Six Lessons from the PG&E Real Time Pricing Rate Proceeding

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Getting Real Time Pricing "Right"

OVERVIEW OF PRESENTATION

- Lesson #1: An Hourly Capacity Price
- Context: How the PG&E Real Time Pricing Rate Developed
- A Generation-Only Rate
- Energy Costs from CAISO's Day-Ahead Market
- PG&E's PCAF Method
- Lesson #2: A TOU Period Revenue-Neutral Adder
- Lesson #3: Neither Energy Prices nor Net Load Fully Explain Grid Stress / Reliability
- Lesson #4: Forecast Model Data Are Tricky
- Lesson #5: Pricing Signal Based on Logistic Probability Model
- Lesson #6: An RTP Rate Can Increase Battery Savings ("Profit")

PARTIES PARTICIPATING IN STUDY & SETTLEMENTS

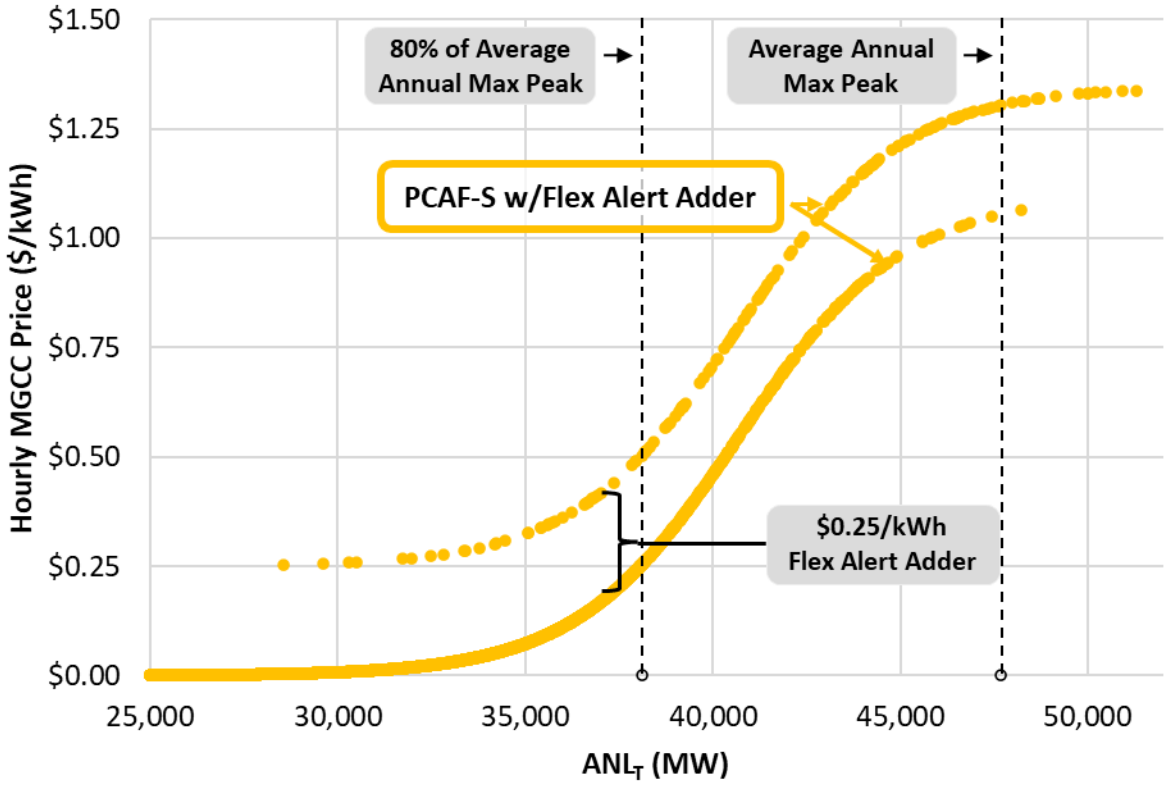
- ✓Pacific Gas & Electric
- ✓California Public Advocates Office
- ✓Small Business Utility Advocates (RII supported)
- ✓California Large Energy Consumers Association
- ✓California Solar and Storage Association, Enel X

Lesson #1: An Hourly Capacity Price

- Extensive research
- S-shaped (sigmoidal) curve represents increasing grid stress and reliability probabilities
- A $0.25/kWh adder for hours in which the CAISO has declared a "Flex Alert" event
- When applied to 2017-2021 data, the formula collects exactly the marginal generation capacity cost approved for PG&E

Hourly Generation Capacity Pricing Formula

Applied to Net Load for 2017-2021



Context: How the PG&E Real Time Pricing Rate Developed

PG&E'S ORIGINAL PROPOSAL

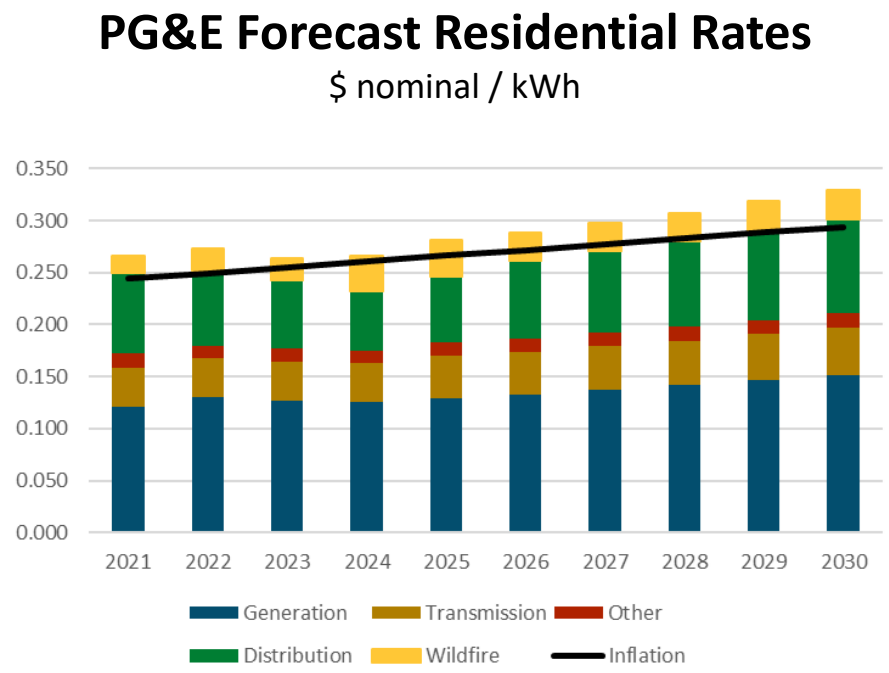
- RTP for generation portion of rate only
- Energy costs from CAISO's day-ahead market
- Capacity costs rising linearly from 80% of forecast peak
- Use a flat adder to collect remaining costs (uniform across all rate classes)

COUNTER-PROPOSALS

- ✓ Agreed
- × Initially contested – CAISO also has "day-of" markets
- × Conduct study and use a sigmoidal curve, event adders
- × Use a class-specific, TOU period rate

A Generation-Only Rate

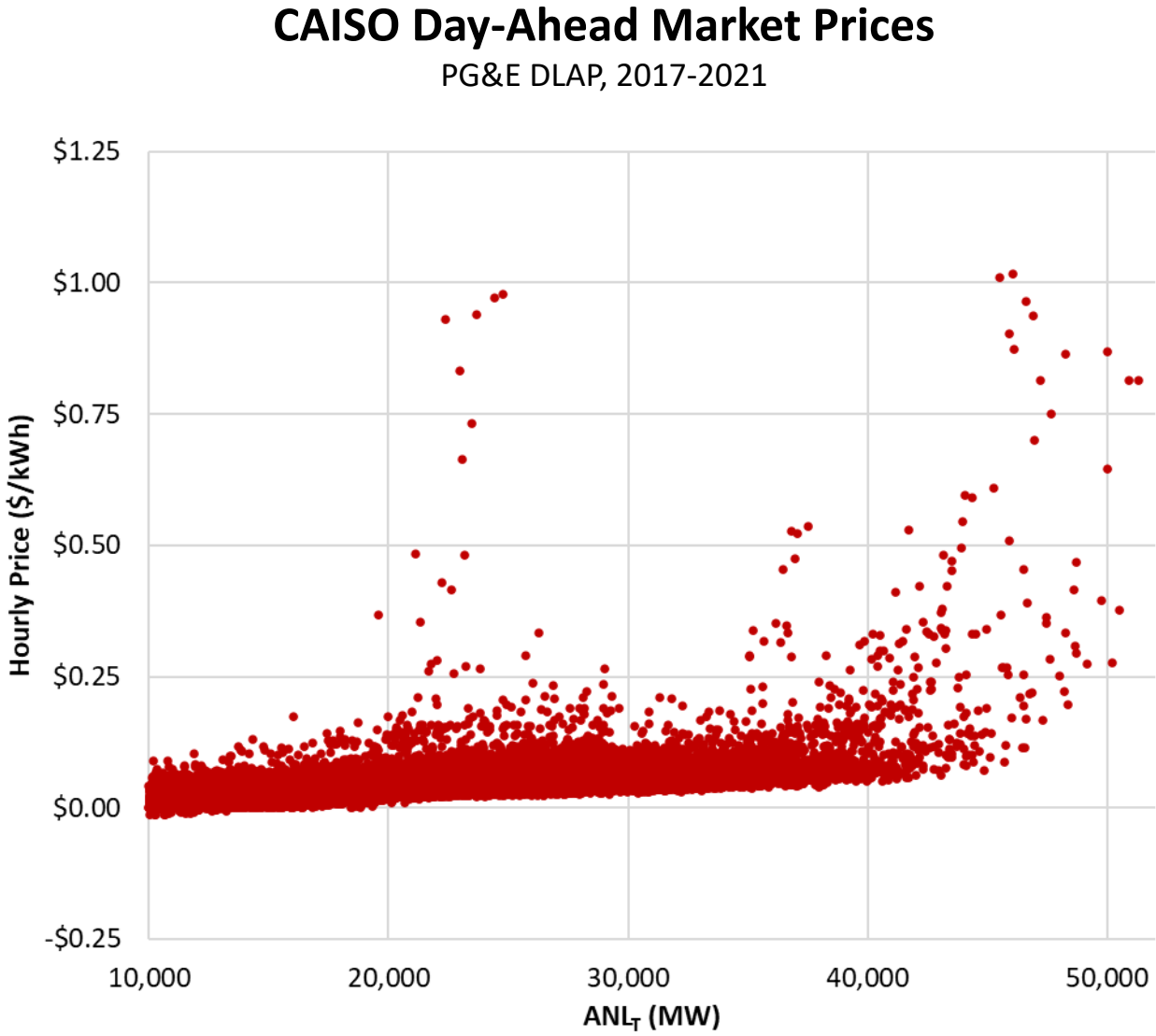
- Generation represents a bit less than half of the total PG&E rate
- Customer charges are generally low in California
- Transmission charges are set by FERC, not TOU
- Distribution and wildfire costs are collected using (mostly) TOU rates
- Shifting distribution TOU rates to RTP would be complicated:
  - New data systems
  - Confusing to customers with multiple accounts
  - California has funded a project to pursue this concept



California Public Utilities Commission, *Utility Costs and Affordability of the Grid of the Future* (May 2021), Figure ES-1.

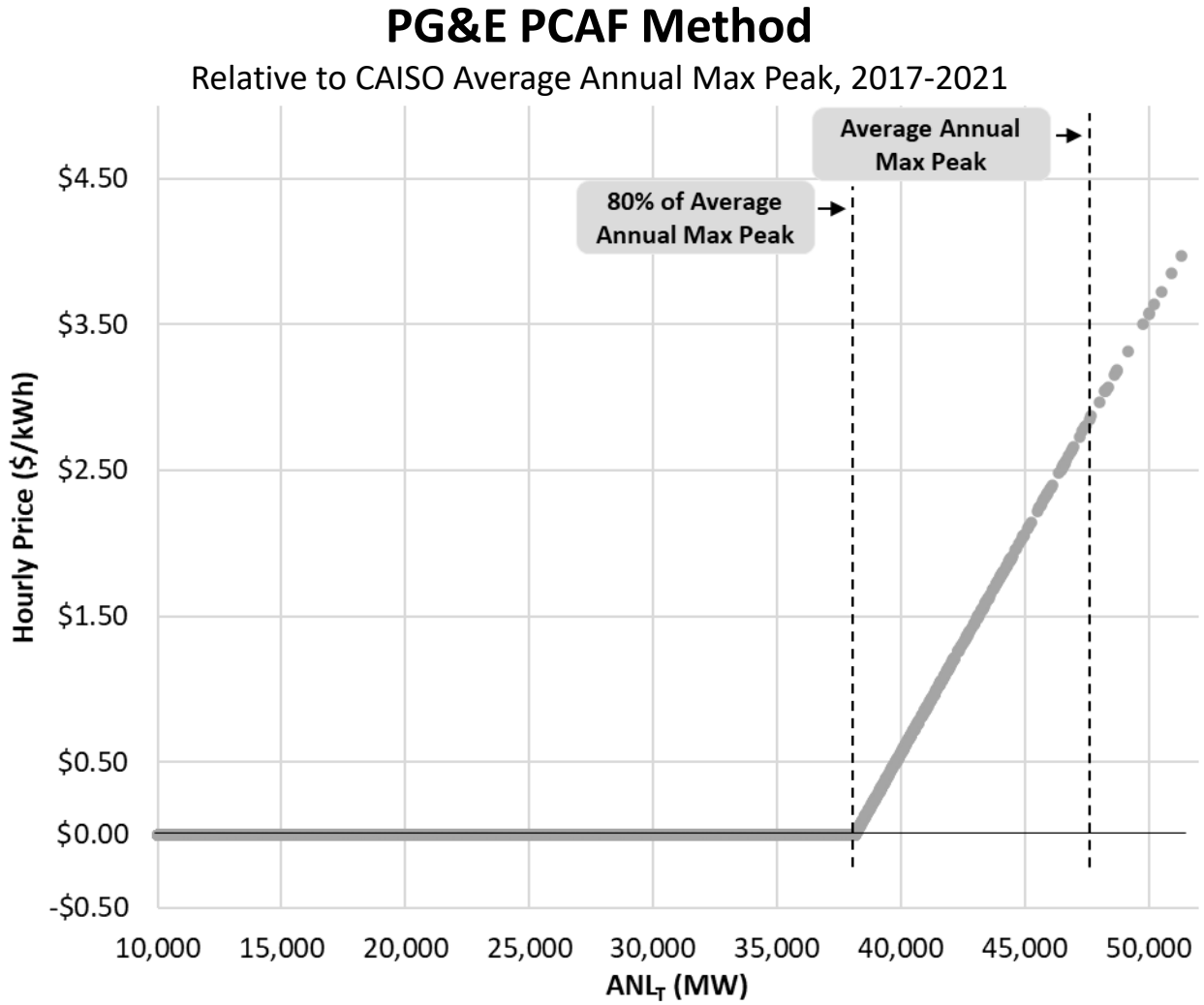
Energy Costs from CAISO's Day-Ahead Market

- Day-ahead market represents vast majority of PG&E's fuel costs
- Final pricing to load for Fifteen Minute Market (FMM) and Real Time Dispatch (RTD, a five-minute market) is not available until later in the day
- Easy decision to focus on day-ahead market in CAISO for a RTP rate



PG&E's PCAF Method

- Established method for cost allocation but …
- Uncapped pricing
- No evidence that cost increases linearly or correlates with load in this fashion



Lesson #2:
A TOU Period Revenue-Neutral Adder

PG&E Proposed a Flat Adder

- Needed to collect generation revenues in excess of marginal energy and marginal capacity costs
- California's "PCIA" (essentially, stranded costs) are collected in a relatively uniform flat adder across all rate classes
- The remaining revenues, including RPS costs, were also proposed as a flat adder
  - Would shift costs between classes
  - Would increase revenues during off-peak, decrease revenues during on-peak
  - And other thorny technical problems …

Settlement on a Class and TOU Specific RNA

- ✓Keeps costs within the class
- ✓Keeps costs within the TOU period
- ✓Simple to administer
- ✓Adds incentive to manage load / battery charge based on peak/off-peak periods

Other Options

- Flat rate by class – Some argued that it was justified because the costs don't vary by TOU, but it would reduce the incentive to manage load / charge
- Multiplier to the RTP rate – Some argued this would better enhance the hourly price signal, but it could enhance the RTP rate *too much*

Lesson #3: Neither Energy Prices nor Net Load Fully Explain Grid Stress / Reliability

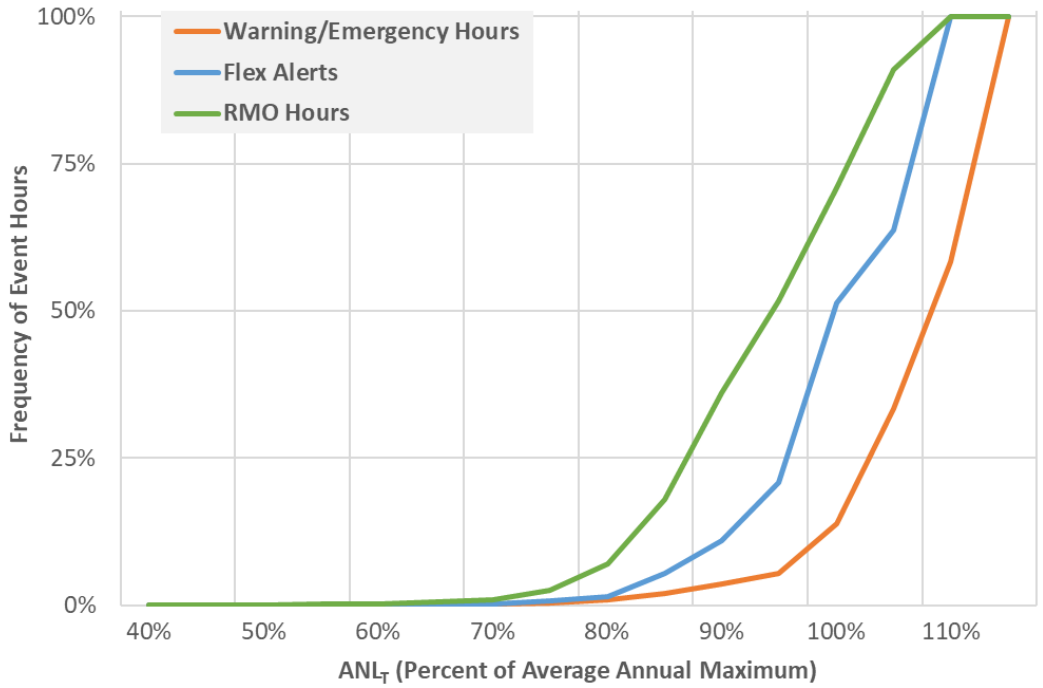
TEMPERATURE-ADJUSTED NET LOAD

Six load metrics were evaluated

1. **Gross Load (GL)** – Excludes behind-the-meter (BTM) generation
2. **Net Load (NL)** – Also excludes interconnected solar and wind generation
3. **Resource-Adjusted Net Load (ANL_R)** – NL adjusted to exclude other GHG-free resources, including hydroelectric, nuclear, biomass/biomass and geothermal
4. **Temperature-Adjusted Net Load (ANL_T)** – NL adjusted to account for non-CAISO system conditions, such as imports availability, using weather stations at Phoenix Airport (PHX) and Seattle-Tacoma Airport (SEA)
5. **ANL_{RT}** – Combines the adjustments for NL, ANL_R and ANL_T into a single metric
6. **ANL_{RTG}** – Combines GL, ANL_R and ANL_T into a single weighted average metric

GRID STRESS / RELIABILITY EVENTS

CAISO Alert, Warning, or Emergency Events, 2010-2021



Lesson #4: Forecast Model Data Are Tricky

Attempt to Use SERVM Data

- SERVM: Stochastic, hourly production model
- Preference for forecast data because:
  - Generation resources are shifting in the near future
  - Stochastic modeling provided a lot of detail about potential grid stress in low-probability circumstances
- Forecast data not used for rate design because:
  - No way to forecast "called" reliability events
  - Not all hourly data preserved / made available
  - An artificial import constraint created potential over/under-estimates of *hourly* grid stress
  - Understanding and attempting to apply these data took effort that is not reflected in the final report

MGCC RTP Rate Design Used Historical Data

- Mainly used 2017-2021, but considered 2010-2021

Key Learning from SERVM Data

- Grid stress includes:
  - Reserve shortfalls
  - Dispatch of load management
  - Unserved energy (rolling blackouts)

Potential Grid Stress Metric

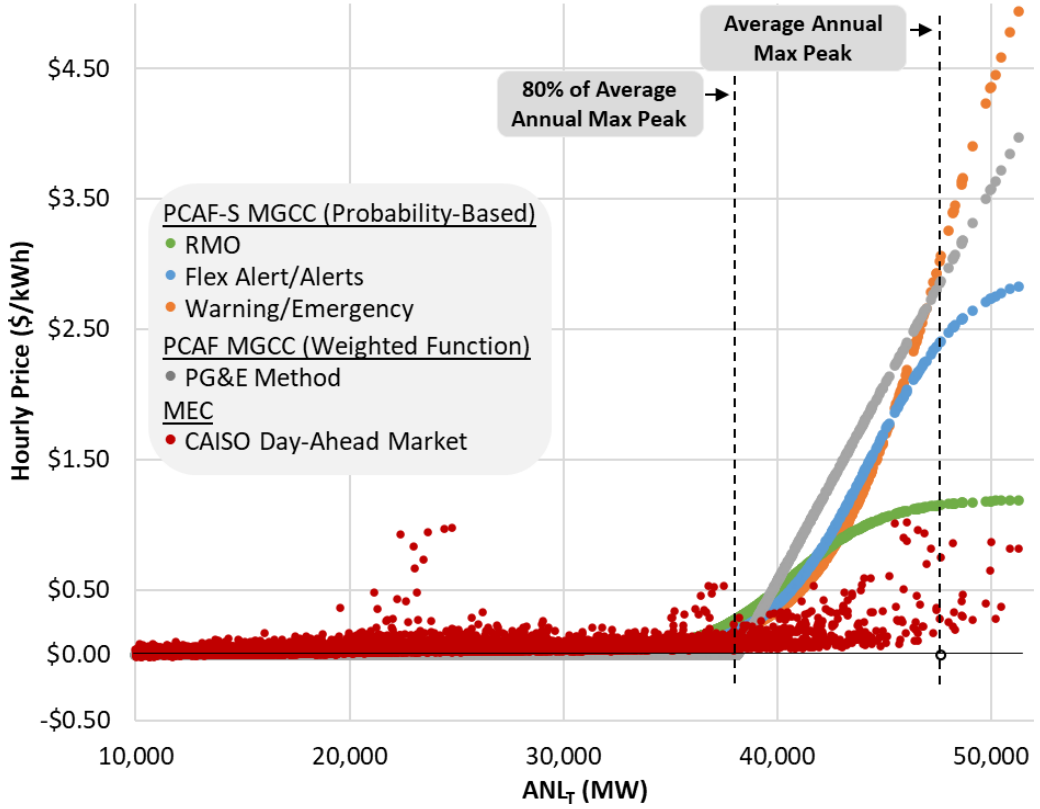
Reliability Metric	Value	Weighting Factor
Expected Unserved Energy (EUE)	$2,000 per MWh	64.5%
Demand Response (DR)	$600 per MWh	19.3%
Upward Reserve Shortfall	$250 per MWh	8.1%
Non-Spin Reserve Shortfall	$250 per MWh	8.1%

Lesson #5: Pricing Signal Based on Logistic Probability Model

- A logistic regression provides the relationship between hourly adjusted net load (ANL_T) and probability that a reliability event is occurring
- Three alternative PCAF-S functions, equally "valid"
- Capacity price signal exceeds energy price signal at high loads
- Selected RMO (Restricted Maintenance Operations) probability as dependent variable:
  - Lowest maximum price
  - Most hours, thus encourages preventative behavior
  - Moderates inter-annual revenue variability

Alternative Functions for Hourly Pricing Formula

Derived from CAISO Events and System Load, 2017-2021



Lesson #6: An RTP Rate Can Increase Battery Savings ("Profit")

- ✓ Battery savings increase by 30% with recommended DAHRTP pricing formula
  - ➢ Profits could be higher with PCAF method, but inter-annual variability (CV) increases too much
  - ➢ Another PCAF-S function with two adders performed less well
- ➢ Load shifting was not tested, but would provide additional savings
  - ➢ Battery savings model is very simplistic, may underestimate savings opportunity

Battery Savings for Alternative Pricing Formulas

Applied to CAISO Events, System Load, and Energy Prices, 2017-2021

Year	Battery Value (5-kW, 2-hour)			
	Base Tariff	PCAF PG&E Method	PCAF-S W/E + RMO & Flex Alert Adders	Recommended PCAF-S RMO + Flex Alert Adder
2017	$ 294	$ 503	$ 400	$ 422
2018	294	372	291	349
2019	294	246	207	287
2020	294	616	517	470
2021	294	342	376	387
Average	**294**	**416**	**358**	**383**
CV	*0.00*	*0.31*	*0.29*	*0.16*

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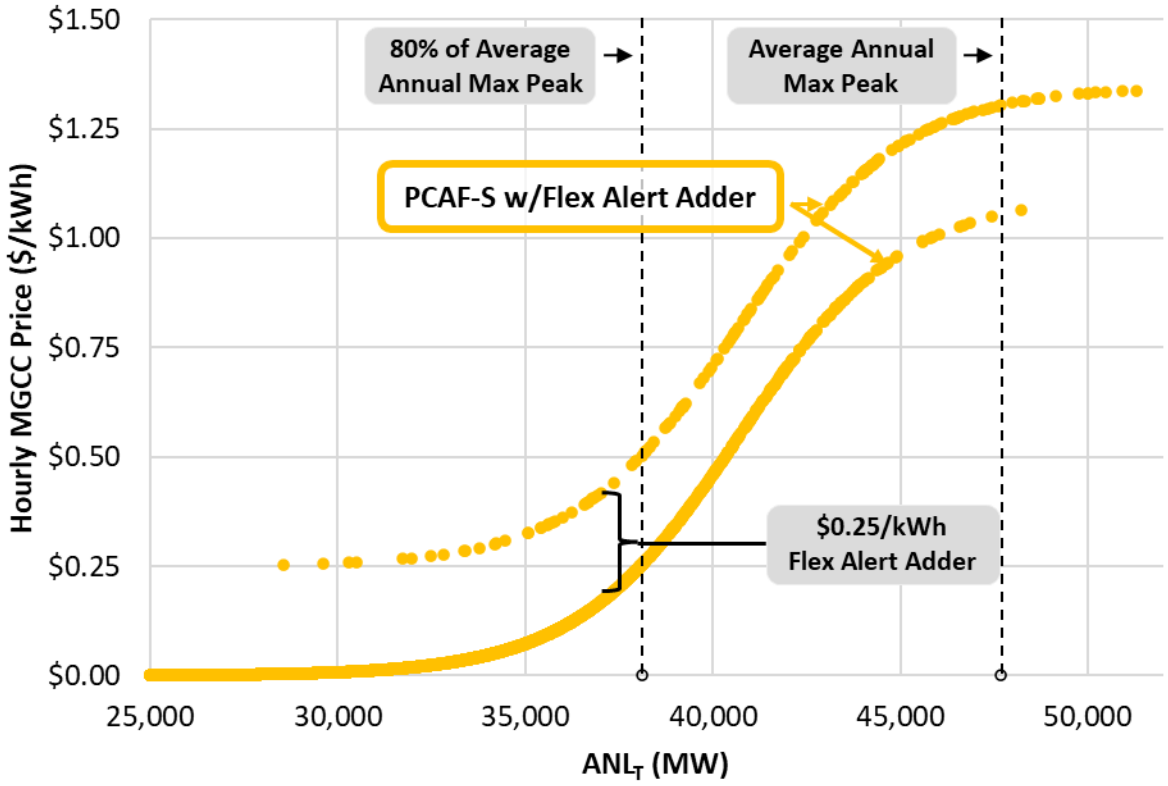

MGCC Pricing Formula for PG&E's Day-Ahead Hourly Real Time Pricing (DAHRTP) Rates

The report is available at:

https://resourceinsight.com/dahrtp/

Questions or comments:

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