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Toward a Low-Carbon Economy: Municipal Financing for Energy Efficiency and Solar Power

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The economic and environmental need to transition to a low-carbon economy is now at the forefront of energy science, engineering, and policy discussions in the United States and internationally. Former Vice President Al Gore has called for a carbon-free electricity supply in the United States by 2018,[1] and in California, Japan, and the United Kingdom, a growing list of municipalities have legislated 70–80 percent or higher reductions in their greenhouse gas emissions over the next four to five decades. These cuts are consistent with the recommendations of the Intergovernmental Panel on Climate Change (IPCC). Thus far much of the effort has been focused on technology and policy solutions, with very little attention given to how this change can be enabled through creative financing.

A critical arena for this transformation is in buildings, which account for more than 70 percent of the electricity use[2] and almost 40 percent of greenhouse gas emissions[3] in the United States. Many of the more stringent laws to reduce energy use in buildings, such as Title 24 in California,[4] target new buildings. However, because buildings have many-decade lifetimes, it may be virtually impossible to reduce greenhouse gas emissions to the levels described by the lower-risk scenarios of the IPCC[5] and adopted by local municipalities,[6] states,[7] and nations[8] without a targeted effort to reduce energy demand in existing homes and commercial spaces.

This means that retrofit efforts, such as improving energy efficiency and adding solar photovoltaics (PV) and solar thermal systems to buildings, need to expand dramatically. Some states, including California, have already set targets for “net zero energy” new buildings, where efficiency and on-site generation are combined to reduce residential buildings to zero net energy use by 2020 and commercial buildings by 2030.[9] The California Public Utilities Commission has also set the ambitious goal to reduce energy use in existing homes by 40 percent and install low-energy heating and cooling systems in 50 percent of new and existing homes by 2020.[10] In addition, since 2002, the average nominal cost of electricity has risen more than 5 percent per year, and the average cost of natural gas has risen more than 10 percent a year for residential customers in the United States,[11] driving up the need and demand for programs that bring down energy costs.

Many barriers exist to reducing energy consumption and increasing the use of renewable energy. One is high first cost (“up-front cost”), which is both a psychological and financial barrier for many people. Our research group from the University of California, Berkeley, has worked with a number of cities, initially Berkeley to address this barrier by making financing for solar power installations and energy-efficiency retrofits more appealing and accessible to property owners. Urgency around the need to cut emissions has inspired cities to apply old tools, such as municipal financing, to the new problem of reducing the amount of carbon in the energy supply.

Clean energy municipal financing mechanisms like the City of Berkeley’s program Berkeley FIRST (Financing Initiative for Renewable and Solar Technology) have the potential to help catalyze the transition to a more sustainable use of energy and also deliver benefits beyond emissions reductions, including a new source of job growth, reduced strain on the electric power system, and more comfortable and well-maintained buildings. How do these initiatives work, and what might the financial impact be on participants at the state and national levels? How do the benefits of clean energy municipal financing compare to other available financing options like mortgages and loans, especially in light of the current financial crisis?

Barriers to Reducing Energy Demand

Over the last 30 years, a contentious debate has continued over why consumers and businesses choose or forego energy-efficient products and practices, and what role public policy and enabling programs (financing and other) should play in influencing these decisions. Researchers have often tried to explain consumer efficiency-related decisions using a life-cycle cost analysis, which looks at the up-front costs of adoption versus the energy savings over time. Many public policy efforts start with the premise that regulations should only promote options that give consumers a positive net present value for the life-cycle cost, using a discount rate for future savings of 5–8 percent. This takes into account the fact that the future savings are worth less to an individual than if they were received today. Thus, the discount rate presents the lost value of, for example, $100 received a year from now versus $100 received today that could be invested at 5 percent and therefore worth $105 in a year. The net present value is the future discounted benefits minus the initial investment. Appliance standards were created using this framework with the intention of removing the least-efficient appliances from the market while keeping the financial burden to a minimum. However, ex-post analyses of implicit discount rates for customer choices reveal extremely high and widely varying discount rates, often in the range of 25 percent to 75 percent.[12]

The difference between a market rate of return and the implicit discount rates observed in consumer choice was labeled the “energy-efficiency gap,” and much effort has been devoted to closing this gap through incentives and policies to address perceived barriers.[13] Several traditional barriers are purported to cause the energy-efficiency gap; these same barriers also affect the decision to install solar power systems. The barriers include lack of information, transaction costs, principal-agent barriers, and high first cost.

In this Issue

- Bytes of Note - U.S. Government Information
- Commentary - Giving Credit Where Credit Is Due
- Community Conservation and Early Ecotourism: Experiments in Kenya
- Editorial - Scale Still Matters
- Editors' Picks - January/February 2009
- Has Foreign Aid Been Greened?
- Top-Down Solutions: Looking Up from East Africa's Rangelands
- Toward a Low-Carbon Economy: Municipal Financing for Energy Efficiency and Solar Power

On this Topic

- A New Market Paradigm for Zero-Energy Homes: A Comparative Case Study
January/February 2008 (Abstract)
- A Widening Gap: Republican and Democratic Views on Climate Change
September/October 2008 (Full)
- Books of Note - July/August 2008
July/August 2008 (Full Text)
- Bytes of Note - Climate Change Skeptics: Disagreement, Hot Air, or Conspiracy?
March 2007 (Full)
- Bytes of Note - Climate Policy’s Quiet Giants
July/August 2008 (Full Text)
- California's Climate Change Policy: Raising the Bar
September 2007 (Abstract)
- Campus Greening: Behind the Headlines
January/February 2008 (Abstract)
- Climate Change and U.S. Agriculture: Examining the Connections
July/August 2008 (Abstract)
- Climate Change and Vulnerabilities and Responses in a Developing Country City: Lessons from Cochin, India
June 2007 (Abstract)
- Climate Policy Architectures for the Post-Kyoto World
May/June 2008 (Full)

Berkeley's novel financing model for low-carbon energy focuses on the last of these. A contractor may audit a house and suggest improvements that save money in the long term while increasing the comfort of the house, but the owner may not have the money available for the project. Up-front costs can even cause individuals with access to capital to decline a project, as they may prefer to spend their money on higher-priority items. The psychological burden of a large payment may also be significant, especially to reduce an expense such as a utility bill, which is often a small percentage of total expenditures for individuals and businesses. Financing alleviates this problem by allowing individuals and businesses to pay over time and match the timing of the payments with the benefits realized from the projects.

Clean Energy Municipal Financing

Berkeley FIRST is an example of clean energy municipal financing in development by the City of Berkeley that will provide the up-front funds for residential and commercial property owners to install electric and thermal solar systems and make energy-efficiency improvements to their buildings. Berkeley has committed to provide funding for the program through the issuance of a special tax bond that is repaid semi-annually over 20 years through special taxes collected on only the property tax bills of participating property owners. The financing mechanism is based on California's Mello-Roos financing law and does not require a city subsidy or exposure to the city's general fund.[14] As of summer 2008, the city had received more than 1,300 inquiries from municipalities around the world asking how this program will be implemented.

To participate in a clean energy municipal financing program, a residential or commercial property owner selects a contractor and identifies their choice of solar and energy-efficiency upgrades that fit within the scope of the program, as defined by the municipality. A project might include a solar PV array or a solar thermal system and improvements to the energy efficiency of a building, such as adding insulation and new ducts, sealing building shell leaks, and replacing a furnace or air conditioning unit. Improvements to a residential property could cost $4,000–$20,000 or more. The property owner submits an application to the municipality, whose staff reviews the scope of work and checks that they have a clear property title. After the municipality approves the application, the work is completed, a lien is placed on the property, and a check is issued to the property owner. A special tax is added to future property bills. If the property is sold before the end of the 20-year repayment period, the new owner pays the remaining special taxes as part of their property's annual tax bill. The interest component of the special tax payments will be tax deductible, similar to a home equity line or home mortgage. The special tax bond is backed by the liens on participating property owners' homes.

Berkeley FIRST is expected to be a major component of Berkeley's effort to reduce local greenhouse gas emissions, promote energy-efficiency improvements in its buildings, and make the shift to renewable sources of energy more affordable. Berkeley's Measure G, a city-wide public ballot measure, set a target greenhouse gas reduction of 80 percent from the 1990 baseline for the city by 2050, consistent with the IPCC findings.[15] The measure was approved by 81 percent of voters. Energy-efficiency improvements, solar PV, or solar hot water systems are already cost-effective for many residential and commercial property owners with the existing state and federal subsidies. Berkeley FIRST addresses high first cost and the concern of some property owners that they will not get the full benefit of their investment if they sell the property. Initial signs show strong demand for the program. The City of Berkeley started accepting applications through its Web site on 5 November 2008, and applications to claim the $1.5 million available for the pilot were submitted within 10 minutes.

This program has the potential to be implemented in municipalities across the country. Laws in many states already enable a similar financing mechanism, and other states are pursuing legislation to enable the use of clean energy municipal financing. For example, State House Bill 08-1350, passed by the Colorado legislature and signed into law in 2008, allows local governments to finance improvements with a repayment over 20 years through special assessments collected through the property tax system. This law allows local governments to proactively provide a mechanism for property owners to decrease their use of fossil fuels for heating and electricity, providing a public benefit. In November 2008, Boulder used this authority to pass Measure 1A, which allows the county to issue up to $40 million in special assessment bonds to finance clean energy improvements. Similar legislation has been enacted in California and is proposed in other states. These early programs have been implemented through city, county, and state-level initiatives; the federal government could support such programs by providing capital or by assisting municipalities in aggregating bonds so that larger bonds can be issued at a lower cost.

Financial Modeling Analysis

To assess the impact of clean energy municipal financing on residential customers, our research team at the University of California, Berkeley, created a model to compare the net present value of annual cash flows over 25 years for a system like Berkeley FIRST using an "average" California home and three U.S. cases with high, low, and average energy prices. See Table 1 for model assumptions. The model was created in close collaboration with the energy and sustainability team of Berkeley Mayor Tom Bates, whose office came up with the initial idea for the program, and the staff of former local assemblymember Loni Hancock.

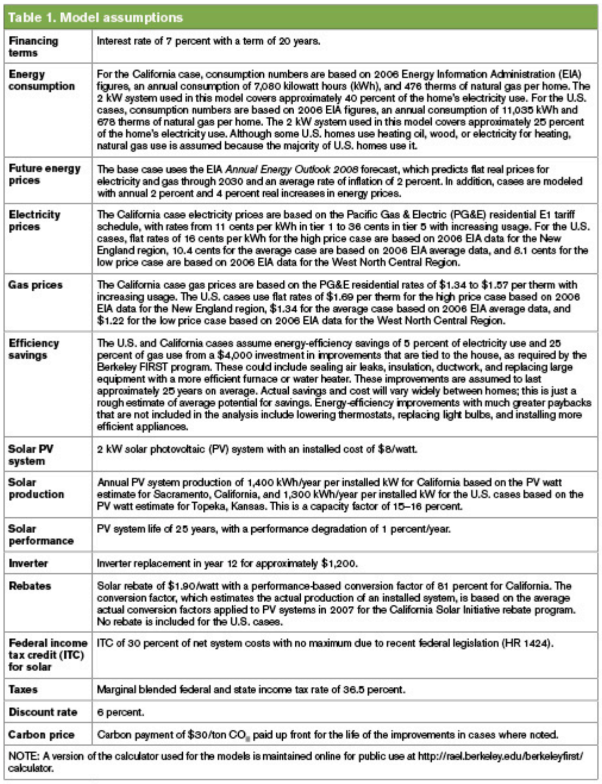


Table 1. Model assumptions

Financing terms	Interest rate of 7 percent with a term of 20 years.
Energy consumption	For the California case, consumption numbers are based on 2006 Energy Information Administration (EIA) figures, an annual consumption of 7,080 kilowatt hours (kWh), and 476 therms of natural gas per home. The 2 kW system used in this model covers approximately 40 percent of the home's electricity use. For the U.S. cases, consumption numbers are based on 2006 EIA figures, an annual consumption of 11,035 kWh and 678 therms of natural gas per home. The 2 kW system used in this model covers approximately 25 percent of the home's electricity use. Although some U.S. homes use heating oil, wood, or electricity for heating, natural gas use is assumed because the majority of U.S. homes use it.
Future energy prices	The base case uses the EIA *Annual Energy Outlook 2008* forecast, which predicts flat real prices for electricity and gas through 2030 and an average rate of inflation of 2 percent. In addition, cases are modeled with annual 2 percent and 4 percent real increases in energy prices.
Electricity prices	The California case electricity prices are based on the Pacific Gas & Electric (PG&E) residential E1 tariff schedule, with rates from 11 cents per kWh in tier 1 to 36 cents in tier 5 with increasing usage. For the U.S. cases, flat rates of 16 cents per kWh for the high price case are based on 2006 EIA data for the New England region, 10.4 cents for the average case are based on 2006 EIA average data, and 8.1 cents for the low price case are based on 2006 EIA data for the West North Central Region.
Gas prices	The California case gas prices are based on the PG&E residential rates of $1.34 to $1.57 per therm with increasing usage. The U.S. cases use flat rates of $1.69 per therm for the high price case based on 2006 EIA data for the New England region, $1.34 for the average case based on 2006 EIA average data, and $1.22 for the low price case based on 2006 EIA data for the West North Central Region.
Efficiency savings	The U.S. and California cases assume energy-efficiency savings of 5 percent of electricity use and 25 percent of gas use from a $4,000 investment in improvements that are tied to the house, as required by the Berkeley FIRST program. These could include sealing air leaks, insulation, ductwork, and replacing large equipment with a more efficient furnace or water heater. These improvements are assumed to last approximately 25 years on average. Actual savings and cost will vary widely between homes; this is just a rough estimate of average potential for savings. Energy-efficiency improvements with much greater paybacks that are not included in the analysis include lowering thermostats, replacing light bulbs, and installing more efficient appliances.
Solar PV system	2 kW solar photovoltaic (PV) system with an installed cost of $8/watt.
Solar production	Annual PV system production of 1,400 kWh/year per installed kW for California based on the PV watt estimate for Sacramento, California, and 1,300 kWh/year per installed kW for the U.S. cases based on the PV watt estimate for Topeka, Kansas. This is a capacity factor of 15–16 percent.
Solar performance	PV system life of 25 years, with a performance degradation of 1 percent/year.
Inverter	Inverter replacement in year 12 for approximately $1,200.
Rebates	Solar rebate of $1.90/watt with a performance-based conversion factor of 81 percent for California. The conversion factor, which estimates the actual production of an installed system, is based on the average actual conversion factors applied to PV systems in 2007 for the California Solar Initiative rebate program. No rebate is included for the U.S. cases.
Federal income tax credit (ITC) for solar	ITC of 30 percent of net system costs with no maximum due to recent federal legislation (HR 1424).
Taxes	Marginal blended federal and state income tax rate of 36.5 percent.
Discount rate	6 percent.
Carbon price	Carbon payment of $30/ton CO_2 paid up front for the life of the improvements in cases where noted.

NOTE: A version of the calculator used for the models is maintained online for public use at http://rael.berkeley.edu/berkeleyfirst/calculator.

For an average household in California, the net present values of four cases were modeled: solar installations only, energy-efficiency improvements only, solar and energy-efficiency projects together, and solar and energy-efficiency projects with a $30 payment per ton of abated carbon dioxide (CO_2). For each case, three energy-price scenarios are modeled: the Energy Information Administration (EIA) forecast of no increase in real energy prices (with 2 percent inflation), a +2 percent scenario, and a +4 percent scenario. Between 2001 and 2006, U.S. nominal electricity rates rose by 4 percent per year, and U.S. gas rates rose by 8.4 percent per year.[16] Increases in energy price are likely to continue over the long run, and these higher-than-forecasted price scenarios represent this possibility.

As shown in Table 2, the energy-efficiency measures alone always have a positive net present value. The solar-only case is positive when energy prices increase 4 percent annually over the EIA forecast, an annual price increase of about 6 percent in nominal terms. The combination of energy-efficiency improvements and solar installations is positive only in the +4 percent case, and the case with a $30 payment per ton of abated CO_2 is positive only in the +2 percent and +4 percent scenarios. These numbers are sensitive to the cost of solar installations and changes in electricity and gas prices.

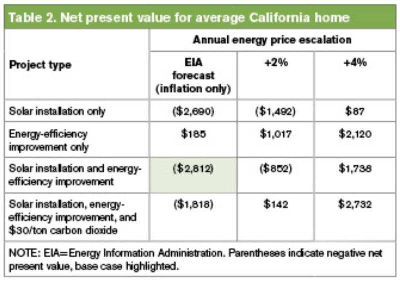


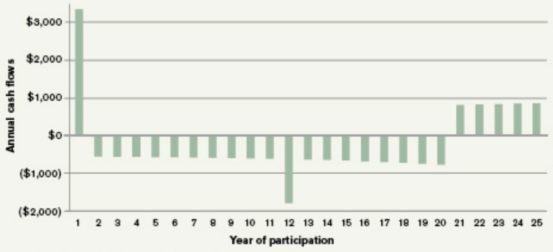
Table 2. Net present value for average California home

	Annual energy price escalation		
Project type	**EIA forecast (inflation only)**	**+2%**	**+4%**
Solar installation only	($2,690)	($1,492)	$87
Energy-efficiency improvement only	$185	$1,017	$2,120
Solar installation and energy-efficiency improvement	($2,812)	($852)	$1,738
Solar installation, energy-efficiency improvement, and $30/ton carbon dioxide	($1,818)	$142	$2,732

NOTE: EIA=Energy Information Administration. Parentheses indicate negative net present value, base case highlighted.

As Figure 1 shows, the cash flows for the base case vary over 25 years. The high positive cash flow in year one is due to the federal income tax credit, which is currently 30 percent of net system costs, and the negative drop in year 12 is the cost of purchasing a new inverter, which is expected to require replacement at this time. The small annual losses between years 2 and 20 increase slightly every year as the falling interest tax deduction outpaces the marginal energy price increases forecasted by the EIA. Income in the last five years shoots up after the financing is repaid in year 20. For a typical $17,000 package in California, $13,000 would be devoted to the solar electricity system, and $4,000 to energy-efficiency upgrades. For a representative California base case over 25 years, the solar energy system would total $10,600, the income tax credit would be $3,900, the energy efficiency $7,600, and the interest from tax deductions are a loss of $5,500. It is important to note that this average case obscures differences between climate zones and between buildings; low energy users will tend to have lower project net present values, while high energy users will have economic benefits that exceed the average case.

Figure 1. California base case annual cash flows



NOTE: Parentheses indicate negative net present value.

The model also assesses the net present value for households on a national level. Because energy prices can vary widely, for instance, between North Dakota and Massachusetts, three cases are modeled: a U.S. average case, a high energy price case, and a low energy price case. Again, see Table 1 for model assumptions.

The differences between the three U.S. cases (see Tables 3–5) show how higher energy prices make solar installations and energy-efficiency retrofits significantly more financially rewarding. However, the solar-only option has a negative net present value for all of the cases because electricity prices are still below the levelized cost of solar power. The solar and energy-efficiency combination becomes positive only in the +2 percent and +4 percent scenarios for the high price U.S. case. With a CO_2 price of $30 per ton, the high price U.S. case is positive in all pricing scenarios, and the average U.S. case becomes positive in the +4 percent scenario.

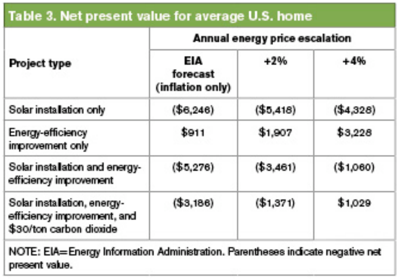


Table 3. Net present value for average U.S. home

Project type	Annual energy price escalation		
	EIA forecast (inflation only)	+2%	+4%
Solar installation only	($6,246)	($5,418)	($4,328)
Energy-efficiency improvement only	$911	$1,907	$3,228
Solar installation and energy-efficiency improvement	($5,276)	($3,461)	($1,060)
Solar installation, energy-efficiency improvement, and $30/ton carbon dioxide	($3,186)	($1,371)	$1,029

NOTE: EIA=Energy Information Administration. Parentheses indicate negative net present value.

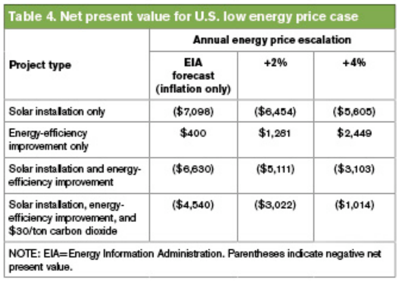


Table 4. Net present value for U.S. low energy price case

Project type	Annual energy price escalation		
	EIA forecast (inflation only)	+2%	+4%
Solar installation only	($7,098)	($6,454)	($5,605)
Energy-efficiency improvement only	$400	$1,281	$2,449
Solar installation and energy-efficiency improvement	($6,630)	($5,111)	($3,103)
Solar installation, energy-efficiency improvement, and $30/ton carbon dioxide	($4,540)	($3,022)	($1,014)

NOTE: EIA=Energy Information Administration. Parentheses indicate negative net present value.

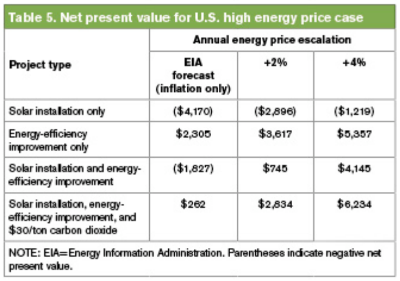


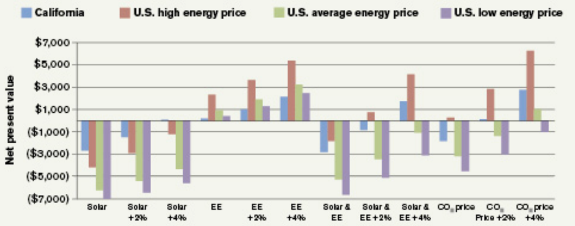
Table 5. Net present value for U.S. high energy price case

Project type	Annual energy price escalation		
	EIA forecast (inflation only)	+2%	+4%
Solar installation only	($4,170)	($2,896)	($1,219)
Energy-efficiency improvement only	$2,305	$3,617	$5,357
Solar installation and energy-efficiency improvement	($1,827)	$745	$4,145
Solar installation, energy-efficiency improvement, and $30/ton carbon dioxide	$262	$2,834	$6,234

NOTE: EIA=Energy Information Administration. Parentheses indicate negative net present value.

As shown in Figure 2, the U.S. numbers are significantly different from the California case. The solar-only net present values are much lower because no rebates are included as in the California case, the U.S. average electricity price is lower, and a flat rate is assumed instead of the steep inclining rates in California that allow solar power to offset the highest tier prices there. The energy-efficiency savings are greater in the U.S. cases because energy consumption is significantly higher for the U.S. average, leading to a greater capacity for energy-efficiency savings and more savings per installed measure. The effect of $30 per ton of CO_2 is probably the most striking of the differences; it allows the U.S. high price case to have a far higher net present value than the California case, even with the significant California rebates and high California electricity prices. The impact of the CO_2 price is so much larger for the U.S. cases because the U.S. average electricity mix has about three times more CO_2 emissions than the California electricity mix. With the increasing likelihood that federal climate change legislation will be enacted in the next few years, this factor may significantly affect the economics of building retrofits.

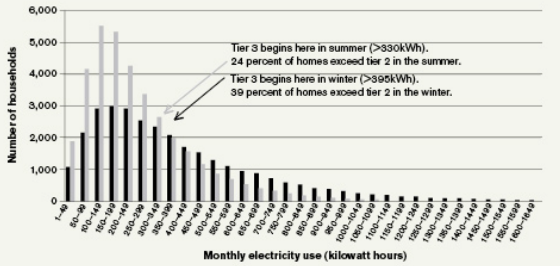
Figure 2. Net present values for California and U.S. cases



NOTE: Solar=solar installation; EE=energy-efficiency improvement; and CO_2=carbon dioxide. Parentheses indicate negative net present value.

It is important to note that Berkeley's average energy use is low compared to state and national averages, largely because of Berkeley's mild climate, which requires little or no air conditioning. Berkeley homes also tend to be smaller than newer homes in the state and Berkeley residents tend to be more conscious about energy consumption. This means that the average Berkeley resident pays for only a small fraction of their energy at rates higher than 13 cents per kWh (tier 2). Figure 3 graphs Berkeley electricity consumption in summer and winter and shows how many homes pay the tier 3 rate of 23 cents per kWh, which is the first rate tier that is higher than the levelized per kWh cost of solar power after state and federal subsidies. The implication is that this financing program will produce even better returns in other parts of the state, such as the Central Valley, Los Angeles, and San Diego, which have higher overall energy consumption and produce more electricity per solar panel because of better solar resources.

Figure 3. Berkeley residential electricity use, 2007



Municipal Financing versus Other Financing Options

Homeowners and businesses traditionally have relied on several options to finance improvements to their homes and offices. These include paying for the improvements up front, refinancing their mortgages or securing home equity lines of credit, and taking out personal loans. How does clean energy municipal financing compare? To answer this question, it is helpful to look at the net present value of a solar and energy-efficiency project in California based on how it is financed. Four alternatives are compared in Table 6:

- no financing, cash paid up front;
- a 20-year fixed mortgage refinance at 7 percent;
- a 15-year home equity line at 8.5 percent; and
- a 5-year unsecured personal loan at 13 percent (interest not tax-deductible).

Compared with up-front cash or a 5-year loan, clean energy municipal financing is superior because it gives the participant the tax advantage of deducting the interest payments. It is also preferable to a 15-year equity line because of its lower interest rate. The closest competitor to municipal financing is the 20-year mortgage refinance, which has the same term and similar rate. A mortgage refinance may be a better option for a property owner if they have particularly good credit or are already planning on refinancing for other reasons. However, especially in the current credit market, other transaction costs, fees, and barriers could make mortgage refinancing a more expensive option. The mortgage refinance also must be repaid upon sale of the home, so it does not have the benefit that the outstanding financing repayments will transfer to the new owner.

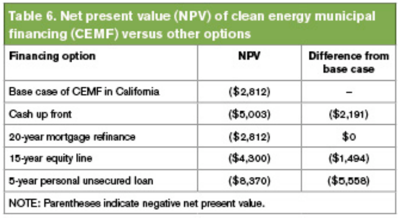


Table 6. Net present value (NPV) of clean energy municipal financing (CEMF) versus other options

Financing option	NPV	Difference from base case
Base case of CEMF in California	($2,812)	–
Cash up front	($5,003)	($2,191)
20-year mortgage refinance	($2,812)	$0
15-year equity line	($4,300)	($1,494)
5-year personal unsecured loan	($8,370)	($5,558)

NOTE: Parentheses indicate negative net present value.

Conclusion

Offering affordable financing lowers the barriers for many property owners to install solar power systems or make energy-efficiency improvements. However, financing alone cannot make up for the current high cost of solar PV without rebates. Until solar PV costs decrease, property owners will need to be moderate to high energy users in regions with significant rebates and inclining electricity rates, or they need to be willing to pay more for low-carbon electricity. Relief may be on the way, too, as the global shortage of solar PV materials eases and prices could decline, further benefiting programs such as this—and the evolution of the entire clean energy economy.

A price on CO_2 emissions—through a tax or a cap-and-trade scheme—changes the equation significantly, as seen in the case of a U.S. region with high energy prices. Even with no additional state subsidies and flat real energy prices, a solar and energy-efficiency project was net present value positive with a $30 per ton price on CO_2. Many states have already enacted climate change legislation, and this program has natural extensions to the federal level. This may push average U.S. electricity prices up toward the high energy price case and, combined with declining solar costs, may greatly increase the economic benefits of solar installations. It is also important to emphasize that financing programs for energy-efficiency improvements already make economic sense, depending on the measures implemented.

The recent financial crisis and economic slowdown may significantly affect these financing programs. Municipal bonds will likely have slightly higher interest rates, at least in the short term. However, homeowners' options for financing through traditional sources have dried up considerably, making programs like Berkeley FIRST even more important. Purchases of high-ticket items such as solar PV may slow down in the short term, though the recent dramatic expansion of the federal income tax credit for homeowners may have a moderating effect. Signs are promising that investments in low-carbon technologies will remain strong. For example, while venture capital investment has slowed for many sectors, investments in energy reached $1.18 billion in the third quarter of 2008, an increase of 90 percent over the same period in 2007.[17] However, in communities with high foreclosure rates and steeply declining home values, it is unlikely that this program will be an option because outstanding property tax and mortgage bills will make property owners ineligible for financing.

It is also important to note that the other barriers to adoption—information, transaction costs, and principal-agent barriers—still exist even if first cost is addressed. In fact, these barriers may be what determine the success or failure of financing programs. In the case of access to information, research shows that the way information is communicated and by whom is extremely important. Research also shows that the entity conducting an energy audit makes a difference. According to one study, when performance is measured by cost, performance, and response rate, community groups outperformed private subcontractors, which outperformed utilities.[18] This implies that choosing partners and crafting an appropriate marketing strategy when launching a new program are extremely important. Such partnerships between an academic or other analysis group, local government, and state officials can provide the team needed to overcome the diverse issues that can arise.

Transaction costs will also be an important factor in the success of versions of this financing model. Much of the onus of reducing this barrier falls on the contractors and installers who need to get in and out of a property quickly at times convenient to the owner. However, the financing itself needs to be easy to access for both property owners and contractors. Turnaround time for getting approved for financing must be fast and painless for property owners. And payment must get to the contractor or installer quickly so that they do not have to carry project costs.

The principal-agent barrier is probably the most difficult obstacle to overcome and is especially difficult in the case of rental properties. Rental housing is also more often occupied by lower-income families, so these groups of people who could greatly benefit from reduced energy bills are less likely to see changes to their buildings. Additional subsidies may be needed to overcome these barriers, and further research needs to be done on how to best provide incentives for rental property owners to make improvements.

Applied nationwide to fund energy-efficiency and solar upgrades in 15 percent of residential buildings in the United States, models forecast this program would require financing of $280 billion. Assuming current U.S. average prices for electricity and gas, no increases in real energy price in the next 25 years, and no state-level subsidies, property owners would pay an additional $400 per year on average over the 25-year term while building clean energy equity in their homes.[19] In regions with high initial energy prices and annual energy prices increases of 2 percent in real terms, owners would save $125 per year on average. With a carbon price of $30 per ton of CO_2, the savings would be $215 per year. In addition to receiving energy services from the improvements, this initiative would eliminate more than a gigaton of CO_2 emissions with no additional cost to local, state, or federal governments beyond existing incentives.[20] This reduction would conservatively contribute 4 percent of the savings needed for the United States to reach 1990 emissions levels by 2020,[21] with very significant additional savings if the program expands to commercial buildings.

Other forms of financing are currently being used to fund energy-efficiency projects, such as on-bill financing, specialized unsecured bank loans for solar installations and energy-efficiency retrofits, mortgages designed to reward investments in energy efficiency, and traditional sources of funds such as home equity lines, second mortgages, and unsecured personal loans. Time will tell which of these best serves customers' needs, but it is clear that experimentation in this area is important for speeding the transition to a low-carbon economy. The importance of developing novel mechanisms of this sort is clear if we are to meet energy security and climate goals; the challenge will be implementing programs in this vital yet uncertain time of national and global financial instability. If we do not invest in programs of this nature, we may be simply rearranging the deck chairs on the Titanic.

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NOTES

1. A. Gore, "**A Generational Challenge to Repower America**," speech given at the D.A.R. Constitutional Hall, Washington, DC, 17 July 2008 (accessed 9 October 2008).
2. Building Technologies Program, *2007 Buildings Energy Data Book* (Washington, DC: Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, September 2007), Section 1.1: Buildings Sector Energy Consumption.
3. Energy Information Administration (EIA), *EIA 2006: Emissions of Greenhouse Gases in the United States*, DOE/EIA-0579 (Washington, DC, 2006).
4. **Title 24 documentation** is available from the California Energy Commission (accessed 13 May 2008).
5. The Intergovernmental Panel on Climate Change (IPCC) reports, including the latest, the Fourth IPCC Assessment Report, are available at **http://www.ipcc.ch/ipccreports/index.htm** (accessed 1 December 2008).
6. Measure G in Berkeley, California, sets an 80 percent greenhouse gas reduction target by 2050. Members of **C40**, a climate leadership group of mayors from cities such as Tokyo, Sydney, Rome, New York, and Mumbai, are working together to set targets and reduce greenhouse emissions (accessed 26 May 2008).
7. California has committed to statewide greenhouse gas emissions reduction targets of 2000 levels by 2010, 1990 levels by 2020, and 80 percent below 1990 levels by 2050. Minnesota has committed to statewide emissions reduction goals of 15 percent by 2015, 30 percent by 2025, and 80 percent by 2050, based on 2005 levels. Florida has committed to statewide emissions reduction targets of 2000 levels by 2017, 1990 levels by 2025, and 80 percent below 1990 levels by 2050. Other state targets can be found at **http://www.pewclimate.org/states-regions** (accessed 26 May 2008).
8. Japan and the United Kingdom have adopted 2050 targets of over 60 percent reductions in emissions; Austria has established the goal of 80 percent decarbonization; and Sweden is committed to eliminating carbon emissions by 2030.
9. California Energy Commission, ***2007 Integrated Energy Policy Report***, CEC-100-2007-008-CMF (2007, accessed 13 May 2008); and B. Farhar and T. Coburn, "**A New Market Paradigm for Zero-Energy Homes: A Comparative Case Study**," *Environment* 50, no. 1 (January/February 2008): 18–32.
10. California Public Utilities Commission, *California Long Term Energy Efficiency Strategic Plan: Achieving Maximum Energy Savings in California for 2009 and Beyond* (2008).
11. These increases are based on EIA average U.S. retail prices from 2002 to 2006 for residential electricity and natural gas.
12. A. Goett and W. Moss, *Implicit Discount Rates in Residential Customer Choices, Investments in Conservation Measures*, EM-5587, Volume 1, Research Project 2547-1 (Palo Alto, CA: Electric Power Research Institute, 1988).
13. A. B. Jaffe and R. N. Stavins, "The Energy-Efficiency Gap: What Does It Mean?" *Energy Policy* 22, no. 10 (1994): 804–10.
14. The Mello-Roos Community Facilities Act (Gov. Code Section 53339.3 (b)) allows local agencies, when they form a community facilities district, to "identify territory proposed for annexation in the future, with the condition that parcels within the territory may only be annexed with the unanimous approval of the owner or owners of each parcel or parcels at the time that parcel or those parcels are annexed." The new code will incorporate this provision. Before the city pays the contractor, the property owner must agree to annex into the special tax district and pay a specific special tax. In short, the act authorizes creation of community facilities districts, the issuance of taxable municipal bonds, and the levy of special taxes to finance public facilities and certain improvements to private property. The Mello-Roos Act does not currently authorize local agencies to finance energy projects for private property, but Berkeley and all other charter cities have the power to adopt a special tax financing law to adapt the Mello-Roos Act for that purpose. Another California law, Assembly Bill 11, creates a similar financing mechanism using assessment districts, but unlike Mello-Roos does not require that participating municipalities be charter cities. Palm Desert has implemented financing using this law.
15. IPCC, *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Core Writing Team, R. K. Pachauri, and A. Reisinger, eds. (Geneva, Switzerland: IPCC), available at **http://www.ipcc.ch/ipccreports/index.htm** (accessed 1 December 2008).
16. The baseline EIA energy prices can be found in EIA, *2008 Annual Energy Outlook with Projections to 2030* (Washington, DC, 2008).
17. VentureSource data as cited in C. Sullivan, "Renewable Energy: Has Silicon Valley Carved a Safe Niche from the Economic Storm?" *Greenwire,* 22 October 2008.
18. P. C. Stern et al., "The Effectiveness of Incentives for Residential Energy Conservation," *Evaluation*

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19. It is likely that homes with solar and efficiency features will increase in value. Recent research suggested this is true for commercial buildings, which have higher rental and sales prices when labeled EnergyStar buildings. P. Eichholtz, N. Kok, and J. M. Quigley, "Doing Well by Doing Good? Green Office Buildings," UC Berkeley Program on Housing and Urban Policy, Working Paper W08-001, April 2008.

20. This assumes the U.S. average case described in the text. We use the EIA 2006 average of 0.00061 tons carbon dioxide per kilowatt hour and the 2006 U.S. Census figure of 126,316,181 housing units.

21. This assumes the EIA projection of business-as-usual carbon dioxide emissions for 2020 of 6,384 million metric tons. The savings from 15 percent participation of U.S. residential buildings is 4 percent of the difference between the business-as-usual projection and the 1990 emissions level. This target has been frequently mentioned in proposed U.S. climate legislation, as seen in L. Parker, B. Yacobucci, and J. Ramseur, *Greenhouse Gas Reduction: Cap-and-Trade Bills in the 110th Congress* (Washington, DC: Congressional Research Service: 2008), 29.