DOCKET
07-BSTD-1
DATE OCT 21 2005
RECD. APR 29 2008

Life Cycle Cost Methodology

2008 California Building Energy Efficiency Standards

October 21, 2005

Prepared for

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Introduction **1**

Methodology **2**
New 2008 TDV Curves 2
Adjusting the 2005 TDV Curves - A Second Option 2
Time Period of Analysis 3
Maintenance and Replacement Costs 3
Demand Response Measures 3
Continuous Measures 3

Tier II Standard (High Energy Efficiency Plus PVs) **4**

Appendix A: Methodology for Developing TDV Curves and Net Present Values **5**
Using the 2005 TDV Curves 6

Appendix B: Summary of Statistical Values for 2008 TDV Present Value Costs **7**
2008 TDV Lifecycle Costs – Non-Residential, Climate Zones 1-8 7
2008 TDV Lifecycle Costs – Non-Residential, Climate Zones 9-16 8
2008 TDV Lifecycle Costs – Residential, Climate Zones 1-8 9
2008 TDV Lifecycle Costs – Residential, Climate Zones 9-16 10

Introduction

The Warren-Alquist Act, requires the Energy Commission to develop and maintain energy efficiency standards that are "*… cost effective, when taken in their entirety, and when amortized over the economic life of the structure when compared with historic practice*".[1] This document describes the life cycle cost (LCC) methodology to be used to evaluate proposed standards changes for the 2008 Building Energy Efficiency Standards. Cost effectiveness analysis is needed only for mandatory measures and prescriptive requirements. It is not required for compliance options.

With the 2005 update to the energy efficiency standards, the California Energy Commission moved to time dependent valued (TDV) energy, which gives greater weight to energy saved during peak periods or periods when the generation capacity is at its limit and when the distribution system is near capacity. The life-cycle cost approach to be used with the 2008 standards also will be based on TDV energy. The weight assigned to energy consumption depends on climate zone, time of use, building type (residential or nonresidential) and fuel type (electricity, natural gas, or propane). Appendix III in the *Joint Appendices for the 2005 Building Energy Efficiency Standards* has more information on the TDV values used with the 2005 Standards. Complete data for the 2005 Standards TDV values is available at http://www.h-m-g.com/projects/TDV/index.htm.

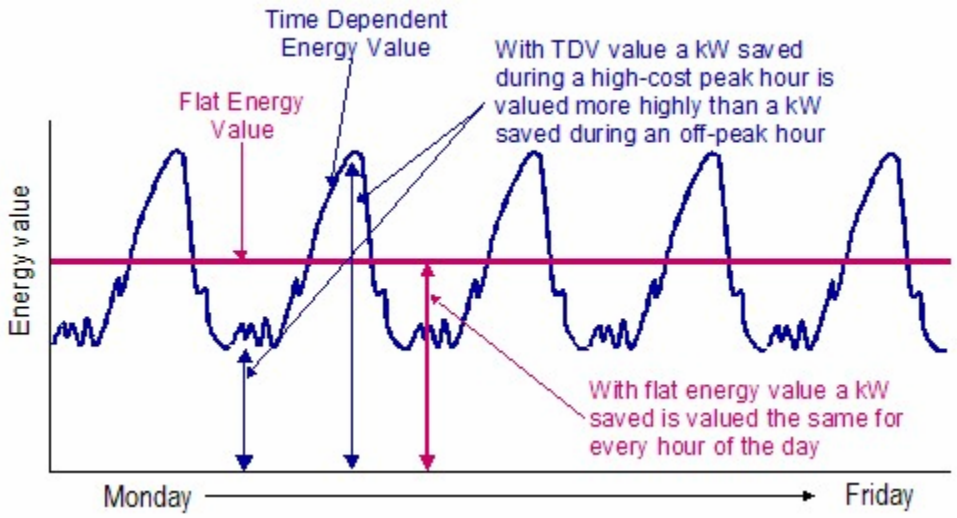


Figure 1 – Concept of Time Dependent Valued Energy
Courtesy www.h-m-g.com

[1] Warren-Alquist Act, Public Resources Code Section 25402.

Methodology

If a measure reduces overall life cycle cost, then it is cost effective. It is not necessary (or even desirable) to calculate absolute life cycle cost. The change in life cycle cost is given in the following equation. If the life-cycle cost is negative then the measure is cost effective relative to the basecase. Negative life-cycle cost means that the present value of TDV energy savings is greater than the initial cost premium, i.e., total life-cycle cost is reduced.

$$\Delta LCC = \text{Cost Premium} - \text{Present Value of Energy Savings}^{2}$$

$$\Delta LCC = \Delta C - (PV_{TDV\text{-}E} * \Delta TDV_{E} + PV_{TDV\text{-}G} * \Delta TDV_{G} + PV_{TDV\text{-}P} * \Delta TDV_{P})$$

where

ΔLCC	change in life cycle cost
ΔC	cost premium associated with the measure, relative to the basecase
$PV_{TDV\text{-}E}$	present value of a TDV unit of electricity
$PV_{TDV\text{-}G}$	present value of a TDV unit of gas
$PV_{TDV\text{-}P}$	present value of a TDV unit of propane
ΔTDV_{E}	TDV of electricity
ΔTDV_{G}	TDV of gas
ΔTDV_{P}	TDV of propane

New 2008 TDV Curves

For the 2008 Standards new TDV curves have been developed to reflect updated electricity and natural gas cost forecasts. The new 2008 TDV curves can be found at www.ethree.com/TDV2008.html. The preferred method for cost effectiveness analysis will be to use the 2008 TDV curves. Cost effectiveness analyses will use the TDV curves and the values in Table 1 to convert TDV energy to net present value costs. This table summarizes the 30-year and 15-year net present value dollars per TDV kBtu for residential and nonresidential buildings for all energy types. The 2008 TDV curves are not currently incorporated in the approved compliance software and TDV calculations will have to be made outside the simulation process, based on hourly estimates of electricity, gas and propane. Appendix A provides a summary of the methodology used to compute the 2008 net present value per TDV kBtu for use with the 2008 TDV curves. Appendix B contains a summary of the statistical values for the present value costs that underlie the 2008 TDV curves; these data are presented by cost component and are listed separately for residential and nonresidential buildings.

Table 1 – Statewide TDV Net Present Value 2008$/kBtu (All Fuel Types)

Building Type	30-year ($/TDV)	15-year ($/TDV)
Low-Rise Residential	$0.24374	n.a.
Nonresidential & High-rise Residential	$0.21890	$0.12428

Adjusting the 2005 TDV Curves - A Second Option

A second method that may be used in some cost effectiveness analysis is to use the TDV energy that is obtained from currently approved compliance software and then applying multipliers to that energy to adjust the results to approximate the values in the 2008 TDV curves. Although this is not the preferred method, for the purposes of life-cycle cost analysis, they results will be close. This method should not be used for peak-focused energy saving measures. Table 2 summarizes the 30-year and 15-year net present value (PV) per

[2] The Commission uses a 3% discount rate for determining present values for Standards purposes.

TDV for residential and nonresidential buildings by climate zone and fuel type that are to be used when adjusting energy results based on the 2005 TDV curves. Software approved for use with the 2005 energy efficiency standards automatically produces estimates of TDV energy based on the 2005 curves. These estimates include the weights defined in Joint Appendix III and in data tables available from the CEC. Appendix A provides a summary of the methodology to compute the 2008 net present value per TDV kBtu with the 2005 TDV curves.

Table 2 – TDV Net Present Value 2008$/kBtu for Climate Zones

Building Type	Fuel Type	Climate Zone	30-year ($/TDV)	15-year ($/TDV)
Low-Rise Residential	Electricity (PV_{TDV-E})	1, 2, 3, 4, 5, 11, 12, 13, 16	$0.17910	n.a.
		6, 8, 9, 10, 14, 15	$0.20002	n.a.
		7	$0.20282	n.a.
	Natural Gas (PV_{TDV-G})	All	$0.26618	n.a.
	Propane (PV_{TDV-P})	All	$0.28778	n.a.
Nonresidential & High-rise Residential	Electricity (PV_{TDV-E})	1, 2, 3, 4, 5, 11, 12, 13, 16	$0.17592	$0.09355
		6, 8, 9, 10, 14, 15	$0.13603	$0.06957
		7	$0.18985	$0.10224
	Natural Gas (PV_{TDV-G})	All	$0.24698	$0.12433
	Propane (PV_{TDV-P})	All	$0.22276	$0.10265

Time Period of Analysis

All low-rise residential measures shall be evaluated over a period of 30 years. Nonresidential building envelope measures shall also be evaluated over a period of 30 years; however, nonresidential lighting, HVAC and water heating measures shall be evaluated over a period of 15 years. Values from Table 1 or Table 2 shall be selected accordingly.

Maintenance and Replacement Costs

Sometimes, a measure will have different maintenance or replacement costs as compared to the basecase. When this occurs, the cost premium should discount all future costs to present value at a discount rate of 3%. The initial cost of both the measure and basecase should include costs that are expected to occur over the assumed life of the measure (see section above on Period of Analysis). Measure costs shall be estimated in 2008 dollars.

Demand Response Measures

Demand response measures will be considered as part of the 2008 standards. One example is a programmable communicating thermostat (PCT), a thermostat that can communicate with the utility and be set to a higher setpoint during an emergency situation or during critical peak periods when the cost of electricity is very high. A separate analysis and documentation will be produced for demand responsive measures. Economic analysis needed for the demand response work resulted in the updated TDV values that are proposed for the 2008 Standards. These new TDV values include higher valuation for the limited number of critical peak hours each year and updates for the other hours of the year that reflect the most recent forecasting of electricity and natural gas costs.

Continuous Measures

Some energy efficiency measures have continuous levels. Insulation is an example. The approach expected to be used for determining the life-cycle cost choice for continuous measures is to search for the level of the measure that reduces life-cycle cost the most, relative to the basecase. This is comparable to ranking the measures by energy saving potential and showing that each incremental change is cost effective relative to the previous measure.

Tier II Standard (High Energy Efficiency Plus PVs)

The Energy Commission intends to develop a Tier II standard for low-rise residential buildings. Tier II will be a combination of a high level of energy efficiency measures (substantially beyond what is necessary to comply with the base Standards) plus a photovoltaic system (PVs). The Tier II energy efficiency measures are expected to be "beyond standards level" building envelope, HVAC and lighting measures. The Energy Commission anticipates determining what energy efficiency measures will be included in the Tier II Standard by comparing the cost effectiveness of energy efficiency measures to the cost of generating electricity with PVs. The Commission believes that it is important for all measures more cost effective than PVs to be incorporated into the building design and construction. With these energy efficiency measures in place, a smaller and more affordable PV System can be installed. This concept also is consistent with California goals to promote zero energy new homes. The methodologies for how the Tier II Standard will be developed will be presented in a subsequent report.

Appendix A: Methodology for Developing TDV Curves and Net Present Values

The 2008 TDV approach is the same as the approach taken for 2005, but updated with more current projections of energy costs. When TDV was initially calculated, the values represented the present value of each hour's energy cost over the 15-year or 30-year nonresidential analysis period and over the 30-year residential analysis period. Forecasts of commodity costs and rates over these time periods were used to project the future costs and the present value was determined by applying a 3% real (inflation adjusted) discount rate.

While the TDV values were initially calculated in terms of cost, from a policy perspective, TDV values are presented in the Standards in terms of energy units for the following reasons:

- Describing TDV in terms of energy units is consistent with past performance method compliance methods. The intent was to minimize the impact of TDV on practitioners. The proposed design would still use less energy than the standard design; TDV energy simply is substituted for source energy and the absolute value would be similar.
- Using present value dollars as the currency for compliance would imply that the building owner's savings should be equal to this amount over the period of analysis. Given that local utility rates may vary and actual building operating assumptions are likely to be different, it was not desirable to imply that the TDV savings are the same as the dollar savings that any single building owner might realize.

Converting the TDV dollar values into energy units followed the precedent of source energy. The base energy unit for source energy was natural gas. The base energy unit for TDV is based on the forecasted cost of natural gas (the forecasted, usage weighted average cost of natural gas across the entire state for each customer class over the entire year).

Thus there is a nonresidential forecasted gas cost and a residential forecasted gas cost. The nonresidential forecasted net present value (NPV) gas cost of $0.12428/kBtu is based on a 15 year forecast of natural gas costs for nonresidential customers expressed in 2008 dollars. The residential forecasted NPV gas cost of $0.24374/kBtu is based on a 30 year forecast for residential customers.

The TDV dollar values for electricity are given in terms of NPV $/kWh for electricity, and NPV $/therms for natural gas and propane. Dividing these TDV dollar values by the forecasted value cost for natural gas results in TDV energy units of TDV kBtu/kWh for electricity and TDV kBtu/therm for natural gas and propane. The equations below provide the units analysis.

For electricity, the TDV energy factors are in terms of TDV kBtu per kWh of electricity:

$$\text{TDV energy factors} = \frac{\text{TDV Dollars}\left[\text{NPV\$/kWh}\right]}{\text{Forecasted Cost}\left[\text{NPV\$/TDV kBtu}\right]} = \frac{\frac{\text{NPV\$}}{\text{kWh}}}{\frac{\text{NPV\$}}{\text{TDV kBtu}}} = \frac{\text{TDV kBtu}}{\text{kWh}}$$

Just like TDV dollar values, the TDV energy factors vary for each hour of the year. To evaluate the TDV valuation of a measure, each hour's electricity savings is multiplied by that hour's TDV energy value. As shown below, this yields an annual savings figure in terms of TDV kBtu.

$$\text{Annual TDV Savings}\left[\text{TDV kBtu}\right] = \sum_{h=1}^{8,760} \text{Energy Savings}_h\left[\text{kWh}\right] \times \text{TDV Energy Factor}_h\left[\frac{\text{TDV kBtu}}{\text{kWh}}\right]$$

For evaluating the cost-effectiveness of new measures, the annual TDV energy savings can be multiplied by the following forecasted gas costs in NPV $/kBtu 2008.

Table 3 – Lifecycle Value (NPV$/kBtu) with 2008 TDV Curves (kBtu/unit)

Statewide Electric TDV Value PV 2008$/kBtu (All Energy Types)

	NPV (30-year)	NPV (15-year)
Low-Rise Residential	$0.24374	
Nonresidential & High-rise Residential	$0.21890	$0.12428

Note that there is a 15-year and a 30-year value for nonresidential measures. For the 2005 standards, the cost-effectiveness of nonresidential envelope measures will be evaluated based upon 30-year life cycle cost. All other nonresidential measures will be evaluated over 15 years.

Unlike the 2005 TDV values, there is not an additional set of multipliers with the environmental externality. The environmental costs are now included in the default multipliers.

Using the 2005 TDV Curves

An additional set of present values were developed to apply to the 2005 TDV curves. This allows an analyst with a building simulation model using the adopted 2005 TDV curves to determine approximately what the present value would be in 2008 dollars. Note that the results will not be exactly the same, but for the purposes of life-cycle cost analysis, they are reasonably close. The 2005 curves should not be used for peak-focused energy saving measures.

The methodology to compute the present value of TDV energy using the 2005 curves is to compute the ratio of the sales weighted average lifecycle value based on the most recent CEC forecast (NPV$/kWh, or NPV$/therm) to the sales weighted average of the lifecycle value adopted in the 2005 standards update. This ratio is then multiplied by the existing multiplier ($/kBtu) developed in the 2005 standards and results in a lifecycle multiplier ($/kBtu) at the 2008 lifecycle value.

For example, the calculation to compute the appropriate 2008 electric TDV multiplier is the following;

$$\text{TDV energy factors } 2008 = \frac{\text{TDV Dollars}\left[\text{NPV\$2008/kWh}\right]}{\text{TDV Dollars}\left[\text{NPV\$2005/kWh}\right]}\left[\frac{\text{TDV \$2005}}{\text{kBtu}}\right] = \frac{\text{TDV \$2008}}{\text{kBtu}}$$

Since the PV$2008/kWh, PV$2005/kWh and PV$2008/kWh values vary by climate zone this calculation results in a different multiplier by climate zone. A statewide average was used for propane in both the 2005 and 2008 TDV analysis. The following table provides the new multipliers using this calculation;

Table 4 – TDV Net Present Value 2008$/kBtu for Climate Zones

Building Type	Fuel Type	Climate Zone	30-year ($/TDV)	15-year ($/TDV)
Low-Rise Residential	Electricity (PV_{TDV-E})	1, 2, 3, 4, 5, 11, 12, 13, 16	$0.17910	n.a.
		6, 8, 9, 10, 14, 15	$0.20002	n.a.
		7	$0.20282	n.a.
	Natural Gas (PV_{TDV-G})	All	$0.26618	n.a.
	Propane (PV_{TDV-P})	All	$0.28778	n.a.
Nonresidential & High-rise Residential	Electricity (PV_{TDV-E})	1, 2, 3, 4, 5, 11, 12, 13, 16	$0.17592	$0.09355
		6, 8, 9, 10, 14, 15	$0.13603	$0.06957
		7	$0.18985	$0.10224
	Natural Gas (PV_{TDV-G})	All	$0.24698	$0.12433
	Propane (PV_{TDV-P})	All	$0.22276	$0.10265

Appendix B: Summary of Statistical Values for 2008 TDV Present Value Costs

2008 TDV Lifecycle Costs – Non-Residential, Climate Zones 1-8

Climate Zone:1	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 24.53	$ 31.50	$ 0.62
Max	$ 601.69	$ 65.32	$ 18.94	$ 714.69	$ 358.13	$ 16.58	$ 24.53	$ 1,229.71	$ 24.10
Avg.	$ 66.19	$ 4.89	$ 2.02	$ 3.64	$ 6.26	$ 8.93	$ 24.53	$ 116.47	$ 2.28
Wtd. Average	$ 67.22	$ 5.05	$ 2.05	$ 4.05	$ 6.96	$ 9.01	$ 24.53	$ 118.88	$ 2.33

Climate Zone:2	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 25.30	$ 32.27	$ 0.63
Max	$ 601.69	$ 65.32	$ 18.94	$ 714.69	$ 325.88	$ 16.58	$ 25.30	$ 1,230.48	$ 24.12
Avg.	$ 66.19	$ 4.89	$ 2.02	$ 3.64	$ 5.58	$ 8.93	$ 25.30	$ 116.55	$ 2.28
Wtd. Average	$ 67.22	$ 5.05	$ 2.05	$ 4.05	$ 6.19	$ 9.01	$ 25.30	$ 118.88	$ 2.33

Climate Zone:3	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 27.26	$ 34.22	$ 0.67
Max	$ 601.69	$ 65.32	$ 18.94	$ 714.69	$ 320.22	$ 16.58	$ 27.26	$ 1,232.43	$ 24.16
Avg.	$ 66.19	$ 4.89	$ 2.02	$ 3.64	$ 3.82	$ 8.93	$ 27.26	$ 116.74	$ 2.29
Wtd. Average	$ 67.22	$ 5.05	$ 2.05	$ 4.05	$ 4.24	$ 9.01	$ 27.26	$ 118.88	$ 2.33

Climate Zone:4	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 26.35	$ 33.31	$ 0.65
Max	$ 601.69	$ 65.32	$ 18.94	$ 714.69	$ 572.70	$ 16.58	$ 26.35	$ 1,434.08	$ 28.11
Avg.	$ 66.19	$ 4.89	$ 2.02	$ 3.64	$ 4.66	$ 8.93	$ 26.35	$ 116.68	$ 2.29
Wtd. Average	$ 67.22	$ 5.05	$ 2.05	$ 4.05	$ 5.15	$ 9.01	$ 26.35	$ 118.88	$ 2.33

Climate Zone:5	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 26.38	$ 33.34	$ 0.65
Max	$ 601.69	$ 65.32	$ 18.94	$ 714.69	$ 500.00	$ 16.58	$ 26.38	$ 1,231.55	$ 24.14
Avg.	$ 66.19	$ 4.89	$ 2.02	$ 3.64	$ 4.55	$ 8.93	$ 26.38	$ 116.60	$ 2.29
Wtd. Average	$ 67.22	$ 5.05	$ 2.05	$ 4.05	$ 5.12	$ 9.01	$ 26.38	$ 118.88	$ 2.33

Climate Zone:6	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 51.69	$ 58.66	$ 1.15
Max	$ 601.69	$ 50.83	$ 18.53	$ 600.23	$ 441.89	$ 16.58	$ 51.69	$ 1,132.11	$ 22.19
Avg.	$ 66.78	$ 5.04	$ 2.04	$ 3.06	$ 5.52	$ 9.09	$ 51.69	$ 143.22	$ 2.81
Wtd. Average	$ 69.57	$ 5.30	$ 2.13	$ 4.43	$ 7.57	$ 9.34	$ 51.69	$ 150.03	$ 2.94

Climate Zone:7	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 23.82	$ 30.78	$ 0.60
Max	$ 601.69	$ 48.67	$ 18.47	$ 600.23	$ 737.66	$ 16.58	$ 23.82	$ 1,455.45	$ 28.53
Avg.	$ 66.78	$ 4.91	$ 2.04	$ 3.06	$ 11.35	$ 9.09	$ 23.82	$ 121.05	$ 2.37
Wtd. Average	$ 67.91	$ 5.04	$ 2.07	$ 3.30	$ 12.32	$ 9.21	$ 23.82	$ 123.66	$ 2.42

Climate Zone:8	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 51.59	$ 58.55	$ 1.15
Max	$ 601.69	$ 50.83	$ 18.53	$ 600.23	$ 430.32	$ 16.58	$ 51.59	$ 1,201.77	$ 23.56
Avg.	$ 66.78	$ 5.04	$ 2.04	$ 3.06	$ 5.42	$ 9.09	$ 51.59	$ 143.02	$ 2.80
Wtd. Average	$ 69.57	$ 5.30	$ 2.13	$ 4.43	$ 7.68	$ 9.34	$ 51.59	$ 150.03	$ 2.94

2008 TDV Lifecycle Costs – Non-Residential, Climate Zones 9-16

Climate Zone:9	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 51.11	$ 58.07	$ 1.14
Max	$ 601.69	$ 50.83	$ 18.53	$ 600.23	$ 637.18	$ 16.58	$ 51.11	$ 1,626.11	$ 31.87
Avg.	$ 66.78	$ 5.04	$ 2.04	$ 3.06	$ 5.65	$ 9.09	$ 51.11	$ 142.76	$ 2.80
Wtd. Average	$ 69.57	$ 5.30	$ 2.13	$ 4.43	$ 8.16	$ 9.34	$ 51.11	$ 150.03	$ 2.94

Climate Zone:10	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 50.59	$ 57.55	$ 1.13
Max	$ 601.69	$ 50.83	$ 18.53	$ 600.23	$ 385.12	$ 16.58	$ 50.59	$ 1,131.01	$ 22.17
Avg.	$ 66.78	$ 5.04	$ 2.04	$ 3.06	$ 5.96	$ 9.09	$ 50.59	$ 142.55	$ 2.79
Wtd. Average	$ 69.57	$ 5.30	$ 2.13	$ 4.43	$ 8.68	$ 9.34	$ 50.59	$ 150.03	$ 2.94

Climate Zone:11	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 24.14	$ 31.10	$ 0.61
Max	$ 601.69	$ 65.32	$ 18.94	$ 714.69	$ 375.14	$ 16.58	$ 24.14	$ 1,604.46	$ 31.45
Avg.	$ 66.19	$ 4.89	$ 2.02	$ 3.64	$ 6.65	$ 8.93	$ 24.14	$ 116.46	$ 2.28
Wtd. Average	$ 67.22	$ 5.05	$ 2.05	$ 4.05	$ 7.35	$ 9.01	$ 24.14	$ 118.88	$ 2.33

Climate Zone:12	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 24.98	$ 31.95	$ 0.63
Max	$ 601.69	$ 65.32	$ 18.94	$ 714.69	$ 475.91	$ 16.58	$ 24.98	$ 1,268.12	$ 24.86
Avg.	$ 66.19	$ 4.89	$ 2.02	$ 3.64	$ 5.87	$ 8.93	$ 24.98	$ 116.52	$ 2.28
Wtd. Average	$ 67.22	$ 5.05	$ 2.05	$ 4.05	$ 6.51	$ 9.01	$ 24.98	$ 118.88	$ 2.33

Climate Zone:13	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 27.01	$ 33.98	$ 0.67
Max	$ 601.69	$ 65.32	$ 18.94	$ 714.69	$ 170.67	$ 16.58	$ 27.01	$ 1,378.27	$ 27.01
Avg.	$ 66.19	$ 4.89	$ 2.02	$ 3.64	$ 4.05	$ 8.93	$ 27.01	$ 116.74	$ 2.29
Wtd. Average	$ 67.22	$ 5.05	$ 2.05	$ 4.05	$ 4.48	$ 9.01	$ 27.01	$ 118.88	$ 2.33

Climate Zone:14	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 50.55	$ 57.51	$ 1.13
Max	$ 601.69	$ 50.83	$ 18.53	$ 600.23	$ 278.75	$ 16.58	$ 50.55	$ 1,402.71	$ 27.49
Avg.	$ 66.78	$ 5.04	$ 2.04	$ 3.06	$ 5.97	$ 9.09	$ 50.55	$ 142.52	$ 2.79
Wtd. Average	$ 69.57	$ 5.30	$ 2.13	$ 4.43	$ 8.72	$ 9.34	$ 50.55	$ 150.03	$ 2.94

Climate Zone:15	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 50.44	$ 57.41	$ 1.13
Max	$ 601.69	$ 50.83	$ 18.53	$ 600.23	$ 277.30	$ 16.58	$ 50.44	$ 1,223.30	$ 23.98
Avg.	$ 66.78	$ 5.04	$ 2.04	$ 3.06	$ 6.06	$ 9.09	$ 50.44	$ 142.51	$ 2.79
Wtd. Average	$ 69.57	$ 5.30	$ 2.13	$ 4.43	$ 8.82	$ 9.34	$ 50.44	$ 150.03	$ 2.94

Climate Zone:16	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 6.96	$ 23.69	$ 30.65	$ 0.60
Max	$ 601.69	$ 65.32	$ 18.94	$ 714.69	$ 588.42	$ 16.58	$ 23.69	$ 1,364.29	$ 26.74
Avg.	$ 66.19	$ 4.89	$ 2.02	$ 3.64	$ 7.06	$ 8.93	$ 23.69	$ 116.42	$ 2.28
Wtd. Average	$ 67.22	$ 5.05	$ 2.05	$ 4.05	$ 7.81	$ 9.01	$ 23.69	$ 118.88	$ 2.33

2008 TDV Lifecycle Costs – Residential, Climate Zones 1-8

Climate Zone:1	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 47.60	$ 52.52	$ 0.63
Max	$ 557.10	$ 60.48	$ 17.54	$ 790.30	$ 360.89	$ 11.70	$ 47.60	$ 1,288.40	$ 15.38
Avg.	$ 60.63	$ 4.48	$ 1.85	$ 4.02	$ 6.31	$ 6.30	$ 47.60	$ 131.20	$ 1.57
Wtd. Average	$ 63.78	$ 5.04	$ 1.95	$ 5.64	$ 8.55	$ 6.48	$ 47.60	$ 139.04	$ 1.66

Climate Zone:2	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 48.11	$ 53.02	$ 0.63
Max	$ 557.10	$ 60.48	$ 17.54	$ 790.30	$ 328.37	$ 11.70	$ 48.11	$ 1,288.91	$ 15.39
Avg.	$ 60.63	$ 4.48	$ 1.85	$ 4.02	$ 5.62	$ 6.30	$ 48.11	$ 131.02	$ 1.56
Wtd. Average	$ 63.78	$ 5.04	$ 1.95	$ 5.64	$ 8.04	$ 6.48	$ 48.11	$ 139.04	$ 1.66

Climate Zone:3	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 50.76	$ 55.67	$ 0.66
Max	$ 557.10	$ 60.48	$ 17.54	$ 790.30	$ 322.57	$ 11.70	$ 50.76	$ 1,291.55	$ 15.42
Avg.	$ 60.63	$ 4.48	$ 1.85	$ 4.02	$ 3.85	$ 6.30	$ 50.76	$ 131.89	$ 1.57
Wtd. Average	$ 63.78	$ 5.04	$ 1.95	$ 5.64	$ 5.39	$ 6.48	$ 50.76	$ 139.04	$ 1.66

Climate Zone:4	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 49.62	$ 54.53	$ 0.65
Max	$ 557.10	$ 60.48	$ 17.54	$ 790.30	$ 577.01	$ 11.70	$ 49.62	$ 1,457.80	$ 17.40
Avg.	$ 60.63	$ 4.48	$ 1.85	$ 4.02	$ 4.69	$ 6.30	$ 49.62	$ 131.60	$ 1.57
Wtd. Average	$ 63.78	$ 5.04	$ 1.95	$ 5.64	$ 6.53	$ 6.48	$ 49.62	$ 139.04	$ 1.66

Climate Zone:5	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 50.23	$ 55.14	$ 0.66
Max	$ 557.10	$ 60.48	$ 17.54	$ 790.30	$ 503.75	$ 11.70	$ 50.23	$ 1,291.02	$ 15.41
Avg.	$ 60.63	$ 4.48	$ 1.85	$ 4.02	$ 4.59	$ 6.30	$ 50.23	$ 132.10	$ 1.58
Wtd. Average	$ 63.78	$ 5.04	$ 1.95	$ 5.64	$ 5.92	$ 6.48	$ 50.23	$ 139.04	$ 1.66

Climate Zone:6	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 27.45	$ 32.36	$ 0.39
Max	$ 557.10	$ 47.06	$ 17.16	$ 684.28	$ 418.08	$ 11.70	$ 27.45	$ 1,152.69	$ 13.76
Avg.	$ 61.17	$ 4.61	$ 1.87	$ 3.48	$ 5.23	$ 6.42	$ 27.45	$ 110.23	$ 1.32
Wtd. Average	$ 64.96	$ 4.98	$ 1.99	$ 5.26	$ 7.43	$ 6.69	$ 27.45	$ 118.75	$ 1.42

Climate Zone:7	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 60.39	$ 65.30	$ 0.78
Max	$ 557.10	$ 45.07	$ 17.10	$ 684.28	$ 729.74	$ 11.70	$ 60.39	$ 1,533.16	$ 18.30
Avg.	$ 61.17	$ 4.50	$ 1.87	$ 3.48	$ 11.23	$ 6.42	$ 60.39	$ 149.06	$ 1.78
Wtd. Average	$ 64.09	$ 4.79	$ 1.96	$ 4.84	$ 15.30	$ 6.63	$ 60.39	$ 158.00	$ 1.89

Climate Zone:8	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 27.43	$ 32.34	$ 0.39
Max	$ 557.10	$ 47.06	$ 17.16	$ 684.28	$ 401.57	$ 11.70	$ 27.43	$ 1,186.12	$ 14.16
Avg.	$ 61.17	$ 4.61	$ 1.87	$ 3.48	$ 5.06	$ 6.42	$ 27.43	$ 110.05	$ 1.31
Wtd. Average	$ 64.96	$ 4.98	$ 1.99	$ 5.26	$ 7.45	$ 6.69	$ 27.43	$ 118.75	$ 1.42

2008 TDV Lifecycle Costs – Residential, Climate Zones 9-16

Climate Zone:9	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 26.71	$ 31.63	$ 0.38
Max	$ 557.10	$ 47.06	$ 17.16	$ 684.28	$ 612.59	$ 11.70	$ 26.71	$ 1,574.27	$ 18.79
Avg.	$ 61.17	$ 4.61	$ 1.87	$ 3.48	$ 5.43	$ 6.42	$ 26.71	$ 109.70	$ 1.31
Wtd. Average	$ 64.96	$ 4.98	$ 1.99	$ 5.26	$ 8.16	$ 6.69	$ 26.71	$ 118.75	$ 1.42

Climate Zone:10	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 25.87	$ 30.78	$ 0.37
Max	$ 557.10	$ 47.06	$ 17.16	$ 684.28	$ 383.76	$ 11.70	$ 25.87	$ 1,151.10	$ 13.74
Avg.	$ 61.17	$ 4.61	$ 1.87	$ 3.48	$ 5.93	$ 6.42	$ 25.87	$ 109.36	$ 1.31
Wtd. Average	$ 64.96	$ 4.98	$ 1.99	$ 5.26	$ 9.01	$ 6.69	$ 25.87	$ 118.75	$ 1.42

Climate Zone:11	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 46.66	$ 51.57	$ 0.62
Max	$ 557.10	$ 60.48	$ 17.54	$ 790.30	$ 378.05	$ 11.70	$ 46.66	$ 1,665.51	$ 19.88
Avg.	$ 60.63	$ 4.48	$ 1.85	$ 4.02	$ 6.70	$ 6.30	$ 46.66	$ 130.65	$ 1.56
Wtd. Average	$ 63.78	$ 5.04	$ 1.95	$ 5.64	$ 9.49	$ 6.48	$ 46.66	$ 139.04	$ 1.66

Climate Zone:12	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 47.64	$ 52.56	$ 0.63
Max	$ 557.10	$ 60.48	$ 17.54	$ 790.30	$ 479.57	$ 11.70	$ 47.64	$ 1,295.17	$ 15.46
Avg.	$ 60.63	$ 4.48	$ 1.85	$ 4.02	$ 5.91	$ 6.30	$ 47.64	$ 130.84	$ 1.56
Wtd. Average	$ 63.78	$ 5.04	$ 1.95	$ 5.64	$ 8.51	$ 6.48	$ 47.64	$ 139.04	$ 1.66

Climate Zone:13	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 50.38	$ 55.29	$ 0.66
Max	$ 557.10	$ 60.48	$ 17.54	$ 790.30	$ 171.93	$ 11.70	$ 50.38	$ 1,438.33	$ 17.17
Avg.	$ 60.63	$ 4.48	$ 1.85	$ 4.02	$ 4.08	$ 6.30	$ 50.38	$ 131.75	$ 1.57
Wtd. Average	$ 63.78	$ 5.04	$ 1.95	$ 5.64	$ 5.77	$ 6.48	$ 50.38	$ 139.04	$ 1.66

Climate Zone:14	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 25.89	$ 30.80	$ 0.37
Max	$ 557.10	$ 47.06	$ 17.16	$ 684.28	$ 275.75	$ 11.70	$ 25.89	$ 1,419.95	$ 16.95
Avg.	$ 61.17	$ 4.61	$ 1.87	$ 3.48	$ 5.90	$ 6.42	$ 25.89	$ 109.35	$ 1.31
Wtd. Average	$ 64.96	$ 4.98	$ 1.99	$ 5.26	$ 8.99	$ 6.69	$ 25.89	$ 118.75	$ 1.42

Climate Zone:15	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 25.75	$ 30.66	$ 0.37
Max	$ 557.10	$ 47.06	$ 17.16	$ 684.28	$ 275.73	$ 11.70	$ 25.75	$ 1,242.90	$ 14.84
Avg.	$ 61.17	$ 4.61	$ 1.87	$ 3.48	$ 6.03	$ 6.42	$ 25.75	$ 109.33	$ 1.31
Wtd. Average	$ 64.96	$ 4.98	$ 1.99	$ 5.26	$ 9.13	$ 6.69	$ 25.75	$ 118.75	$ 1.42

Climate Zone:16	Energy and Capacity	Losses	A/S	Capacity Residual	T&D	Environment	Retail Rate Adder	Levelized Value ($/MWh)	PV $/kWh
Min	$ -	$ -	$ -	$ -	$ -	$ 4.91	$ 46.34	$ 51.25	$ 0.61
Max	$ 557.10	$ 60.48	$ 17.54	$ 790.30	$ 593.01	$ 11.70	$ 46.34	$ 1,375.08	$ 16.42
Avg.	$ 60.63	$ 4.48	$ 1.85	$ 4.02	$ 7.12	$ 6.30	$ 46.34	$ 130.74	$ 1.56
Wtd. Average	$ 63.78	$ 5.04	$ 1.95	$ 5.64	$ 9.81	$ 6.48	$ 46.34	$ 139.04	$ 1.66