Evaluation of Assembly Bill 811:
Climate Protection Benefits and Costs

Dave Erickson, Technical Director
Climate Protection Campaign
www.climateprotectioncampaign.org

September 30, 2008

Summary

Assembly Bill 811 provides powerful financial tools for enabling property owners to install energy efficiency and renewable energy improvements on their property. In this report, we quantify the potential greenhouse gas (GHG) emission reduction impact of a large-scale energy efficiency and distributed renewable energy installation on residential and non-residential property in Sonoma County. This analysis identifies the types of improvements that could potentially be done by property owners using financing through AB 811. We evaluate the "value proposition" for property owners for the different types of AB811-qualifying building retrofits and renewable energy installations. Finally, based on an average residence, we assess the GHG impact in electricity and natural gas consumption of cost-effective measures available under AB 811.

Assembly Bill 811

Assembly Bill 811 (AB811) allows cities, counties, or a city/county combination to set up contracts with property owners to finance energy efficiency or distributed generation renewable energy projects. These projects are secured with a lien on the property where they are located. The payments on the amount financed are made via property tax assessment. The city or county (referred to generically as "city" in the statute) is empowered to develop funding sources to provide capital for improvements.

AB 811 does not cover properties that are being developed. It does not cover any improvement not permanently connected to the property such as appliances. The city must develop a plan that describes how the capital amount for work performed will be raised. The sale of bonds may be used to finance work performed under contractual assessment. There is no up front cost to the property owner. (There may be an application cost.) The indebtedness of the property owner is not increased, although the annual property tax payment may be significantly increased. There does not appear to be any qualification required for the property owner as part of the statute. However, individual cities may specify qualification such as credit worthiness as part of the contract negotiation.

Interest rate and repayment period is set for each contract. Program costs are apportioned among the consenting property owners.

Climate Protection Impacts

The climate protection effect of AB811 must be evaluated on the customer side of the electric and/or gas meter. That is, each property and associated meter contributes to total GHG reduction as the consenting property owner contractually participates in the program and reduces their electricity or natural gas use. The reduction in electricity or natural gas bills will be netted out against an increase in property taxes for the property owner to pay for measures.

If a property owner is not responsible for the electricity or natural gas bill for a property, such as for a rental property, it may be difficult for the property owner to justify the increase in property tax. This fact may restrict the participation in this program to parties that own and operate facilities on a property such as homeowners or business owners that own their buildings.

We separate potential climate protection impacts of AB811-funded measures into those that result from reduction of natural gas or propane use, and the results of reduced electricity use. Building envelope efficiency upgrades and heating/ventilation/air conditioning (HVAC) and water heater upgrades will generally be covered under AB811 because they are permanent modifications to the property. These upgrades will generally affect natural gas or propane use in the Sonoma County area because the majority of water and space heating energy is from natural gas and propane.

Any appliance not permanently installed at the property will not be covered by AB811. As shown in the chart below from the 2006 California Energy Commission (CEC) end-use study, the majority of electricity end-use is in “plug load” or appliances not permanently installed in the property. The primary exceptions are central air conditioning, water heat, and furnace fan. Built in lighting would also qualify. The total load represented by AB811 eligible retrofits is 20 percent or less.[1]

[1] According to a recent study 50 percent of the residences in the PG&E service territory have central air conditioning. AB811 qualified retrofit would thus apply to a total of 8 percent of the load from air conditioning, 9.1 percent from water heaters, and the furnace fan load of 3.3 percent.

End Use	% of total use
Refrigerator	**13.7**
A/C (central + room)	**16**
Space Heat	**10.1**
Water Heat	**9.1**
Lighting	**8.8**
Residual	7.3
Clothes dryer	**5.8**
Freezer	**3.5**
Furnace Fan	3.3
Television	2.9
Electric Range Top	2.8
Dishwasher	**2.5**
Electric Oven	1.8
Microwave Oven	1.7
Personal Computer (Desk Top)	1.5
Other	9.2
Total	100

The other permanent improvement to a property that would reduce electricity costs generally falls into the category of small scale onsite electricity generation. The generation facility will be connected to the grid via net-metering in most cases, although there is a new "feed-in" tariff available. Financing could conceivably be used to build generation only facilities subject to the Small Renewable Generator tariff.[2]

There are also technologies that would qualify for AB811 financing such as air-source heat pumps and solar hot water heaters that would nearly or completely eliminate natural gas or propane use, but might increase electricity use.

The building efficiency retrofit described below reduces electrical energy used by HVAC fan. Central air conditioning upgrade was not considered, since we assumed that the typical residence with central air would have been retrofitted more recently. There is no data available for Sonoma County penetration of central air. The reduction in furnace fan energy use will typically be less than 10 percent, based on building performance modeling using Energy-10™ software.[3]

We evaluate the number of property owners that would have to install improvements in order to achieve the target in the electricity and natural gas sectors, given projected business-as-usual electricity and natural gas annual consumption for 2015. We also evaluate the costs and the associated emissions reductions of AB811 financed measures.

[2] Otherwise known as the "Small Renewable Generator PPA" or "feed-in tariff," it specifies how PG&E can purchase power from a Small Renewable Energy Resource, which is 1.5 megawatts or less.

[3] Energy-10™ is exclusively distributed by the Sustainable Buildings Industry Council. The software was developed by National Renewable Energy Laboratory (NREL) under funding from the U.S. Dept. of Energy, Copyright 2005 Midwest Research Institute.

Electricity Sector

Grid electricity supplied by PG&E in 2015 is projected to be less GHG intense (GHG emissions per kWh generated) than 1990. By 2015, the emissions intensity of electricity procured by PG&E is projected to be 25 percent less than today.[4] Because of this, demand reductions in each subsector would be less than what is required today to meet the target. Based on projected load growth for 2015, overall emissions from electricity use would need to be about 17 percent below the projected residential level and about 28 percent below the projected non-residential level to reach the reduction target.

Climate Protection Campaign has developed projections for total electricity consumption for Sonoma County by the year 2015. For all community sectors of the County, the projected energy consumption is approximately 3,230 GWh per year. This is based on a population of 524,000. In 2005, there were 233,000 residential electric accounts and 31,000 commercial accounts consuming approximately 2,900 GWh per year, based on a population of 466,891. For 2015, we project over 270,000 residential accounts and over 40,000 non-residential accounts. We project that the PG&E emissions factor will be reduced from 0.489 lb/kWh in 2005 to 0.362 in 2015.

In order to reach the emission reduction target for the electricity sector, 17 percent of residential and 28 percent of commercial accounts would have to participate in the program and reduce their net electricity consumption to near zero. This equates to nearly 45,000 residential accounts and about 14,000 non-residential accounts that would have to participate to reach the reduction target in the electricity sector for the county.

Natural Gas/Propane Sector

In 2005 in Sonoma County there were 187,000 residential natural gas accounts, using approximately 77 million therms, which is an average of 404 therms per year per account. There were nearly 11,000 commercial and industrial gas accounts using about 37 million therms, an average of about 3,500 therms per year per account. These consumption levels are projected to increase, but at a lower rate than electricity consumption. Projected use for the residential sector for 2015 is approximately 82 million therms, and 47 million for non-residential. The reduction required to meet the target is approximately 30 percent below projected business-as-usual consumption level for both residential and non-residential since the emission factor for natural gas does not vary.[5]

Cost Estimates

A typical residence in Sonoma County uses about 5,200 kWh per year for lighting, heating/air conditioning, and plug loads. An average of 405 therms is used primarily for space heating and water heating.[6] AB811 would not cover plug loads, or most lighting. It would cover baseboard or central heat, central air conditioning, and building envelope retrofits such as building shell sealing, insulation, and windows. It would also cover water heating retrofits.

---

[4] Based on 2006 Long Term Procurement Plan filed with California Public Utilities Commission (CPUC), March 2007

[5] U.S. Environmental Protection Agency (EPA) publication AP-42: (http://www.epa.gov/ttn/chief/ap42/). See also the Source Material for the Sonoma County Community Climate Action Plan available online at (www.coolplan.org)

[6] Data from PG&E, personal communication with Carol Foreman

For AB811 to offer a value proposition to residential and commercial property owners and thus yield high participation rates, we assume that the savings in energy costs would have to approximately equal or be less than the increase in property taxes. A 25- to 30-year repayment schedule is assumed for this analysis. The repayment schedule is related to the life of the asset being financed. It is conceivable that building envelope retrofits could be financed on a longer term.

We assume a 3 percent to 5 percent interest rate if tax exempt municipal bonds are used for project capital.

We use a current cost of $0.16 cents per kWh for residential electricity and $1.32 per therm.[7] This puts the average annual residential electricity bill at $830 and the natural gas bill at $540. Again, we assume that if electricity and natural gas bills can be decreased an amount equal to or greater than the increase in property tax, most property owners will be inclined to participate, which would increase the likelihood of reaching Sonoma County's GHG emissions target.

Electricity Emission Reduction Cost

We assume that the electrical efficiency upgrades covered by AB811 are minimal, since the big electricity end uses in the residential sector are not permanently connected to the property, with the exception of central air conditioning, electric central heat or baseboard heat, and built-in lighting. Thus we evaluate the financial benefit to the property owner of a small distributed generation system based on solar photovoltaics.

Based on an average annual electricity use of about 5,200 kWh, the average residential solar photovoltaic (PV) installation would be 3.3 kW to cover 90 percent of the electricity use per year. Non-residential properties have an average annual energy use of nearly 40,000 kWh. A 25 kW PV system would generate 90 percent of this electricity. Assume that the average installed cost was $7/watt including rebates. Assume that the current state rebates would apply, but not tax credits, since the payments are being made through property taxes. This results in an average residential system cost of about $23,000 and an average non-residential system cost of about $150,000.

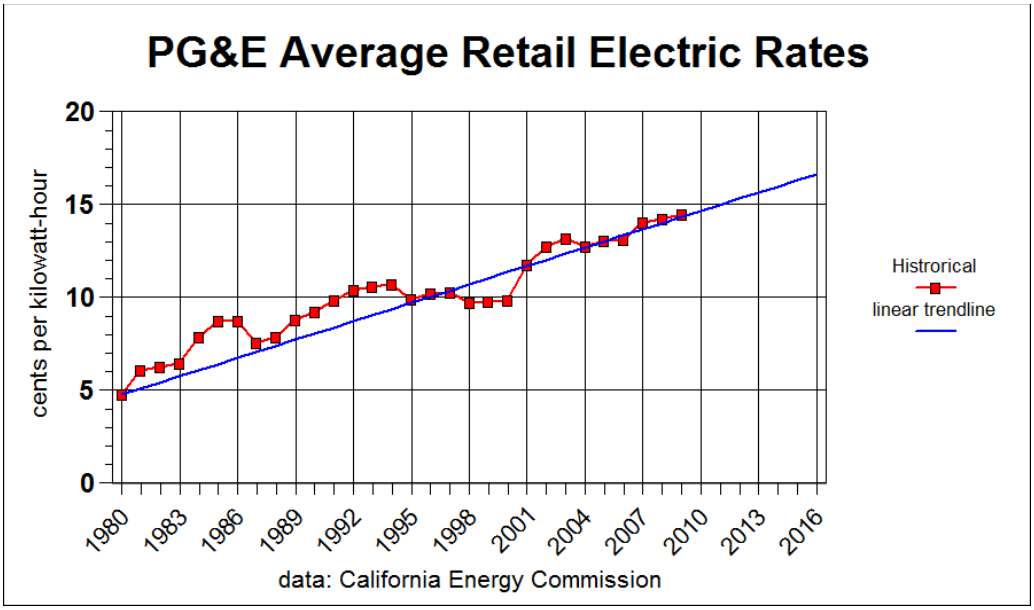
If financing was available from tax exempt municipal bonds, assume a 30-year term at 3.5 percent could be offered. The annual payment for the residential system on these terms is approximately $1,630. The annual payment includes operation and maintenance (O&M), which is primarily inverter replacement at years 15 and 30. Program administration costs are included in the property tax increase. With these terms, the property owner would be paying about $0.35 per kilowatt hour over 30 years.[8]

If a 4.4 percent escalator is applied to the current average PG&E rate ($0.16), over 30 years the average rate would be $0.33. The chart below shows the historical PG&E increase since 1980.

[7] Average costs from PG&E.

[8] Actual financing terms being used in Palm Desert, CA are less favorable than those quoted in this example. Loan terms are being quoted at 20 years, maximum, with a maximum interest rate of 7 percent.

With this escalator, the annual cost of electricity from the system would equal the PG&E rate at year 18.



The average residential system cost would have to be approximately $10,000 ($3/watt), financed at 2 percent in order for electricity cost (hence annual property tax increase) to equal the current cost from PG&E. Currently, these costs and interest rates are unavailable. Participation at current costs and interest rates will probably be low given the differential between property tax increase and current annual electricity bill.

If we assume that the average residential system cost could be brought down to $10,000 and an average non-residential cost of $75,000 and that a 2 percent interest rate was available, we could then project a higher rate of property owner participation and thus a higher likelihood of meeting the target. For a total of 44,000 residential systems and 14,000 non-residential systems, the total amount financed (bond amount) would be approximately $1.5 billion at $3/watt and 2 percent interest rate. At $7/watt and 3.5 percent interest rate, $3.5 billion is the total financed by 2015. This would reach the overall target level of 25 percent below the1990 level for the electricity sector (for residential and non-residential).

Natural Gas/Propane Emission Reduction

The Energy-10™ program was used to estimate the effect of building envelope retrofit on natural gas use for a typical residence in Sonoma County. The building retrofit measures that were simulated were:

- Building shell air seal
- Increasing attic insulation from R-19 to R-60
- Install high efficiency (92 percent AFUE) gas furnace
- Programmable thermostat

These measures have an estimated average total cost of approximately $6,300. The building simulation indicates that these upgrades will save approximately $400/year and will reduce GHG emissions by 29 percent. The annual payment on $6,300 at 3.5 percent interest over 30 years is $342. This represents an attractive tradeoff for the property owner

Additionally, other measures such as replacing and sealing ducts and window upgrades could be cost effective. These measures add $5,250 and $5,000 to the cost respectively. The annual property tax increase if the window upgrade or the duct seal was selected would be approximately $650, if the terms were the same as above. Whether or not these measures or others would produce equivalent or greater energy savings would have to be determined on a case-by-case basis.

Most efficiency measures were found to reduce combined electricity and natural gas costs more than the annual property tax increase required to repay the loan at 3 percent interest over 30 years. However, the particular "optimal" package would have to be determined for each home, based on a detailed energy audit. It should also be noted that higher interest rates could significantly reduce the value proposition to the customer, and thus the uptake of this program.

Conclusion

AB811 provides powerful financial tools to property owners to enable them to install aggressive energy efficiency and distributed renewable generation measures. Low interest rates combined with ease of obtaining financing should make it possible for property owners to make significant energy and GHG emission reductions, cost-effectively, in their buildings. However, AB811 is not a panacea that will address all applications equally well.

We found in this analysis that residential solar PV installations do not make economic sense for homeowners, even under the most liberal cost and financing assumptions. An average residential PV installation would result in annual property tax payments that are double the current average residential electricity bill. We assume that this would not be attractive to most residential property owners. We anticipate that as long as the tax benefits are kept in place, that there would be an increase in the uptake of non-residential PV systems, for business owners that own their own property.

However, we found that the most effective potential use of AB811 financing would be for building envelope efficiency improvements. A package of measures including building shell air sealing, increased attic insulation, programmable thermostat, high efficiency furnace upgrade, and possibly either duct replacement/sealing or window upgrades would result in a reduction in annual energy cost greater than the AB811 property tax increase. It is important to emphasize that the interest rate of the available financing is critically important in determining whether there is a negative or positive effect on the customer's cash flow.

We think that replacement of natural gas furnaces with air-source heat pumps and replacement of gas water heaters with domestic solar hot water heaters could also be cost effective. These replacements would virtually eliminate natural gas and propane use, and would potentially be cost effective using AB811 financing.

The authors believe that AB811 can be used in conjunction with other financing systems including PAYS ® and Community Choice Aggregation to maximize the GHG emissions impact of electricity and natural gas use for the lowest possible cost.[9]

Reaching the 2015 GHG Reduction Target in the Residential and Commercial Electricity Sector with AB 811 funded PV installations

SC Population 2005	***Persons/Acc't***
466,891	2.00436599

Persons/Acc't 2015(Adjusted to match 2015 projected consumption)

1.94

2005 Sonoma County Residential and Commercial Electricity use,

	2005 Number of Accounts	2005 Total kWh	2005 Average Annual E (kWh)	Average 90% production level	*Note: 90% is used to estimate system size*
Residential	232,937	1,208,035,188	5,186	4,667	
Commercial	31,181	1,212,494,587	38,886	34,997	

2015 PG&E Emission Factor	**0.362**	**lb/kWh**

Note: Assuming per account consumption remains level

Projected Pop 2015	***total accounts***	***total kWh***	***tons GHG (2015 emission factor)***
524,176	270,194	1,401,252,851	253,627
Commercial	46,900	1,823,757,632	330,100

Projected 2015 Use and Target

	2015 Total GHG tons (projected)	GHG tons Target Level (25% below 1990)	GHG tons reduction below projected 2015
Residential	253,627	209,632	43,995
Commercial	330,100	239,136	90,964

Residential Target		
43,995	tons to reduce	
87,989,539	lbs to reduce	
207,586,096	kWh to reduce	
44,475	total installs	

Commercial Target		
90,964	tons to reduce	
181,928,884	lbs to reduce	
498,435,299	kWh to reduce	
14,242	total installs	

o

[9] For a fuller discussion of the complementary set of financing tools, please see the Sonoma County Community Climate Action Plan available online at (www.coolplan.org).

Average Res PV array size			*Average Com'l PV array size*		
3.3	kW		25	kW	
8760	hr		8760	hr	
16.0%	cf		16.0%	cf	
4,625	kWh		35,040	kWh	
0.362	lbs/kWh		0.362	lbs/kWh	
0.8	tons/year (2015)		6.3	tons/year (2015)	
7	$/watt installed		7	$/watt installed	
Average Res PV system cost			*Average Comm'l PV system cost*		
$300	permit fees ?		$1,000	permit fees ?	
$23,400	total cost	including permit cost	$176,000	total cost	
3.5%	interest rate		3.5%	interest rate	
($1,272.29)	annual P&I payment		($9,569.35)	annual P&I payment	
($105.08)	($1,260.92)				
($38,168.67)	total payments over period		($287,080.63)	total payments over 30 years	
0.25%	program overhead		0.50%	program overhead	
$58.50	annual program cost		$880.00	annual program cost	
$300	annual O&M		$1,000	annual O&M	
($1,630.79)	total annual cost				
($1,619.42)	total annual cost monthly pay				
30	yr financing		30	yr life	
$10,755.00	total lifecycle program cost + O&M		$56,400.00	total lifecycle program cost + O&M	
($48,923.67)	total cost over period		($343,480.63)	total cost over 30 years	
Levelized Cost Residential			***Levelized Cost Commercial***		
138,758	total production over contract perio		1,051,200	total production over 30 years	
($0.35)	$/kWh over financing period		($0.33)	$/kWh over 30 year life of system	
$0.26	Average PG&E over period (4.4% escalator)				

$1,040,711,859 Total residential program cost
147 installed residential MW

$2,506,623,924 Total commercial program cost
356 installed commercial MW

Building Simulation Results for Basic Efficiency Retrofit

Description:	Reference Case	Low-Energy Case
Weather file:	SANTA ROSA.ET1	SANTA ROSA.ET1
Floor Area, ft²	1200	1200
Surface Area, ft²	3672.8	3672.8
Volume, ft³	10800	10800
Total Conduction UA, Btu/h-F	694.3	650.7
Average U-value, Btu/hr-ft²-F	0.189	0.177
Wall Construction	2 x 4 frame, R=12.6	2 x 4 frame, R=12.6
Roof Construction	attic, r-19, R=18.9	attic, r-60, R=60.2
Floor type, insulation	Slab on Grade, Reff=9.4	Slab on Grade, Reff=9.4
Window Construction	4060 single, alum, U=1.23	4060 single, alum, U=1.23
Window Shading	None	None
Wall total gross area, ft²	1273	1273
Roof total gross area, ft²	1200	1200
Ground total gross area, ft²	1200	1200
Window total gross area, ft²	336	336
Windows (N/E/S/W:Roof)	4/3/4/3:0	4/3/4/3:0
Glazing name	single, U=1.11	single, U=1.11

Attic insulation upgrade
Cost: $788

Operating parameters for zone 1		
HVAC system	DX Cooling with Gas Furnace	DX Cooling with Gas Furnace
Rated Output (Heat/SCool/TCool), kBtu/h	32/27/36	32/27/36
Rated Air Flow/MOOA,cfm	1200/0	1200/0
Heating thermostat	67.0 °F, no setback	67.0 °F, setback to 62.0 °F
Cooling thermostat	120.0 °F, no setup	120.0 °F, setup to 125.0 °F
Heat/cool performance	eff=80,EER=8.9	eff=92,EER=13.0
Economizer?/type	no/NA	no/NA
Duct leaks/conduction losses, total %	11/10	11/10
Peak Gains; IL,EL,HW,OT; W/ft²	0.20/0.04/0.66/0.50	0.20/0.04/0.66/0.50
Added mass?	none	none
Daylighting?	no	no
Infiltration, in²	ELA=169.3	ELA=45.8
Results:		
Energy cost	1.320$/Therm,0.160$/kWh,0.000$/kW	1.320$/Therm,0.160$/kWh,0.000$/kW
Simulation dates	01-Jan to 31-Dec	01-Jan to 31-Dec
Energy use, kBtu	89613	63053
Energy cost, $	1833	1438
Total Electric (**), kWh	5659	5268
Internal/External lights, kWh	943/103	943/103
Heating/Cooling/Fan +Aux, kWh	0/0/644	0/0/252
Hot water/Other, kWh	0/3970	0/3970
Peak Electric, kW	1.3	1.1
Fuel, hw/heat/total, kBtu	11738/58564/70302	11738/33340/45078
Emissions, CO2/SO2/NOx, lbs	11070/52/32	7900/47/27

Programmable thermostat
Cost: $213

High efficiency furnace
Cost: $3290

Building envelope air seal
Cost: $2000

Energy use reduction: 30%

Energy cost reduction: $395

CO2 emissions reduction: 29%