments in regular time intervals, such as every 10 years.

Prescriptive vs. Performance. Whether efficiency upgrade measures should be prescriptive or performance-based is another important consideration. Berkeley's RECO Program currently is prescriptive, requiring residents to complete a predetermined list of actions (Table 12) within the cost caps provided.

[78] Berkeley Municipal Code Chapter 19.72 Section 19.72.020.

Table 12 List of Prescriptive Measures from the City of Berkeley RECO Program

Toilets	1.6 gal/flush, or flow reduction devices
Showerheads	3.0 gal./minute flow rate.*
Faucet aerators	2.75 gal./minute flow rate for kitchens and bathrooms.*
Water heater blankets	Insulation wrap of R-12 value
Hot & Cold Water Piping	Insulate the first two feet from the heater to R-3 value
Hot Water Piping in Pumped, Re-circulating Heating Systems	Insulate all pipes to R-3 value
Exterior Door Weatherstripping	Permanently affix weather stripping, and door sweeps or door shoes
Furnace duct work	Seal duct joints add insulation wrap to R-3 value
Fireplace chimneys	Must have dampers, doors or closures
Ceiling insulation	Insulate to R-30 value or greater
Common Area Lighting (multi-unit buildings)	Replace incandescent bulbs with compact fluorescent lamps (CFL) of at least 25 lumens. CFLs will save up to 75% per year of the lighting portion of your electricity costs. A 20-watt CFL is equivalent to a 75-watt incandescent bulb in output. Use a CFL that is 1/4 the watts of the bulb you are replacing to keep the light levels the same.

*Available free from East Bay Municipal Utility District

An alternative to this approach is to make the requirements performance-based. Under this approach, facilities would have to reach a required level of efficiency and the building owner would have some level of flexibility to determine the most cost effective way to achieve those levels. Establishing a standard rating system is required for this approach. As discussed in the section above on rating and disclosure, the California Home Energy Rating System is a possible standard to rate the efficiency of existing residential units and to establish targets for compliance. For commercial buildings, Energy Star Portfolio Manager could be used to assess efficiency and set targets.

Enforcement. Enforcing compliance is essential to the success of energy efficiency upgrade policies. Ultimately enforcement depends on the structure of the policy. For example, enforcement measures for a prescriptive program will differ from those used in a performance program. In most cases, final compliance documents must be filed with a relevant city department and permits or recording of property transfer can be withheld if a property is not in compliance. In addition, some jurisdictions levy fines for violating the efficiency upgrade requirement. For example the City of Berkeley RECO program and Wisconsin Rental Weatherization Program fine property owners who do no comply up to $500.[79]

Transferability of Obligation. Some efficiency retrofit policies allow the building owner to transfer the obligation to the purchaser. For example the Berkeley RECO and CECO programs

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[79] Berkeley Municipal Code Chapter 1.20 Section 1.20.020 and Wisconsin Administrative Code Dept of Commerce Chapter Comm 67, Subchapter III, Section Comm 67.08.

and the Wisconsin Rental Weatherization Program allow compliance to be passed to the buyer.[80]

Buildings Covered. Berkeley's policy requires both residential and commercial buildings to increase efficiency at the time of sale. San Francisco's policy only requires residential buildings to comply. The age of the building is another possible consideration. Since building standards were not adopted until 1979, limiting buildings built before 1980 could be a way to phase in such a policy. The size of the building can also be a policy criterion, particularly for commercial buildings.

The following residential buildings are exempt from San Francisco's RECO: any residential building for which proof of compliance has been properly recorded; any residential building constructed on or after July 1, 1978; any mobile home; any residential building or portion thereof, which is occupied as a hotel or motel unit and which has a certificate of use for tourist occupancy; any portion of a residential building converted to a tourist hotel; and, any building or portion thereof which is a live/work. In addition, title transfers that result from an operation of law, such as such as probate, transfer between family members, and foreclosure are also exempt from RECO.[81]

Other exemptions exist in other policies. For example, the City of Austin's upgrade requirement for multi-family buildings exempts buildings owners that have completed certain energy efficiency upgrades, such as HVAC or duct remediation, through participation in an Austin Electric Utility rebate program within the last ten years.[82] Burlington exempts from its rental efficiency ordinance owner-occupied portions of a multi-unit building; rental properties not rented in winter months; new construction projects subject to and in compliance with the current energy construction standards; hotels, motels, tourist rooming houses, dormitories, hospitals, hospices and nursing homes; buildings or apartments where heating costs are paid by owners of the rental properties; and transfers such as those related to inheritance, divorce, foreclosures, bankruptcies, condemnations and tax sales.[83]

Climate Zone. Buildings located in hotter climate zones may be able to reduce energy more cost effectively than coastal communities. Efficiency retrofit policies may be most effective in hotter, inland climates and communities that span more than one climate zone might consider targeting the hotter climate zones first.

Spending Cap. Both the Berkeley and San Francisco policies provide for a spending cap that limits the amount of money a resident must spend to comply. The caps can be established as a specific dollar amount or a percentage of the property value or renovation costs.

Integration with Other Policies. Local governments should consider how related energy policies interact. For example, the City of Berkeley has a finance program for solar photovoltaics that requires participants to have met the requirements of the RECO program to be eligible.

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[80] Berkeley Municipal Code Chapter 19.16 Section 19.16.080 and Chapter 19.72 Section 19.72.110.

[81] San Francisco Housing Code Chapter 12 Section 1208.

[82] Austin Municipal Code Chapter 6-7 § 6-7-24 Exemptions.

[83] Burlington Code of Ordinances Chapter Article VII Sec. 18-502.

Advantages and Disadvantages of Efficiency Retrofit Policies

Requiring existing buildings to increase efficiency has one main advantage: unlike the rating and disclosure policy discussed above, an efficiency retrofit policy would guarantee a certain level of energy and GHG emissions reductions. And because existing buildings in the residential and commercial sectors hold the highest potential for energy savings in the region, an efficiency retrofit policy could yield significant GHG emissions reductions. In general efficiency retrofits are cost effective. Commercial efficiency retrofits had among the lowest cost of GHG reduction of all the policies we evaluated here. Residential efficiency retrofits had a medium cost but the highest potential for GHG reductions. Also, because there are several long standing efficiency retrofit policies in California, policy development would be relatively easy.

Perhaps the biggest disadvantage to such a policy at this time is the insufficient number of qualified energy auditors and retrofit companies in the region. A required efficiency retrofit policy would require a significant increase in the number of auditors and retrofit professionals. Also, an efficiency retrofit policy would require more administrative start up and cost than a rating and disclosure policy. If a rating and disclosure policy is adopted first, it might be easier to implement an efficiency retrofit policy, since the rating infrastructure and procedures would already be in place. The real estate and commercial building owner and manager communities could oppose a required efficiency retrofit policy.

3.2.6. Retro-Commissioning of Commercial Buildings

"Building commissioning is a systematic process of ensuring that a building performs in accordance with the design intent, contract documents, and the owner's operational needs."[84] Commissioning can occur at any or all three phases of building's life-cycle. Initial commissioning applies to new buildings and involves subjecting the structure to an intensive quality assurance process that beings with construction and continues into the building's operational period. Retro-commissioning applies to existing buildings and involves improving the way building elements function together and the buildings operations and maintenance practices. Re-commissioning applies to previously commissioned buildings that require re-verification due to some triggering event such as change in building use or similar transition.[85]

This section focuses on retro-commissioning. According to the CEC, retro-commissioning is 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."[86] A proposed New York City policy defines retro-commissioning measures as "non-capital work such as repairs, maintenance, adjustments, changes to controls or operational improvements that optimize a building's energy performance, and that have been

[84] Monitoring-Based Commissioning: Benchmarking Analysis of 24 UC/CSU/IOU Projects. Lawrence Berkeley National Laboratory Report (LBNL-1972E) (June 2009).

[85] Mills, E., H. Friedman, T. Powell, N. Bourassa, D. Claridge, T. Haasl, and M.A. Piette. 2004. "The Cost-Effectiveness of Commercial Buildings Commissioning: A Meta-Analysis of Existing Buildings and New Construction in the United States." Lawrence Berkeley National Laboratory Report No. 5663.

[86] California Energy Commission, Options for Energy Efficiency in Existing Buildings, p.viii (Dec. 2005).

identified by a systematic process of investigating and analyzing the performance of a building's equipment and systems that impact energy consumption."[87]

Experience of Other Jurisdictions

The New York City Council is considering a policy that would, among other things, require retro-commissioning in large buildings. [88] Under the proposed policy, buildings that are 50,000 gross square feet or larger and multiple buildings on the same lot that exceed 50,000 gross square feet, would be required to receive an audit to identify all reasonable retro-commissioning and retrofit measures. A building owner would be required to complete all retro-commissioning measures identified that have a simple payback of 7 years or less. Certain exemptions apply for buildings that have demonstrated an acceptable level of efficiency or are LEED certified and in cases where the actual installation of a measure contained in the audit report exceeds the projected cost by more than 20% and increasing the simple payback beyond the 7-year maximum.

Cost Considerations of Retro-Commissioning Policies

A 2004 Lawrence Berkeley National Laboratories (LBNL) report on the cost effectiveness of retro-commissioning estimated that implementation costs of those projects surveyed average $0.41 per square foot.[89] The study also found that on average retro-commissioning projects reduced energy use by 15% and had a simple payback of 8.5 months. More energy-intensive buildings, such as laboratories, had a 2.5-year payback. A 2005 CEC report estimated costs at $0.68 per square foot.[90] To be conservative, for purposes of calculating preliminary cost effectiveness levels, we assume a rate of $0.55, a blend of these two estimates. Retro-commissioning is among the most cost effective policies that we evaluated in this report.

GHG Impact of Retro-Commissioning Policies

The CEC estimates that retro-commissioning could reduce energy use annually by 1.5 kWh and 0.07 therms per square foot of commercial building space.[91] Given San Diego's climate and slightly lower average gas and electric use compared to the state as a whole, to estimate GHG emissions reductions, we used savings rates of 1.3 kWh and 0.03 therms per square foot. We assume, based on estimates by the CEC, that about 2% of the buildings each year could be retro-commissioned.

Based on these assumptions, we estimate that a retro-commissioning policy would reduce GHG emissions by 0.08 MMT CO_2E and 0.02 MMT CO_2E if applied to all buildings and pre-1980 buildings, respectively. Table 13 presents the potential GHG reductions associated with a retro-

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[87] Int 967-2009. The New York City Council Website *available at* http://webdocs.nyccouncil.info/textfiles/Int%200967-2009.htm?CFID=381204&CFTOKEN=24968752.

[88] *Id*.

[89] Mills, E., H. Friedman, T. Powell, N. Bourassa, D. Claridge, T. Haasl, and M.A. Piette. 2004. "The Cost-Effectiveness of Commercial Buildings Commissioning: A Meta-Analysis of Existing Buildings and New Construction in the United States." Lawrence Berkeley National Laboratory Report No. 5663.

[90] California Energy Commission, Options for Energy Efficiency in Existing Buildings, p.67 (Dec. 2005).

[91] California Energy Commission, California Energy Commission, Options for Energy Efficiency in Existing Buildings, p.67 (Dec. 2005).

commissioning program and its relation to the Itron potential for existing commercial buildings and the adjusted EPIC GHG reduction target for electric and natural gas efficiency.

Table 13 GHG Reductions from a Commercial Retro-Commissioning Policy, San Diego County (2020)

Building Population	GHG Reduction (MMT CO2E)	% of ITRON Existing Commercial Total	% EPIC GHG Reduction Target
All Buildings	0.08	75%	8%
Pre 1980	0.02	24%	3%

Policy Considerations

The considerations for developing a retro-commissioning policy are similar to those discussed above for auditing and disclosure and retrofit policies.

Trigger Point. There is a range of options to establish the point at which a building owner would be required to comply with a retro-commissioning policy. Similar to the existing building policy options above, these include, time of sale, time of lease, date certain, or a rolling requirement that would require buildings to have their facilities commissioned after a given number of years.

Buildings Covered. Retro-commissioning is typically intended for commercial buildings. Buildings covered by a policy could be based on age and buildings size, and measured in square feet. As mentioned above, New York City's proposed policy would require retro-commissioning for buildings that are 50,000 square feet or larger and 10 years old or older.

Compliance Cost Cap. Similar to auditing and disclosure and retrofit policies, a retro-commissioning policy could include a limit on the cost to comply. New York City's proposed policy would set a maximum payback limit at 7 years. Other options would be to establish a dollar amount calculated as a percentage of the value of the buildings, as is done in the Berkeley CECO program, which has a compliance cost cap of the lesser of 1% of the value or $150,000.

Integration with Other Policies. The proposed New York City retro-commissioning policy is part of a broader policy to reduce energy use in existing buildings that requires audits and retrofit measures.

Advantages and Disadvantages of Retro-Commissioning Policies

The most significant advantage of a commercial retro-commissioning policy is cost effectiveness. Retro-commissioning had among the lowest GHG abatement cost of the policies evaluated here. If a policy were targeted to all existing buildings, it could yield moderate GHG reduction. Also, retro-commissioning is an established practice and there is a developed retro-commissioning infrastructure in the region, including incentive programs offered by San Diego Gas & Electric.

One drawback to adopting such a policy is that none currently exist in the U.S., which could add to policy development and start up costs. If a retro-commissioning policy only targeted buildings built prior to 1980, it would only deliver a low level of GHG emissions reductions. In addition, any requirement on existing commercial buildings could engender opposition from the commercial building owner and management communities.

3.2.7. Solar Water Heating Retrofits

While no cities in the U.S. have adopted a policy to require residential solar water heating retrofits, examples exist from other regions of the world. As an example, in July 1999, Barcelona, Spain adopted a policy requiring that solar hot water systems supply a portion of the overall hot water supply of certain buildings.[92] Barcelona's Solar Thermal Ordinance applies to new construction, major rehabilitations, buildings seeking a change of use that have an annual average forecasted hot water need greater than 276,000 net British Thermal Units (BTU) or 2.8 therms.[93]

A policy to encourage or require solar water heating could significantly reduce GHGs in the region. Assuming that 10% of all residential units installed solar water heaters by 2020, annual energy savings is 117 for systems that offset natural gas therms and 2,700 kWh for electricity, and that 60% of retrofits offset natural gas and 40% offset an electricity, total emission reductions would be 0.09 MMT CO_2E, if applied to a percentage of all buildings.[94] If applied as a percentage of pre-1980 buildings, total emissions savings would be 0.05 MMT CO_2E. Estimated solar water heating implementation costs, based on data from the CSI Solar Water Heating Pilot Program, are slightly below average among the policies we evaluated – greater than residential efficiency retrofits but less than photovoltaics requirements.

3.2.8. Summary of Findings for 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. Improving the energy efficiency of existing residential and commercial buildings has the greatest potential among the policies assessed to reduce energy and GHG emissions in the region. Residential and commercial retrofits have the greatest potential to reduce GHG emissions among the policies evaluated here. Figure 7 presents estimates of emissions reductions for the all-buildings and pre-1980 building scenarios. Four policies have high potential to reduce GHG emissions[95]: residential efficiency retrofits in all buildings, commercial efficiency retrofits in all buildings, residential efficiency retrofits in pre-1980 buildings, and commercial retrofits in all buildings. Two policies, commercial efficiency retrofits and retro-commissioning, have both a low cost per metric ton of CO_2E reduction and high potential to reduce GHG emissions, depending on how many buildings are targeted by the policy. Residential efficiency retrofits have a medium cost of implementation. None of the policies with a high potential to reduce GHG emissions had a high cost. A summary of the GHG reduction potential and cost of implementation are presented in Table 14, which is sorted by potential to reduce GHG emissions.

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[92] For a copy of the ordinance, see the Barcelona Energy Agency Website, *available at,* http://www.barcelonaenergia.cat/document/OST_Explicac_eng.pdf (last visited June 20, 2009); *See also* http://www.barcelonaenergia.cat/eng/operations/ost.htm (last visited June 30, 2009).

[93] City of Barcelona, Spain. Ordinance on the Incorporation of Solar Therms Energy Collection in Buildings. Article 2 (c).

[94] Energy reduction estimates and percentage of natural gas and electric systems from CSI-Thermal Program: Energy Division Staff Proposal for Solar Water Heating Program, issued in Rulemaking 08-03-008, *available at* http://docs.cpuc.ca.gov/efile/RULINGS/104403.pdf.

[95] *See* Section 7.5 in the Appendix for more information the GHG reduction potential and implementation cost categories.

Residential energy rating and disclosure is the only policy intended for existing buildings that has a low potential to reduce GHG. It also has a high cost in part because only a fraction of the homes audited were assumed to have conducted efficiency improvements. Despite its emissions reduction potential and cost profile, this policy could help to raise awareness about building energy performance and provide the framework for future efficiency retrofit requirements.

Figure 7 Greenhouse Gas Emission Reduction Estimates for Existing Building Policies (2020)

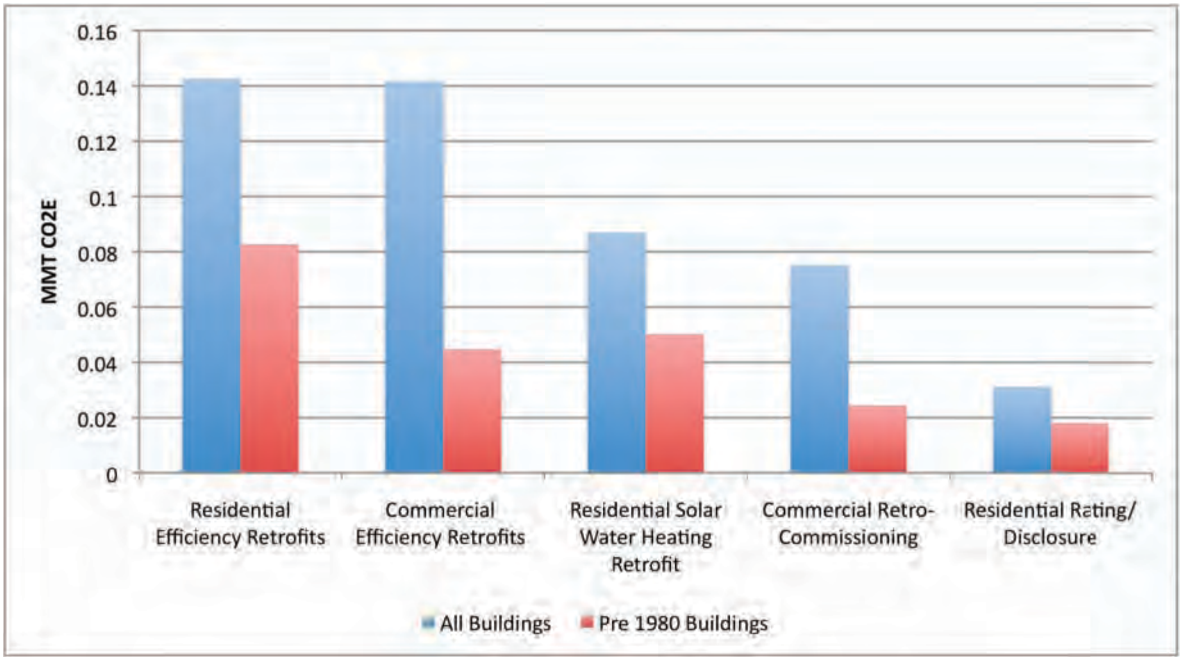

Table 14 Summary of GHG Reduction Potential and Cost for Existing Building Policies (Medium Scenario 2020)

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 Rating/Disclosure (ALL)	M	H
Commercial Retro-Commissioning (Pre-1980)	L	L
Residential Rating/Disclosure (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.

3.3. Policy Options for Reducing Energy in New Construction

In the San Diego region, new homes account for about 1% of the total building stock annually and therefore hold significantly less potential for GHG reductions than the existing building sector. Of the total energy efficiency *program* potential remaining in San Diego, less than 1% is expected to come from residential new construction and 6% from commercial new construction.[96] This estimate, taken from the Itron efficiency potential study, only represents the remaining potential from programs such as those managed by the local utility and belie the potential savings from future new construction and appliance standards; however, this report focuses on areas that local governments have direct jurisdiction over, such as local codes and standards, permitting, and zoning, and areas that they have some influence over. The new construction policies evaluated below are presented in Table 15 along with examples of jurisdictions that have adopted similar policies.

[96] Itron, Inc., California Energy Efficiency Potential Study- CALMAC Study ID: PGE0264.01, (Sept. 2008).

Table 15 New Construction Policies

POLICY OR MEASURE	JURISDICTIONS THAT HAVE ADOPTED THE POLICY OR MEASURE
Enhanced New Construction Building Energy Standards	San Francisco (CA), City of Santa Barbara (CA), Palm Desert (CA), Marin County (CA), 10 other CA Cities
Energy Efficiency Appliances	Santa Barbara (CA)
Energy Rating and Disclosure	Kansas, South Dakota
Pre-Plumb for Solar Water Heating	Chula Vista (CA), Carlsbad (CA)

3.3.1. Enhanced New Construction Building Energy Standards

California's Building Energy Efficiency Standards comprise the provisions of California Code of Regulations, Title 24, Part 1, Ch. 10 (California Building Standards Administrative Code) and Title 24, Part 6 (California Energy Code). The Chapter 10 provisions set forth the governing regulations relevant to Part 6, which actually contains the substantive provisions pertaining to building energy performance and standards. The California Energy Code, which sets energy efficiency standards for residential and nonresidential buildings, is administered by the CEC and updated periodically to incorporate new technology, methods, and legislative mandates. Title 24 is published triennially and enforced at the state level by the by the Building Standards Commission; however, enforcement is delegated to the local government agency in charge of overseeing building permitting and construction within each jurisdiction.

CA law permits local governments to adopt mandatory building energy standards that exceed California's Title 24. Since building energy standards in California are developed at the state level, a local government must obtain official approval before imposing more stringent standards within its jurisdiction. The procedure for obtaining such approval is set forth by Public Resources Code § 25402.1(h)(2) and Section 10-106 of the Building Standards Administrative Code. The Public Resources Code calls for two separate inquiries: a determination by the local government that the proposed standards are "cost effective," and the finding by the Commission that the proposed standards "will require the diminution of energy consumption levels permitted by [Title 24]." The process allows local governments to do three things: adopt the periodic updates to the state standards before the statewide effective date (advanced adoption); require additional energy conservation measures; and/or, set more stringent energy budgets.

The CPUC recommends in its Energy Efficiency Strategic Plan that local governments consider adopting enhanced building energy codes – referred to sometimes as "reach codes."[97] Many local governments in California have adopted some form of enhanced green building standards, but only 14 have adopted ordinances requiring higher energy standards than required by California's 2005 Building Energy Efficiency Standards Title 24, Part 6.[98]

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[97] California Public Utilities Commission, California Long Term Energy Efficiency Strategic Plan (Sept. 2008).

[98] Local governments that have adopted more strict energy standards include: Culver City, La Quinta, Los Altos, Los Altos Hills, Marin County, Mill Valley, Palo Alto, Palm Desert, Rohnert Park, City and County of San Francisco, San Mateo County, Santa Barbara, Santa Monica, and Santa Rosa, *available at*: http://energy.ca.gov/title24/2005standards/ordinances_exceeding_2005_building_standards.html.

The CPUC also has established a long-term goal that all new homes will be net zero energy by 2020.[99] To achieve this ambitious goal the CPUC also recommends developing a pathway to achieving zero net energy, including the following targets to reach zero net energy by 2020[100]:

- By 2011, 50% of new homes will surpass 2005 Title 24 standards by 35%; 10% will surpass 2005 Title 24 standards by 55%.
- By 2015, 90% will surpass 2005 Title 24 standards by 35%.
- By 2020, all new homes are zero net energy.

In 2008, the California Building Standards Commission approved the California Green Building Standards Code.[101] The code seeks to establish a voluntary statewide green building standard that addresses health and water and energy efficiency. These standards, which will become effective August 1, 2009 provides a minimum standard that can be adopted or exceeded by local governments.[102] Although not required, the code encourages buildings to achieve a level of energy performance at least 15% better than the 2005 version of Title 24 requirements.

Overview of Enhanced New Building Energy Standard Policies

Enhanced new construction energy standards vary in scope, strictness, and design. Some focus on energy specifically while others are part of broader green building policies. Some are mandatory, while others are voluntary. Because the new construction sector has relatively low potential for GHG reductions, we present a sample of the mandatory policies in California.[103] The policies summarized here represent a range of policy approaches and city sizes.

In 2002, the County of Marin adopted mandatory energy efficiency standards for single-family homes.[104] Under the ordinance, all new single family homes, additions and substantial remodels must exceed the 2005 Title 24 Standards by 15% or greater. Projects that are 4,500 square feet or greater are required to reduce energy use to a greater degree. Residential buildings between 9,500 and 10,499 square feet are required to exceed Title 24 requirements by 51.5%. Energy targets for these buildings increases as the square footage of the building increases and vary by climate zone.

In 2008, the City and County of San Francisco enacted a mandatory Green Building Standard that requires new commercial buildings over 5,000 square feet, all new residential buildings, and renovations to areas over 25,000 square feet to meet certain levels of green building

[99] California Public Utilities Commission, California Long Term Energy Efficiency Strategic Plan, Section 1 page 6 (Sept. 2008).

[100] California Public Utilities Commission, California Long Term Energy Efficiency Strategic Plan, Section 2, p. 11 (Sept. 2008).

[101] California Green Building Standards Code, CCR, Title 24, Part 11.

[102] *Id.* at Section 101.7.

[103] For a more complete listing of energy-related and green building policies, see the California Office of the Attorney General Website *available at* http://www.ag.ca.gov/globalwarming/greenbuilding.php.

[104] Ordinance No. 3492. Ordinance of the Marin County Board of Supervisors Amending Section 19.040.100 Adopting Energy Efficiency Standards for Single Family Dwellings, Available at: http://www.co.marin.ca.us/depts/CD/main/comdev/advance/sustainability/greenbuilding/pdf/Ord3492-2008SFDEEO.pdf.

requirements.[105] In most cases building classes are required to meet an increasing Green Building standards over time, based either on the LEED or GreenPoint rating systems. The energy component of the policy requires buildings to achieve a level of efficiency 14% better than Title 24.[106] All projects that meet or exceed LEED Gold rating receive priority permit processing.[107]

The City of Santa Barbara's Local Energy Efficiency Standards requires the following building projects to meet energy efficiency standards: all new buildings, renovations above 100 square feet of conditioned area, indoor lighting alterations in conditioned space greater than 100 square feet in non-residential buildings, all new mechanical heating or cooling systems, and all projects that involve, new heaters or circulation pumps for swimming pools, spas and water features.[108] Santa Barbara requires certain mandatory efficiency requirements including that all appliances for residential construction must be Energy Star rated, all swimming pool and spa heaters and pumps must meet performance specifications, and mechanical heating and cooling systems must also meet certain National Electrical Manufacturers Association (NEMA) standards.[109] In addition, the policy requires all low-rise residential new construction or remodel projects are required to be 20% more efficient than Title 24, all new high rise residential building to be 10-15% more efficient, depending on compliance approach, and additions to high rise residential buildings to be 15% more efficient. Commercial buildings also are covered by the policy. All non-residential and hotel/motel occupancies must be 10% more efficient than required by Title 24.

The City of Palm Desert adopted required energy efficiency standards that combine prescriptive requirements and performance targets. All new homes and remodels are required to install certain lighting, mechanical, swimming pool equipment.[110] In addition, new projects are required to meet energy standards that are between 5% and 15% better than Title 24, depending on building type and size.[111]

Many jurisdictions in California have adopted voluntary new building standards that encourage energy performance better than Title 24, including the City of San Diego and City of Solana Beach. The City of San Diego's Sustainable Building Policy expedites the ministerial and discretionary permitting processes for project that meet specified energy performance standards, renewable energy generation targets, and green building certification.[112] Solana Beach has adopted a program that provides expedited permit processing and public recognition for building projects that meet the voluntary green building targets using the GreenPoint rating system (residential) and LEED (commercial).[113] Given the low numbers of homes built each

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[105] City of San Francisco Building Code Chapter 13C.

[106] City and County of San Francisco, Department of Building Inspection, Administrative Bulletin No AB-093 (Sept. 24, 2008).

[107] San Francisco Planning Department. Director's Bulletin 2006-02 (Sept. 28,2006).

[108] Santa Barbara Municipal Code Title 22, Chapter 22.82, Section 22.82.030.

[109] *Id.* at Section 22.82.050.

[110] Code of the City of Palm Desert Chapter 24.30, Section 24.30.030.

[111] *Id.* at Section 24.030.040.

[112] City of San Diego Council policy 900-14, Sustainable Building Policy (May 20, 2003).

[113] City of Solana Beach Green Building Policy *available at* http://www.ci.solana-beach.ca.us/ContentPage.asp?ContentID=322.

year relative to the total building stock and the voluntary nature of these policies, it is likely that the GHG reductions would be minimal.

Cost Considerations for Enhanced New Building Energy Standards

Cost to comply with enhanced building standards varies depending on many factors including climate, building type and size, and the requirements of the policy. Local governments seeking to adopt required building energy standards that exceed California's Title 24 requirements must demonstrate the cost effectiveness of compliance. Based on the review of local government proposals to enact local building energy standards, to calculate the cost to comply with a 15% increase over 2008 residential Title 24 standards, we assumed a cost of $1,500. For commercial building standards, we assumed a $1.00 per square foot cost to comply with a policy that requires 10% better than Title 24.

Because Title 24 and enhanced building standards based on Title 24 do not affect appliances, we also calculated to cost of requiring Energy Star appliances in new homes. Based on information from the U.S Environmental Protection Agency and the U.S. Department of Energy, the additional cost of an Energy Star appliance is $30 for refrigerators, $129 for washing machines, and for dishwashers there is no incremental cost. Based on these cost data and the potential energy savings, requiring Energy Star appliances in new homes is among the most cost effective policy measures we evaluated. Further declines in the incremental cost of Energy Star appliances would make this policy even more cost effective.

GHG Impact of Enhanced New Building Energy Standard Policies

Greenhouse impacts from enhanced new construction energy standards likely will be relatively small compared to those possible from the existing building sector. This is true for three main reasons. First, compared to the existing building stock, the percentage of new buildings constructed each year is relatively small. For example, in the residential sector, about 3 times as many homes are sold than built new each year. Second, Title 24 is one of the best building energy standard in the nation and any incremental improvement would yield relatively small energy savings. Finally, Title 24 does not regulate the total amount of energy used in a home or commercial buildings; therefore an incremental increase in Title 24 requirements may not have a significant impact on overall energy usage.

Nonetheless, local enhanced energy standards for new buildings could yield measurable GHG savings. Assuming a standard that is 15% better than 2008 Title 24 for residential buildings and 10% better for commercial buildings, a policy could reduce greenhouse gas emissions by 0.05 MMT CO_2E (0.01 MMT CO_2E from residential standards and 0.04 MMT CO_2E from commercial standards). These GHG reduction values are equal to or higher than those provided by Itron (commercial 0.04 MMT CO_2E and residential 0.003 MMT CO_2E). It should be noted that Itron's numbers are for potential for energy efficiency *programs* only and the values presented here would be more akin to the savings expected from building standards. Table 16 includes the estimated GHG reductions for both residential and commercial enhanced building standards without the retrofit mitigation option discussed below.

Table 16 GHG Reduction from Enhanced New Building Standards (Medium Scenario 2020)

Building Population	GHG Reduction (MMT CO2E)	% EPIC GHG Reduction Target
Residential	0.01	2%
Commercial	0.04	4%
Total	**0.05**	**6%**

A policy to require Energy Star appliances in all new homes would reduce GHG emissions in the region by about 0.01 MMT CO_2E, about commensurate with the emissions savings from an enhanced residential building energy standard and among the lowest of all the policies evaluated.

Policy Considerations for Enhanced New Building Energy Standards

There are many policy design and implementation options related to enhanced new building energy standards. The following discusses a range of potential policy considerations.

Mandatory vs. Voluntary Measures. Whether a policy is mandatory or voluntary is an important policy consideration. Mandatory policies capture more buildings and lead to more energy and GHG savings. A potential downside is that they are not as politically feasible as voluntary measures. As mentioned above, while voluntary measures can raise awareness about energy and other issues related to new construction, and they can lead to savings, because the new construction sector touches such a small percentage of the overall building stock, voluntary measures likely would not deliver significant energy or GHG reductions.

Performance vs. Prescriptive. Similar to efficiency retrofit policies, enhanced energy or green building standards can be performance based or prescriptive. Performance based policies can use an accepted rating standards like Build it Green or LEED to set targets and to determine compliance. Most of the jurisdictions that have enacted these policies use a performance based approach; however, there are some examples where a jurisdiction used a combined approach with a general performance based requirement coupled with mandatory prescriptive measures. Examples of cities that have prescriptive energy efficiency elements include: Palm Desert, which requires certain lighting, motor and pump efficiency; City of Rohnert Park, which requires variable speed pool pumps and Energy Star exhaust fans; Santa Barbara, which also requires variable speed pool pumps and energy star appliances and NEMA premium HVAC motors; and, City of Santa Monica, which requires efficient water heating, Energy Star appliances, light sensors and dimmers.[114]

Baseline Energy Standard. Many policies use California's Title 24 as a benchmark energy standard and require buildings to be some percentage more efficient than required under state law. Because Title 24 is periodically reviewed and regularly updated to be stricter, a local requirement to exceed Title 24 is an increasing target. Local governments can either revise their local standards periodically when Title 24 is revised or adopt a percentage knowing that it will be increasingly difficult to attain.

[114] California Department of Justice, California Attorney General Office, Local Government Green Building Ordinances in California (Dec. 18, 2008).

Pathway to Net Zero Energy. The CPUC has established aggressive long-term efficiency targets for California, including a goal for all new homes to be zero net energy by 2020. Local governments could structure an enhanced energy standard to create a pathway to this ambitious goal. For example, the City of San Francisco has implemented a standard that has increasingly strict targets over time and provides credits for solar photovoltaics.

Buildings Covered. Residential and commercial new construction projects are typically covered by most enhanced energy or green building policies. Some policies also specify which building sizes (by square footage) are covered by the policy. Many cities have also required major remodels, typically defined by floor space, to comply with the standard. The specific building types and sizes should be determined in part by general building patterns in a jurisdiction. More urban areas cities like San Francisco might have different building patterns than more diffuse development common in the San Diego region.

Enforcement. Increased standards are ineffectual if they are not property enforced. Enforcement of enhanced energy standards is usually incorporated into the standard enforcement regime the jurisdiction uses to ensure building code compliance in general. This can range from passive measures like requiring documentation or certification prior to permit approval or deed recording, or active measures such as requiring on-site inspection and/or review of plans and materials to ensure compliance and avoid extra fees or fines. Recognizing the importance of enforcement, the County of Marin's Single Family Dwelling Energy Efficiency Ordinance includes specific language regarding enforcement.[115] A more detailed discussion of T24 enforcement is included in Section 3.3.2.

Mitigation via Existing Building Offsets. One option to increase flexibility of such a policy would be to develop an offset mechanism to allow new home builders to meet energy or green building standards by paying into a mitigation bank that would provide funding for projects to reduce energy use or greenhouse gas emissions in existing buildings. It is not clear that builders would be willing either to conduct retrofits directly or pay into a mitigation bank; builders might prefer to use money to enhance their products. In addition, such a program would have some level of administrative cost and complexity, particularly allocating funds for existing building projects. Another challenge for such a mitigation plan would be measurement and verification of energy or GHG savings.

The offset concept has been used to mitigate for the effects of new development on water. The City of Lompoc requires new buildings to offset through retrofits in existing buildings an amount of water expected to be consumed by the new construction project.[116] Project developers can execute the water retrofits themselves or pay an "in-lieu" fee to the City to help fund the City's water retrofit/rebate program.

Incentives. Jurisdictions that have adopted mandatory energy or green building standards often provide incentives for meeting or exceeding the standard. Incentives mechanisms include expedited permit processing and inspections, fee waivers, recognition, and floor-to-area and

[115] Ordinance No. 3492. Ordinance of the Marin County Board of Supervisors Amending Section 19.040.100 Adopting Energy Efficiency Standards for Single Family Dwellings, *available at* http://www.co.marin.ca.us/depts/CD/main/comdev/advance/sustainability/greenbuilding/pdf/Ord3492-2008SFDEEO.pdf.

[116] City of Lompoc. 2005 Urban Water Management Plan, *available at* http://www.cityoflompoc.com/utilities/pdf/2005_uwmp_final.pdf.

unit density bonuses.[117] An alternative to these incentive structures is a "feebate," which could impose a fee on projects that meet minimum requirements of Title 24 and provide financial rebates to projects that exceed Title 24. The City of Portland, has proposed a Green Building Feebate that would charge higher permit fees for new buildings meeting only the minimum requirements of Oregon's energy code and would waive the fee or provide a cash reward for new buildings that exceed minimum requirements.[118]

Advantage and Disadvantages of Enhanced New Building Energy Standards

The main advantage of enhanced new building energy standards is that the resulting energy savings and GHG emissions reductions are built in to the structure and persist over time. Also, there are several existing new construction rating systems, including LEED and Build it Green, which could reduce administrative start up costs. Further, many local governments in California have adopted either enhanced energy or green building standards. These examples could reduce costs related to policy development. In the case of commercial standards, the cost of implementation is relatively low.

On the other hand, new construction standards only capture about small percentage of the total building stock, therefore GHG emissions reductions would be low (residential) to medium (commercial). The cost of implementation is high for residential buildings. Other disadvantages include the need to enforce enhanced standards and potential opposition from the building and development communities.

3.3.2. Title 24 Enforcement

As mentioned above, California Title 24 building energy efficiency codes are among the best in the U.S.; however, standards are only effective if they are enforced. And, while the California Standards Commission promulgates building standards, local governments enforce them. The Air Resources Board recognized the importance of code compliance in its Scoping Plan, stating that "lack of compliance and enforcement of building and appliance energy standards has been identified as a significant barrier, especially in the application of standards to remodels and retrofits."[119] The CPUC also acknowledged this issue in its Energy Efficiency Strategic Plan.

A 2004 Itron Inc. study that sampled new homes found that 47% complied with state building standards, 27% of homes were non-compliant, and in 26% of cases it was not possible to determine compliance because their compliance margin was within the error range of the study.[120] The study examined compliance rates based on climate zones. Three climate zones included in the study are located in San Diego County – climate zone 2 (coastal), climate zone 3

[117] California Department of Justice, California Attorney General Office, Local Government Green Building Ordinances in California (Dec. 18, 2008).

[118] City of Portland Bureau of Planning and Sustainability Website, *available at* http://www.sustainableportland.org/bps/index.cfm?c=45879 (last visited June 22, 2009).

[119] California Air Resources Board, Scoping Plan Appendix p. C-107.

[120] Itron Inc., Analysis of Title 24 Compliance for Single Family Homes p. 4-4. Non-Compliance is defined as having a compliance margin less than the lower end of the error band (i.e., <-5%), indeterminate is a compliance margin within the error band (-5% to 4%), compliant includes sites that have a % compliance margin greater than the upper end of the error band (i.e., > 4% and < 19%).

(inland), climate zone 5 (mountains and desert).[121] Of the homes sampled, ninety-three percent (93%) of homes in the coastal zone complied with energy codes, 83% of homes in the coastal inland region complied, and 18% of homes in the mountain and desert regions complied. Given the relatively small sample size from San Diego County, it is difficult to draw specific conclusions from the study, but it appears that in general Title 24 code enforcement is worse in mountain and desert communities, where populations are smaller but energy consumption is typically higher per capita primarily due to cooling needs.

CARB recommends that the state assist local governments with enforcement activities, including additional training for local building department inspectors and plan checkers, contractors and builders, and energy related trades (e.g., plumbers, electricians, controls technicians and engineers). It also proposes that the state support enforcement activities "by developing and providing to localities information on best practices for energy efficiency code enforcement. Furthermore, the CEC is in the process of streamlining compliance verification tools and mechanisms; additional work may be needed in this area if resources are available."[122]

In its Single Family Dwelling Energy Efficiency Ordinance, the County of Marin acknowledges the importance of code enforcement, Section 4 of the policy states:

> Given that the purpose of this ordinance is to adopt stricter local energy efficiency standards for the construction of residential buildings within Marin County, the Board of Supervisors recognizes that the adoption of new standards without additional education and training for County staff responsible for enforcement of the standards can diminish compliance and potentially undermine the efficacy of this ordinance. Therefore, in order to ensure greater compliance and enforcement of the applicable energy efficiency standards, to better equip building department staff, and to provide a greater resource to the County's building community, the County will seek out additional education and training opportunities for building department staff in the areas of energy standards, building energy technology and energy code implementation. [123]

Given the relatively limited number of homes affected by enhanced Title 24 compliance and the relatively low potential to reduce GHG emissions, this report does not provide any analysis of cost, time to implement, and GHG impacts. We include it here as a reference.

3.3.3. Solar Water Heating

As noted above, California's Long-Term Energy Efficiency Strategic Plan seeks to make all new homes in 2020 net zero energy homes. Often this is interpreted to mean net zero *electricity* homes. To be – or to approach – truly net zero *energy*, a combination of efficiency, on-site generation (e.g., photovoltaics), and solar water heating likely would be needed. As part of the decision approving the California Solar Initiative, the CPUC approved a pilot solar water

[121] Id at 3-2 and 3-3. Note that the study uses the RMST climate zone classifications. For San Diego County climate zones, California Energy Commission Climate Zone (CZ) 7 is contained in RMST CZ2, CEC CZ 10 is contained in RMST CZ 3, and CEC CZ 14 and 15 are contained in RMST CZ 5.

[122] California Air Resources Board. Scoping Plan Appendix p. C-107.

[123] Ordinance No. 3492. Ordinance of the Marin County Board of Supervisors Amending Section 19.040.100 Adopting Energy Efficiency Standards for Single Family Dwellings, *available at* http://www.co.marin.ca.us/depts/CD/main/comdev/advance/sustainability/greenbuilding/pdf/Ord3492-2008SFDEEO.pdf.

heating incentive program for the San Diego Gas & Electric territory.[124] The Solar Water Heating Pilot Program (SWHPP), implemented by the California Center for Sustainable Energy, provides financing incentives to offset a portion of the cost of installing an eligible solar water heater. The CPUC is considering making this a statewide program, which would make incentives available beyond the pilot period.

Local governments can adopt policies to help to encourage use of solar water heating and to leverage the financial incentives that will be available under the CPUC solar water heating program. This section provides a brief summary of several related policies.

Pre-plumb for solar water heating

Two jurisdictions in the San Diego region currently require that all new homes be pre-plumbed to accommodate future installation of solar water heating. The City of Carlsbad, which adopted such a requirement in 1981, requires all new residential units to include "plumbing specifically designed to allow the later installation of a system which utilizes solar energy as the primary means of heating domestic potable water."[125] A builder can be exempt from this requirement if he can demonstrate that including the pre-plumbing is not practical due to shading, building orientation, construction constraints, or configuration of the parcel. The City of Chula Vista recently adopted a similar ordinance.[126]

A pre-plumb policy would result in relatively low GHG emissions reductions. Assuming that 1% of all homes are built new each year, 15% of the pre-plumbed homes actually installed solar water heating, and that annual natural gas savings is 117 therms, total GHG savings would be 0.01 MMT CO_2E. Emissions reductions would be higher if a higher percentage of homebuyers install systems.

The costs associated with a pre-plumb policy include those associated with additional construction requirements and the eventual cost of installing a solar water heater. Piping and other equipment related to compliance likely would be small relative to the overall cost of a typical home. When considering adoption of its current pre-plumb policy, the City of Chula Vista estimated that it would cost $450 per residential unit to comply.[127] The cost of installing a solar water heater would be significantly higher. The average cost of a system installed through the CSI Solar Water Heating Pilot Program (SWHPP) in the San Diego region has been $6,500.[128] The CPUC is evaluating whether to extend the SWHPP statewide and to increase its funding significantly. This would continue the financial incentives available in the San Diego region to reduce the first cost of such systems.

The main advantages to pre-plumb requirements are the relatively low cost to comply and reducing the complexity and possibly cost of future installations. A significant drawback to a

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[124] California Public Utilities Commission (CPUC) Decision D.06-01-024 (Jan. 12, 2006).

[125] Carlsbad Municipal Code Section 18.30.020. (Ord. NS-676 § 7 (part), 2003; Ord. 1261 § 26, 1983; Ord. 8094 § 1, 1981; Ord. 8093 § 1 (part), 1981).

[126] City of Chula Vista Municipal Code -- Section 15.28.015 Ord. 3122 § 1, 2009.

[127] Personal Communication with Brendan Reed, City of Chula Vista. Email 7-21-09 2:02:40 PM PDT.

[128] California Public Utilities Commission, CSI-Thermal Program: Energy Division Staff Proposal for Solar Water Heating Program. R.08-03-008 Administrative Law Judge's Ruling Noticing Workshop and Requesting Comment on Staff Proposal for Solar Water Heating Program (July 15, 2009), *available at* http://docs.cpuc.ca.gov/efile/RULINGS/104402.pdf and http://docs.cpuc.ca.gov/efile/RULINGS/104403.pdf.

solar pre-plumb policy is that there is no evidence that the existing policies have led to installation of solar water heaters. It is possible that a statewide incentive program could raise awareness of this technology and help to educate new homebuyers about its attributes. It is also possible that new homebuilders would oppose such policies.

Requiring Solar Water Heaters

In July 1999 Barcelona, Spain adopted a policy requiring that solar hot water systems supply a portion of the overall hot water supply of certain buildings.[129] Barcelona's Solar Thermal Ordinance applies to new construction, major rehabilitations, buildings seeking a change of use that have an annual average forecasted hot water need greater than 276,000 net British Thermal Units (BTU) or 2.8 therms.[130] This regulation applies to the following types of buildings: residential, health-care, sports, commercial and industrial use and, generally, any activity involving the existence of dining rooms, kitchens, laundries or other circumstances that lead to high hot water consumption.[131]

Between 2000, when the ordinance went into effect, and 2006, Barcelona had 597 solar water heating projects, equivalent to over 333,000 square feet of solar water heater collectors, a significant increase over the previous total area of collectors, which was just over 17,000 square feet.[132] The City of Barcelona estimates that the amount of solar hot water collector area installed as a result of this ordinance has led to thermal energy reductions equivalent to 32,076 MWh/year and a reduction of 5,604 metric tons of carbon dioxide emissions.

3.3.4. Energy Rating and Disclosure for New Construction

Similar to the energy rating and disclosure requirement for existing residential buildings discussed in Section 3.2.4, local governments could require new homes to disclose energy performance. There are few examples of such policies. Kansas adopted its Thermal Energy Disclosure Law in 2003.[133] It requires homebuilders and realtors to disclose information about the energy efficiency of new homes to potential homebuyers prior to purchase, whenever the house is shown and at any other time upon request. The law requires completion of a disclosure form on which the seller must indicate whether the building has a Home Energy Rating of 80 or more, was built to meet a specified energy code, or has other energy efficient elements listed.

South Dakota adopted a similar law in March 2009.[134] The law requires sellers of previously unoccupied new residential buildings (single-family or multifamily properties of four units or

[129] For a copy of the ordinance, see the Barcelona Energy Agency Website, *available at* http://www.barcelonaenergia.cat/document/OST_Explicac_eng.pdf (last visited June 20, 2009); *See also* http://www.barcelonaenergia.cat/eng/operations/ost.htm.

[130] City of Barcelona, Spain. Ordinance on the Incorporation of Solar Therms Energy Collection in Buildings. Article 2 (c).

[131] *Id.* at Article 3 Section 1.

[132] Barcelona Energy Agency Website, *available at* http://www.barcelonaenergia.cat/eng/operations/ost.htm.

[133] KSA66-1228. Kansas Statutes Chapter 66, Article 12, Stature 66-1128.

[134] SB 64, *available at* http://legis.state.sd.us/Sessions/2009/SessionLaws/DisplayChapter.aspx?Chapter=63. No statutory reference as of June 2009.

less) to disclose to the buyer or prospective buyer information regarding the energy efficiency of the residential building.

It is not possible to estimate the greenhouse gas emissions reductions from an energy and rating disclosure policy; we include it here as a reference.

3.3.5. Overview of Findings for New Construction Policies

In general, policies that address new buildings do not reduce GHG emissions as much as those focused on existing buildings. This is true partly because the number of buildings constructed each year represents a small fraction of the entire building stock. Also, California new construction building standards require significant levels of efficiency and requirements to reach efficiency levels above those required by Title 24 do not yield much savings. Further, Title 24 only regulates a small portion of a buildings overall energy consumption.

Of the policies evaluated here, enhanced commercial building standards have the highest potential to reduce GHG emissions regionally (Figure 8). It is also the only new construction policy to have a low cost per metric ton of GHG emissions. Requiring Energy Star appliances does not have a large potential to reduce emissions, but it is among the most cost effective policies evaluated (Table 17).

Figure 8 Greenhouse Gas Reductions from New Construction Policies (Medium Scenario 2020)

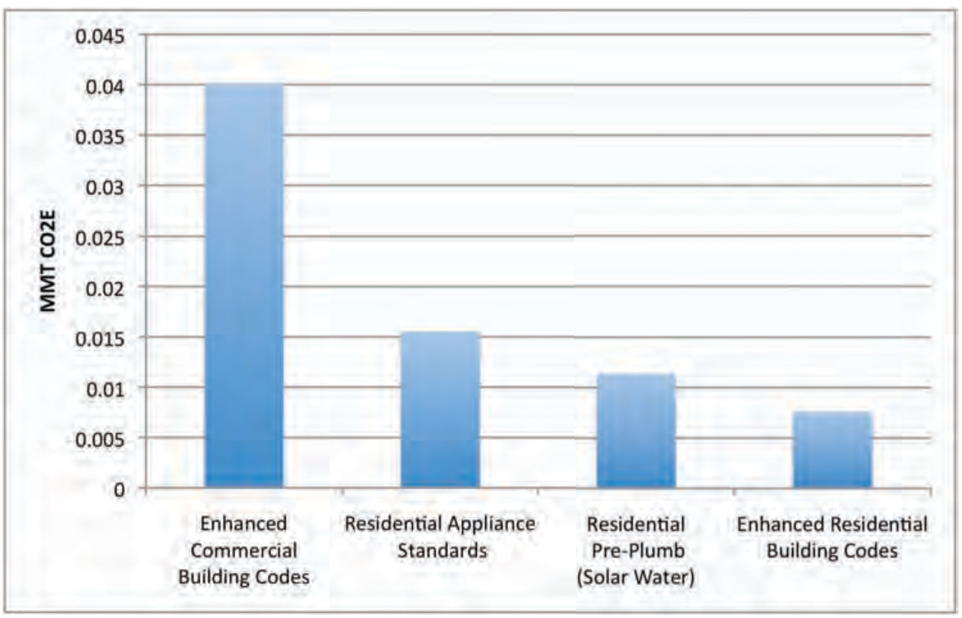

Table 17 Summary of Greenhouse Gas Reduction Potential and Cost for New Construction Policies (Medium Scenario 2020)

GHG Reduction Policy Measure	GHG Reduction Potential	Cost per Ton of GHG Reduction
Enhanced Commercial Building Codes	Medium	Low
Residential Appliance Standards	Low	Low
Residential Pre-Plumb (Solar Water)	Low	High
Enhanced Residential Building Codes	Low	High

4. PHOTOVOLTAICS

Electricity consumption accounts for 26% of overall region GHG emissions. In addition to energy efficiency, reducing the GHG intensity of electricity is another strategy to reduce emissions. California's Renewable Portfolio Standard seeks to increase the amount of renewable energy that electric utilities supply to customers. Another way to increase the renewable content of the overall electricity supply is to encourage distributed photovoltaics.

In the San Diego County Greenhouse Gas Inventory, we estimated the emissions reduction potential from a total of 400 MW of photovoltaics in San Diego County by 2020 to be 0.2 MMT CO_2E, which represents about 1% of the overall GHG emissions reductions needed to reach 1990 levels by 2020.[135] According to a recent report, there are 19 MW of distributed photovoltaics installed within the City of San Diego. This is more than in any other city in California and because California's dominates the U.S. solar market, the City of San Diego likely has more solar than any other City in the U.S.[136]

Distributed photovoltaics, defined as systems installed at or near the point of use, are a desirable generation option in some cases given their modularity, relative speed of installation, and partial coincidence with peak electric loads. As mentioned above, California seeks to achieve net zero energy in new residential buildings by 2020 and commercial buildings by 2030. Photovoltaics will play a critical role in achieving these targets.

Table 18 includes a list of the policies discussed in this section and examples of jurisdictions that have adopted similar policies.

Table 18 Policies to Encourage Photovoltaics

POLICY OR MEASURE	JURISDICTIONS THAT HAVE ADOPTED THE POLICY OR MEASURE
Regional or Citywide Rooftop Photovoltaics Target	San Diego (CA) San Francisco (CA), Sonoma (CA)
Pre-wire for Photovoltaics	Chula Vista (CA), Palm Desert (CA)
Require Photovoltaics on New Buildings - Commercial	Culver City (CA)
Require Photovoltaics on New Buildings - Residential	N/A

4.1. Background

In 2005, the CPUC began developing a long-term program to provide financial incentives to photovoltaics systems.[137] In 2006, Governor Schwarzenegger signed into law SB 1, which

135 This emissions reduction number is revised down from 0.21 in the September 2008 San Diego Regional Greenhouse Gas Inventory due to a refined methodology of calculating emissions and an updated electricity forecast by the California Energy Commission.

136 Environment California, California's Solar Cities: Leading the Way to a Clean Energy Future (July 2009).

137 *See* R.06-03-040, in particular D.05-12-044 and D.06-12-033.

codified this effort and set forth spending limits and basic program requirements.[138] SB 1 allocated $3.3 billion in ratepayer funds with a goal to install 3,000 MW of distributed photovoltaics by 2016. Of this total, $2.17 is allocated to the CPUC's California Solar Initiative, which has a goal to provide incentives for 1,940 MW of photovoltaics system. The CEC administers the New Solar Homes Partnership, which seeks to install 360 MW of photovoltaics in new homes and has a budget of $400 million. SB 1 allocated $784 million to municipal utilities, which have a target of installing 700 MW. Table 19 provides a summary of the program funding and capacity targets for the elements of SB 1.

Table 19 Funding Levels and Capacity Targets Included in SB1

	CA Public Utilities Commission	CA Energy Commission	Municipal Utilities	Total
Program	CA Solar Initiative	New Solar Homes Partnership		
Budget ($million)	$2,167	$400	$784	$3,351
Capacity Target (MW)	1,940	360	700	3,000
San Diego MW	220	31	0	251

In the San Diego region, the CSI program is administered by the California Center for Sustainable Energy. By 2016, the program expects to provide incentives for 180 MW, including 60 MW in the residential sector and 120 MW in the non-residential sectors. As of June 3, 2009, 19 MW of photovoltaics had been installed through the CSI program in the SDG&E service territory, which serves all of San Diego County and a portion of Orange County.[139]

While the CEC New Solar Homes Partnership Program (NSHP) is a statewide program and does not allocated funding or capacity targets to utility service territories or other jurisdictions, the prorated portion of the statewide target of 400 MW based on peak demand would be 31 MW.

If all the expected capacity through all of California's photovoltaics incentive programs were realized, it would equal about 220 MW in the San Diego region. An additional 180 MW would be need be needed between 2017-2020 to reach the 400 MW target included in the EPIC inventory report (Figure 9). It is unclear whether this is possible and achieving such a significant amount of installations in a short period would depend to a large extent on the installed cost of photovoltaics in 2016. One aim of the CSI program is to reduce the installation costs of photovoltaics. The level of subsidies available could provide a limit on the solar photovoltaics market. Both the CSI and federal tax credits will expire in 2016. Whether installed prices without subsidies in 2017 are equal to the previous cost with subsidies will be a significant determining factor in whether the photovoltaics market can continue to expand in the San Diego region.

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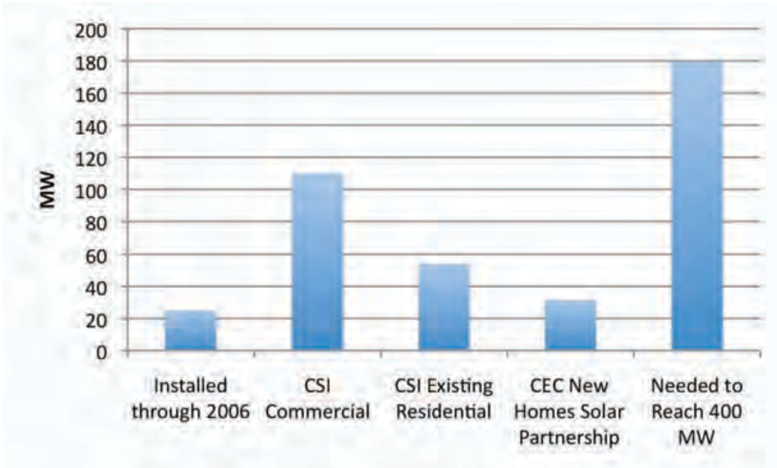
138 Senate Bill 1 (Murray). SB1 also to requires new homebuilders to offer photovoltaics as a standard option by 2011.

139 California Solar Initiative Solar Statistics Website, *available at* http://www.californiasolarstatistics.ca.gov/reports/6-03-2009/Dashboard.html.

Figure 9 Expected Photovoltaics Capacity from Incentive Programs (San Diego County)



Even though it is difficult to determine how many additional MW of photovoltaics would be realized by the policies discussed here between now and 2016, we include the potential GHG emissions reductions potential from policies to encourage photovoltaics in one of the two main scenarios presented below in Section 5.

4.2. Policy Options to Promote Installation of Rooftop Photovoltaics

Similar to energy efficiency policies, local governments have jurisdiction over several areas that affect photovoltaics, including permitting, zoning, general planning, and codes and standards. This section provides a range of policy options that local governments can adopt to promote the use of photovoltaics in the San Diego region.

4.2.1. Establish a Regional or Citywide Rooftop Photovoltaics Target

Several California jurisdictions have established specific photovoltaics installation targets as part of their climate action or sustainability planning. For example, the City of San Francisco has established a target of installing 10,000 photovoltaics systems by 2010.[140] The City of Sonoma has set a goal of installing 25 MW by 2011.[141] In 2003, the City of San Diego City Council adopted Resolution R-298412 that established a goal to install 50 MW of renewable energy within the city limits by 2013, though no specific photovoltaics target is included.[142]

4.2.2. Review Zoning Ordinances to Identify Barriers to PV

California law encourages local governments to remove barriers to solar energy installation. California Government Code Section 65850.5 states the following:

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[140] San Francisco Solar Map, *available at* http://sf.solarmap.org/.

[141] U.S. Department of Energy Solar America Cities Website, *available at* http://www.solaramericacities.energy.gov/Cities.aspx?City=Santa%20Rosa.

[142] City of San Diego RESOLUTION NUMBER R-298412 (Sept. 23, 2003), *available at* http://docs.sandiego.gov/council_reso_ordinance/rao2004/R-298412.pdf.

> It is the intent of the Legislature that local agencies not adopt ordinances that create unreasonable barriers to the installation of solar energy systems, including, but not limited to, design review for aesthetic purposes, and not unreasonably restrict the ability of homeowners and agricultural and business concerns to install solar energy systems. It is the policy of the state to promote and encourage the use of solar energy systems and to limit obstacles to their use. It is the intent of the Legislature that local agencies comply not only with the language of this section, but also the legislative intent to encourage the installation of solar energy systems by removing obstacles to, and minimizing costs of, permitting for such systems.[143]

Certain city policies and zoning requirements may create unintended barriers to installing photovoltaics. While California statute does not require local government to identify and remove barriers, Marin County has reviewed sections of its municipal code to identify potential unintended barriers to energy efficiency, including the zoning component of its municipal code, and identified a number of current requirements that may hinder energy efficiency and renewable energy.[144] Examples of code sections that might unintentionally disadvantage solar installations include set back requirements, which can contain maximum height limits that might preclude certain solar equipment from being placed in the setback, height regulations, which typically include exemptions for other equipment, and use permit requirements, which might affect free-standing, ground-mounted systems.

4.2.3. Pre-wire New Building for Photovoltaics

Several cities in California have adopted ordinances that require certain new buildings to include the wiring necessary to install photovoltaics at a later date. The City of Chula Vista has enacted a photovoltaics pre-wiring ordinance that requires that "all new residential units shall include electrical conduit specifically designed to allow the later installation of a photovoltaic (PV) system which utilizes solar energy as a means to provide electricity." [145] The City of Chula Vista's requirement can be waived if the building owner can demonstrate that compliance would be impractical due to shading, building orientation, construction constraints or configuration of the parcel. The City of Palm Desert has adopted a similar requirement that provides detailed requirements for the location and specifications of the equipment needed to comply.[146]

The costs to develop and implement and to comply with photovoltaics pre-wire requirements likely would be relatively low. Existing ordinances provide models for policy development and given the straightforward nature of the concept, policy considerations are few. The cost of conduit, wiring, and other equipment related to compliance likely would be small relative to the overall cost of a typical home. When considering adoption of its current policy, the City of Chula Vista estimated that compliance would cost $350 per residential unit.[147] If in the future a photovoltaics system is installed on a pre-wired home, the homeowner would incur the cost of installation. The average statewide installed cost of a residential photovoltaics system installed

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[143] Cal. Gov. Code 65850.5(a).

[144] Unintended Barriers to Energy Efficiency in the Development Code, *available at* http://www.co.marin.ca.us/depts/CD/main/fm/cwpdocs/Energy_Dev_Code.pdf.

[145] City of Chula Vista Municipal Code - 15.24.065. (Ord. 3121 § 1, 2009).

[146] City of Palm Desert Ordinance No. 1124, Section 24.30.030.

[147] Personal Communication with Brendan Reed, City of Chula Vista. Email 7-21-09 2:02:40 PM PDT.

through the CSI program in 2008 was $9.41/watt AC.[148] Installation costs have declined over time, so we assumed a 3% annual reduction when estimating the cost of a pre-wire policy. For purposes of comparing the cost of GHG mitigation measures included in this report, we use the total installed cost and did not take into account current financial incentives, which can reduce the cost to customers.

Greenhouse gas emissions reductions from a photovoltaics pre-wire policy could be significant, depending on the rate at which homeowners install systems on pre-wired homes and the average size of systems installed. Similar to the rating and disclosure policy described in Section 3.2.4 and the solar pre-plumb policy in Section 4.4.3, there is no certainty and indeed no evidence that residents would install photovoltaics systems in the future. If significant numbers of residents installed photovoltaics systems after purchasing a new home or existing home that had been pre-wired for photovoltaics, the GHG savings could be notable.

For example, if 15% of the pre-wired homes built each year installed a 2 kW photovoltaics system, the total installed capacity of photovoltaics would be 40 MW by 2020, which would reduce GHG by 0.02 MMT CO_2E. Because the cost effectiveness of installing photovoltaics on homes is heavily dependent on subsidies like the California Solar Initiative and available federal tax credits, it is not clear whether a pre-wire policy would lead to any solar installations above and beyond what we might expect as a result of existing financial programs – at least through 2016.

Advantages and Disadvantages of a Solar Pre-Wire Policy

Solar pre-wire policies have two main advantages. The cost to comply is relatively low and making homes “solar PV ready” may decrease the complexity and costs of future installations. Unfortunately, there is no evidence that owners of pre-wired homes would install solar electric generation systems after purchase; therefore, based in our estimates, potential GHG reductions are comparably low and the cost of implementation (including the eventual PV installation) is relatively high. It is also possible that new homebuilders would oppose such policies.

4.2.4. Require Solar Photovoltaics on New Buildings

The City of Culver City requires new buildings that are 10,000 square feet or greater, additions and major renovations of 10,000 square feet or greater of gross floor area to install 1 kW of photovoltaics for each 10,000 square feet of gross floor area.[149] In the case of major renovations, to be required to comply with the photovoltaics requirement, the renovation must be equal to 50% of the valuation of the existing building. The requirement does not apply to one- and two-family residences, parking structures, and garages. Also, the policy provides for two alternative compliance mechanisms, including a fee-in-lieu options whereby the building owner can pay a fee equal to the cost of installing the system. Revenue generated from the fee would be used to design and install photovoltaics system on city facilities. To comply with the solar requirement, building owners also can install comparable photovoltaics on another building owned by the applicant and located in the city.

[148] California Public Utilities Commission. California Solar Initiative Annual Program Assessment, p. 22 (June 2009). *Available at,* http://docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/103173.PDF.

[149] Ord. No. 2008-004 § 1 (part) § 15.02.1005.

As mentioned above in Section 3.3.1, the County of Marin adopted mandatory energy efficiency standards for single-family homes.[150] This ordinance does not explicitly require photovoltaics but does require very aggressive energy reduction requirements for large homes that likely could require photovoltaics for compliance. The Marin County ordinance does provide for a solar credit to meet the targets.

If all jurisdictions in San Diego County adopted a policy similar to the City of Culver City requirement for commercial buildings and installed 5 kW for every 10,000 square feet of new building space, an estimated 50 MW would be installed by 2020 with relatively low greenhouse gas emission reductions (0.02 MMT CO_2E). Increasing the amount of photovoltaics required per 10,000 square feet would increase the total GHG emission reduction. Similarly, if all new homes were required to install 2 kW of photovoltaics the resulting capacity would be nearly 200 MW and a GHG reduction of 0.1 MMT CO_2E. This number is substantially higher than the commercial results due to per unit amount of photovoltaics assumed in our calculations.

A 2009 CPUC report on the California Solar Initiative reported average statewide installed costs or projects receiving incentives in 2008 to be $9.41 for residential and small commercial systems and $8.14 for large commercial systems. For purposes of estimating the cost per unit of GHG emissions for photovoltaics-related policies, we assumed a steady decline in installed prices. Also, for purposes of estimating life-cycle cost, we assumed a useful life of 20 years.

4.2.5. Summary of Finding for Photovoltaics Related Policies

Of the policies evaluated, requiring photovoltaics on new homes would yield the highest GHG reductions, followed requiring photovoltaics on commercial building, and pre-wiring residential buildings for solar (Figure 10). Each of the policies evaluated has a medium cost of GHG reduction (Table 20).

It is not clear how to account for and allocate GHG reductions associated with photovoltaics. The current market is reliant on financial subsidies in the form of state rebates and federal tax incentives, both of which are set to expire in 2016. Between now and 2016, it is possible that the amount of installed photovoltaics will not increase to a level much higher than that which can be sustained with existing incentive programs.

[150] Ordinance No. 3492. Ordinance of the Marin County Board of Supervisors Amending Section 19.040.100 Adopting Energy Efficiency Standards for Single Family Dwellings, *available at* http://www.co.marin.ca.us/depts/CD/main/comdev/advance/sustainability/greenbuilding/pdf/Ord3492-2008SFDEEO.pdf.

Figure 10 GHG Reductions from Photovoltaics Related Policies (Medium Scenario, 2020)

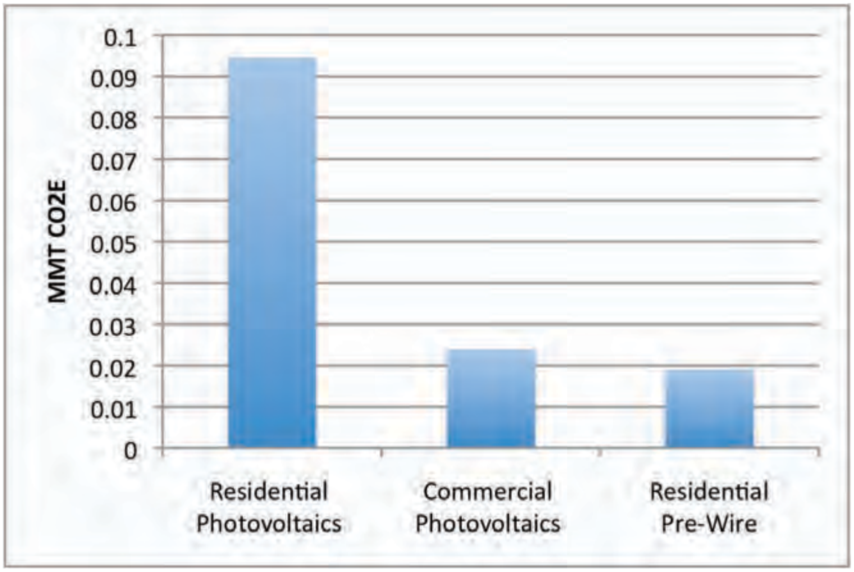


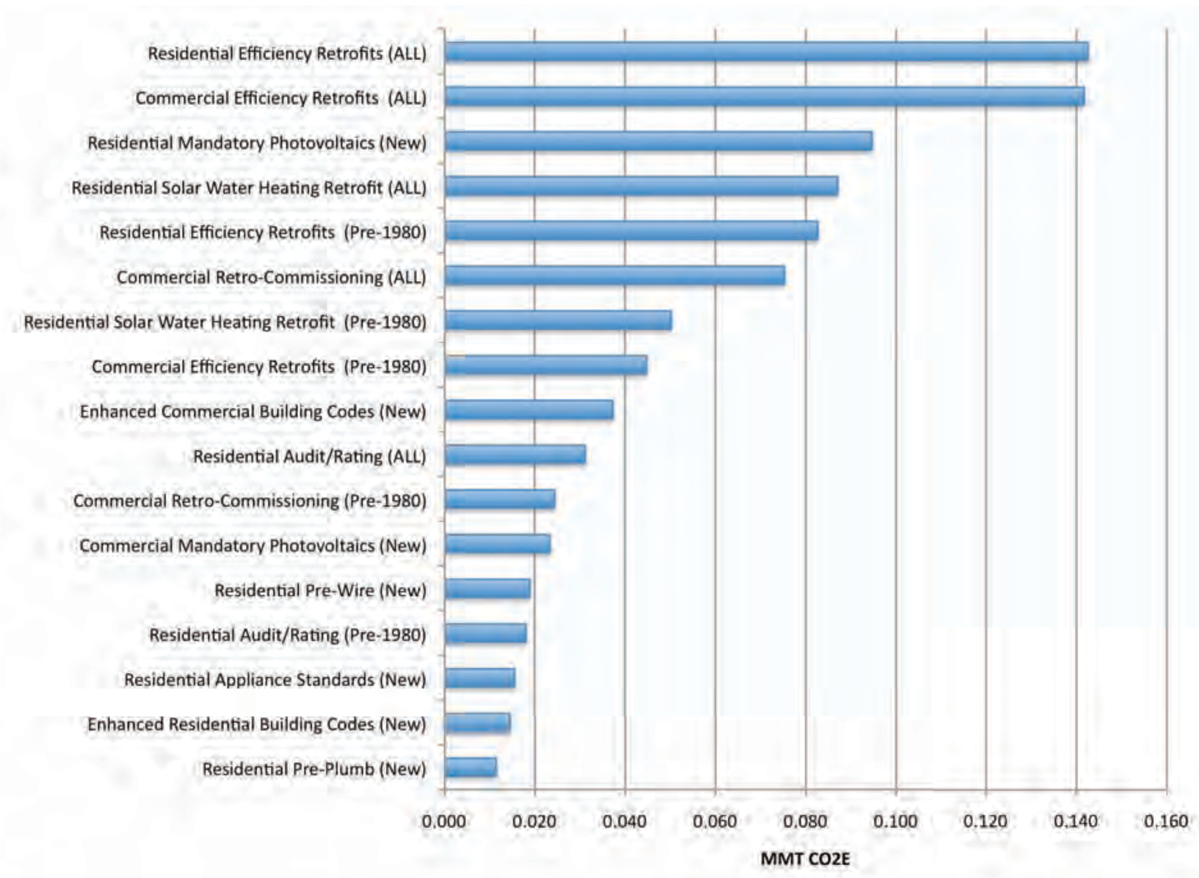
Table 20 Summary of GHG Reduction Potential and Cost

GHG Reduction Policy Measure	GHG Reduction Potential	Cost per Ton of GHG Reduction
Residential Photovoltaics	High	Medium
Commercial Photovoltaics	Low	Medium
Residential Pre-Wire	Low	High

5. 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 (Figure 11) and a policy to install solar water heating systems on existing homes. Also, the vast majority of potential GHG reductions from the policies evaluated – between 55% and 73%, depending on the building population addressed, result from policies that target existing buildings.

Figure 11 Summary of GHG Emission Reduction Potential (Medium Scenario, 2020)



There are 5 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 24 provides a summary of the GHG reduction potential and the associated cost for the policies evaluated in this study. The information presented in

Table 21 is sorted in order of GHG potential from high to low. Figure 12 provides the same results in a different format to show the relationship between GHG reduction potential and cost.

Table 21 Summary Table of GHG Reduction Potential and Cost (Medium Scenario 2020)

GHG Reduction Policy Option	GHG Reduction Potential[1] (MMT CO2E)	Cost per Unit of GHG Reduction[1] ($/MT CO2E)
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.

Figure 12 GHG Reduction Potential and Cost Matrix (Medium Scenario 2020)

GHG Reduction \ Cost to Reduce GHG	Low	Medium	High
Low	Commmercial Retro-Commissioning (Pre-1980) Residential Appliance Standards	Commercial Photovoltaics (New Construction)	Residential Pre-Wire (Photovolitaics) Residential Rating/Disclosure (Pre-1980) Enhanced Residential Building Codes Residential Pre-Plumb (Solar Water)
Medium	Commercial Retro-Commissioning (All) Commercial Efficiency Retrofits (Pre-1980) Enhanced Commercial Building Codes	Residential Solar Water Heating Retrofit (Pre-1980)	Residential Rating/Disclosure (All)
High	Commercial Efficiency Retrofits (All)	Residential Efficiency Retrofits (All and Pre-1980) Residential Photovoltaics (New Construction) Residential Solar Water Heating Retrofit (All)	N/A

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 could 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 is 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 is 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.[151] 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 13 shows a range of GHG emission reductions from 4 scenarios, including a low, medium, and high estimate for each scenario. Table 8 below includes the values used to calculate scenario values.

Figure 13 Scenarios of Policies to Mitigate Regional GHG Emissions

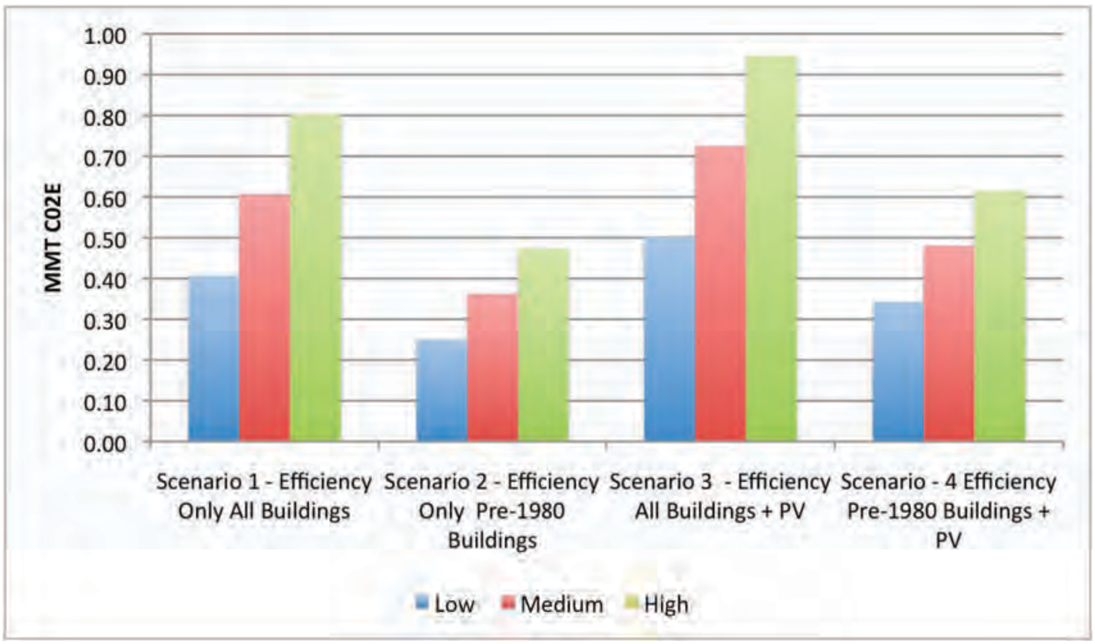


Figure 14 shows the medium level of savings for each local policy included and the amount of reductions that would be needed to reach the revised EPIC target.

[151] Section 8.2 of the Appendix provides emissions reduction values for each of the policy measures included in the four scenarios presented here.

Figure 14 Estimated GHG Emissions Reduction for Scenarios of Policies (2020)

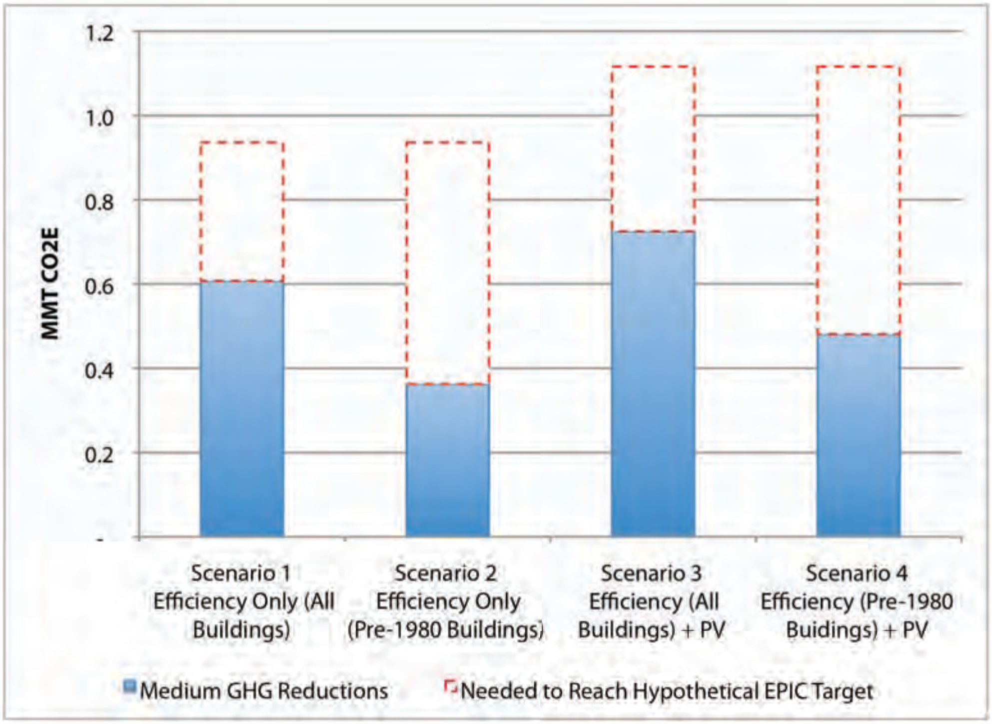


Table 22 provides the emissions reduction data for the four scenarios presented above. It includes data for the low, medium, and high GHG reductions calculations, differentiates between all buildings and those build prior to 1980, and provides total GHG reductions including and excluding solar photovoltaics.

Table 22 Summary of GHG Reduction Estimates (MMT CO_2E in 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.

6. CONCLUSIONS

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.

6.1. 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.

7. APPENDIX

7.1. Greenhouse Gas Calculation Methodology – Existing Buildings

The following general assumptions were used in estimating the GHG reduction potential and implementation cost for existing building policies.

- GHG intensity of electricity declines through 2020 as reduction measures are implemented.
- Transmission and distribution losses included in electricity savings amounts.
- GHG content of natural gas is 0.005 MMT CO_2E/MM therms.
- All energy consumption, housing, and building area data are scaled to SD County.

Table 23 present the assumptions used to calculate both reasonable GHG reduction potential and implementation costs. We recognize that many of the assumptions are based on averages and therefore obscure differences among subsectors. For example, the cost of energy efficiency retrofits likely differs by housing type (single family and multifamily), building age, and climate zone. Further analysis should be conducted to differentiate the GHG reduction potential and implementation costs among different building types, vintages, and locations to help craft policy and prioritize actions.

Table 23 Assumptions used to Estimate GHG Emissions and Cost for Existing Building Policies

Policy Measure	Annual Penetration Rate	Penetration of the Total Building Stock by 2020*		Total Number/Area of Buildings by 2020		Total Annual Energy Reduction (unless units specified)			Cost of GHG Reductions	Average Useful Life (years)	Assumptions/Notes
		All Buildings	*Pre 1980*	*All Buildings*	*Pre 1980*	*Low*	*Medium*	*High*			
Residential Energy Audit and Rating	3.5% receive audit 25% of audits conduct retrofits	37% (audits) 9% (retrofits)	22% (audits) 6% (retrofits)	460,359 (audits) 115,090 (retrofits	278,737 (audits) 69,684 (retrofits)	3%	7.5%	11%	$500/audit $1,000/retrofit	12	1. Adoption rate is constant through 2020 and is equal to the average number of home sales annually in SD County. 2. Savings rate applied to annual average consumption level. 3. Savings rate and audit cost data adapted from CEC 2005 study on existing building efficiency. 4. Based on CEC RASS report, 54% of total energy consumption is natural gas, 46% is electricity.
Residential Efficiency Upgrades	2%	21%	13%	263,062	159,278	10%	15%	20%	$2,500/retrofit $500/audit	12	1. Savings rate adapted from CEC 2005 study on existing building efficiency and Berkeley RECO information. 2. Cost estimate based on Berekely and San Francisco RECO cost caps, Consol estimate of Berkeley RECO costs, and Sustainable Spaces estimate for GHG reductions. 3. Based on CEC RASS report, 54% of total energy consumption is natural gas, 46% is electricity.
Residential Solar Water Heating Retrofit	0.80%	9%	5%	109,609	66,366	88 therms	117 therms	146 therms	$6,500/SWH	20	1. Assumes all solar water heaters offset natural gas. 2. Energy savings and cost values based on ITRON Evaluation of the SWH Pilot Project; CPUC Energy Division report on SWH PP (AB 1470).
Commercial Retro-Commissioning	2%	20%	14%	131 MM SF	45 MM SF	0.625 kWh/SF 0.013 therms/SF	1.25 kWh/SF 0.025 therms/SF	1.875 kWh/SF 0.038 therms/SF	$0.55/SF	10	1. Penetration, energy savings, and cost rates based on LBNL and CEC reports.
Commercial Efficiency Upgrades	2.0%	22%	8%	252 MM SF	86 MM SF	10%	15%	20%	$1.50/SF	12	1. Savings rate adapted from CEC 2005 study on existing building efficiency and Berkeley CECO savings information. 2. Cost based on SDG&E SPC program data for HVAC, lighting, and other categories. 3. Based on CEC Commercial End Use Survey, 35% of total energy consumption is natural gas, 65% is electricity.

*Totals do not equal penetration rate times 11 years, because the number and area of buildings varies each year. Values for pre-1980 bulidings show percentage of the total building stock in 2020.

7.2. Greenhouse Gas Calculation Methodology – New Construction

The same general assumptions listed in Section 7 were used in evaluating new construction policies. The following table presents the assumptions used to estimate the GHG reduction potential and cost for new construction policies.

Table 24 Assumptions used to Calculate GHG Emissions and Cost for New Construction Policies

Policy Measure	Annual Penetration Rate	Penetration of the Total Building Stock by 2020*	Total Number/Area (MM SF) of Buildings by 2020	Annual Energy Reduction / Production			Cost of GHG Reductions (medium scenario)	Useful Life	Assumptions/Notes
				Low	*Medium*	*High*			
Residential Enhanced Energy Buildings Standards	1%	6.8%	131,531	5% of total annual consumption	10% of total annual consumption	15% of total annual consumption	$1,250/home	12	1. 10% of average home's electric consumption is covered by Title 24. 2. 80% of average home's natural gas consumption is covered by Title 24. 3. Percentage consumption covered by T24 based on CEC RASS Study. 4. Percentage better than T24 is phased out and replaced with NZEH standard. No incremental savings from 2016-2020.
Residential Appliance Standard (Energy Star)	1%	11.0%	131,531	Refrigerator 111 kWh Dish Washer 25 kWh, 1 therm Wash. Machine 24 KWh, 10 therms			$200/home	12	1. Cost and energy savings estimates based on Energy Star Cost Calculator assumptions. Calculated value is $159. To be conservative, an incremental cost of $200 per home is used.
Residential Solar PV Pre-wire	1% get prewire % install PV varies	varies	varies	Energy saved based on10% of pre-wired homes install PV	Energy saved based on 15% of pre-wired homes install PV	Energy saved based on 20% of pre-wired homes install PV	$300/home $7,796/kW (average 2010 to 2020)	20	1. 17% capacity factor 2. Cost estimate is average based on $0.25/yr/W reduction until 2015 and a $0.15/yr reductino until 2020. This is reduced from $9.41 statewide cost of CSI in 2008.
Residential Solar PV Mandate	1% homes is target 15% install PV varies based on exemptions	varies	varies	Energy savigs based on 65% of new homes install PV	Energy savigs based on 75% of new homes install PV	Energy savigs based on 85% of new homes install PV	$7,796/kW (average 2010 to 2020)	20	1. 17% capacity factor 2. GHG savings accrue to CSI program 3. Policy allows exemptions 4. Cost estimate is average based on $0.25/yr/W reduction until 2020. This is reduced from $9.41 statewide cost of CSI in 2008.
Residential Solar Water Heater Pre-plumb	1% get pre-plumb 15% install SWH	11%	131,531pre-plumb 19,730 install SWH	88 therms	117 therms	146 therms	$450 for pre-plumb $5,200/SWh	20	1. Assumes solar water will offset natural gas water heating. 2. Savings rates basedon ITRON report on CCSE SWH Pilot Program. 3. Cost estiamate is 80% of retrofit cost and assumes economies of scale.
Commercial Enhanced Energy Buildings Standards	2%	20%	133 MM SF	5%	10%	15%	$1.00/SF	12	1. Based on CEC Commercial End Use Survey, 65% of average commercial energy use is natural gas, 35% is electric. 2. Based on CEC End Lse Survey, 70% of both natural gas and electric consumption are regulated by Title 24. 3. Required percent better than T24 phased out as T24 standard becomes stricter. No incremental savings after 2018 4. Cost estimates based on local government proposals to enhance T24 standards.
Commecial Solar PV Mandate	2% targetted 75% install solar PV	15%	133 MM SF targeted 100 MM SF install PV	2.5 kW/10,000 SF	5 kW/10,000 SF	10 kW/10,000 SF	$6,526/kW	20	1. 17% capacity factor 2. PV capacity adapted from existing City of Culver City policy (1kW/10,000SF). 3. Cost estimate is average based on $0.25/yr/W reduction until 2015 and a $0.15/yr reductino until 2020. This is reduced from $8.41 statewide cost of CSI in 2008.

7.3. Greenhouse Gas Calculation Method – Common Data Used

Table 25 provides the building and energy data used to estimate the GHG reduction and cost for the policies included in this report.

Table 25 Building and Energy Data Used for GHG Reduction and Cost Estimates

Year	Commercial Building Floorspace SD County ONLY (0.91 ot total SDG&E Service Territory) MM SF	Residential Dwelling Units	Average Residential Electricity Consumption SD County (CEC consumption + losses) kWh/Residential Unit	Average Natural Gas Consumption SD County MM Therms/Residential Unit	Average Commercial Electricity Consumption SD County Only (CEC Consumption + Losses) kWh/SF	Average Commercial Natural Gas Consumption SD County Only Therms/SF
1990	337	946,240	6,124	357	16.8	0.35
1991	355	958,859	5,911	348	15.6	0.35
1992	367	971,345	6,133	321	16.6	0.35
1993	375	980,395	6,001	331	16.2	0.42
1994	382	986,983	6,133	344	16.2	0.26
1995	388	993,705	6,076	313	16.3	0.28
1996	395	999,944	6,225	311	16.9	0.26
1997	402	1,006,882	6,341	306	17.9	0.39
1998	410	1,014,858	6,450	339	17.4	0.28
1999	422	1,026,142	6,481	359	17.8	0.29
2000	436	1,040,149	6,455	315	19.3	0.18
2001	451	1,048,699	5,973	315	16.4	0.30
2002	465	1,063,371	6,081	306	16.6	0.30
2003	477	1,078,416	6,392	286	17.0	0.29
2004	488	1,095,077	6,610	299	17.7	0.29
2005	500	1,108,500	6,544	276	17.3	0.29
2006	507	1,121,527	6,845	294	17.7	0.29
2007	517	1,134,854	6,792	279	17.5	0.27
2008	528	1,147,900	6,890	271	17.6	0.27
2009	538	1,151,296	6,792	261	16.9	0.25
2010	545	1,154,291	6,789	261	16.8	0.25
2011	552	1,158,786	6,784	261	16.7	0.26
2012	560	1,164,882	6,805	262	16.9	0.26
2013	570	1,171,977	6,828	262	16.9	0.26
2014	582	1,180,976	6,835	263	16.8	0.26
2015	593	1,191,879	6,849	264	16.7	0.26
2016	603	1,203,061	6,850	264	16.6	0.26
2017	612	1,214,574	6,860	265	16.5	0.26
2018	622	1,226,175	6,873	265	16.4	0.26
2019	631	1,237,630	6,893	266	16.4	0.26
2020	640	1,248,874	6,912	267	16.3	0.26
Median			6,610	286	16.8	0.27
Average			6,533	295	16.9	0.29

7.4. Energy Price Data

Table 26 presents the energy prices used for the implementation cost estimates for the policies evaluated in this report.

Table 26 Energy Price Data Use for Costs Estimate Calculations

Year	Residential Electricity ($/kWh)	Residential Natural Gas ($/therm)	Commercial Electricity ($/kWh)	Commercial Natural Gas ($/therm)
1990	$0.14	$0.29	$0.16	$0.83
1991	$0.13	$0.28	$0.16	$0.48
1992	$0.13	$0.28	$0.16	$0.48
1993	$0.13	$0.29	$0.16	$0.46
1994	$0.13	$0.30	$0.17	$0.43
1995	$0.12	$0.29	$0.16	$0.33
1996	$0.14	$0.30	$0.16	$0.39
1997	$0.13	$0.31	$0.13	$0.44
1998	$0.12	$0.32	$0.14	$0.48
1999	$0.12	$0.33	$0.13	$0.53
2000	$0.15	$0.34	$0.13	$0.65
2001	$0.14	$0.53	$0.16	$1.18
2002	$0.14	$0.28	$0.15	$0.39
2003	$0.14	$0.34	$0.14	$0.63
2004	$0.16	$0.36	$0.14	$0.69
2005	$0.16	$0.39	$0.13	$0.76
2006	$0.18	$0.39	$0.13	$0.57
2007	$0.17	$0.39	$0.14	$0.58
2008	$0.16	$0.51	$0.14	$0.75
2009	$0.16	$0.37	$0.14	$0.54
2010	$0.16	$0.37	$0.14	$0.54
2011	$0.16	$0.37	$0.14	$0.55
2012	$0.16	$0.37	$0.14	$0.55
2013	$0.16	$0.38	$0.14	$0.56
2014	$0.17	$0.38	$0.14	$0.56
2015	$0.17	$0.38	$0.15	$0.57
2016	$0.17	$0.39	$0.15	$0.57
2017	$0.17	$0.39	$0.15	$0.58
2018	$0.18	$0.40	$0.15	$0.58
2019	$0.18	$0.40	$0.16	$0.59
2020	$0.18	$0.40	$0.16	$0.60
2021	$0.18	$0.41	$0.16	$0.60
2022	$0.19	$0.41	$0.16	$0.61
2023	$0.19	$0.41	$0.16	
2024	$0.19	$0.42	$0.17	
2025	$0.20	$0.42	$0.17	
2026	$0.20	$0.43	$0.17	
2027	$0.20	$0.43	$0.17	
2028	$0.20	$0.43	$0.18	
2029	$0.21	$0.44	$0.18	
2030	$0.21	$0.44	$0.18	

Source: California Energy Commission, California Energy Demand 2010-2020, Staff Forecast. Final September 2009.

7.5. Cost Method and Results

Implementation costs for the policies evaluated here were estimated using per-unit costs derived from actual data or published reports and studies, average useful life data from the California Database for Energy Efficient Resources (DEER)[152], energy price data from the CEC, and penetration rates used to estimate GHG reductions. Details on the values used for these calculations are presented above in Tables 23-26. To capture the differences among the useful life of the measures evaluated in this study and to enable comparison across policies, we calculated the net present value (NPV) of each policy over its useful life with a 5% discount rate. For example, NPV calculations for energy efficiency covered a 12-year life, for solar water heating 20 years, and for solar photovoltaics 20 years. Because this study evaluates policies that are implemented annually from 2010 to 2020 and that savings from measures implemented in 2019 will produce GHG reductions for another 10-20 years beyond the 2020 time horizon, for AB 32 compliance, we used average annual implementation costs and customers savings to derive a NPV value. This also allows cost estimates to reflect any potentially declining implementation costs and the GHG-intensity of electricity.

The results of the NPV calculation were used to develop a ratio of cost per metric ton CO_2E, which normalizes cost and allows for comparisons of policy costs. The study estimates cost per metric ton of CO_2E using the net present value for cost.

The costs considered in this report represent the total implementation cost and do not include any financial subsidy such as tax credits or rebates. Subtracting such incentives from the total implementation cost likely will reduce the actual cost paid by homeowners and businesses, thus potentially affecting the economics of specific projects, however such subsidies do not reduce the overall cost of implementation. Results of the cost calculations are presented below in Table 27.

Table 27 Cost Evaluation Results

Local Government Policy Measure	Average Annual Implementation Cost	Annual Customer Savings	NPV @ 5%	Useful Life	Total GHG Reduction (MT CO_2E)*	NPV/MT CO_2E
Commercial Retro-Commissioning	$ (6,355,410)	$ 2,317,710	$ 12,282,330	10	75,161	$ 163
Commercial Efficiency Retrofits	$ (17,896,488)	$ 4,443,638	$ 20,465,332	12	141,683	$ 144
Residential Appliance Standards (New)	$ (2,402,250)	$ 376,977	$ 894,283	12	15,541	$ 58
Enhanced Commercial Building Codes (New)	$ (11,640,437)	$ 1,105,504	$ (1,754,358)	12	37,303	$ (47)
Residential Efficiency Retrofits	$ (72,067,488)	$ 4,515,209	$ (30,521,954)	12	155,522	$ (196)
Residential Solar Water Heating Retrofit	$ (66,151,035)	$ 2,308,075	$ (35,606,966)	20	147,183	$ (242)
Commercial Photovoltaics (New)	$ (28,194,990)	$ 1,125,291	$ (13,496,547)	20	43,423	$ (311)
Residential Photovoltaics (New)	$ (124,385,024)	$ 5,083,742	$ (58,124,149)	20	170,066	$ (342)
Residential Pre-Wire (New)	$ (28,603,253)	$ 1,016,748	$ (15,173,638)	20	34,013	$ (446)
Residential Rating/Disclosure	$ (31,529,526)	$ 988,425	$ (21,684,634)	12	34,020	$ (637)
Residential Pre-Plumb (New)	$ (17,402,811)	$ 76,786	$ (15,662,748)	15	21,095	$ (743)
Enhanced Residential Building Codes (New)	$ (13,333,250)	$ 166,108	$ (11,296,186)	12	14,438	$ (782)

*GHG values here represent total emissions reductions over the useful life of the measure.

[152] The Database for Energy Efficient Resources (DEER) is a California Energy Commission and California Public Utilities Commission (CPUC) sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL). The DEER is *available at* http://www.energy.ca.gov/deer/.

7.5.1. Cost Categories

Based on the results in Table 27, we divided policies into three cost categories: low, medium, and high. The range of costs that constitute the medium category was determined by adding and subtracting one-half of one standard deviation from the mean value. Those policies with costs below one-half a standard deviation from the mean were considered the "low" category, those with a cost above one-half a standard deviation from the mean were considered the "high" category. Table 28 presents the low, medium, and high categorization of the policies evaluated.

Table 28 Cost Categories for Policies Evaluated

Policy or Measure	Cost of GHG Reduction (NPV$/MT CO_2E)	Cost Category
Commercial Retro-Commissioning	163	Low
Commercial Efficiency Retrofits	144	Low
Residential Appliance Standards (New)	58	Low
Enhanced Commercial Building Codes (New)	-47	Low
Residential Efficiency Retrofits	-196	Medium
Residential Solar Water Heating Retrofit	-242	Medium
Commercial Photovoltaics (New)	-311	Medium
Residential Photovoltaics (New)	-342	Medium
Residential Pre-Wire (New)	-446	High
Residential Rating/Disclosure	-637	High
Residential Pre-Plumb (New)	-743	High
Enhanced Residential Building Codes (New)	-782	High