

Energy+Environmental Economics

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MPR Cash Flow Model

CEC Cost of Generation Workshop
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Eric Cutter
Senior Consultant

RPS Standard and Birth of MPR

- **MPR designed to determine**
  - "Market" costs of electricity allocated to ratepayers
  - "Above-market" costs to be paid by the state
- **Proxy Plant – Combined Cycle Gas Turbine**
  - Long-term fixed price contract
  - Merchant owner with utility contract
  - All-in levelized $/MWh needed to attract investment
- **Reflect value of**
  - Peaking vs. base load
  - firm vs. as-available
  - Time-of-Delivery (TOD)



MPR is Brown

MPR is a (Blunt) Policy Instrument

- Part of larger policy promoting renewables
- Finance high capital cost technologies
- Market based benchmark
- Fully recover fixed and variable costs with levelized, fixed all-in energy and capacity ($/MWh)
- Use publicly available and transparent data
- Public stakeholder process

Fundamentally different than avoided costs or SRAC



MPR Assumed Contract Terms

- Proxy for a market / product that doesn't exist
- Energy Price: All-in Fixed with TOD Factors
- Gas Price: Long-term fixed / hedged
- Dispatch: Economic dispatch by plant owner



"Everything seems to be in order with the legal papers for our merger."

MPR Cash Flow Model

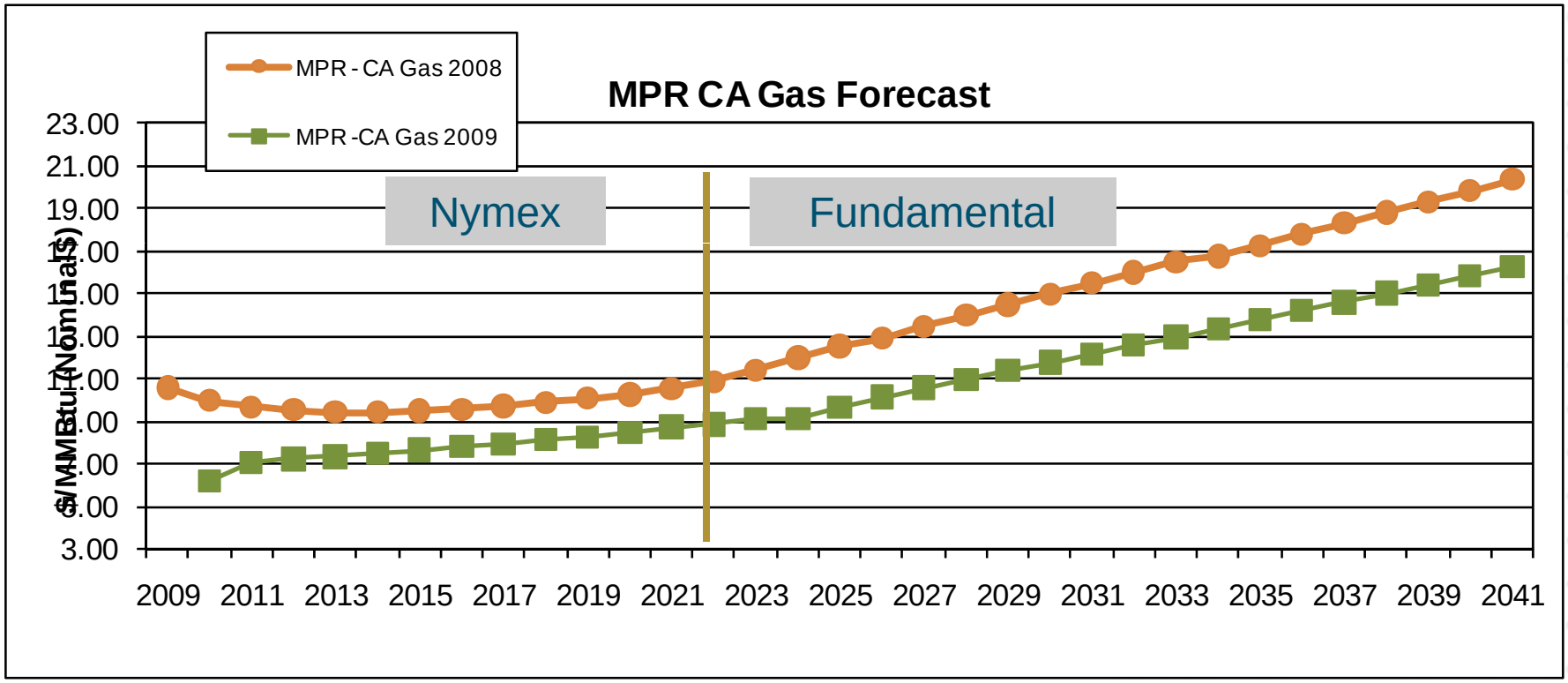
Year	2010	2011	2012
	1	2	3
GENERATION			
Annual Production (kWh) at load center	3,939,643,180	3,939,643,180	3,939,643,180
REVENUES			
Total revenues	$ 268,042,938	$ 293,001,800	$ 317,042,047
VARIABLE COSTS			
Variable O&M and Fuel Costs	$ 191,547,683	$ 215,605,562	$ 238,674,919
OPERATIONAL EXPENSES			
Total Expenses	$ 14,678,948	$ 14,448,726	$ 14,226,198
OPERATING INCOME			
Operating Income	$ 61,816,307	$ 62,947,512	$ 64,140,930
After-Tax Cash Flow	$ 26,621,476	$ 34,631,963	$ 34,053,029

Check on ROE Result			
Equity Investment	Cash Flow		
$ (259,430,243)	$ 26,621,476	$ 34,631,963	$ 34,053,029
11.96%	<-- Should = 11.96%		

+ **Fully recover costs and provide target return on equity to shareholders**

KEY ASSUMPTIONS

MPR Natural Gas Price Forecast



+ **MPR is unusual in that it assumes gas prices are hedged / fixed for full contract term**

~ 60% of total MPR cost

Capital Costs

Install Capital Cost Inputs (2008$)	Palomar (San Diego) Combined-Cycle 555 MW		Cosumnes (SMUD) Combined-Cycle 500 MW		Colusa (PG&E) Combined-Cycle 657 MW	
	(Million $)	$/kW	(Million $)	$/kW	(Million $)	$/kW
Capital Cost Investment - Overnight Costs	506.20	$912	510.83	$1,022	684.40	$1,042
Interconnection (natural gas, water, electric)	Included in Instant Capital Costs Shown Above		$24.55	$49	$0.00	$0
Environmental Review & Permitting			Included in Instant Capital Costs Shown Above		Included in Instant Capital Costs Shown Above	
Emissions offsets						
Dry Cooling Adjustment	$29	$52	$26	$52		
Contingency	-	-	-	-	-	-
AFUDC	-	-	-	-	-	-
EITC	-	-	-	-	-	-
Other or Subtotal	$92	$165	-	-	-	-
Total "Turn-Key" Capital Costs (2008$)	$627	$1,129	$561	$1,123	$684	$1,042

Average Installed Capital Costs (2009 $/kW)	$1,098
nvironmental Permit Costs (2009 $/kW) (incl. abov	$19

+ **Average of three public cost estimates for plants recently built in CA.**

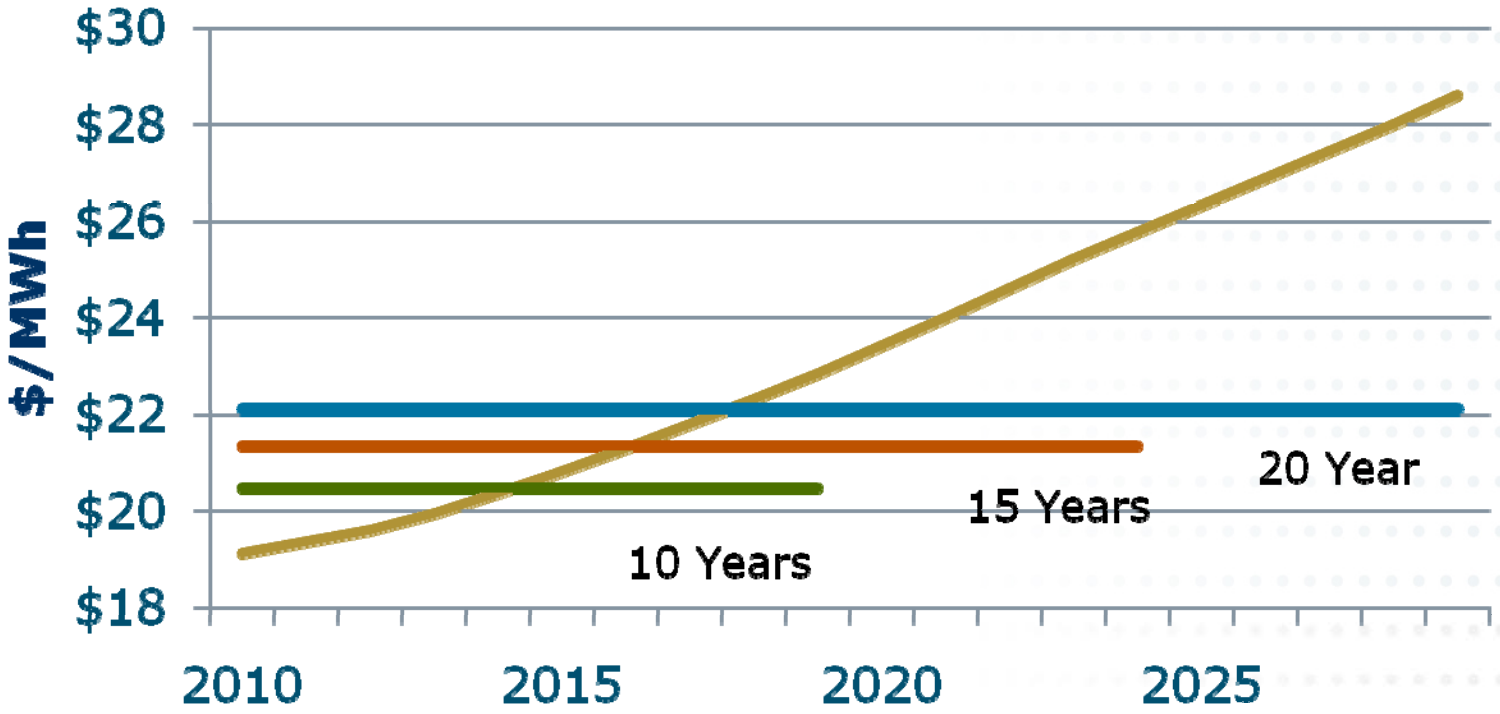
Escalating Capital Costs

	Palomar			
	Date	Plant	Adjustment	Pct
Date of Estimate	Jun-04	$410.15	$74.34	
in $Year	Jun-06			
Backcast from $Year to Date of Estimate	Jun-04	$397.23	$72.00	-3%
Adjusted Cost Estimate	Jun-06	$439.73		7%
Dec-09		$506.20	$91.75	15%

- **Details: Date of estimate, date of operation, $ Year**
- **Escalate costs to current year using Handy-Whitman**
- **Escalate costs forward using Army Corp of Engineers Civil Works Construction Cost Index System (CWCCIS)**

Fixed Cost Escalation

- **Fixed cost recovery escalated in model**
  - Proper levelization over different contract terms



Financing

Input	Value	Notes
Debt (%)	50%	
Equity %	50%	
Cost of Debt (%)	7.67%	Cost of Debt (industrial firms) = risk free rate (20 year T-Bill) + risk premium (mid point between BBB & B+)
Cost of Equity (%)	11.96%	Cost of Equity = risk free rate (20-yr Tbill) + risk premium (equity) + mid-cap risk premium (equity)
WACC	8.25%	Weight-Average Cost of Capital = (Cost of Equity x Equity %) + (Cost of Debt x (1-tax rate) x Debt %)
Risk Free Rate		
10-Year Tbill	3.46%	August 28, 2009
20-Year Tbill	3.84%	Risk Free Rate = Mid point between 10 and 30 yr T-Bill (US Treasury yields)
30-Year Tbill	4.21%	
Risk Premium (Debt)		
BBB/Baa2	2.30%	Average of the 10-Year BBB/Baa2 Risk Premium and 30-Year BBB/Baa2 Risk Premium
Mid Point	3.84%	Risk Premium (Large Manufacturer) = Mid point between BBB and B+ rated company
B+/B1	5.38%	Average of the 10-Year B+/B1 Risk Premium and 30-Year B+/B1 Risk Premium
Risk Premium (Equity)	7.17%	
Mid-Cap Risk Premium (Equity)	0.95%	

Negotiated Settlement: Contract with creditworthy utility ➔ Between utility and IPP

Financial Data

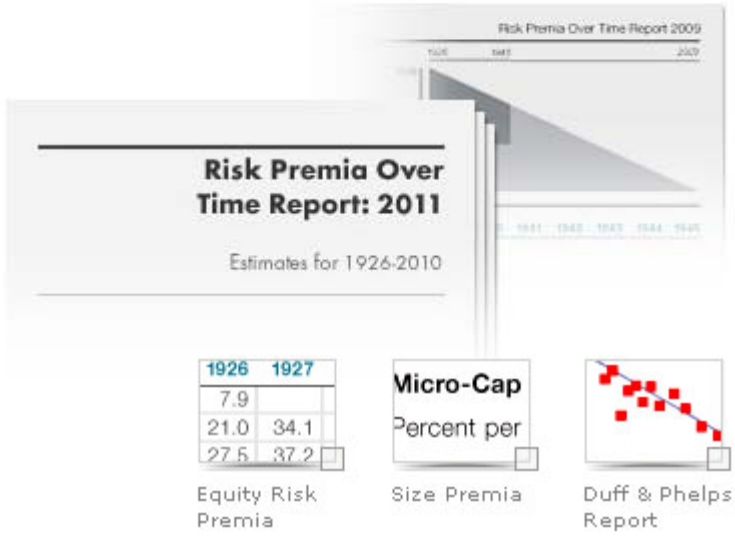
Data Sets

Topic	Current data sets (see above for data of update)	Download Excel file	Archived Data
Corporate Governance	Insider and Institutional Holdings by Industry Sector	Download	Jan 99, Jan 00, Jan 01, Jan 02, Jan 03, Jan 04 , Jan 05 , Jan 06 , Jan 07, Jan 08, Jan 09, Jan 10
Discount Rate Estimation	Historical Returns on Stocks, Bonds and Bills - United States	Download	
	Implied Equity Risk Premiums - United States	Download	
	Risk Premiums for Other Markets	Download	Jan 01, Jan 02, Jan 03, Jan 04, Jan 05, Jan 06 , Jan 07, Jan 08, Jan 09, Jan 10
	Levered and Unlevered Betas by Industry	U.S. Europe Japan Emerg Mkt Just China Just India Global	Jan 99, Jan 00, Jan 01, Jan 02, Jan 03, Jan 04, Jan 05 , Jan 06 , Jan 07, Jan 08, Jan 09, Jan 10
	Marginal tax rate by country For full version go to the KPMG site	Download	
	Total Beta By Industry Sector	Download	Jan 99, Jan 00, Jan 01, Jan 02, Jan 03, Jan 04, Jan 05 , Jan 06 , Jan 07, Jan 08, Jan 09, Jan 10
	Risk Measures by Market Cap Class	Download	
	Costs of Capital by Industry Sector	Download	Jan 99, Jan 00, Jan 01, Jan 02, Jan 03, Jan 04 , Jan 05 , Jan 06 , Jan 07, Jan 08, Jan 09, Jan 10

http://pages.stern.nyu.edu/~adamodar/

Ibbotson U.S. Risk Premia Reports

The Risk Premia Over Time Report gives financial and valuation professionals the tools to determine long-, intermediate-, and short-horizon equity risk premia for the United States, as well as mid-, low-, and micro-cap size premia using customizable start and end dates. The Duff & Phelps, LLC Risk Premium Report examines the size effect through alternative measures of size. Archived versions of these reports are also available.

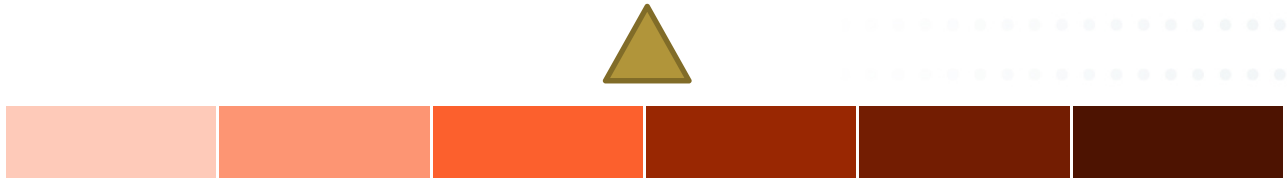


http://corporate.morningstar.com

http://www.bondsonline.com/

Contract Risk

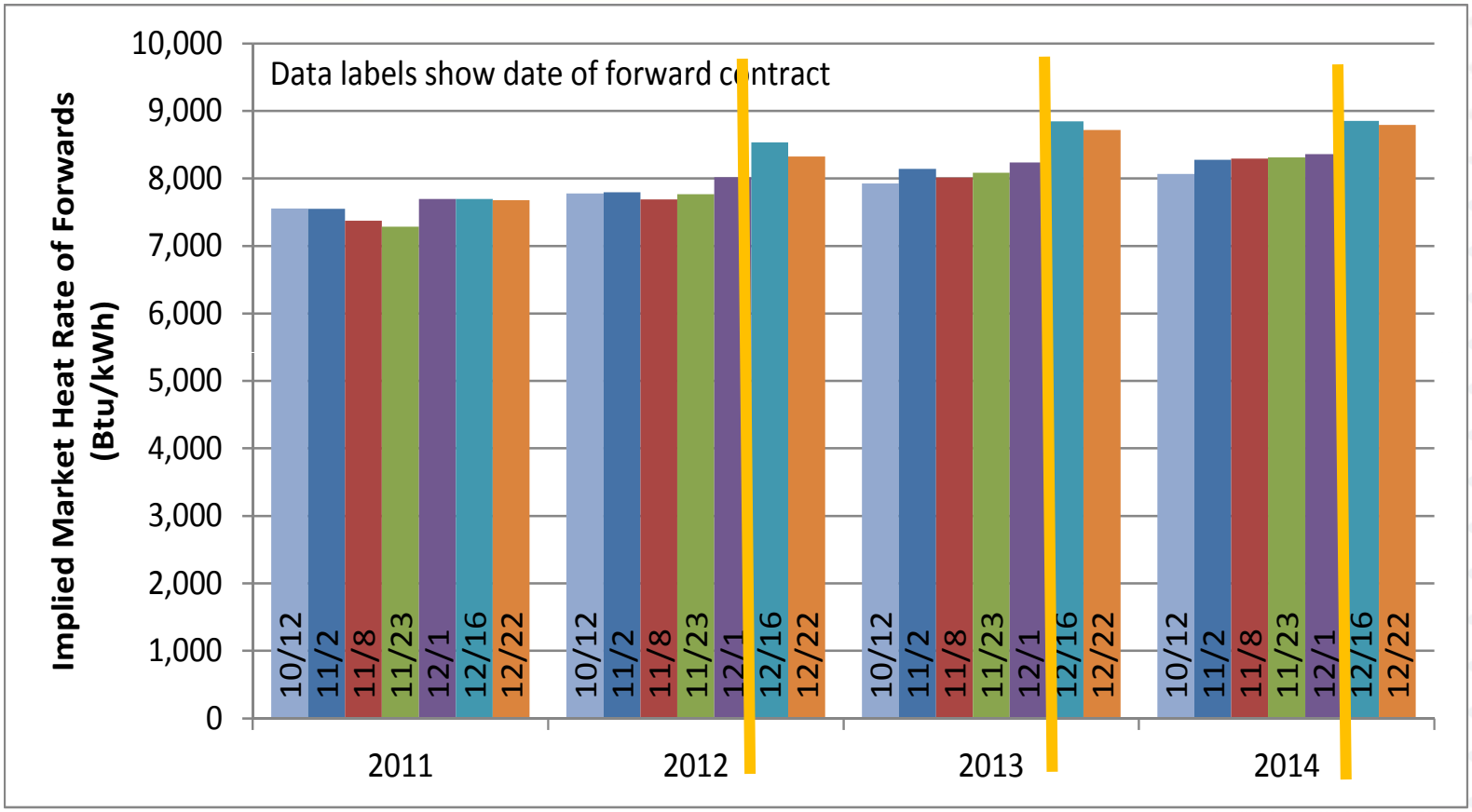
	Owner			Utility	
	IPP	MPR	Renew	MPR	Renew
Energy Price					
Natural Gas Price					
Quantity					
Technology					
Contract					
Regulatory					
Counterparty Credit					



Low

High

GHG



Jump in the implied market heat rate in mid-December, coincident with the ARB's announcement of future AB32 cap-and-trade regulations

MPR LIMITATIONS

MPR Limitations

- **MPR becomes a floor**
  - MPR becomes a anchor
  - IOU's are short RPS generation
- **Single brown price applied to wide variety of renewable technologies**
- **Supplemental Energy Payments (SEPs) not financeable**

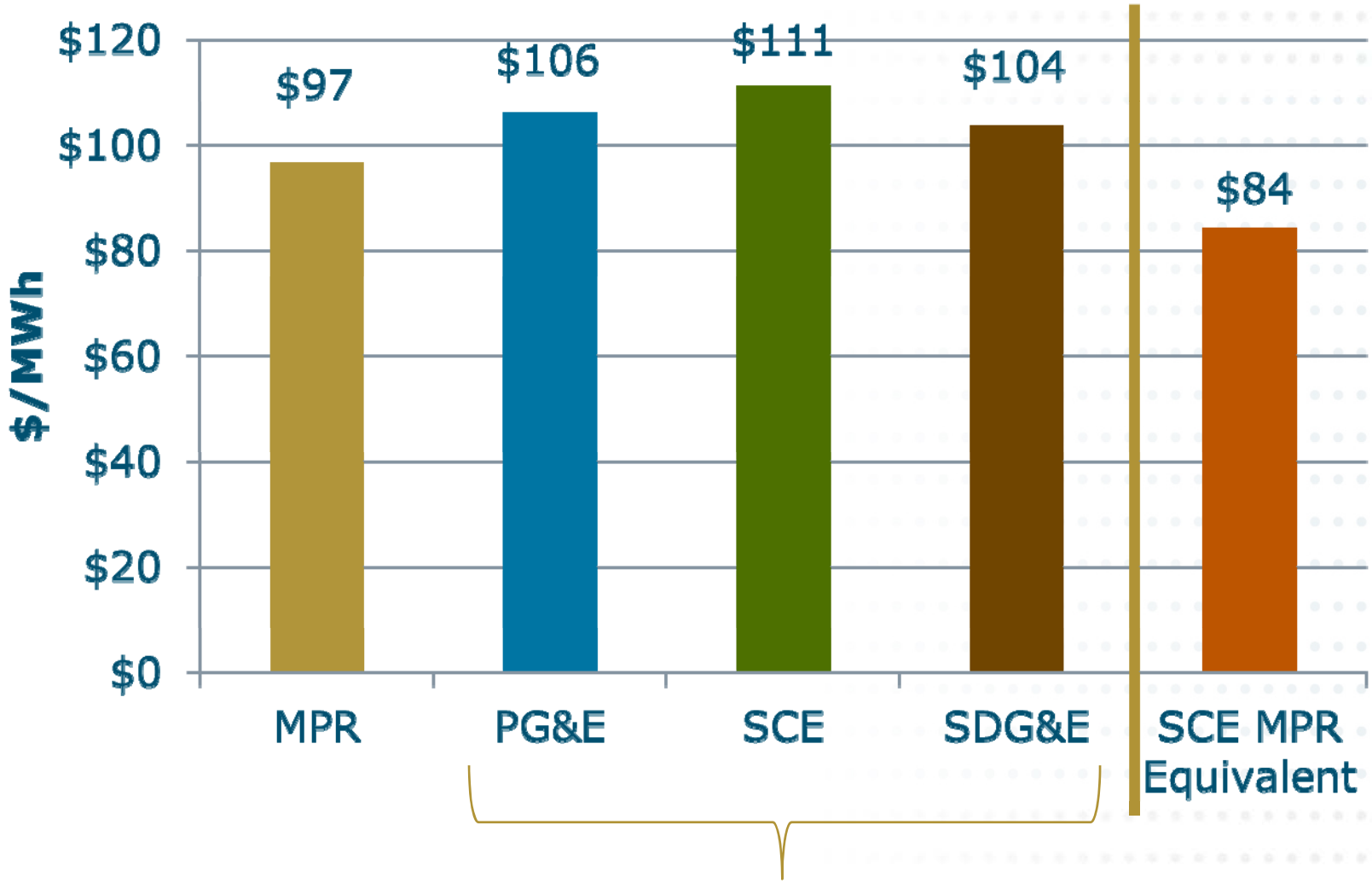
Overconstrained Problem

- Fixed, all-in energy & capacity statewide average $/MWh
- Full cost recovery for the proxy plant.
- Not provide an over/under collection of capacity value for deliveries in off/on-peak periods
- Incorporate the TOD factors of 3 IOUs into the revenue calculations of the MPR model
- Reflect the best estimate of operating behavior under the presumed contract and market conditions for the proxy plant.

Resulting Capacity Factor Calculation

- **MPR is calculated based on technical capacity factor**
  - Scheduled Outage Factor – 3.84%
  - Forced Outage Rate – 4.57%
  - Capacity Factor – 92%
- **TODs capture capacity and time-of-use value**
- ➔ **MPR intended to be used in combination with**
  - TOD Factors
  - Expected Generation Profile

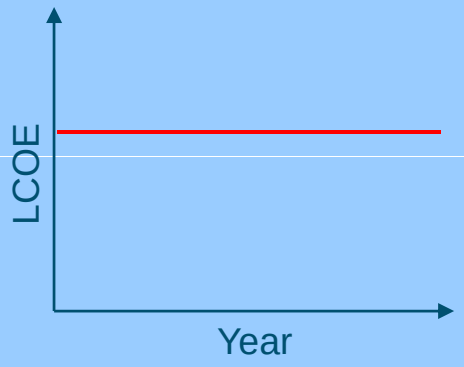
How Solar "Beats" MPR



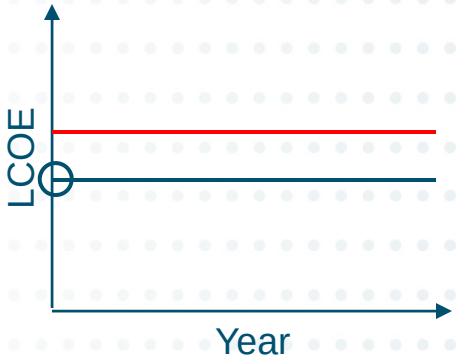
Four PPA Price definitions

Post-TOD flat nominal levelized used to show results

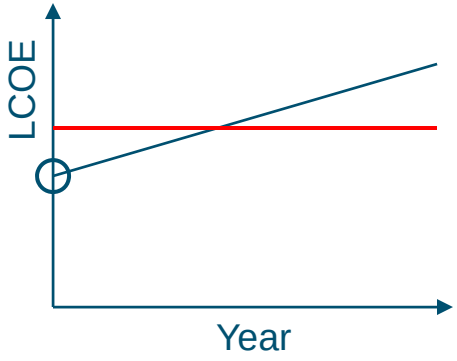
Post Time-Of-Delivery (TOD) Flat nominal levelized



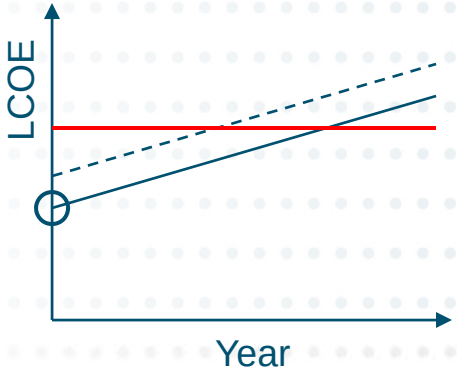
Pre-TOD Flat nominal levelized*



Post-TOD Year-1 cost with escalator



Pre-TOD Year-1 cost with escalator*



LIFE AFTER DEATH

33% RPS legislation

- Deletes existing MPR provisions;
  - instead PUC required to establish limit for each electrical corporation on the procurement expenditures for all eligible resources used for compliance
  - Limits total expenditures to a de minimus increase in rates.
- MPR continued to be used for Feed In Tariff for less than 3 MW
- R. 11-05-005: CPUC OIR on 33% RPS Implementation

Conclusions

- Legislated requirements for idealized market proxy led to over-constrained problem
- Regulatory process leads to compromise, not necessarily “best” cost and input assumptions
- Undue weight given to MPR as CPUC approved benchmark without consideration of original policy goal

Looking Forward for CCGT and CT

- Excess capacity in CA past 2020
- Expected reduced revenues and lower capacity factor in energy market
- Renewable integration rather than Planning Reserve Margin drives need for new capacity
- Peak capacity hour shifted to later in day.

Thank you!

- **Energy and Environmental Economics, Inc. (E3) has provided consulting services and expert analysis on key issues facing electricity sector clients since its founding in 1989.**
- **Robust analytics combined with policy depth uniquely position E3 to provide clients with analytical, technical and regulatory expertise to maximize the value of their assets**
- **Eric Cutter– Senior Consultant**
  - 20+ years in energy industry
  - Leads energy storages, electric vehicles, distributed energy resources and energy/water practice areas



ADDITIONAL SLIDES

Temperature Effects

+ Temperature affects operations in three ways:



- **Heat Rate:** High temperatures result in increases in the heat rate, which in turn increases the cost of generating a unit of energy

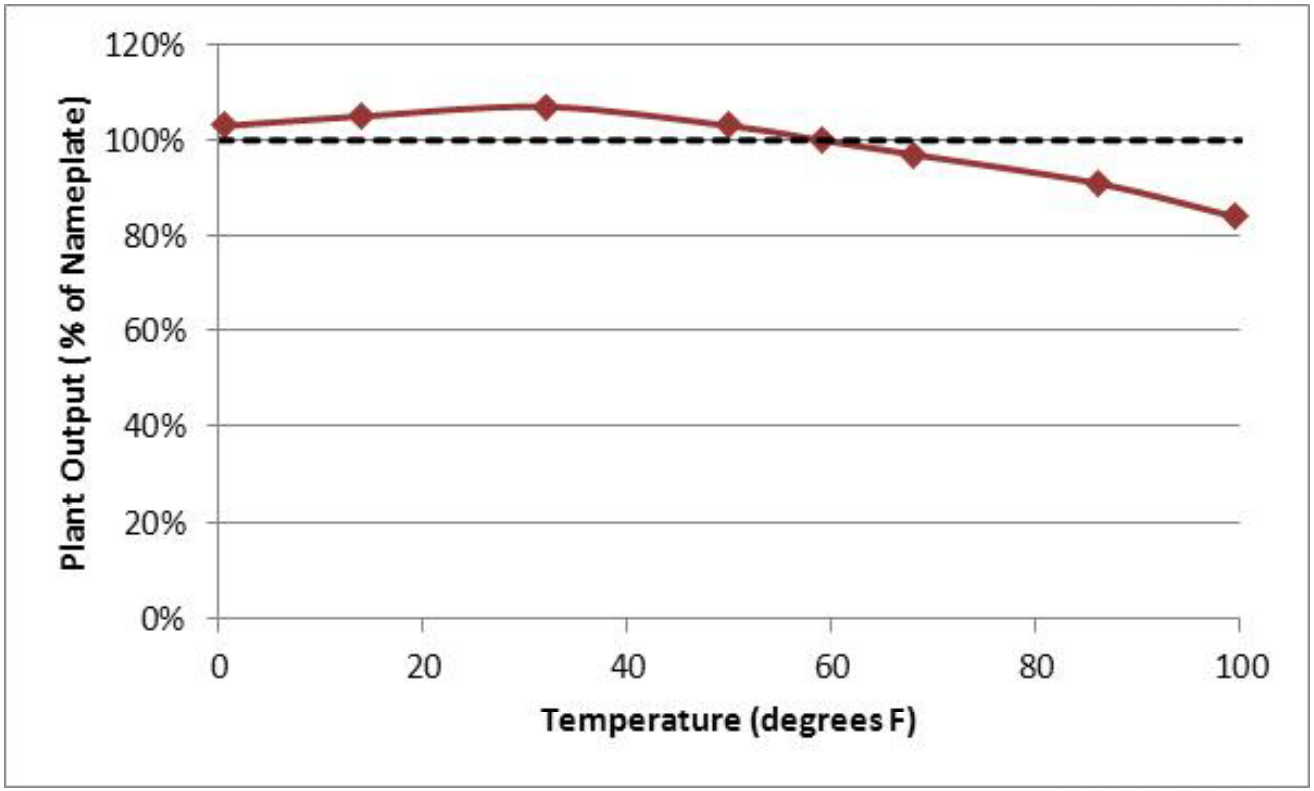


- **MW Output:** At high temperatures, the output is reduced, lowering the revenues the unit can earn by selling into the real-time market



- **Peak Capacity MW:** During peak periods, when temperatures are also high, the output is reduced below nameplate. This reduces its peak capacity (resource adequacy) MW

CT Dispatch: Summer Peak Performance Penalty



GE Energy

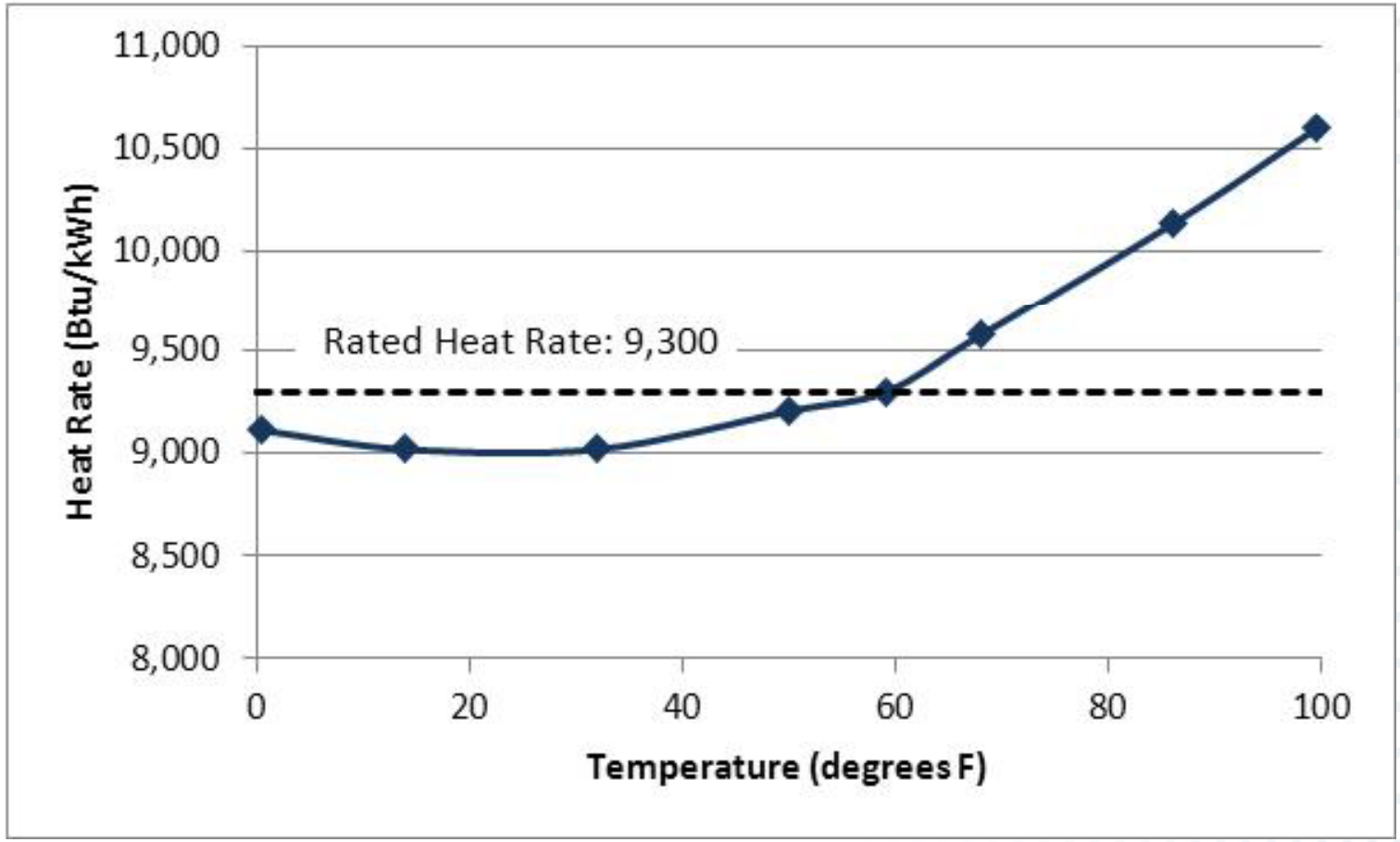
LM6000-60 HZ

Gas Turbine Generator Set
Product Specification



Output curve based on GE LM6000 with SPRINT technology and dry cooling:
http://www.hilcoind.com/images/ftp/SFPUC/7/A/LM6000%2060%20Hz%20Grey%202008%20Rev%202.pdf

CT Dispatch: Heat Rate Adjustment Based on Temperature



Heat rate curve based on GE LM6000 with SPRINT technology and dry cooling

Changes to the CT Dispatch Calculations for DR Cost-effectiveness

- **Added a 10% minimum bid margin to the CT dispatch algorithm, similar to CAISO methodology**
  - CAISO Market Performance Report http://www.caiso.com/2777/277789c42ac70.html
- **Adjusted CT operations based on historical temperature profiles**
  - Heat rate adjustment
  - Reduced output

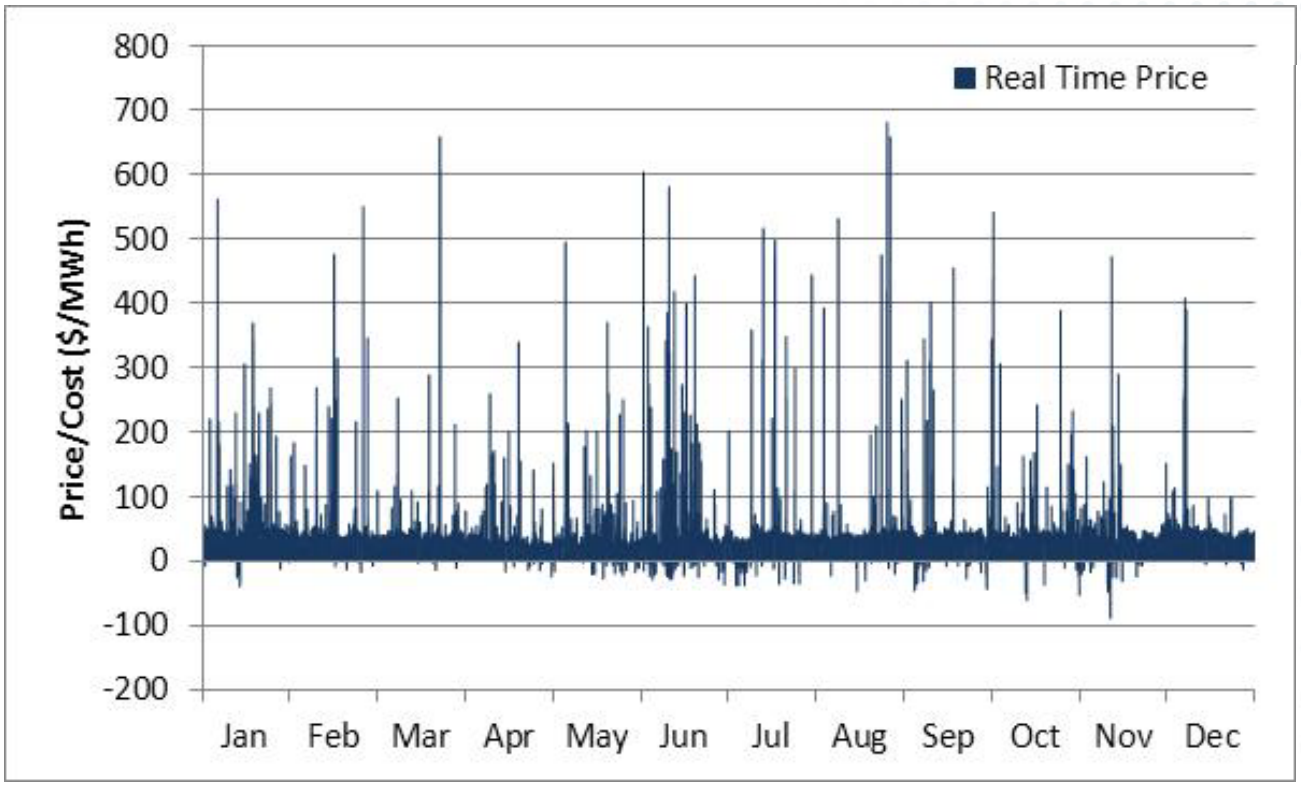
Example CT Dispatch

- **To calculate the value of capacity, E3 assumes that a CT will participate in the CAISO real-time market**
  - Consistent with CAISO Annual Market Report
- **The parameters that determine the CT's net revenues include the real-time prices, the cost of fuel, the unit's heat rate and O&M, and ambient temperature**

Central Station Plant Assumptions	
	CT
Operating Data	
Heat rate (BTU/kWh)	9,300
Cap Factor	5.5%
Lifetime (yrs)	20
Plant Costs	
In-Service Cost ($/kW)	$1,365
Fixed O&M ($/kW-yr.)	$17.40
Variable O&M ($/MWh)	$4.17
Cost Basis Year for Plant Costs	2009
Levelized Costs (2012)	
Annual Fixed Cost ($/kW-yr)	192.72
Real-Time Energy Revenue	(89.01)
AS Revenue	(9.86)
Operating Cost	31.90
Residual Capacity Value	125.76
Summer Output	92%
Summer Capacity Value	136.99
Financing	
Debt-to-Equity	60%
Debt Cost	7.7%
Equity Cost	12.0%
Marginal Tax Rate	40.7%

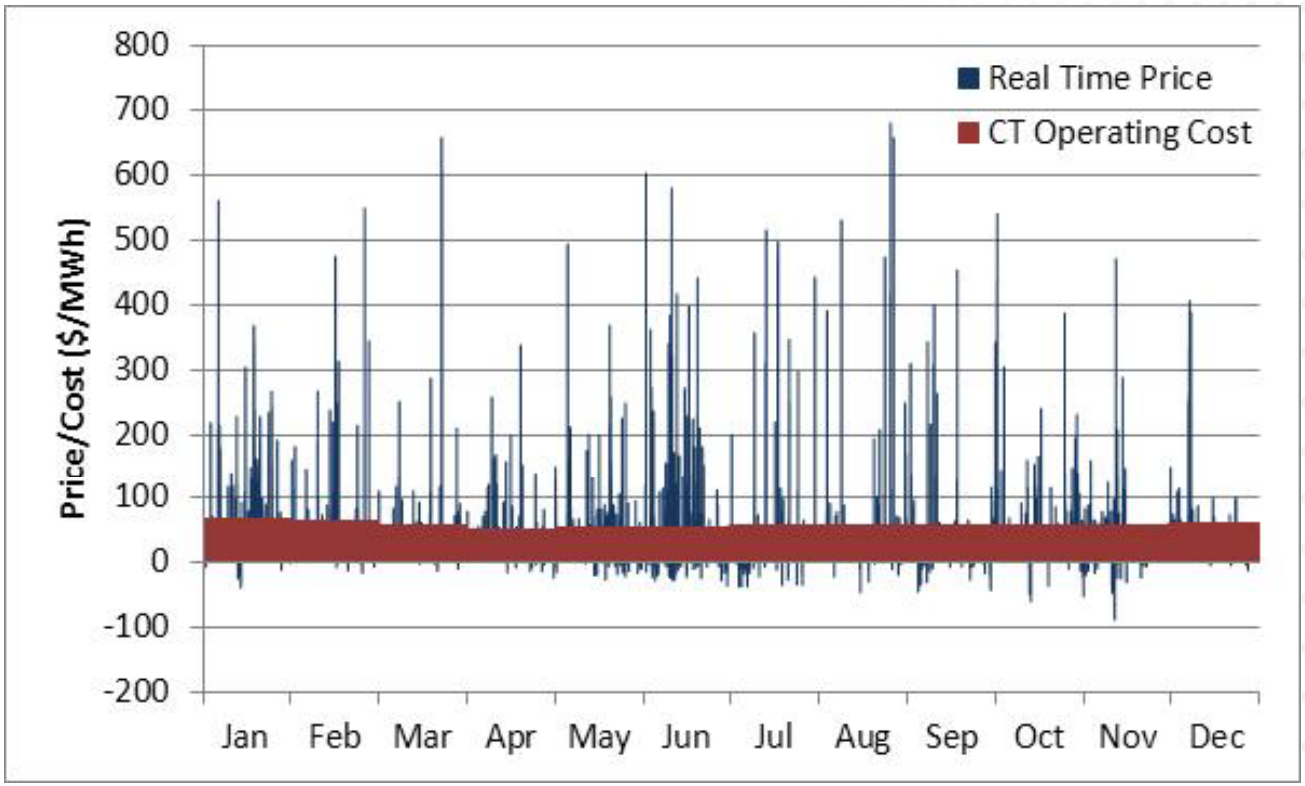
Example CT Dispatch

- **Step 1:** Forecast hourly real-time market prices based on heat rates from July 2009 through June 2010



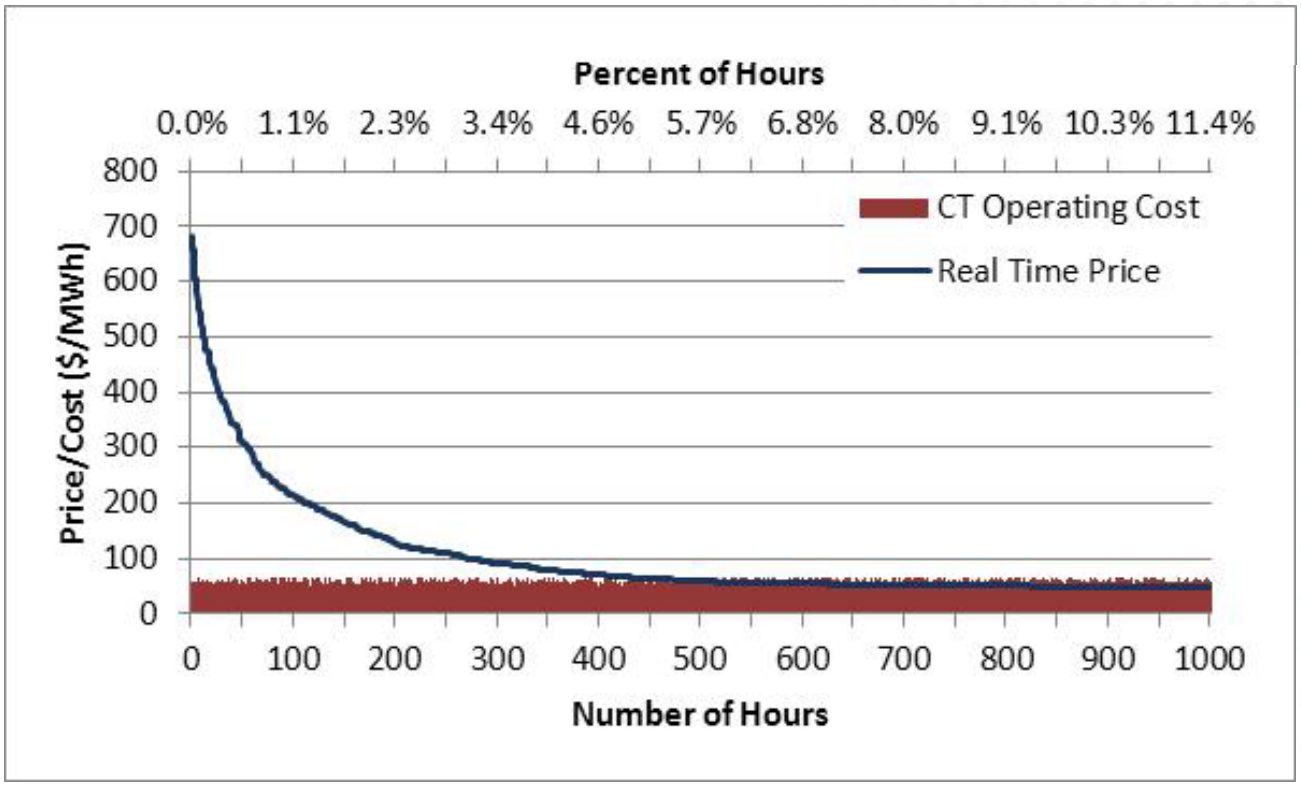
Example CT Dispatch

- **Step 2:** Calculate operating cost ($/MWh) for a CT in each month as a function of the gas price, heat rate, and variable O&M



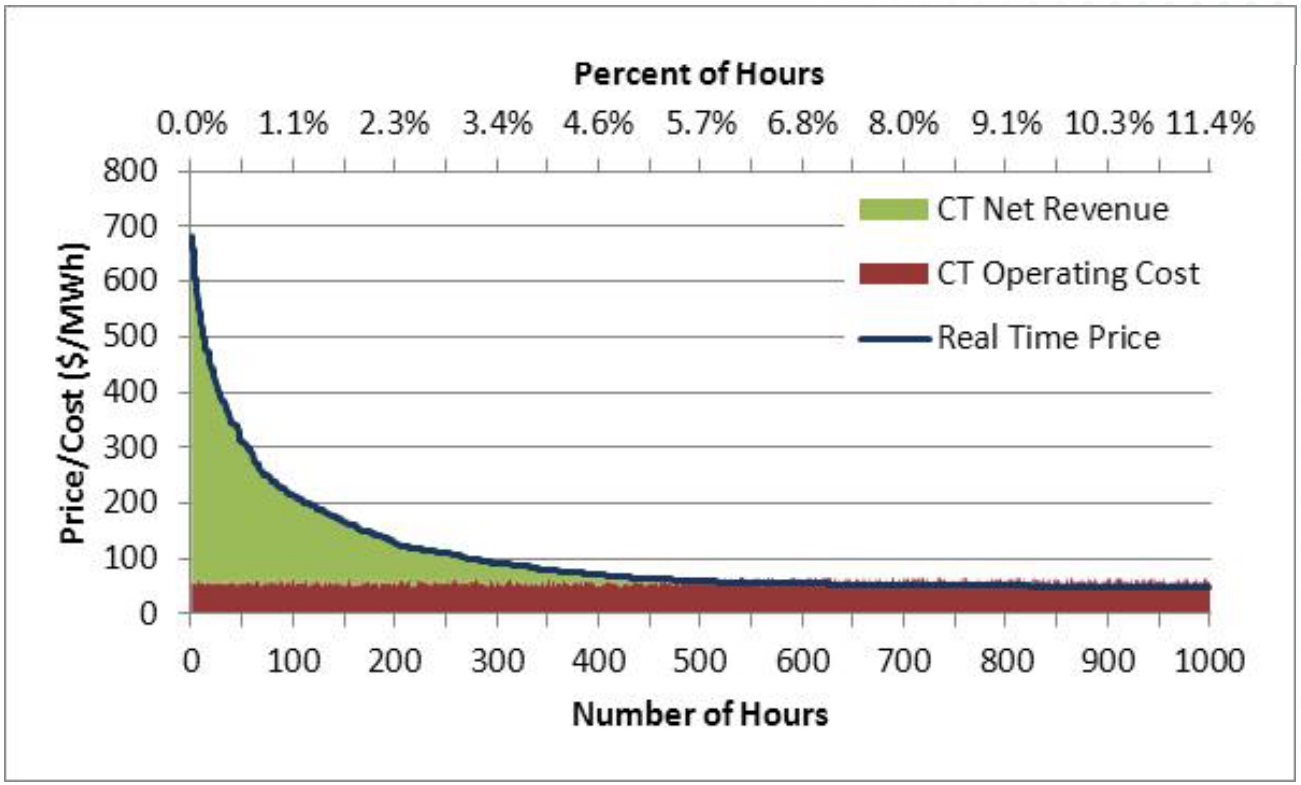
Example CT Dispatch

- **Step 3:** Sort real-time market prices (and corresponding CT operating costs) in descending order (top 1000 hours shown below)



Example CT Dispatch

- **Step 4:** Calculate the CT's revenue assuming it operates when the real-time price exceeds its variable cost plus the 10% bid adder



Resulting California Net Cost of CT

+ Calculation of the final residual value includes several further adjustments

- Energy revenues reduced by 7% for plant outages
- A/S market participation assumed to increase gross revenues by 11% (based on CAISO market report)

			Current DR Program Cycle				
	2010	2011	2012	2013	2014	2015	2016
CT Annualized Fixed Cost	$ 185	$ 189	$ 193	$ 197	$ 201	$ 205	$ 209
Real-Time Dispatch Revenue	*$ 63*	*$ 81*	*$ 89*	*$ 96*	*$ 102*	*$ 106*	*$ 111*
Ancillary Services Revenue	*$ 7*	*$ 9*	*$ 10*	*$ 11*	*$ 11*	*$ 12*	*$ 12*
Operating Cost	*$ (23)*	*$ (29)*	*$ (32)*	*$ (35)*	*$ (37)*	*$ (39)*	*$ (40)*
CT Net Revenue	$ 47	$ 61	$ 67	$ 72	$ 76	$ 79	$ 83
Capacity Residual	$ 138	$ 128	$ 126	$ 125	$ 124	$ 125	$ 126
Temperature Adjusted Capacity Residual	$ 151	$ 139	$ 137	$ 136	$ 135	$ 136	$ 137
Capacity Factor	4.7%	5.3%	5.5%	5.7%	5.9%	5.9%	5.9%

All costs in $/kW-yr

Data Sources and References

Cost Effectiveness Methodology	E3 Demand Response Documents (including Distributed Generation Avoided Cost Calculator) *(Note: outputs from calculator are modified for DR in this spreadsheet)* www.ethree.com\public_projects\cpucdr.html R 08-03-008, D. 09-08-026 http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/105926.pdf CSI Cost Effectiveness Report based on Distributed Generation Cost Effectiveness Framework http://www.ethree.com/public_projects/cpuc.html
CT Cost and Performance	2008 & 2009 CAISO Market Issues and Performance Report www.caiso.com/2390/239087966e450.pdf http://www.caiso.com/2777/277789c42ac70.html 2007 CEC Cost of Generation Report http://www.energy.ca.gov/2007publications/CEC-200-2007-011/CEC-200-2007-011-SF.PDF
Planning Reserve Margin	R. 08-04-012, D. 04-01-050 and Proposed Decision mailed August 23, 2010 closing the proceeding. http://docs.cpuc.ca.gov/efile/PD/122343.pdf
CT Summer Capacity Derate	LM6000 - 60Hz Gas Turbine Generator Set Product Specification http://www.hilcoind.com/images/ftp/SFPUC/7/A/LM6000%2060%20Hz%20Grey%202008%20Rev%202.pdf http://www.gepower.com/prod_serv/products/tech_docs/en/downloads/ger3695e.pdf

33% High DG Case

