Life-Cycle Cost Methodology

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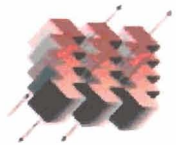
2008 California Building Energy Efficiency Standards

Public Workshop
October 24-25, 2005



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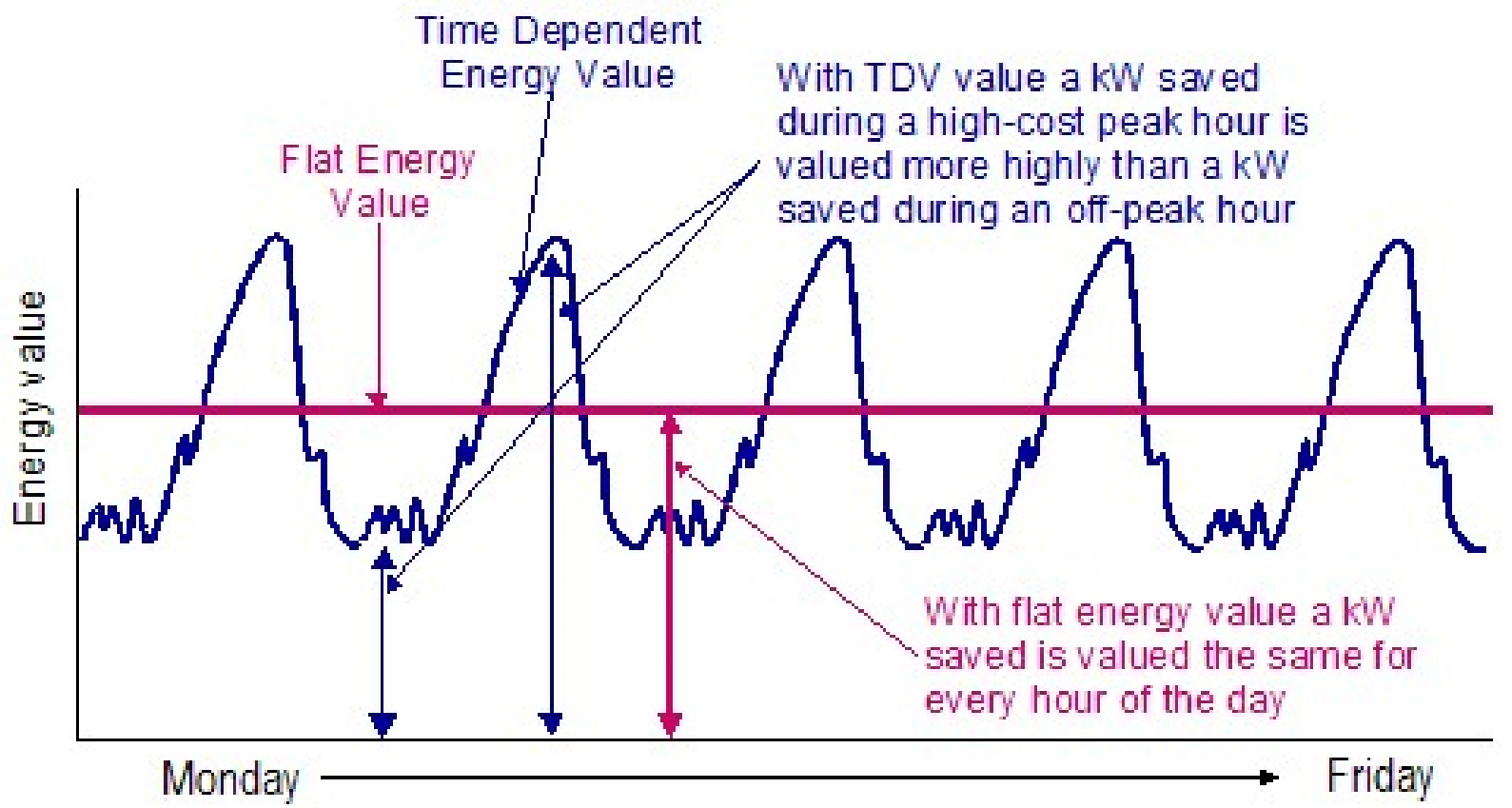
TDV (Time Dependent Valued) Energy



LCC Equation with 2008 Curves

ΔLCC = Cost Premium – Present Value of Energy Savings

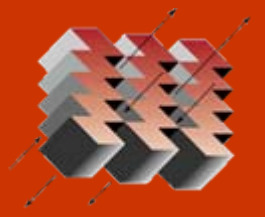
$\Delta LCC = \Delta C - (PV_{TDV\text{-}P} * \Delta TDV)$

www.ethree.com/TDV2008.html

Table 2 – 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

Optional LCC Equation with 2005 Curves



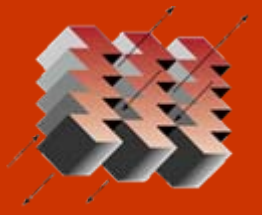
ΔLCC = Cost Premium – Present Value of Energy Savings

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

Table 1 – TDV Net Present Value 2008$/kBtu for Climate Zones

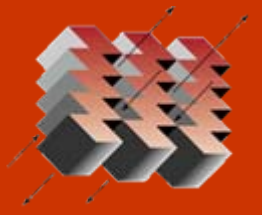
Building Type	Fuel Type	Climate Zone	30-year ($/TDV)	15-year ($/TDV)
Low-Rise Residential	Electricity ($PV_{TDV\text{-}E}$)	1, 2, 3, 4, 5, 11, 12, 13, 16	$0.17910	n.a.
		6, 8, 9, 10, 14, 15	$0.20002	n.a.
		7	$0.20282	n.a.
	Natural Gas ($PV_{TDV\text{-}G}$)	All	$0.26618	n.a.
	Propane ($PV_{TDV\text{-}P}$)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

Time Period of Analysis



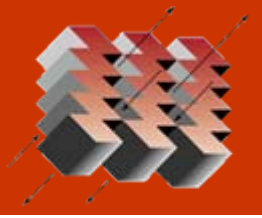
- All low-rise residential measures shall be evaluated over a period of 30 years.
- Nonresidential building envelope measures shall also be evaluated over a period of 30 years
- Nonresidential lighting, HVAC and water heating measures shall be evaluated over a period of 15 years.
- Values from Table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

Maintenance and Replacement Costs



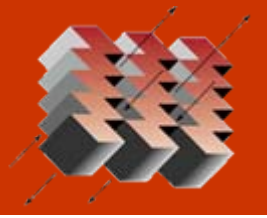
- **Maintenance or replacement costs shall be considered when the costs are different from the basecase.**
- **Future maintenance or replacement costs shall be quantified in 2008 dollars and discounted to present value using a discount rate of 3%.**
- **The present value of maintenance and replacement costs is added to the initial cost of the measure.**

Demand Response Measures



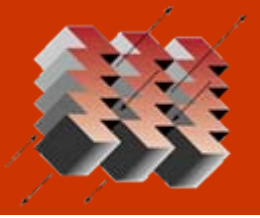
- Demand response measures may be considered as part of the 2008 standards.
- Demand response measures are expected to be included as mandatory measures (no tradeoffs).
- Examples include thermostats that can communicate with the utility and be set to a higher setpoint during an emergency situation.
- When evaluating demand response measures, the 2008 TDV curves should be used since they more accurately reflect the value of savings during emergency situations.

Comparing Incremental Measures



- **Some energy efficiency measures are incremental or continuous. Insulation is an example.**
- **The life-cycle cost principal in finding the life-cycle cost choice for continuous measures is to choose the measure that reduces life-cycle cost the most.**
- **This is equivalent 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.
- 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.

How the TDV Curves and Data were Developed

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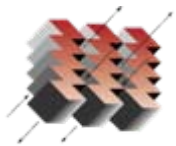

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Lifecycle Cost Using 2008 TDV Curves

Methodology for converting TDV curves into TDV energy and lifecycle cost:

- Divide TDV curves (NPV$/kWh, NPV$/therm) by a constant value (NPV$/kBtu) to obtain TDV energy curves (kBtu/kWh, kBtu/therm)
- Use TDV energy curves in simulation tools to compute the change in TDV energy over one year (kBtu)
- Multiply the change in TDV energy by the same constant value (NPV$/kBtu) to obtain lifecycle cost (NPV$)

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

Constants used for conversion:

Customer Class	NPV (30-year) 2008$/kBtu	NPV (15-year) 2008$/kBtu
Low-Rise Residential	$ 0.24374	
Non-Residential & High-Rise Residential	$ 0.21890	$ 0.12428

Lifecycle Cost Using 2005 TDV Curves

Methodology for using 2005 TDV curves if necessary (not preferred):

• Multiply 2005 energy factors (NPV$2005/kBtu) by the ratio of 2008/2005 forecast energy values (NPV$2008/NPV$2005) to obtain 2008 energy factors (NPV$2008/kBtu). (Results shown in Table 1).

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

Table 1. 2008 energy factors to use with 2005 TDV curves NPV$2008/kBtu

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.
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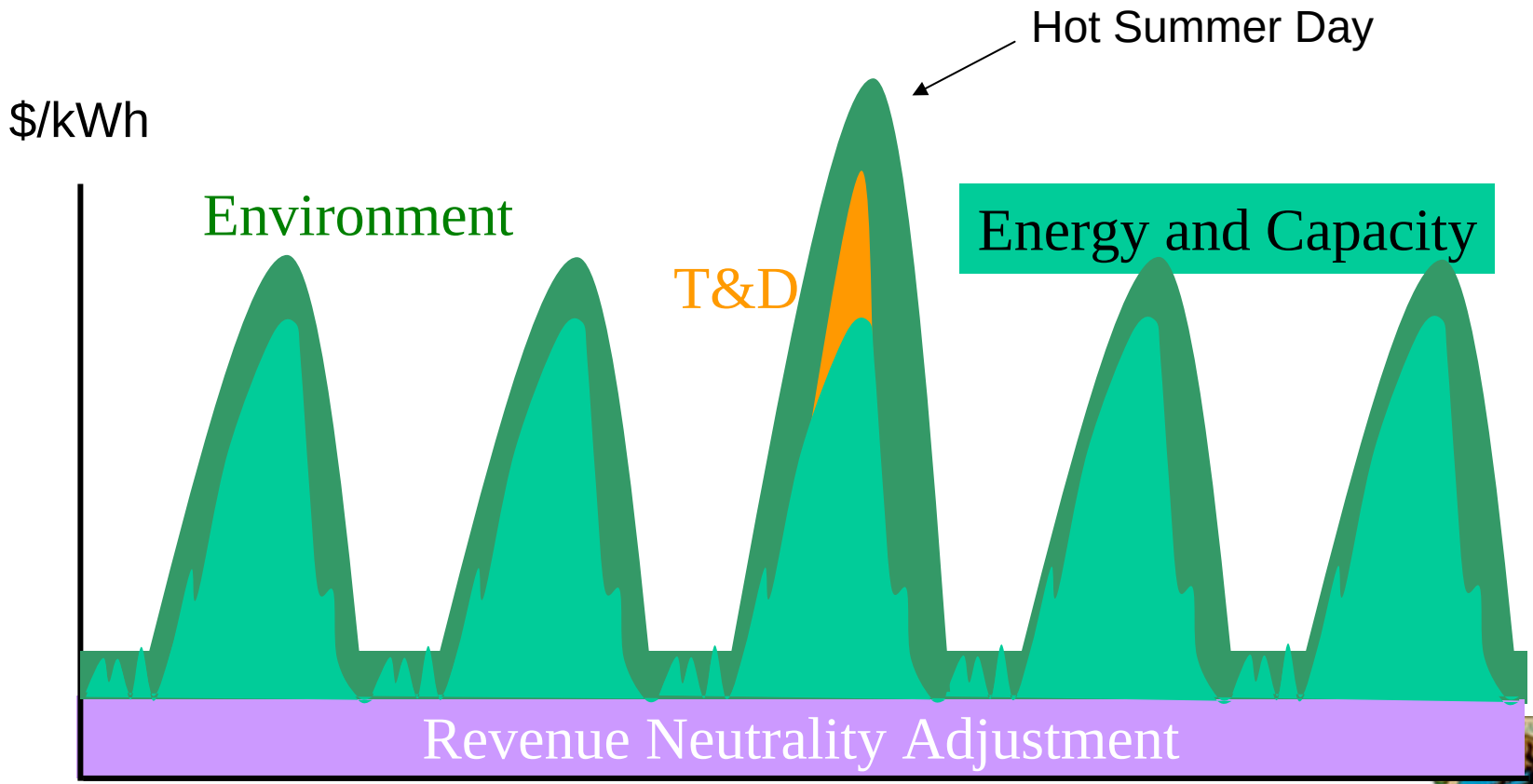
Changes to 2005 TDV Method

1. Updated inputs for each TDV component
2. Updated methodology on peak hours

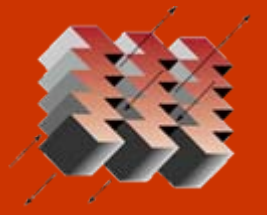


2008 Updates to 2005 TDV

Updated forecast of energy and rates

- electric and gas retail rates (2005 IEPR)
- natural gas price forecast (2005 IEPR)
- propane price forecast (EIA)
- T&D avoided costs (CPUC EE)
- new entrant costs for CT & CCGT (MPR)
- emissions avoided costs (CPUC EE)

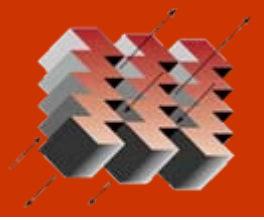
2008 Updates to 2005 TDV

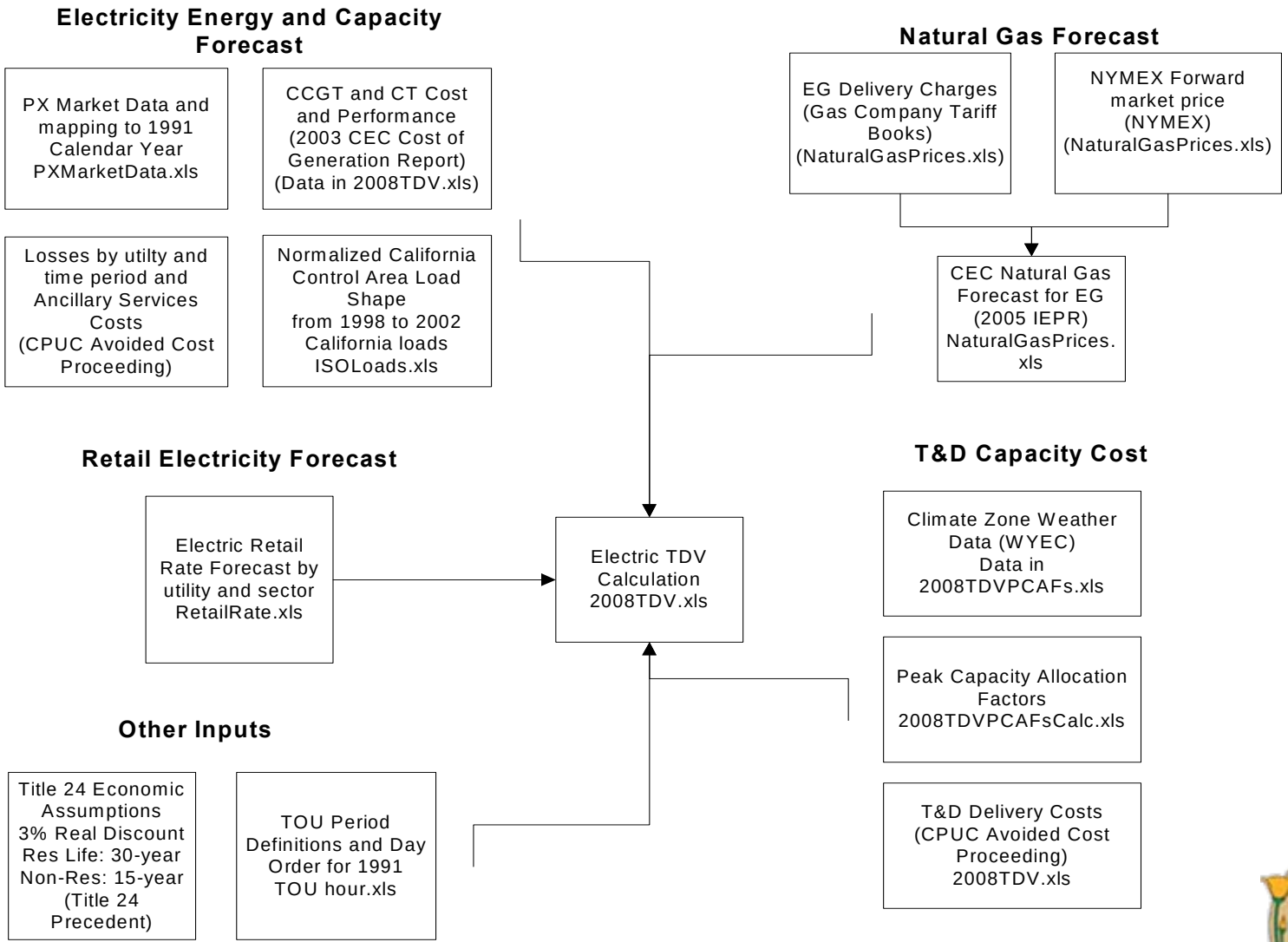


Updated methodology to evaluate DR

- **Modifies the historical market price shape to reflect avoiding the need to add capacity**
- **Assumes that the backstop technology to add capacity in the State is a CT**
- **Observed market prices will pay for part, but not the total costs of a new CT**

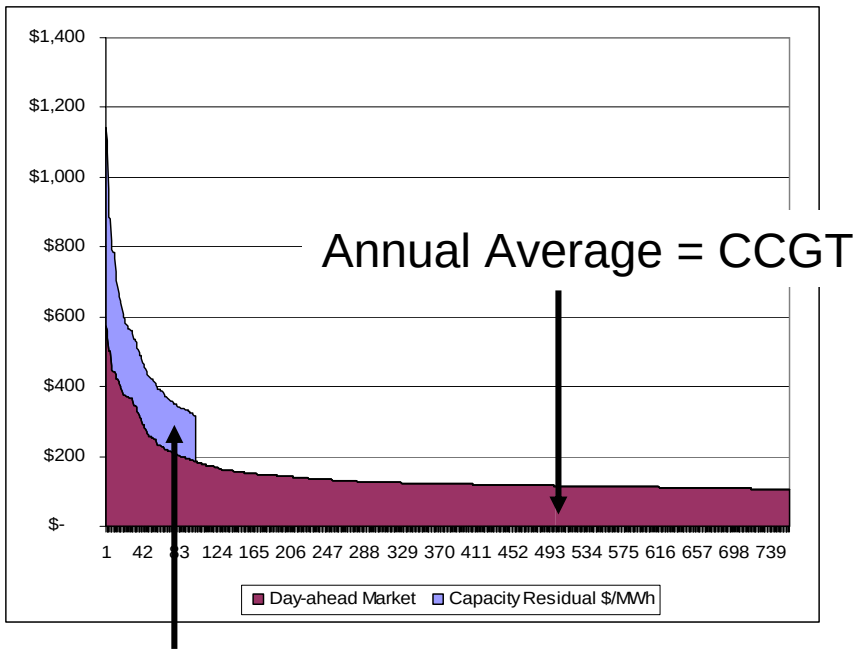
2008 TDV calculation methodology





CT Backstop Methodology

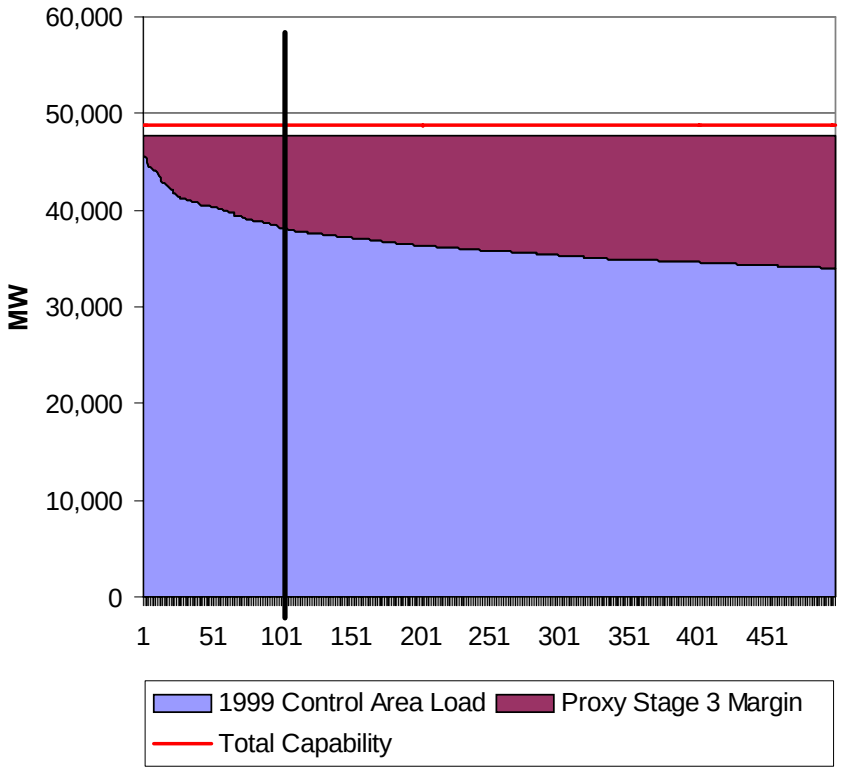
Energy and Capacity Curve for Top 500 Hours



- **Based on cost to add capacity with a CT**
- **Top 100 hours increased to residual value of a CT**
  - ~$35-$40/kW-year
  - Allocated based on ISO control area loads
- **Remaining hours reduced to a value of a CCGT**

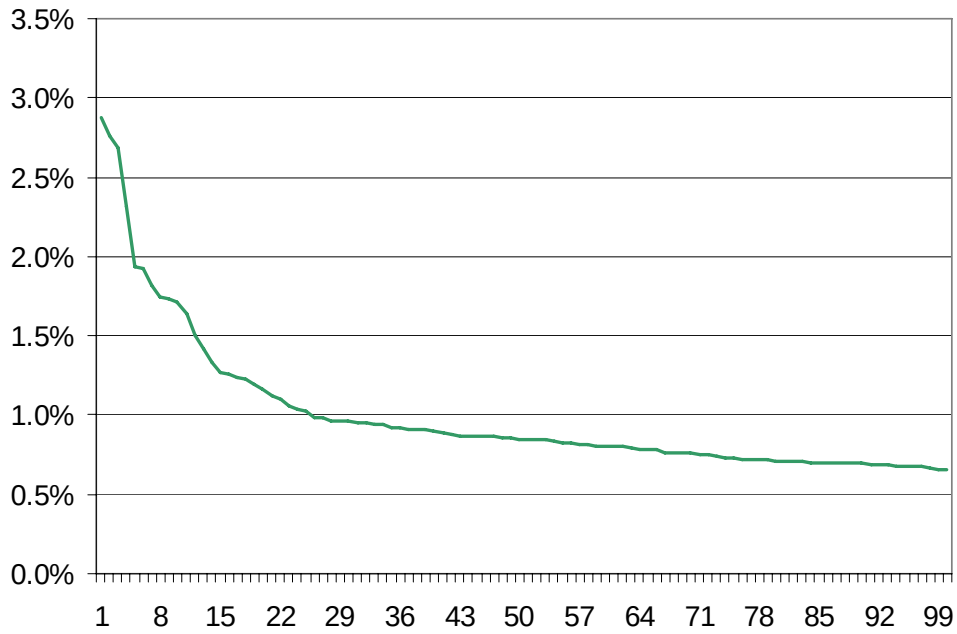
Allocation of Residual Capacity

Control Area Load 1999 Example

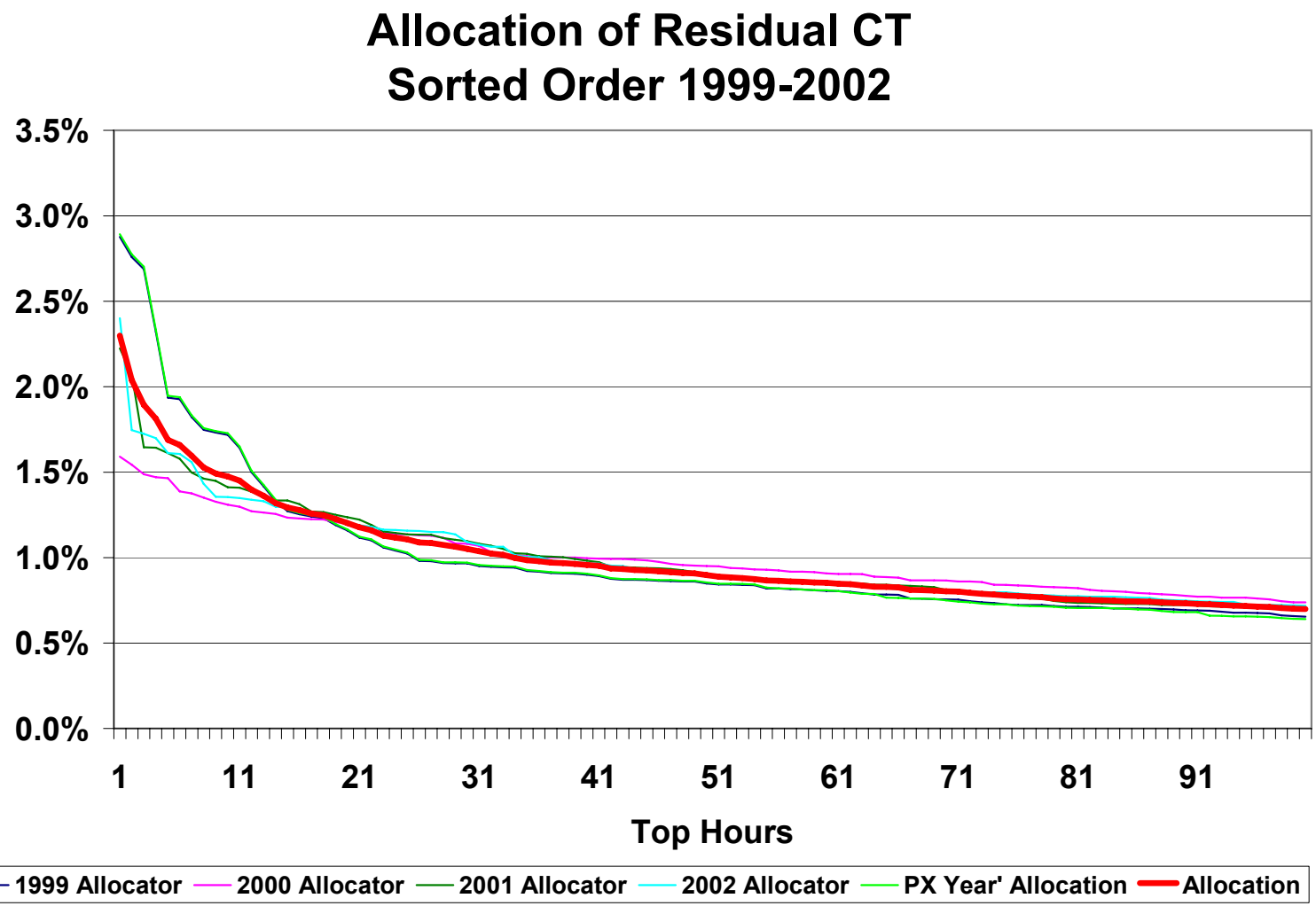


Resulting Allocators

ISO Load Method



Allocation of Residual Capacity



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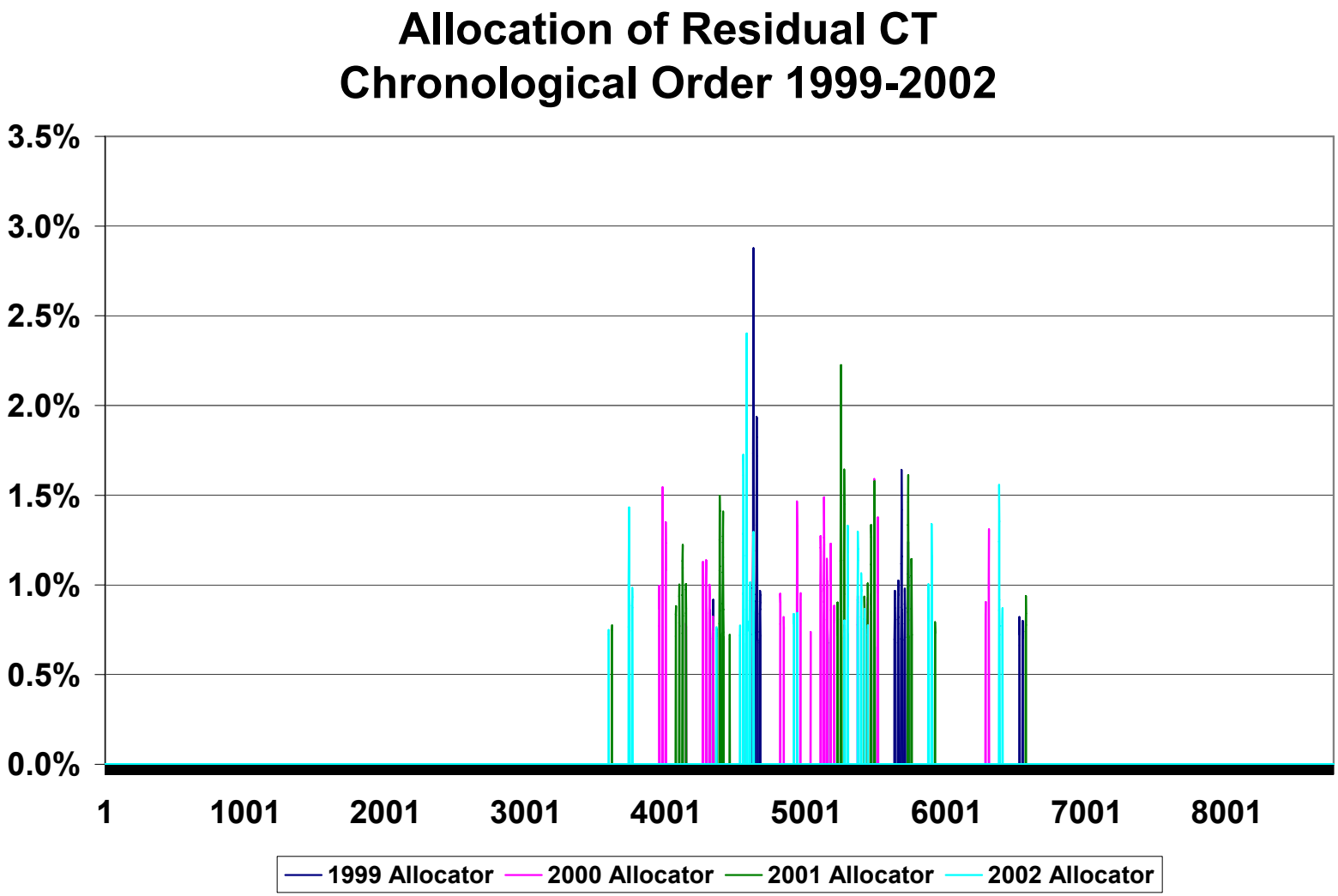
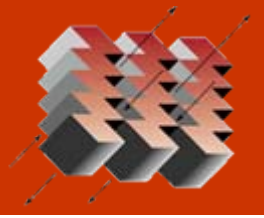


2008 TDV Curves

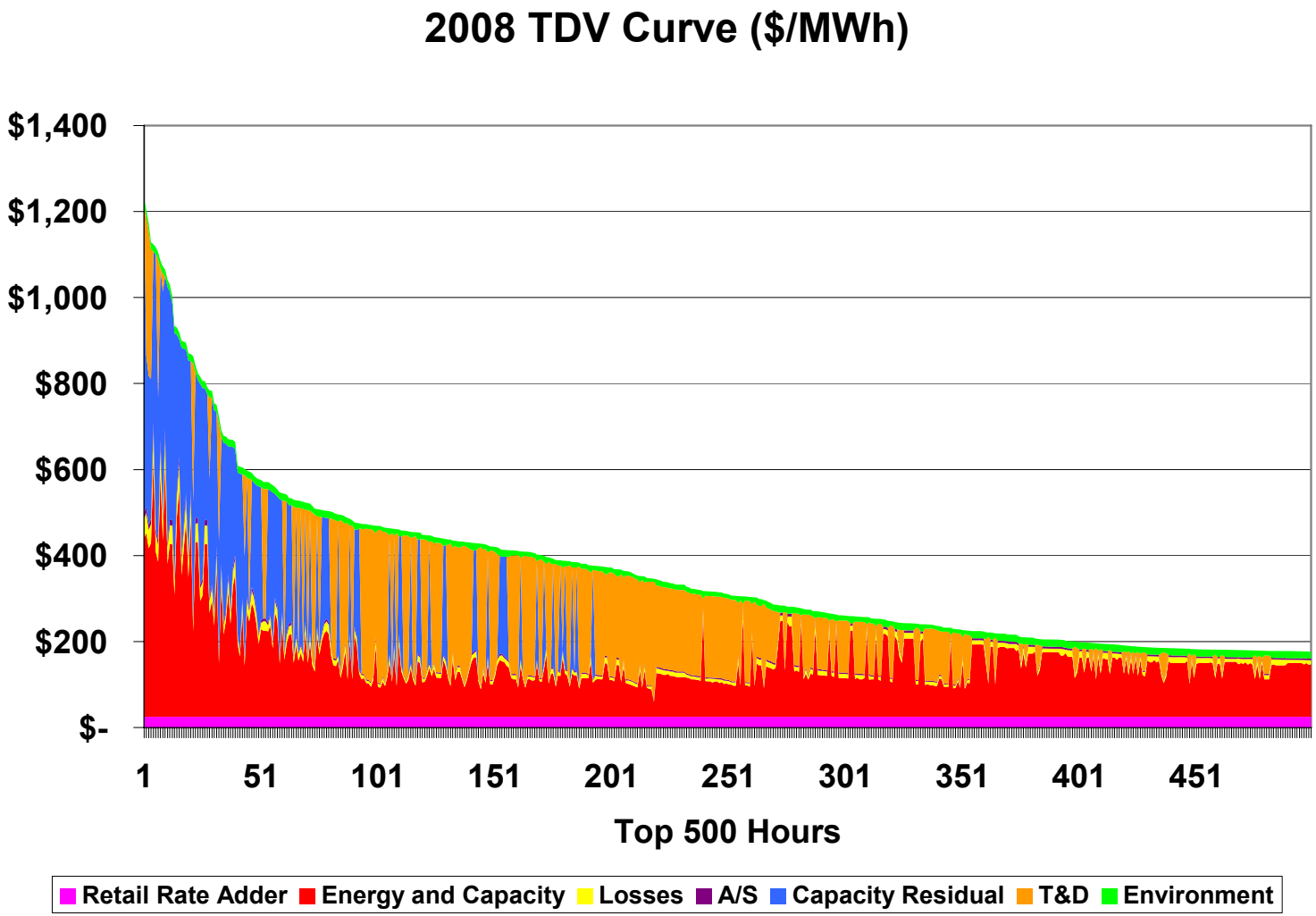


Results

Excel files available

http://www.ethree.com/TDV2008.html

2008 TDV Curves



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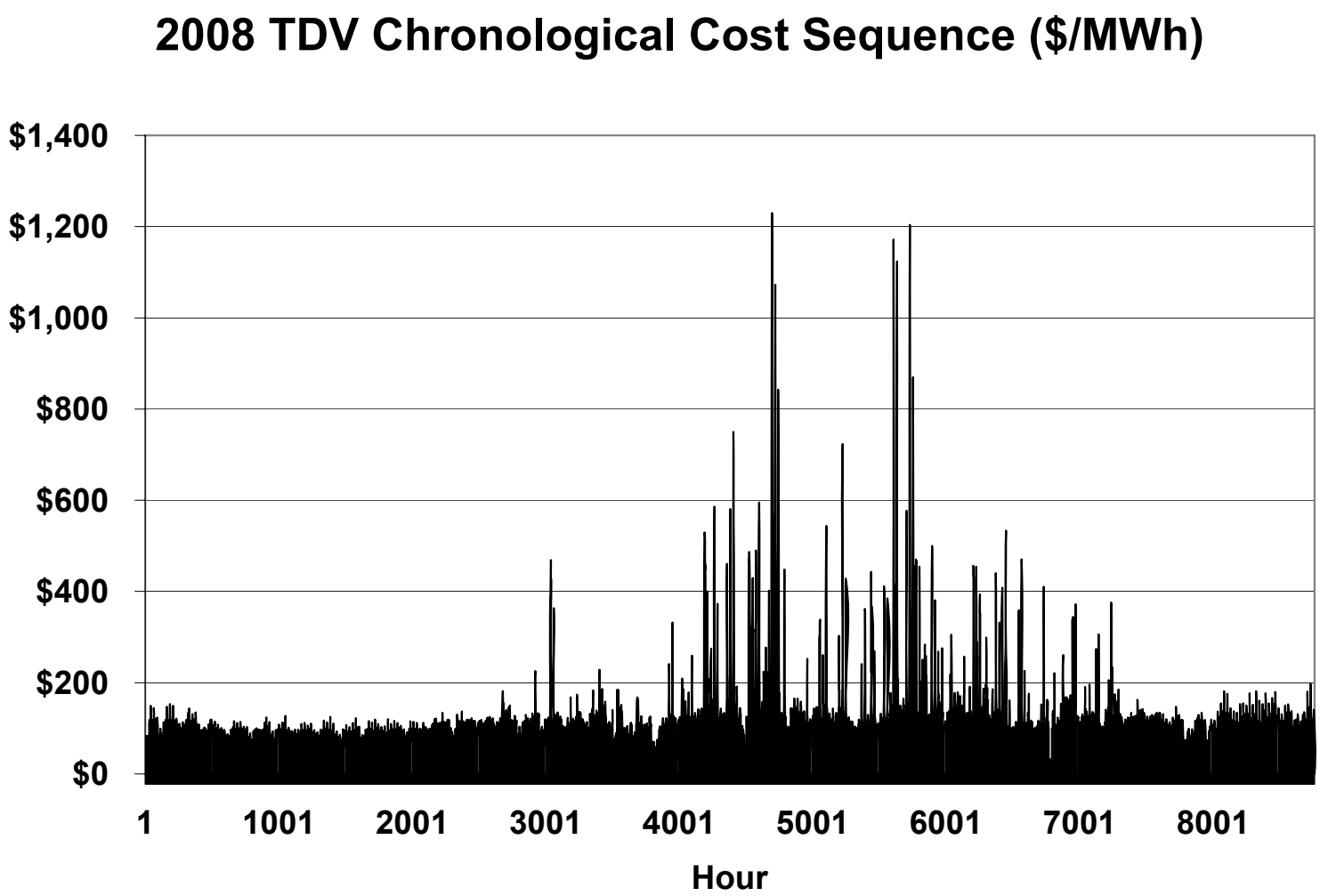

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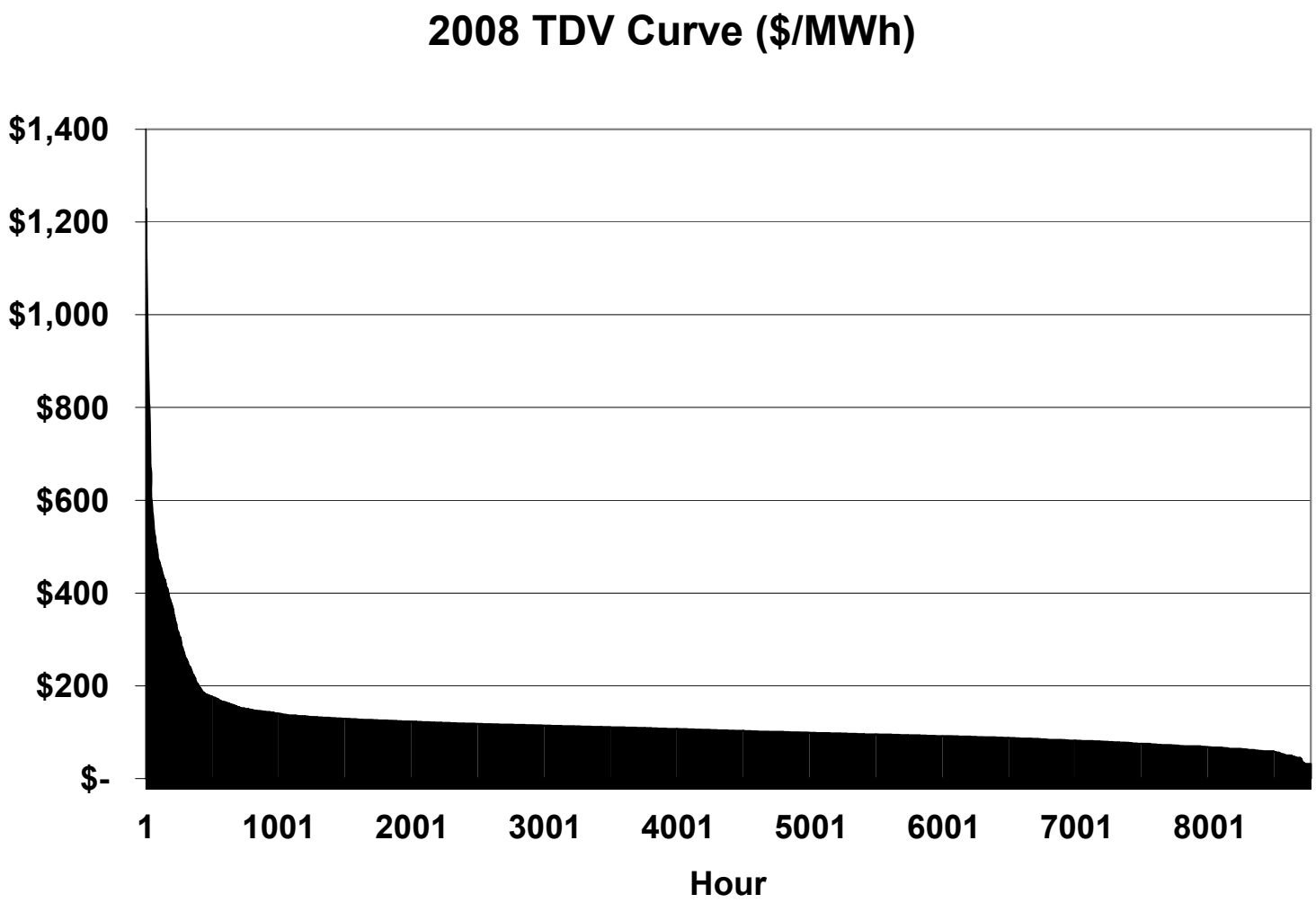

2008 TDV Curves