



Yuba River Development Project FERC Project No. 2246 Relicensing California Power Markets & Yuba Project Operations Overview



January 28, 2014

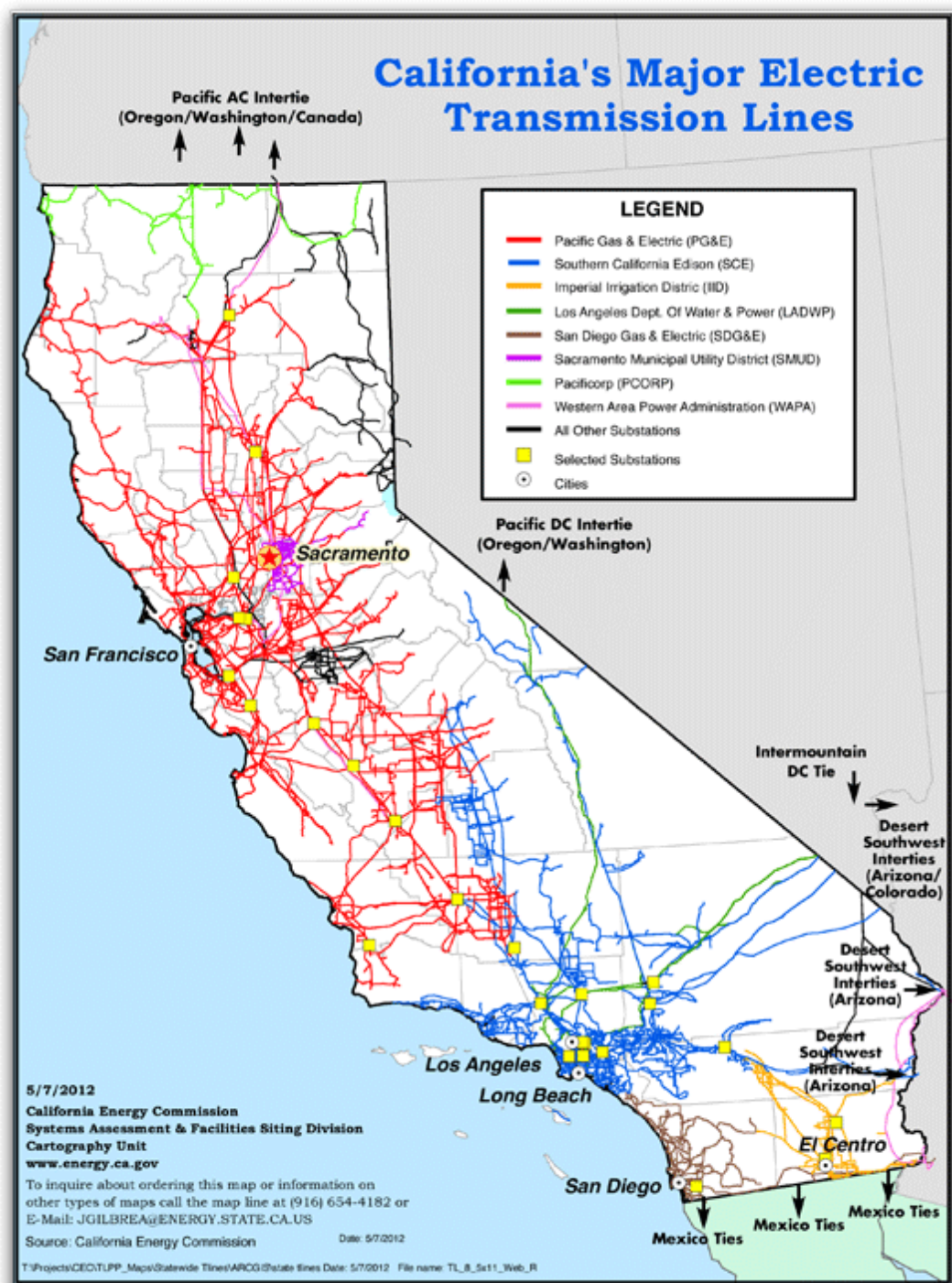
Overview

- CAISO and Energy Markets
 - CAISO Functions
 - The Market
 - Economic Dispatch
- Balancing the System
 - Energy vs. Ancillary Services
 - Renewables
- Hydro's Role and Licensing Considerations
- Yuba Project Operations



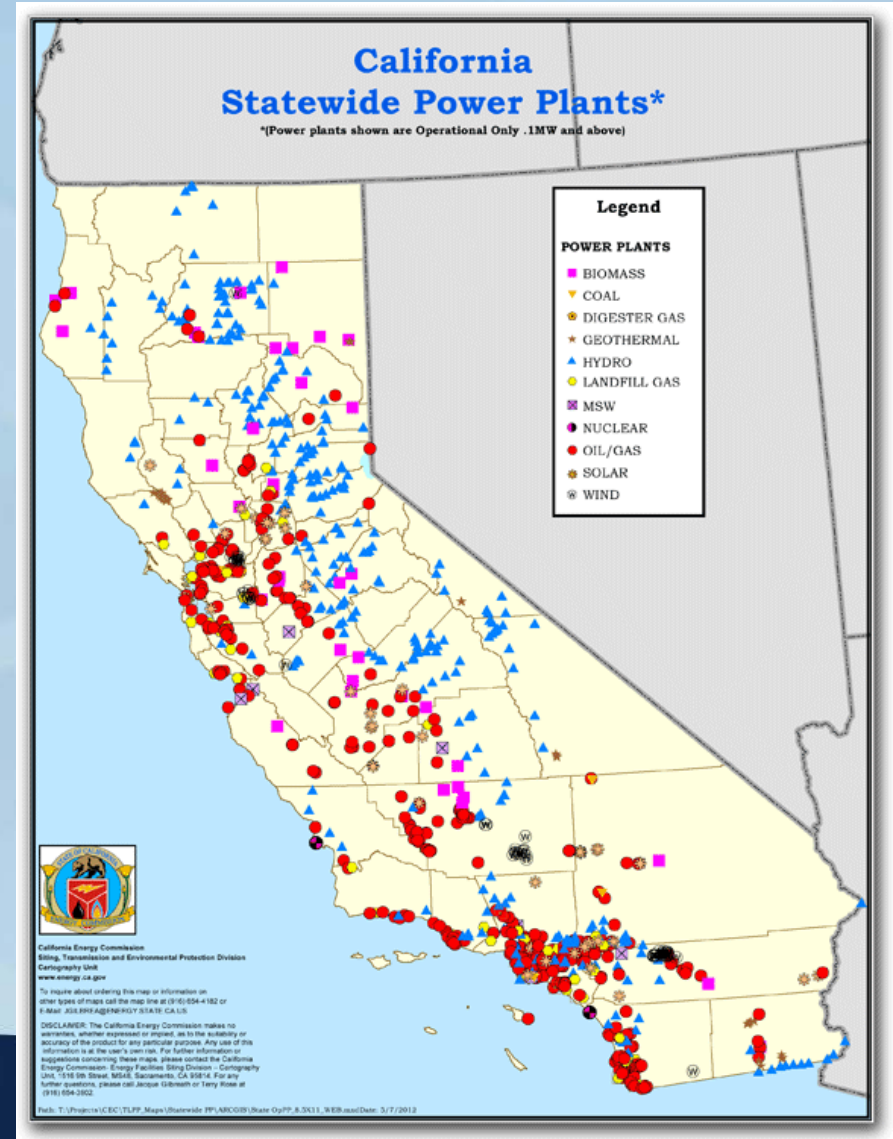
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- Generally, the interconnected electrical system at 60 kV and higher
- Some 60 kV, and all lower voltages = “distribution”



Load and Generator Nodes

- “Arc and Node”
- Generators = injection points
- Load = take off point
- Substations = nodes
- Lines = arcs



Operating an Electrical Grid

■ Grid Management

- Balancing Load and Generation
- Frequency and Voltage stability
- Available assets & resources for control and balancing
- Planning for Reliability
- Emergency response

■ Cost Allocation

- Value of energy provided (cost of generation)
- Value of grid assets (use of transmission & other facilities)
- Costs for regulation
- Costs for planning & emergency response



Grid Management

California Independent System Operator (CAISO)

Obligations:

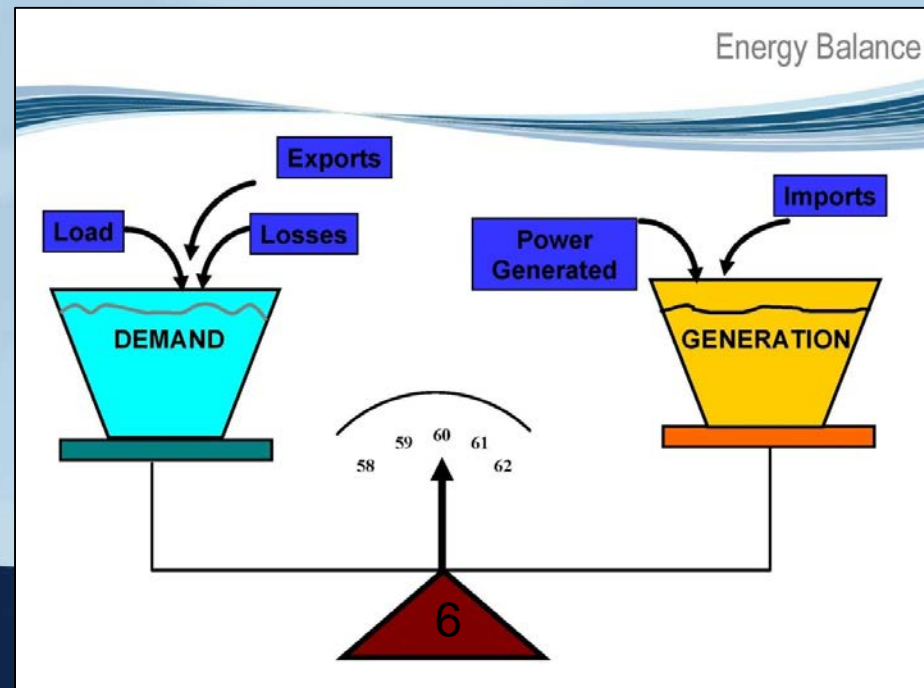
- maintain system frequency (60 Hz)
- Balance loads, losses, imports, exports
- Maintain “reserves” for load changes & emergencies
- Various tools for forecasting, ancillary services for balancing

Revenues:

- Fees and charges placed on load and generation

CAISO Mission

- *Operate the grid reliably and efficiently*
- *Provide fair and open transmission access*
- *Facilitate effective markets and promote infrastructure development*



California ISO Markets

- Integrated Forward Market
 - Day-Ahead Market
 - Real-Time Market (hour-ahead)
 - Ancillary Services markets
- CAISO Models:
 - Optimized Network Model for all Schedules
 - Locational Marginal Pricing computation

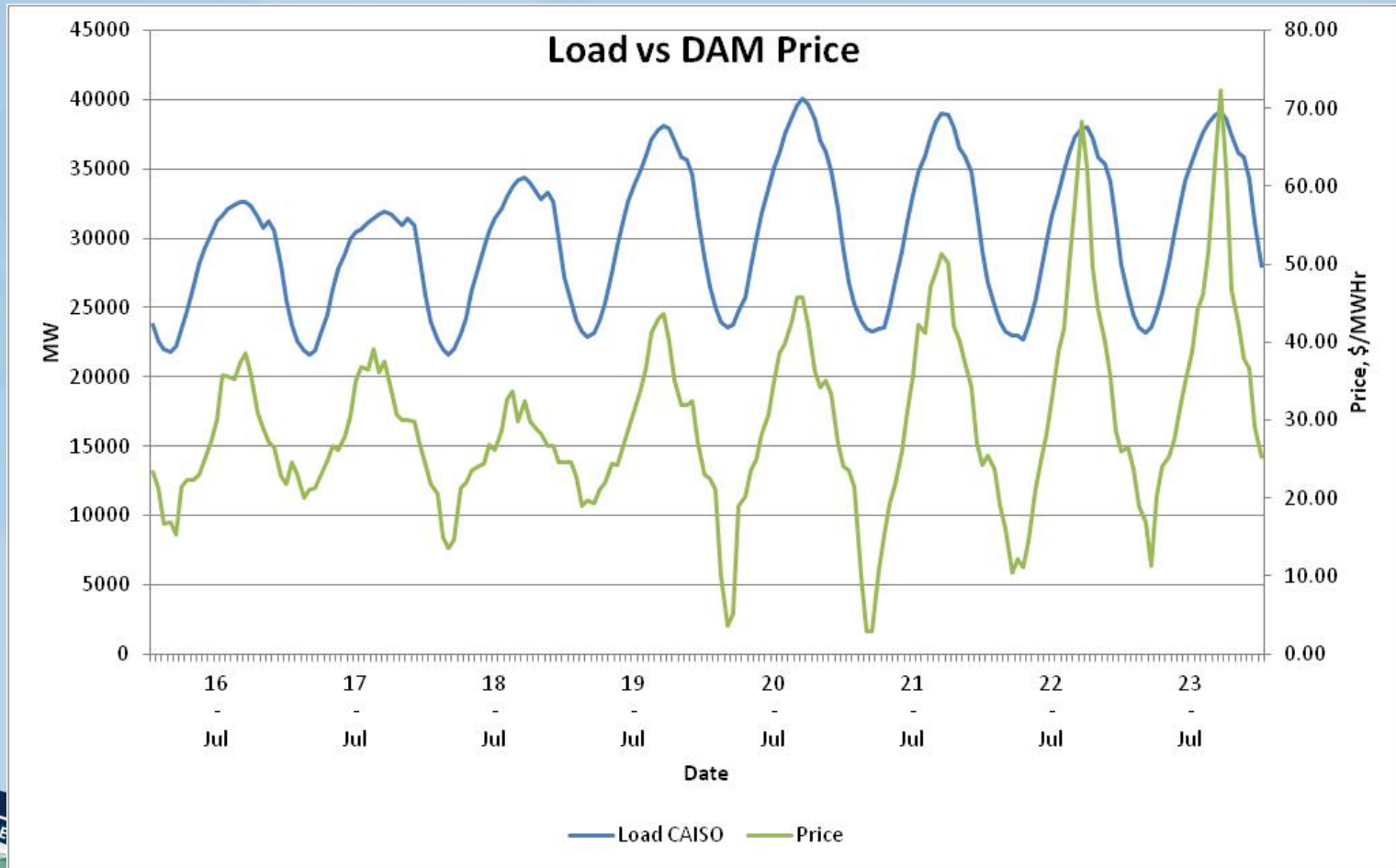


CAISO Control Room Folsom



Primary Market: Day Ahead Energy

Strong Correlation of Load & Price



Size of the Market

Day Ahead Market Results					
Operations					
Date	Product Type	Submitted/ Cleared	Self Schedule	Energy Bid	TOTAL
7/23/2012	DEMAND	Energy Cleared (MWh)	715,186	55,112	839,945
	DEMAND	Dollars Cleared (\$)	\$ 27,568,953	\$ 2,159,795	\$ 32,857,546
	EXPORTS	Energy Cleared (MWh)	29,979	10,275	40,254
	EXPORTS	Dollars Cleared (\$)	\$ 1,146,797	\$ 356,311	\$ 1,503,109
	IMPORTS	Energy Cleared (MWh)	127,119	129,397	256,516
	IMPORTS	Dollars Cleared (\$)	\$ 4,862,143	\$ 3,468,155	\$ 8,330,297
	SUPPLY	Energy Submitted (MWh)	376,431	549,428	983,913
	SUPPLY	Energy Cleared (MWh)	363,963	252,378	642,300
	SUPPLY	Dollars Submitted (\$)		\$ 26,815,367	\$ 32,770,921
	SUPPLY	Dollars Cleared (\$)	\$ 12,650,691	\$ 10,418,470	\$ 23,919,080



Locational Marginal Pricing

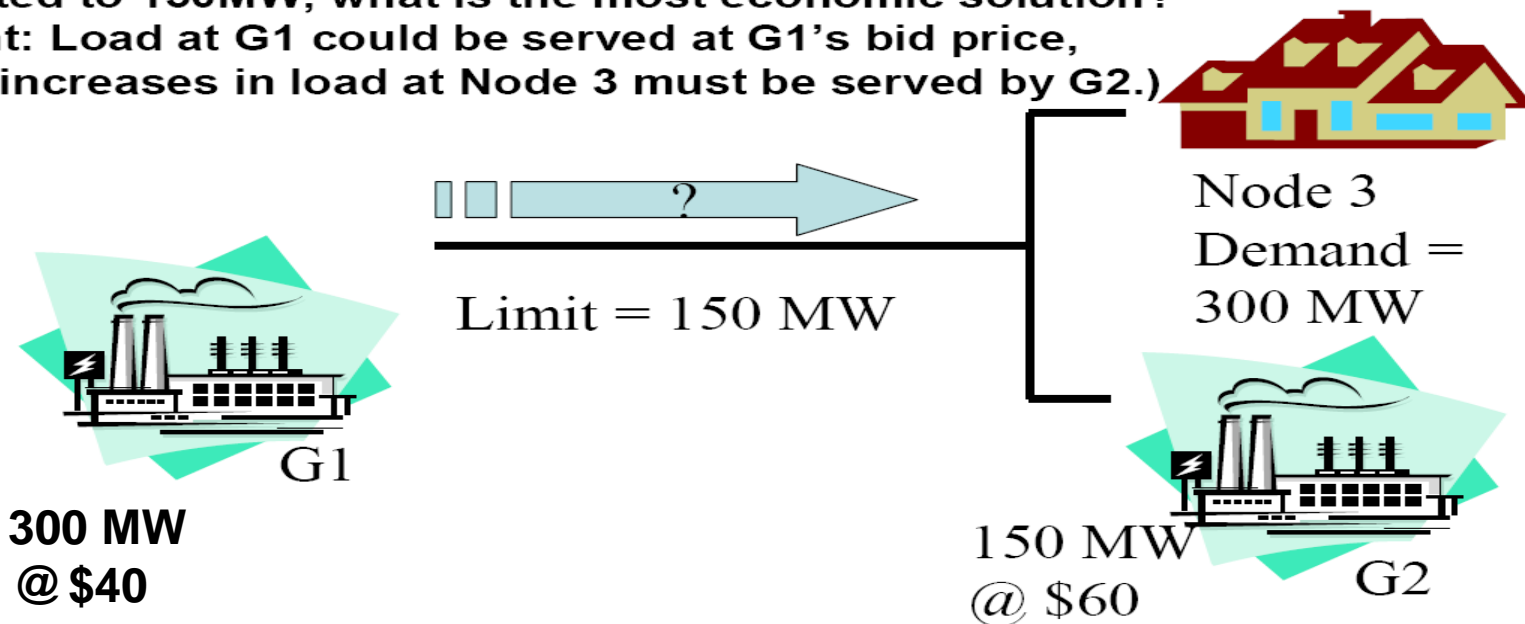
- LMP manages ALL congestion in the Day Ahead to create physically feasible schedules prior to real-time operations.
- Locational price patterns indicate areas where additional generation and transmission upgrades are needed.
- Within the CAISO:
 - Generation is paid the LMP at the generator node.
 - Demand pays the average price within each IOU service area.
 - Congestion is settled separately (System of Congestion Revenue Rights instruments)



LMP makes congestion costs transparent

LMP: Congestion Example

If the need for energy is 300 MW and two generators are offering at \$40 and \$60, EXCEPT the transmission line between G1 and the Demand is limited to 150MW, what is the most economic solution?
(Hint: Load at G1 could be served at G1's bid price, but increases in load at Node 3 must be served by G2.)

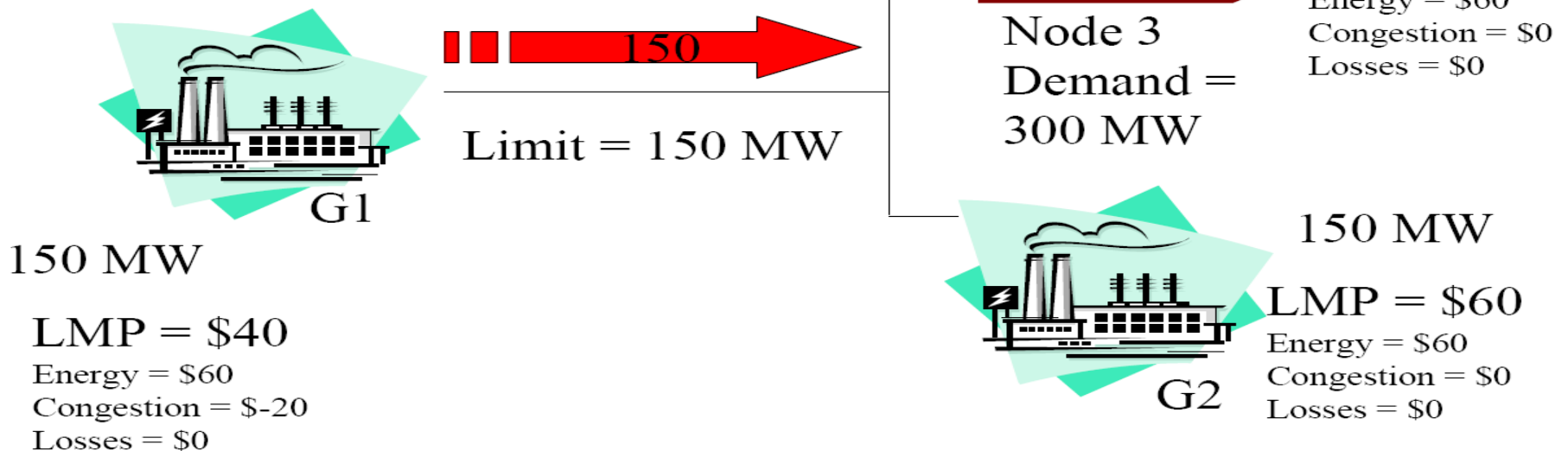


How LMP makes congestion costs transparent

Congestion Example

The most economic solution, that honors the line limit: 150 MW from G1 and 150 MW from G2. The LMP at G1 = \$40, the LMP at Node 3 = \$60 (assuming no losses).

G1's congestion price shows the impact of the constraint.



California ISO Tasks

Long-Term Planning

- Resource Adequacy, Outage Planning, etc.
- May start months ahead!

Load Forecast

- incorporates weather, other variables

Day Ahead Market

- Formal process, ALL loads and generation

Real Time Market

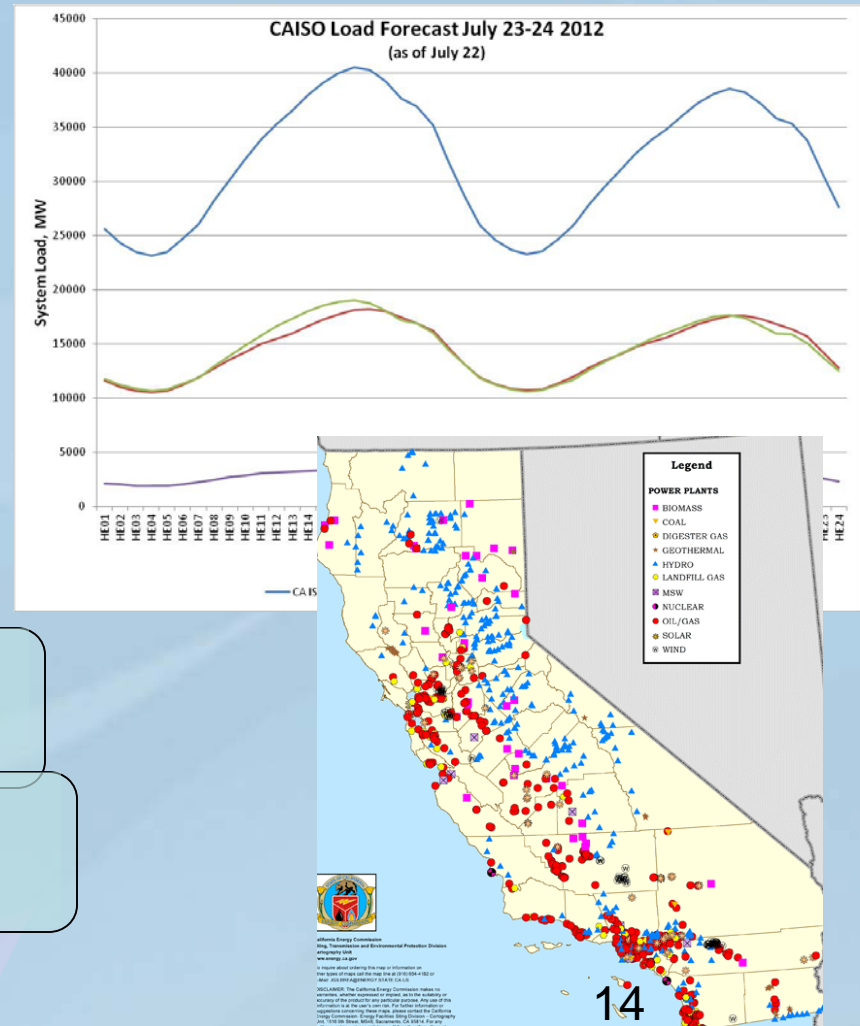
- Five-minute intervals to balance grid

Delivery

- Maintain system balance

Settlement

- Meter data, invoice & payment
- May take months to complete



Day Ahead Market



Predictable prices
Low volatility

Real Time Market



Unpredictable prices
High volatility

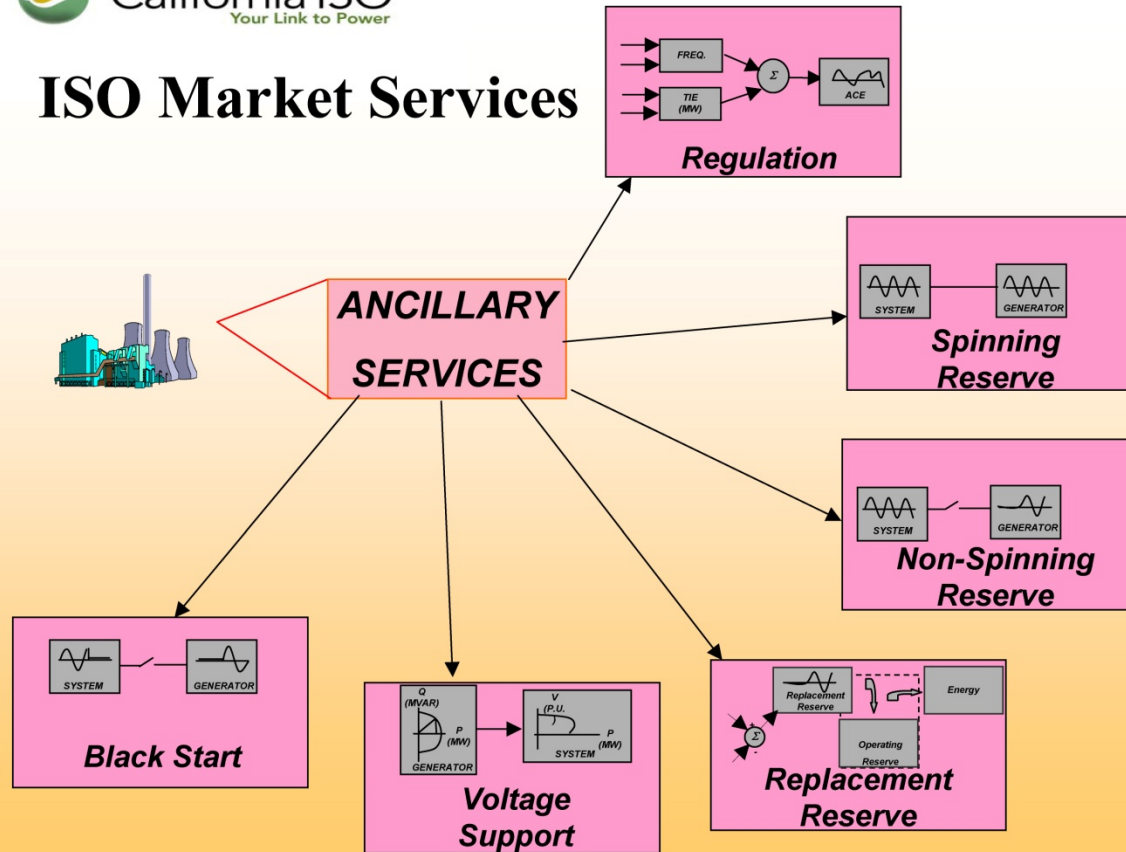


Ancillary Services Products – Keeping the Lights On



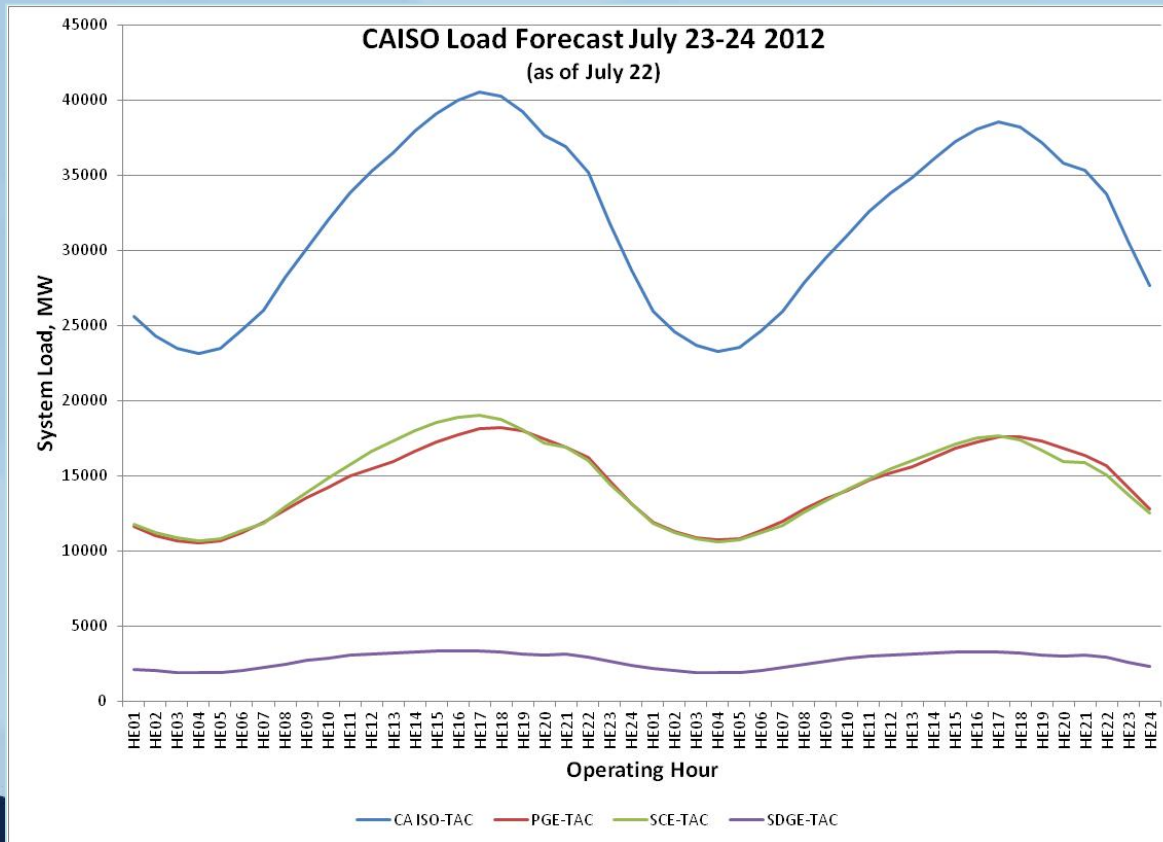
California Independent System Operator

ISO Market Services



Making it Work

- Load is predictable (if you have a good weather forecast and yesterday's results)



- So, managing generation is how the balancing works



A Day in the Life - ISO System Load July 22, 2012 1700 hrs

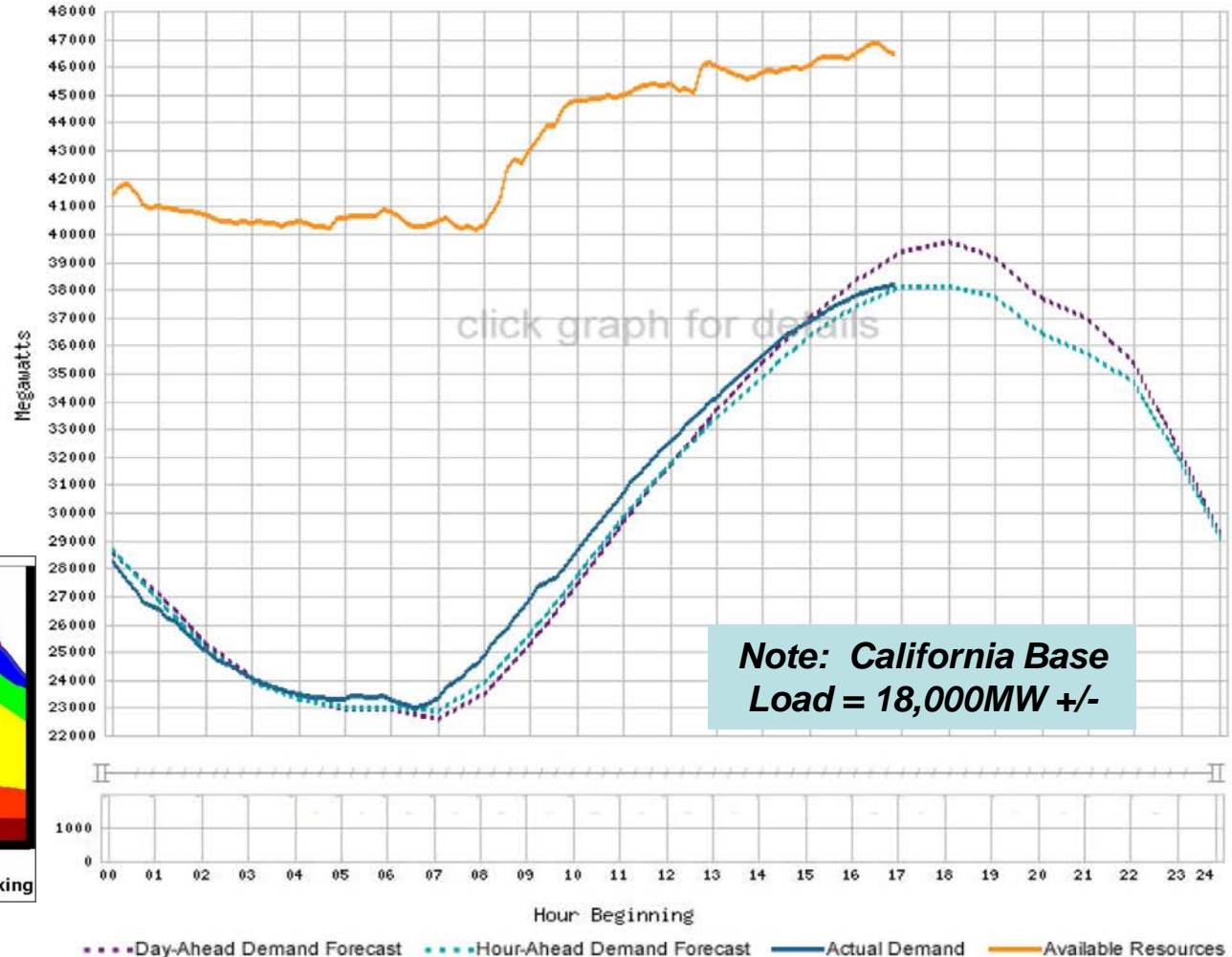
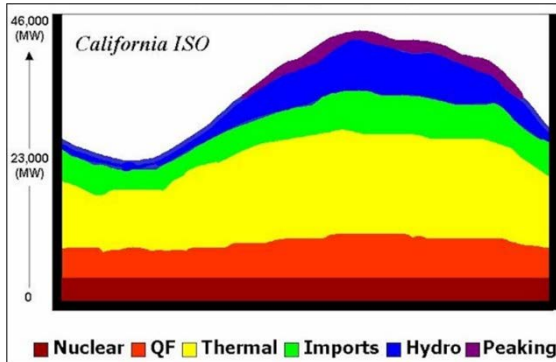
Current System Demand:
(Actual Demand at this point in time)
38131 MW

Today's Peak Demand:
(Highest point thus far today)
38131 MW

Today's Forecast Peak Demand:
(Highest point expected today. Does not appear post-peak.)
38065 MW

Tomorrow's Forecast Peak Demand:
(Not included on graph)
42375 MW

Information is current as of 22-Jul-2012 16:50 . If browser does not support auto refresh, select reload.

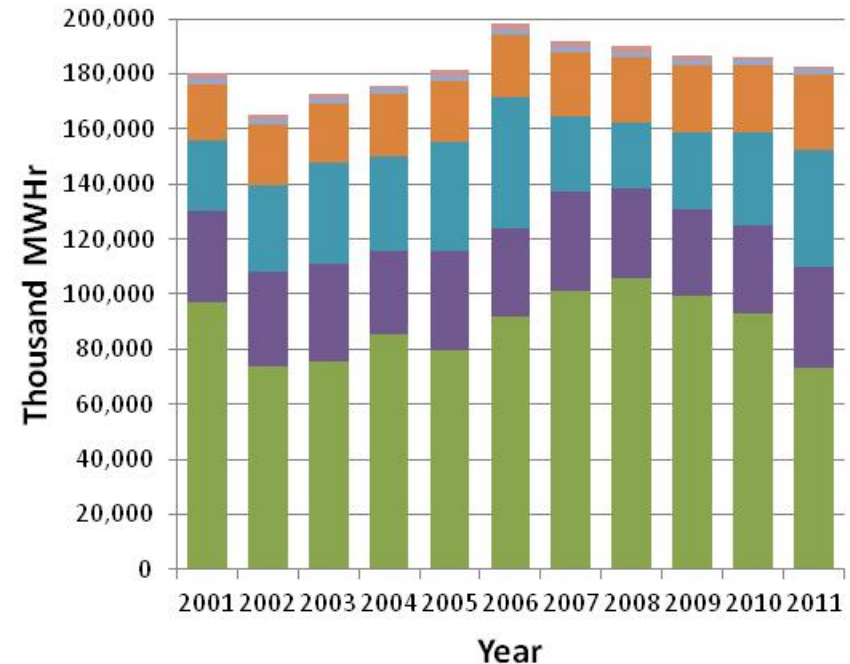


Generation Sources & Flexibility

- All generation sources have pros and cons, relative to other sources:
 - Wind & solar are very expensive to construct & operate
 - Nuclear & coal are generally low cost, but not very flexible
 - Natural gas generation can be fairly flexible and located close to load, but fuel cost is variable
 - Hydro is usually remote, but with a large reservoir can be the most flexible of all

Net Generation for Electric Power in California

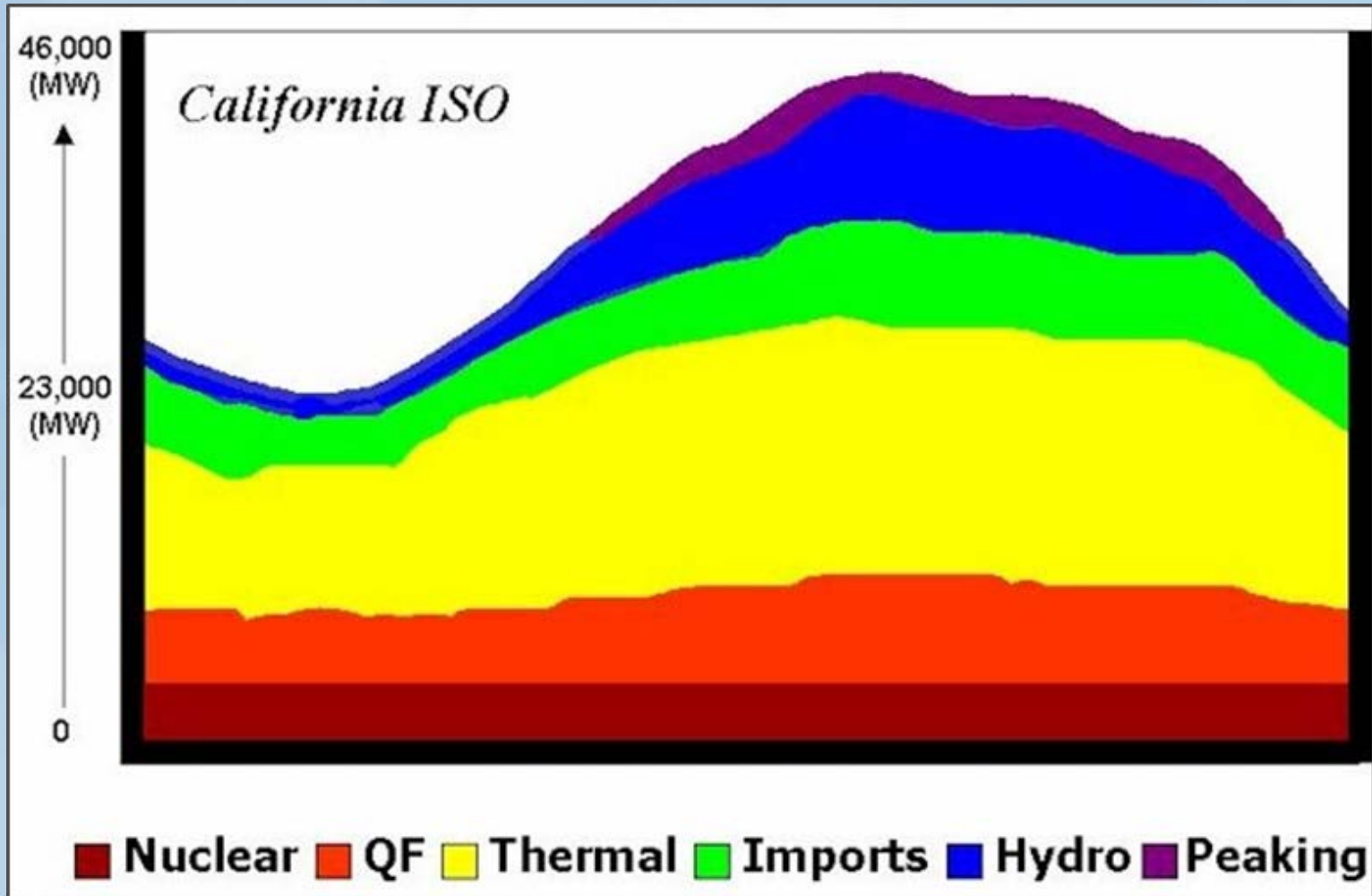
Source: EIA



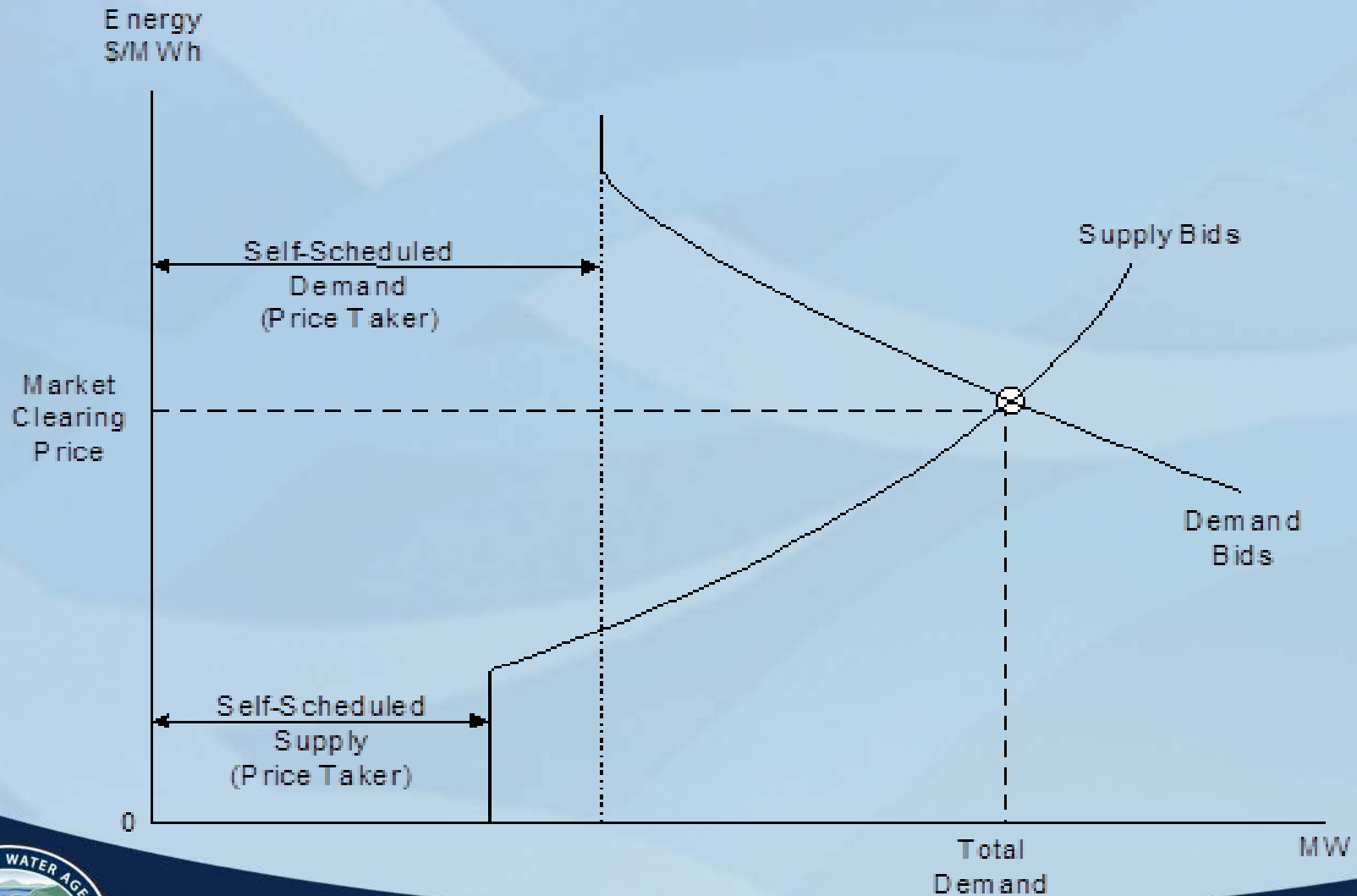
■ Natural Gas
■ Nuclear
■ Conventional Hydroelectric
■ Other Renewables



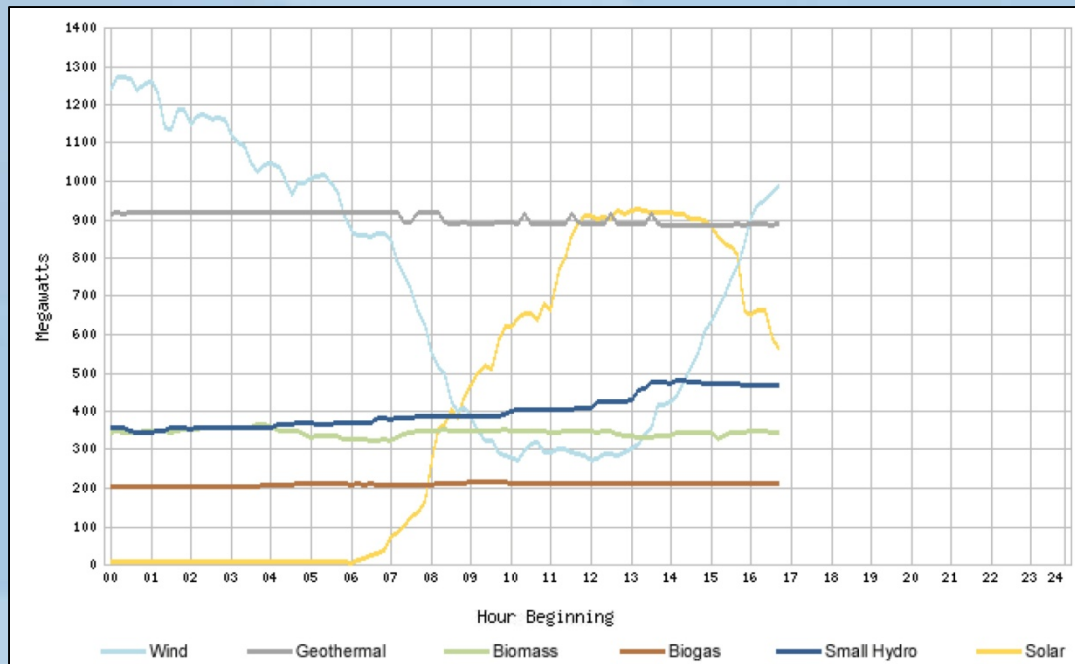
California Generation Sources



Market Clearing Price – Where Supply and Demand Meet

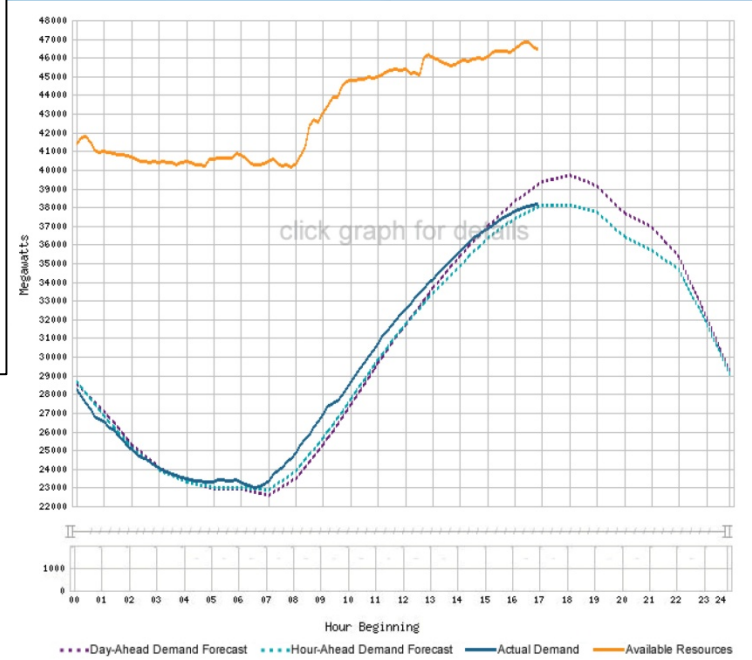


Balancing in the short-term

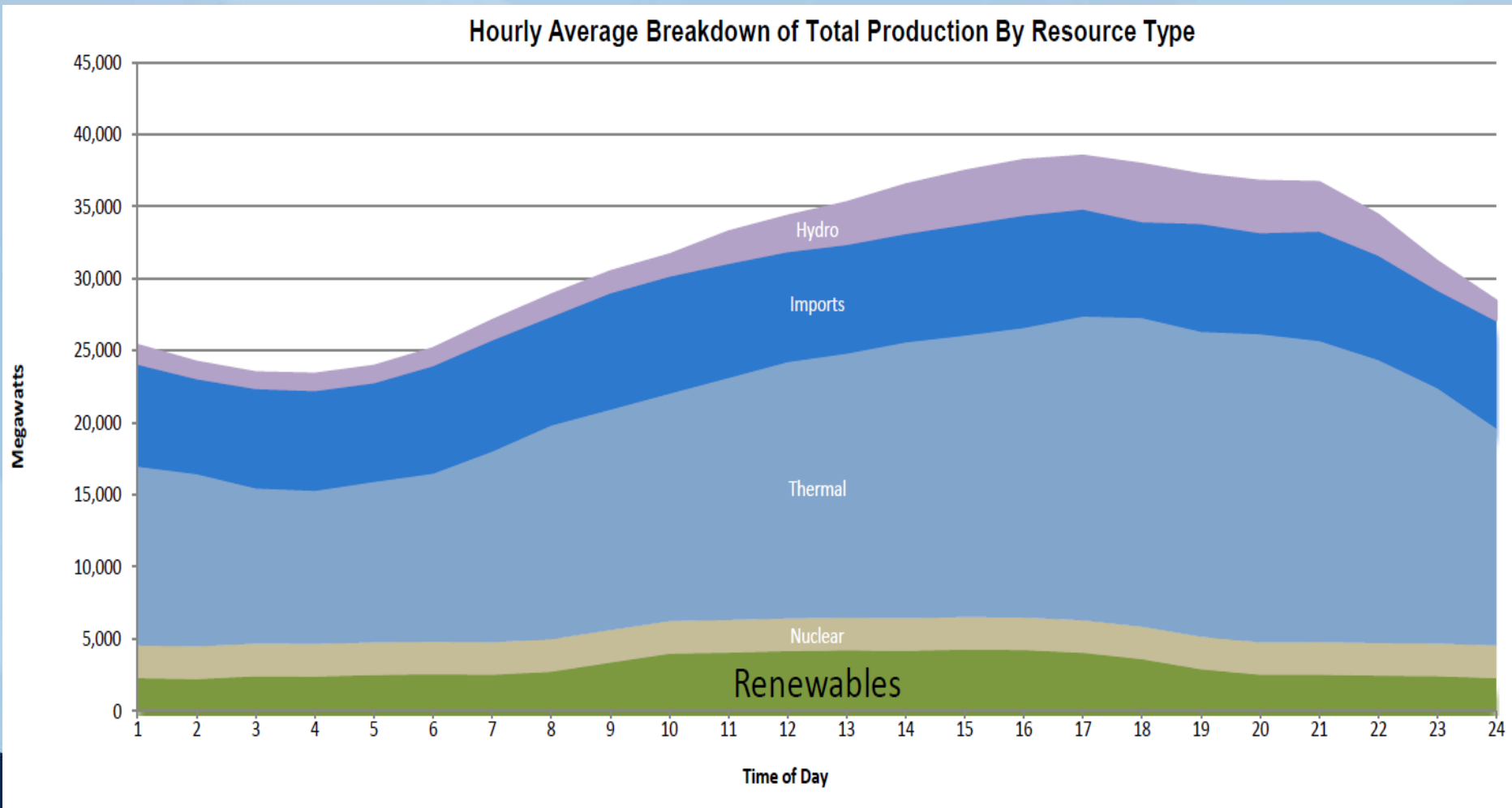


Renewable Generation Load

Total System Load

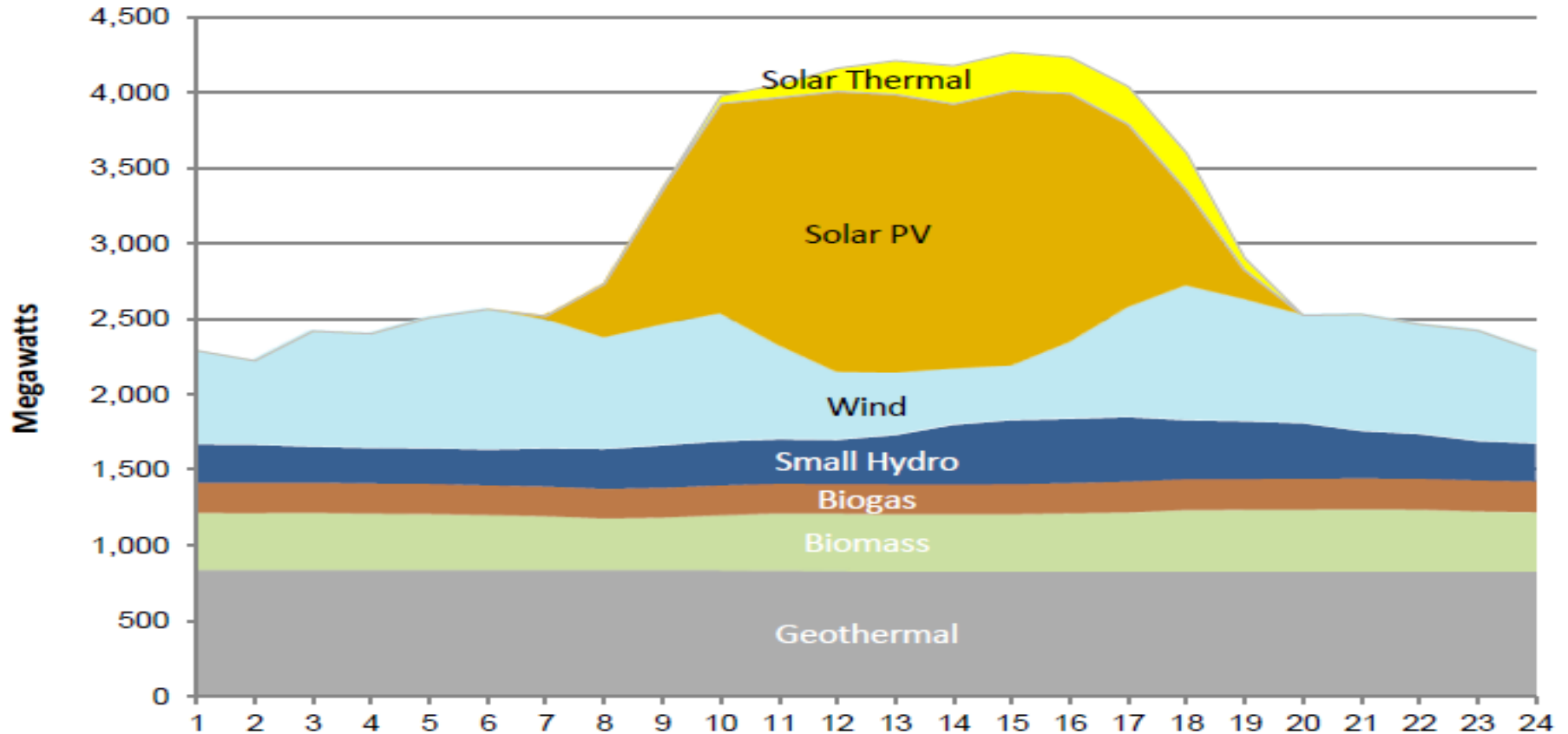


Renewables – a big driver in California markets

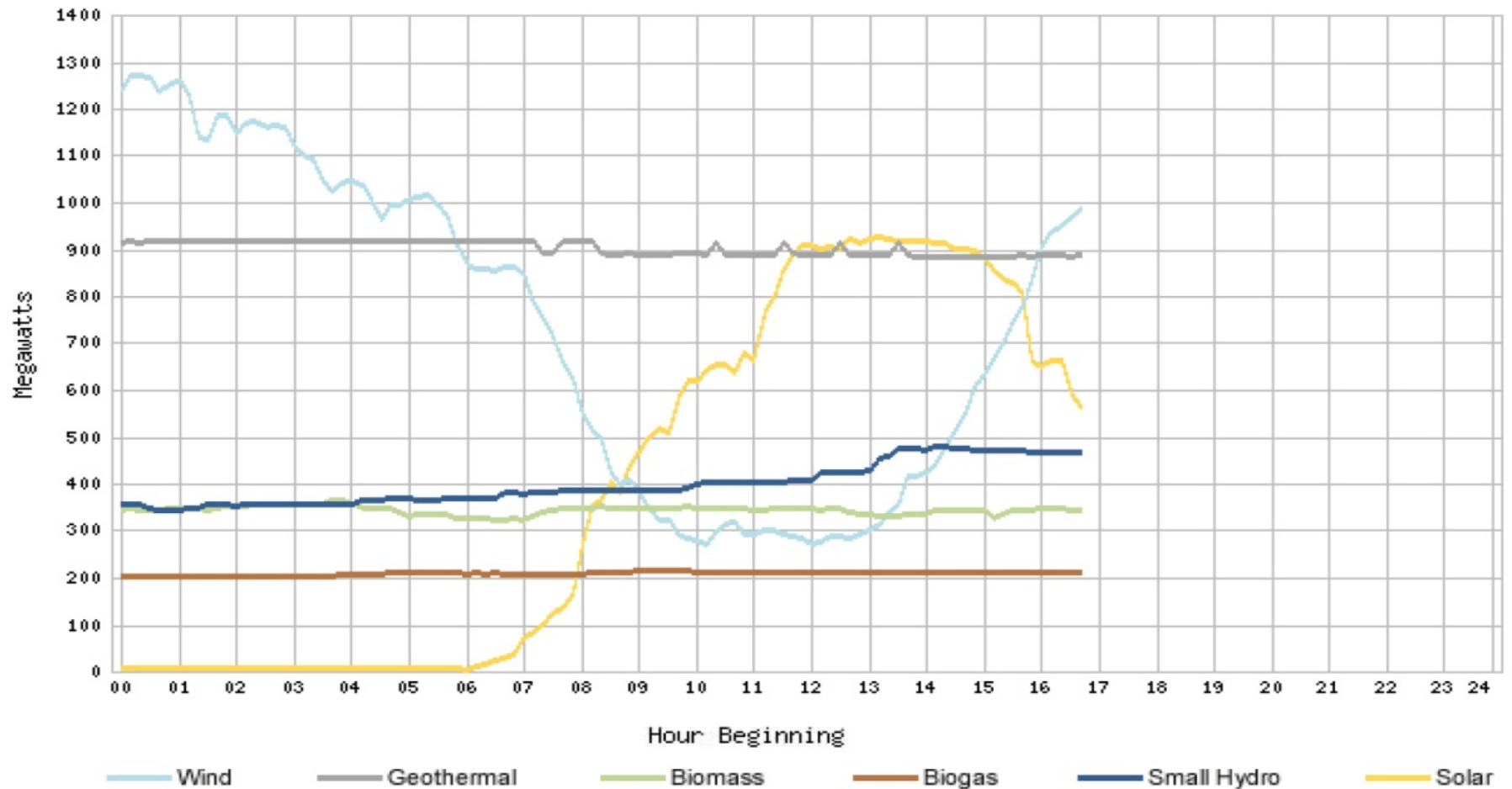


Renewables Breakdown

Hourly Average Breakdown of Renewable Resources

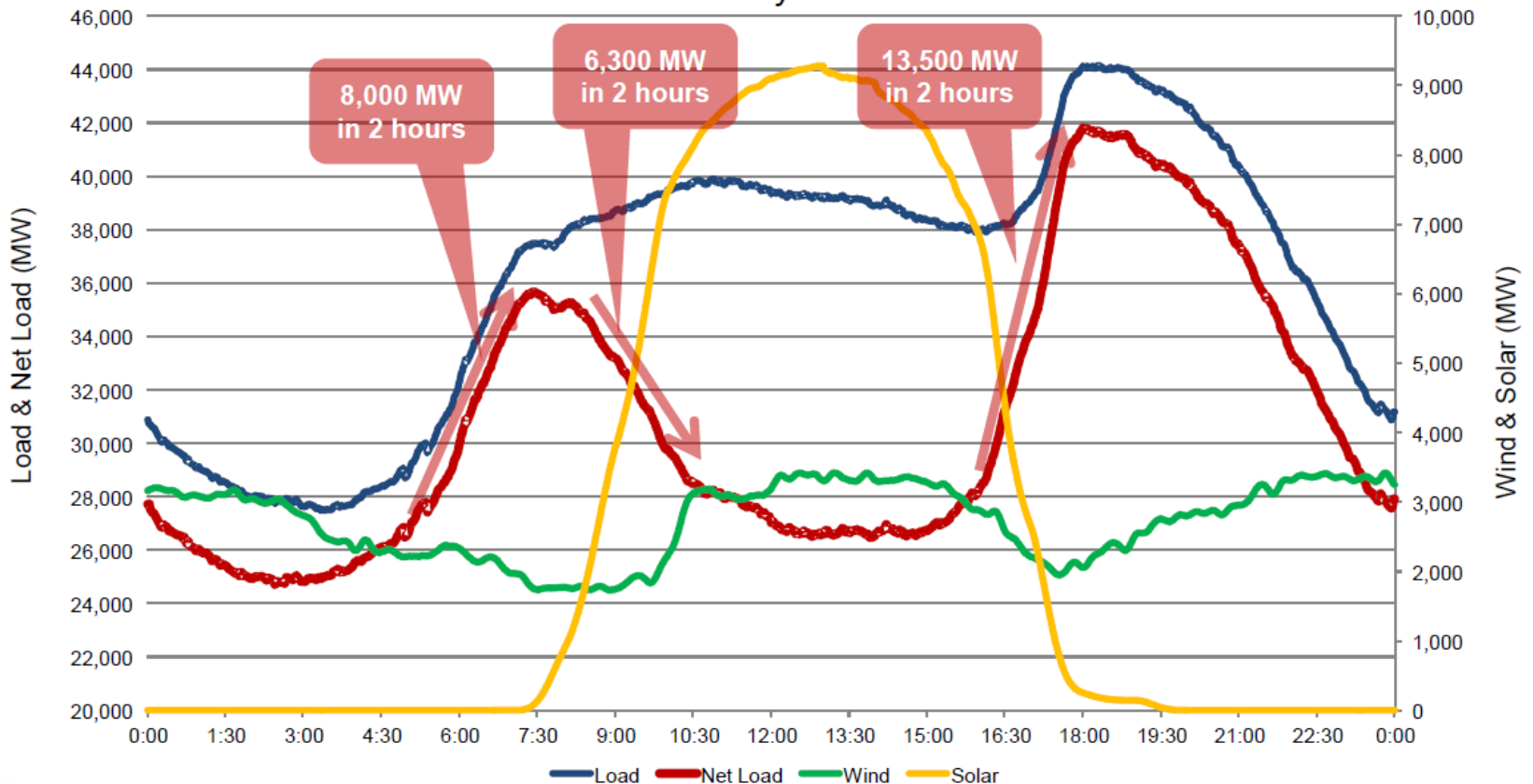


Balancing Renewables – The Known Unknowns

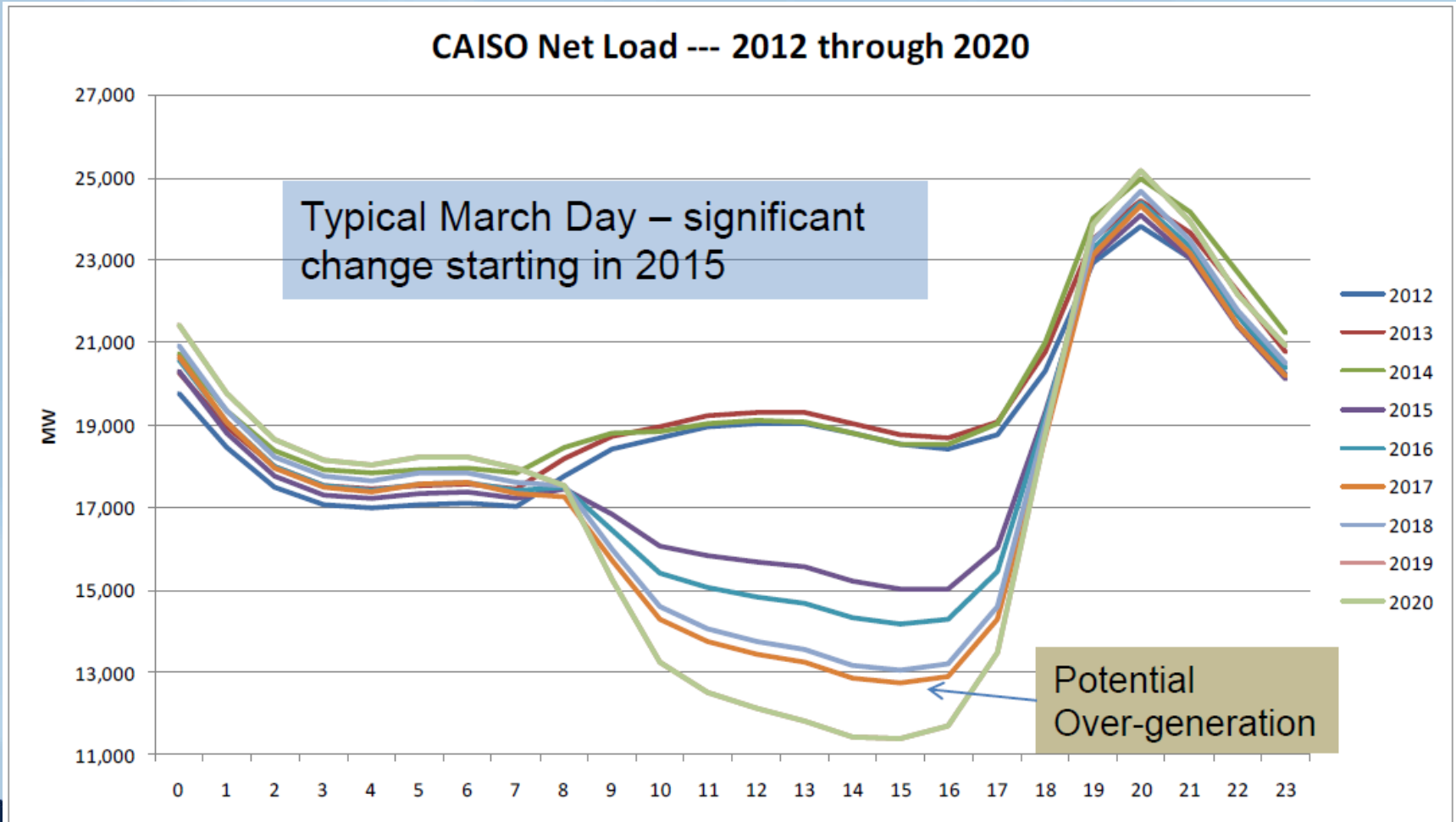


Balancing - Challenges Ahead

CAISO Load, Wind & Solar Profiles – High Load Case
January 2020



Balancing - Challenges ahead as more renewables come on line



Making it Work



Market Instruments for Planning and Balancing

- Planning:
 - Resource Adequacy
 - Market Purchases of AS Products
- Balancing Services:
 - Non-Spinning Reserves
 - Spinning Reserves
 - Regulation
- New Services
 - Flex-Ramp
 - New Product Pipeline



Market Instruments for Planning

- Resource Adequacy
 - 15% “Contingency” reserves
 - Daily load x 1.15
 - Required of all LSE’s (Load Serving Entities), every day
 - Impacts: Scheduled and forced outages
 - Form of “delivery”: bid-in energy, bid-in AS products
- Market Purchases of Energy and AS Products
 - DAM, RT Markets: all energy must move through markets
 - Pre-purchase (Day-ahead) of AS products (CAISO sets volumes)
 - Mix of AS products as needed



Market Instruments for Balancing

- Non-Spinning Reserves
 - Units off line
 - Must be able to synch and ramp up within a set time
- Spinning Reserves
 - Units synched to grid
 - Must be able to ramp up within a set time
- Regulation
 - Online
 - Immediate response (8 sec)
 - CAISO controlled
- Values increase with flexibility
- All services require demonstration & registration



New Services

- Flex-Ramp
 - Still 'beta testing'
- New Product Pipeline
 - Short term RA products, but not a RA market
 - Approximately 80 stakeholder initiatives
 - Prioritized by need



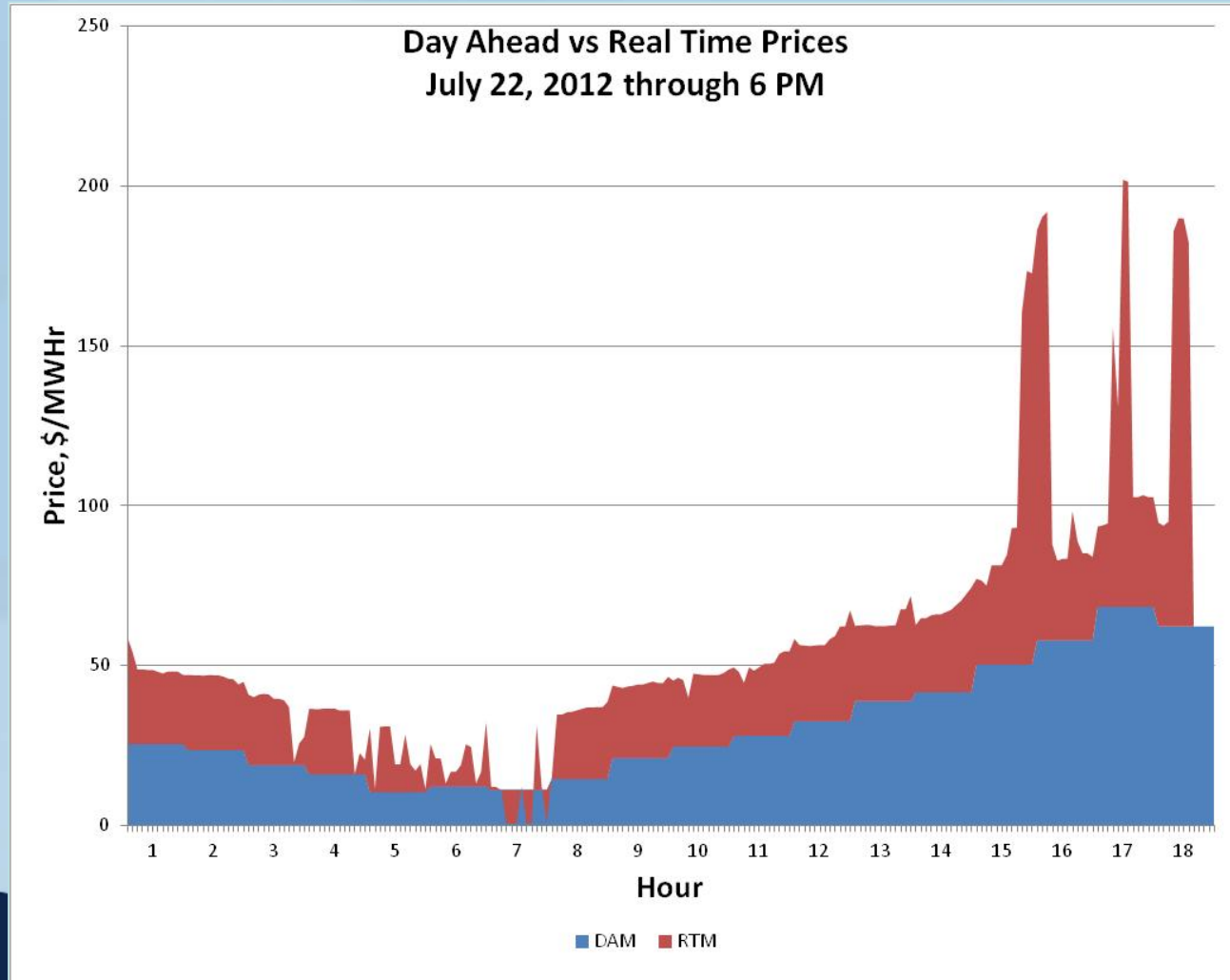
Yuba Project Operations in the California Market

- Yuba Project provides several services:
 - Energy (DAM & RTM)
 - Resource Adequacy
 - Non-Spin
 - Spin
 - Regulation

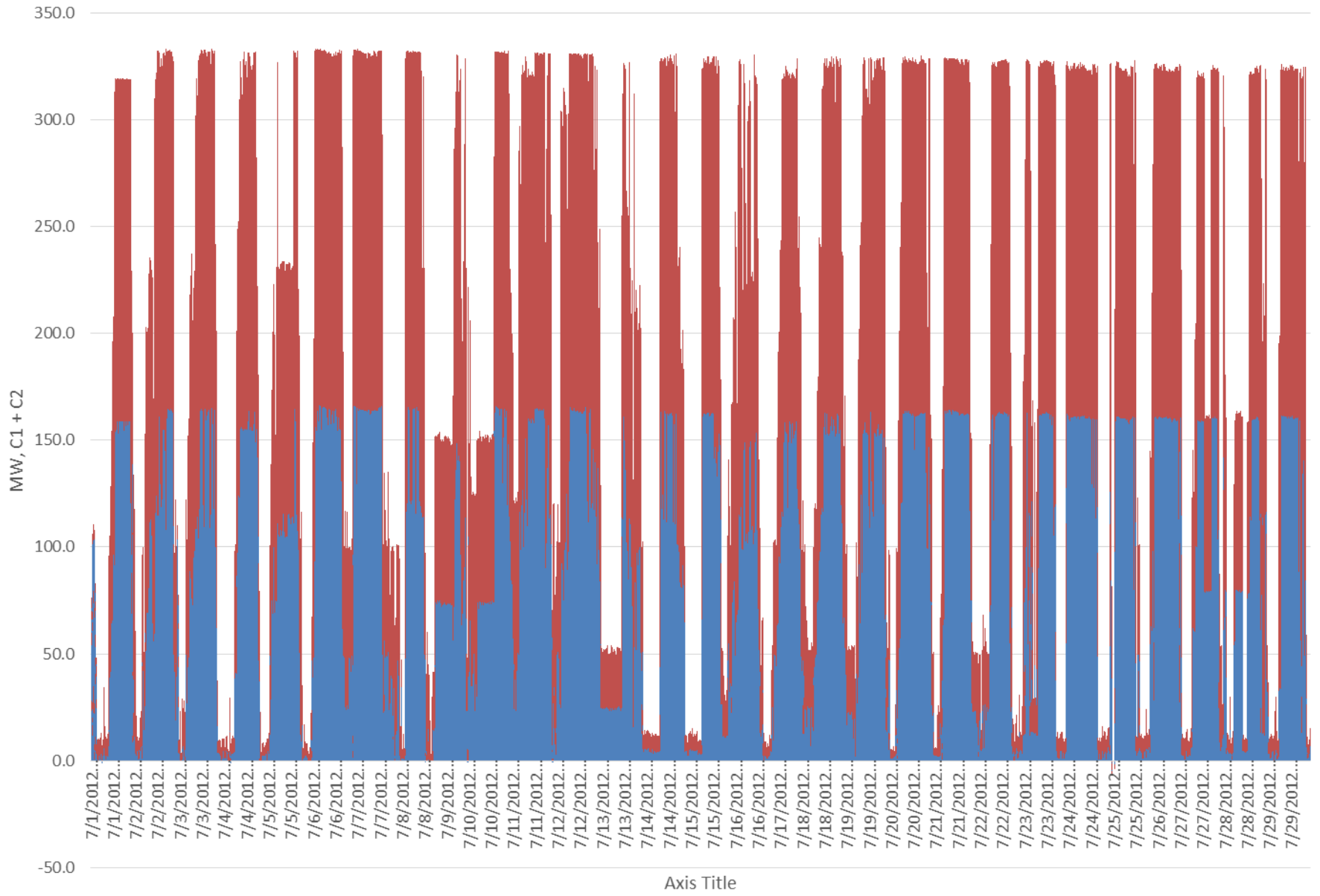


Real Time Market

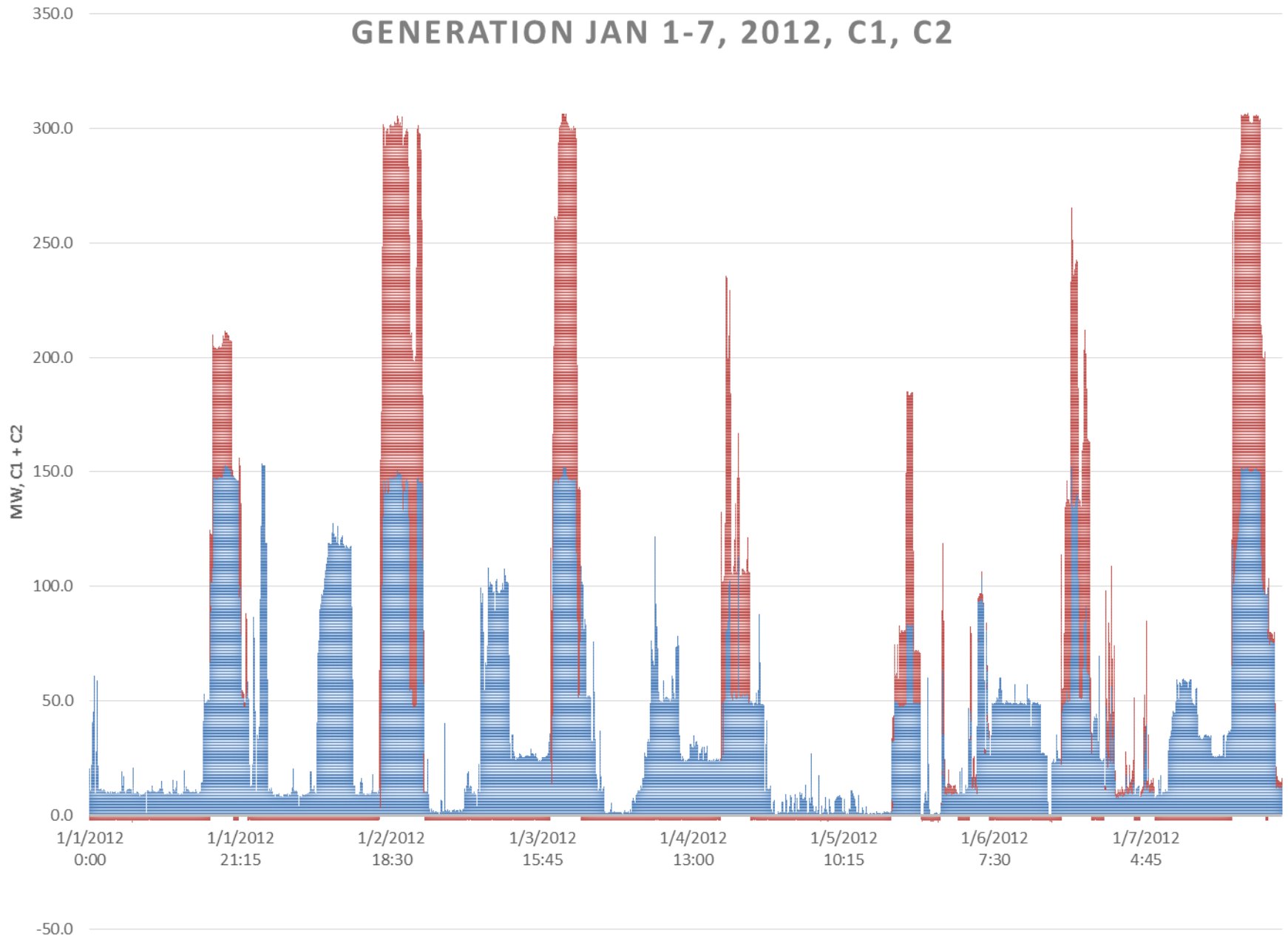
Can deviate from Day Ahead



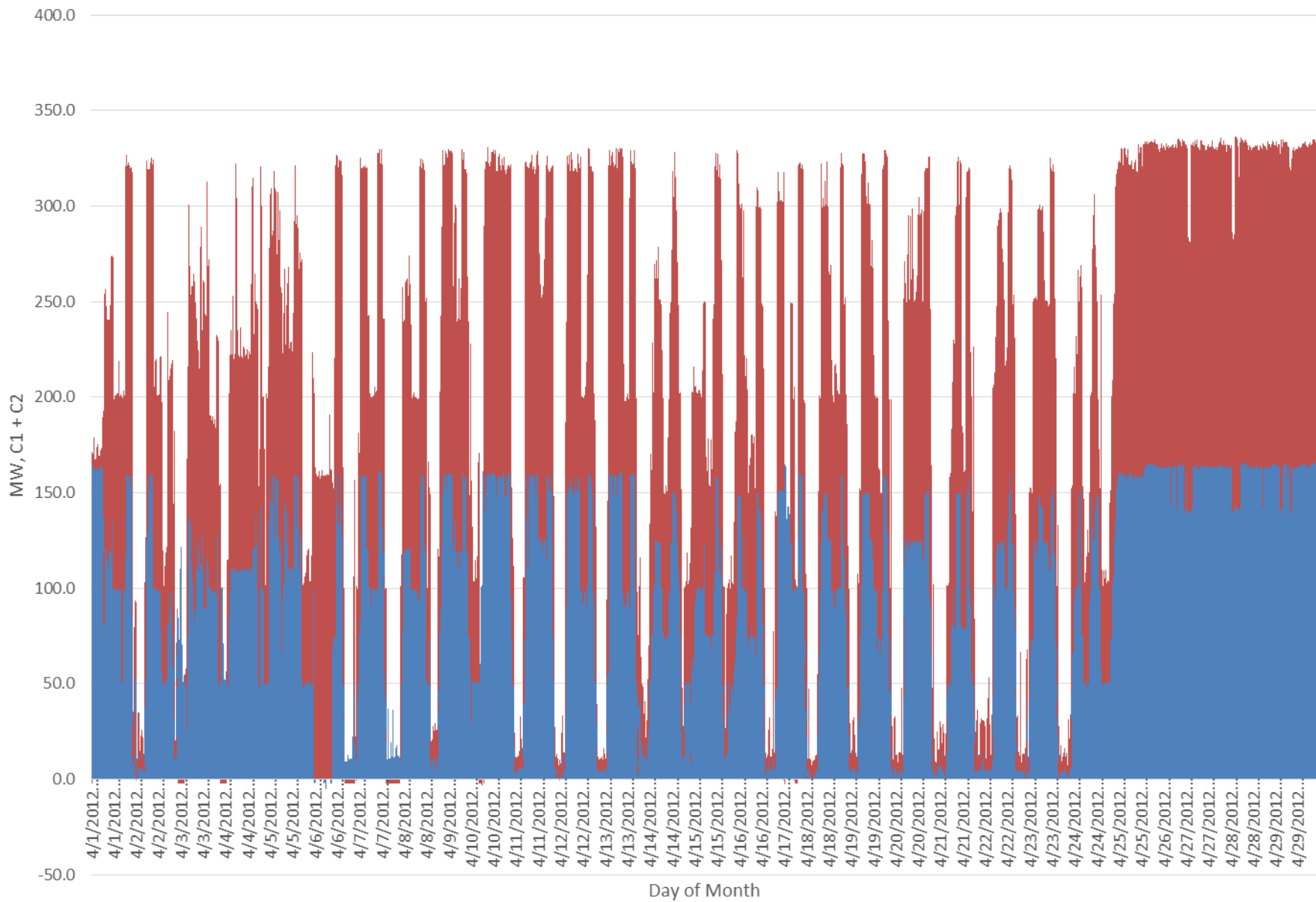
Generation, C1 + C2, July 2012



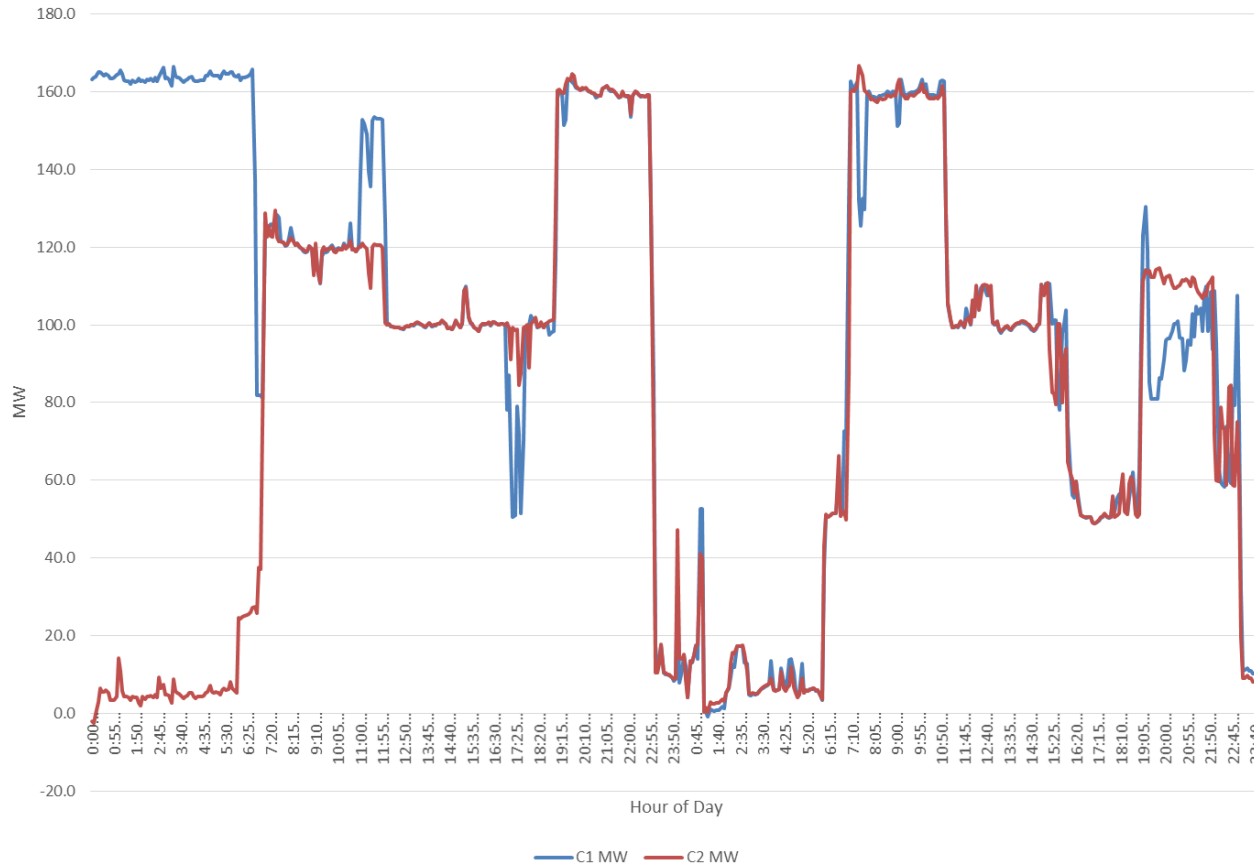
GENERATION JAN 1-7, 2012, C1, C2



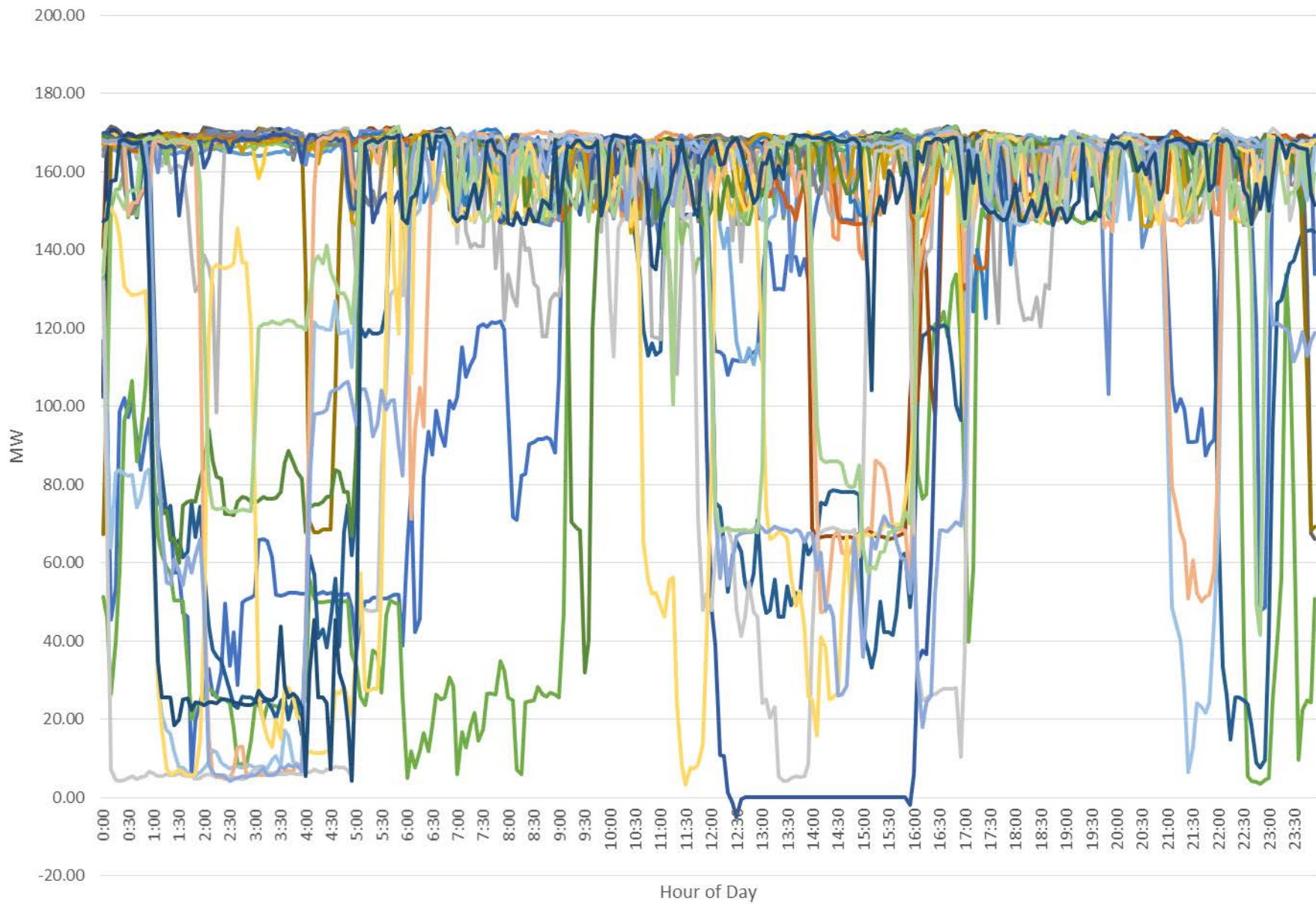
generation, C1, C2 April 2012



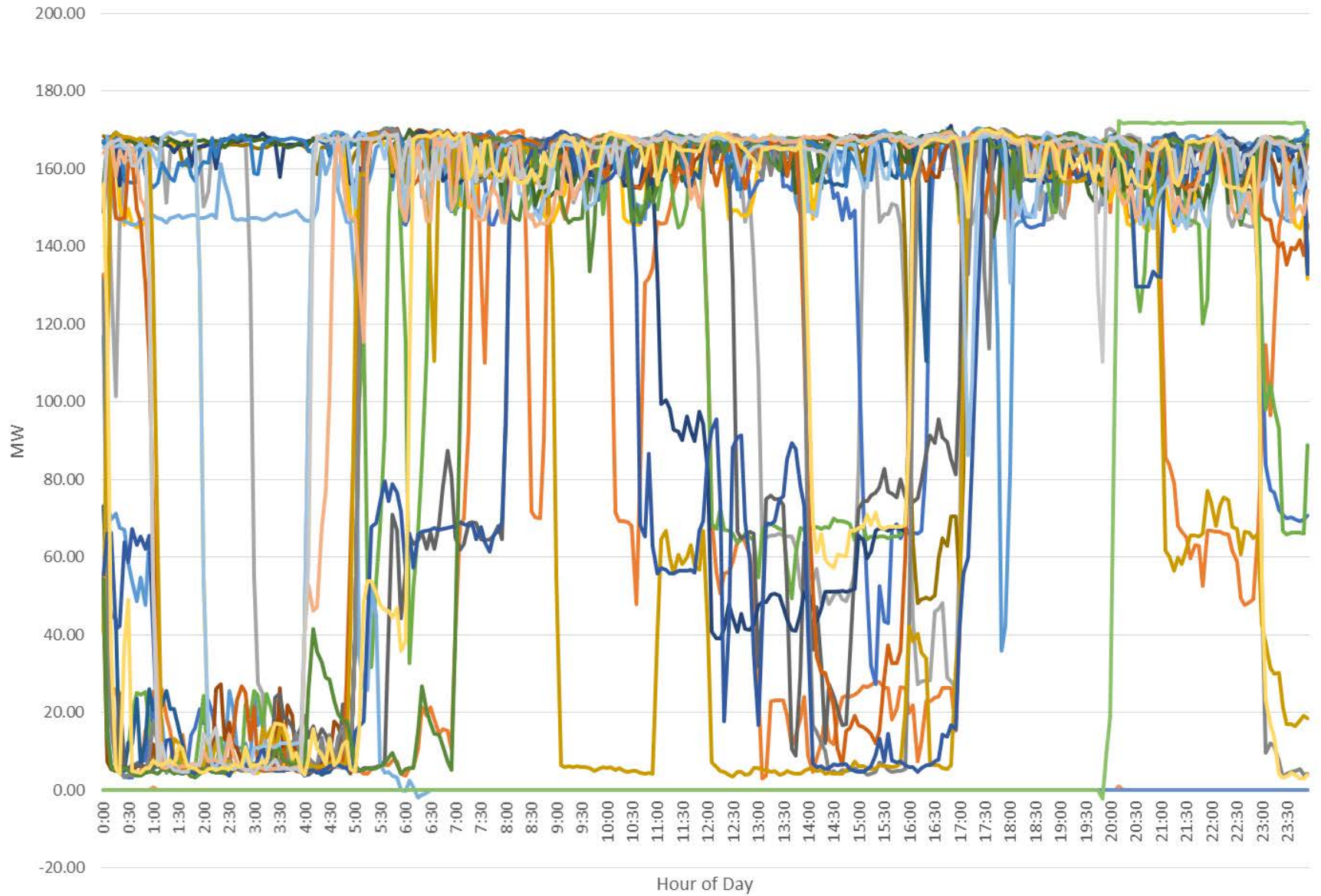
C1, C2 generation April 1,2 2012



C1 Generation Jan 2013 (C2 off line)

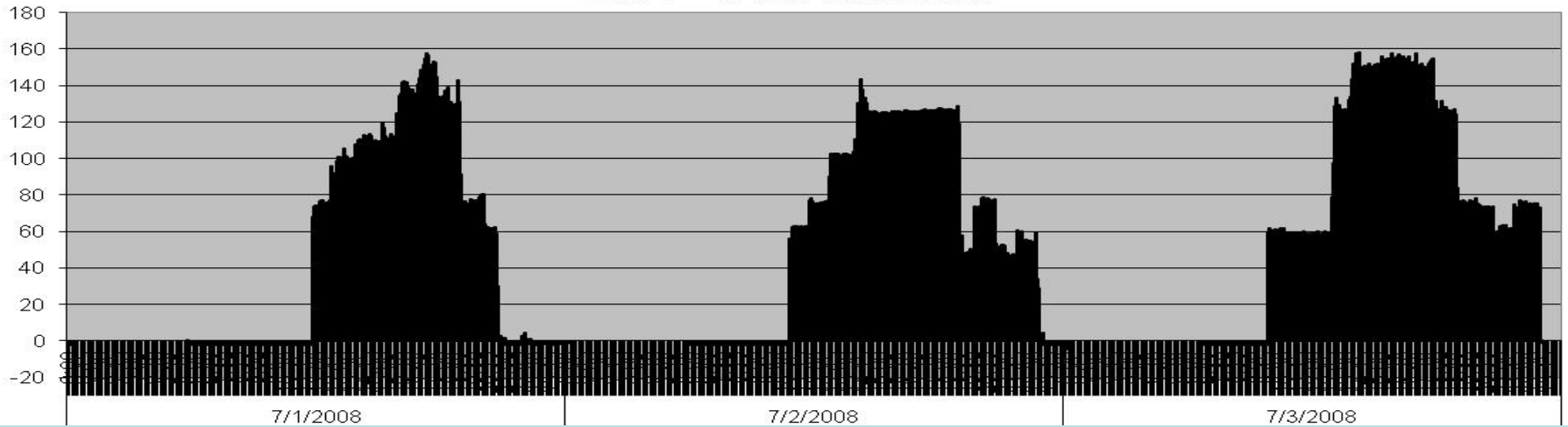


C1 Generation Feb 2013 (C2 off line)

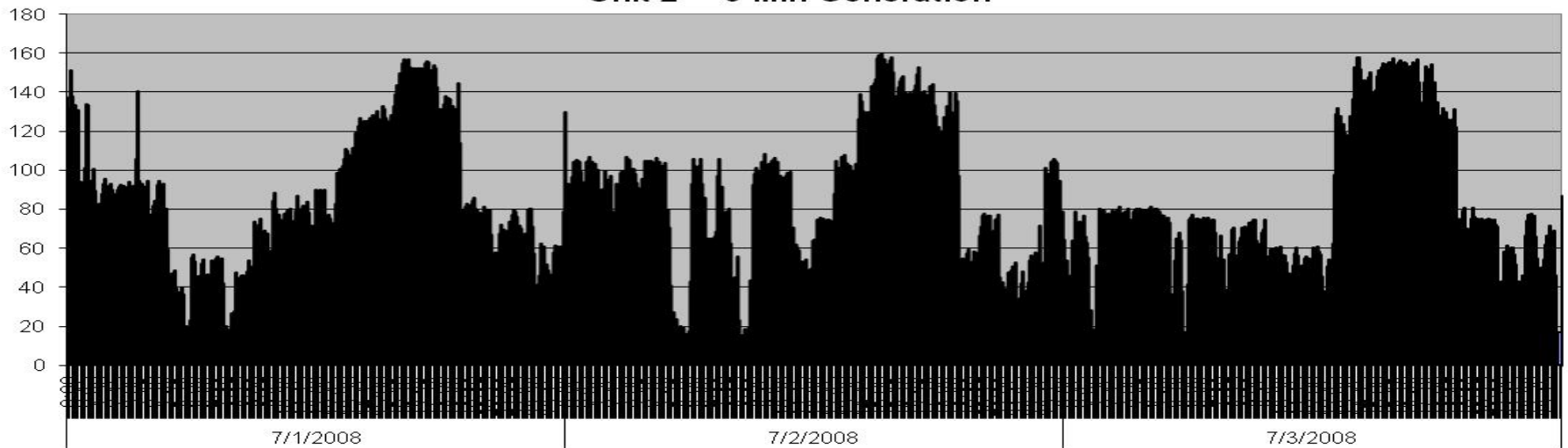


2-Units, 2 dispatch approaches

Unit 1 5 Min Generation



Unit 2 5 Min Generation



Hydro Licensing Considerations

- Energy Production and Fuel
 - License conditions can affect available fuel – water – by dedicating resource to in-stream flow in bypass reaches.
 - Licenses can also limit drawdown in storage reservoirs, hampering summer production
- Flexibility of Dispatch
 - For some hydro projects, flexibility is more important than total production
 - Peaking reach and re-regulating reservoir conditions must remain reasonable to accommodate demands of the California energy market
 - Ramping rates for peaking units are critically important to balancing non-dispatchable resources like renewables.



Conceptual Value

- from YSF analysis
- *Not consistent with FERC!*
 - YSF analysis was for comparative (between Actions) use
 - YSF analysis assumed 'perfect' dispatch
 - YSF made several simplifying assumptions about hydrology, operations, and power market values
 - Assumed generalized value for Narrows complex



Approach to Generation Costs (from YSF analysis)

- 1. Prepare a method for valuing generation (energy and ancillary services [AS])
- 2. Develop baseline generation value (current operations without peaking and AS)
 - YRDP relicensing “Draft” Base Case
- 3. Determine “added” value of peaking and AS
- 4. Determine changes in generating facilities and operation due to Action constraints
 - Changes due to Actions primarily impact peaking and AS at Colgate and capacity/existence at Narrows
- 5. Prepare a comparison matrix
 - “Cost” is change in generation value compared to baseline



Generation Value Approach

(from YSF analysis)

- Value Energy and Ancillary Services
- Three Powerhouses (and potentially a fourth)
 - New Colgate Powerhouse – 340 MW Peaking/AS
 - Narrows 2 Powerhouse – 55 MW Run of River
 - Narrows 1 Powerhouse (PG&E) – 12 MW Run of River (RPS)
 - New Bullards Bar Dam Fish Flow – 150 KW Constant Release

Generation Value Method

(from YSF analysis)

- **Objective:** Determine the value of peaking and ancillary services as a percentage of daily average generation
- **Approach:** “optimize” (maximize) daily total value of energy and ancillary services using historical prices of Day Ahead Market hourly prices for Colgate
- **Baseline Generation** = YRDP model daily generation x average of hourly DAM prices for each day

NOTE: Values from this analysis will not match those used in relicensing

(for comparison of actions, assumes perfect knowledge of market and does not include many limiting factors)

Determining Generation Value

(from YSF analysis)

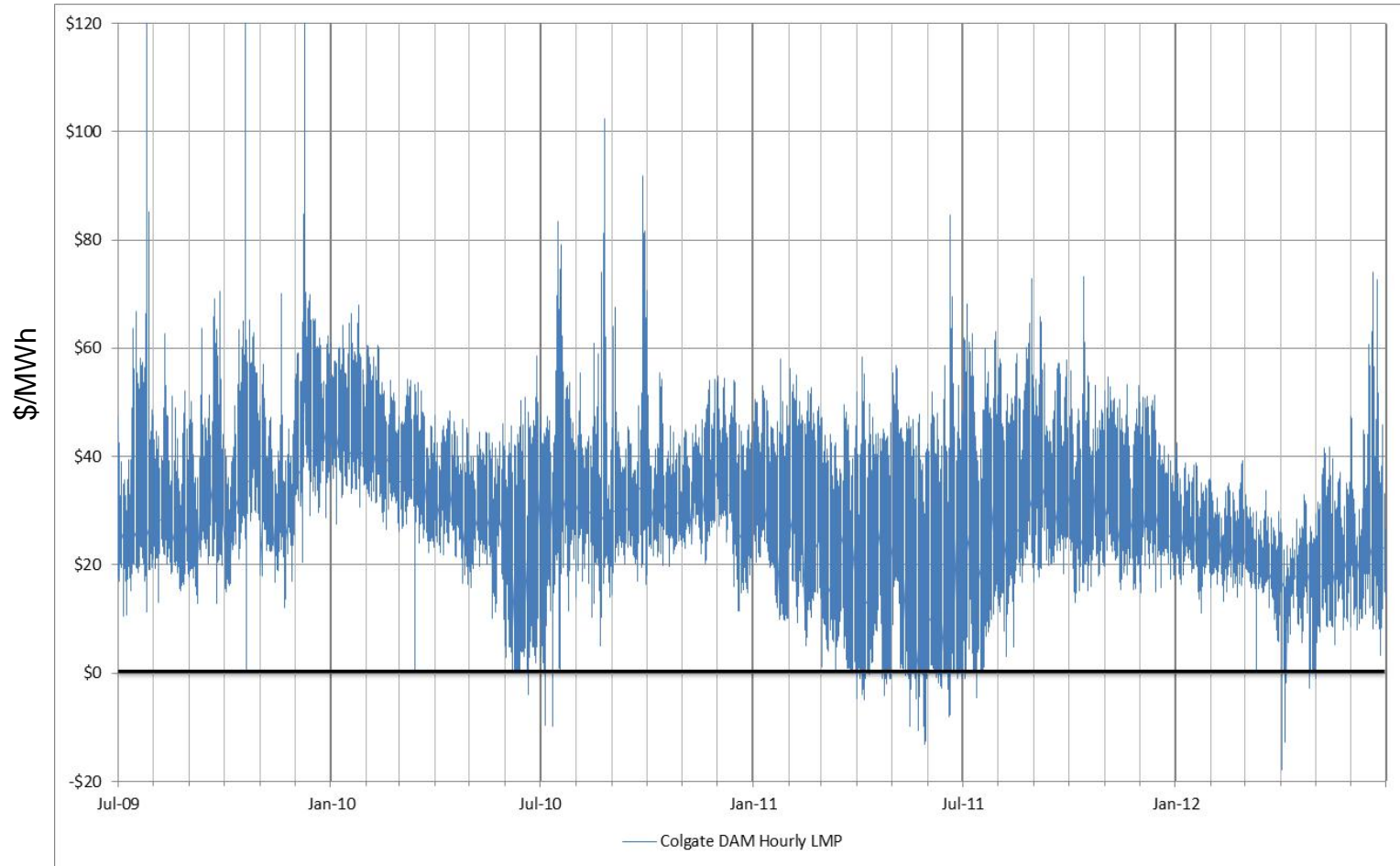
- Energy: Historical Market Prices
 - CAISO Day Ahead Market Hourly Prices
 - Current Prices reflect “new market” (MRTU)
 - Current Prices reflect several drivers of price that may or may not persist
 - Use CAISO Prices for Colgate Unit 1 for all powerhouses
 - Average of last 3 years hourly prices in the DAM
 - Very generalized, as many factors affect market prices

Determining Generation Value

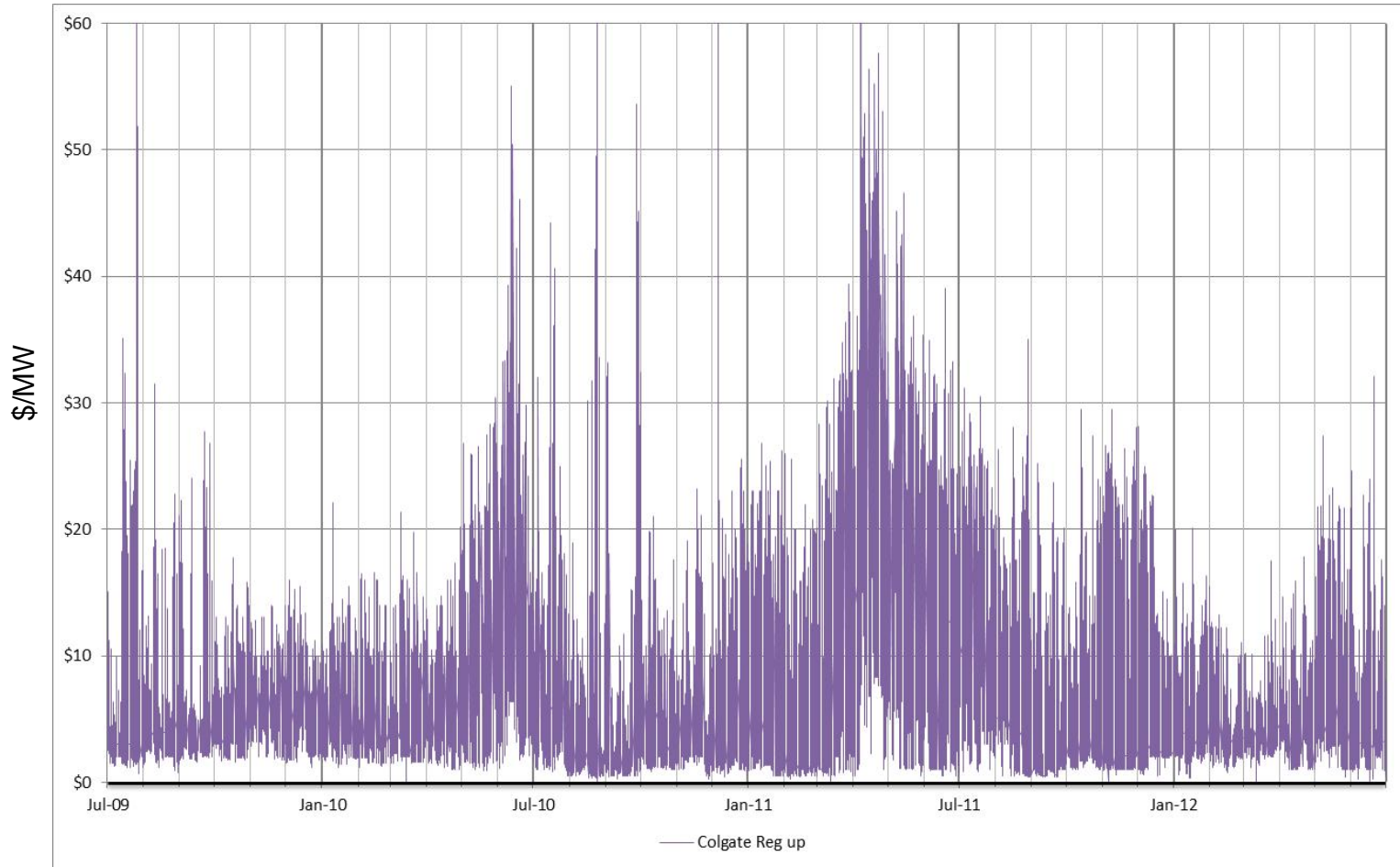
(from YSF analysis)

- Ancillary Services: Historical Market Prices
 - Regulation Up and Regulation Down
 - CAISO Day Ahead Market Hourly Prices
 - Current prices reflect “new market” (MRTU)
 - Current prices reflect several drivers of price that may or may not persist
 - Colgate Unit 1 prices (Unit 2 prices are identical)
 - analysis used the average of last 3 years hourly prices in the DAM
 - May or may not reflect future values, as many factors affect market prices

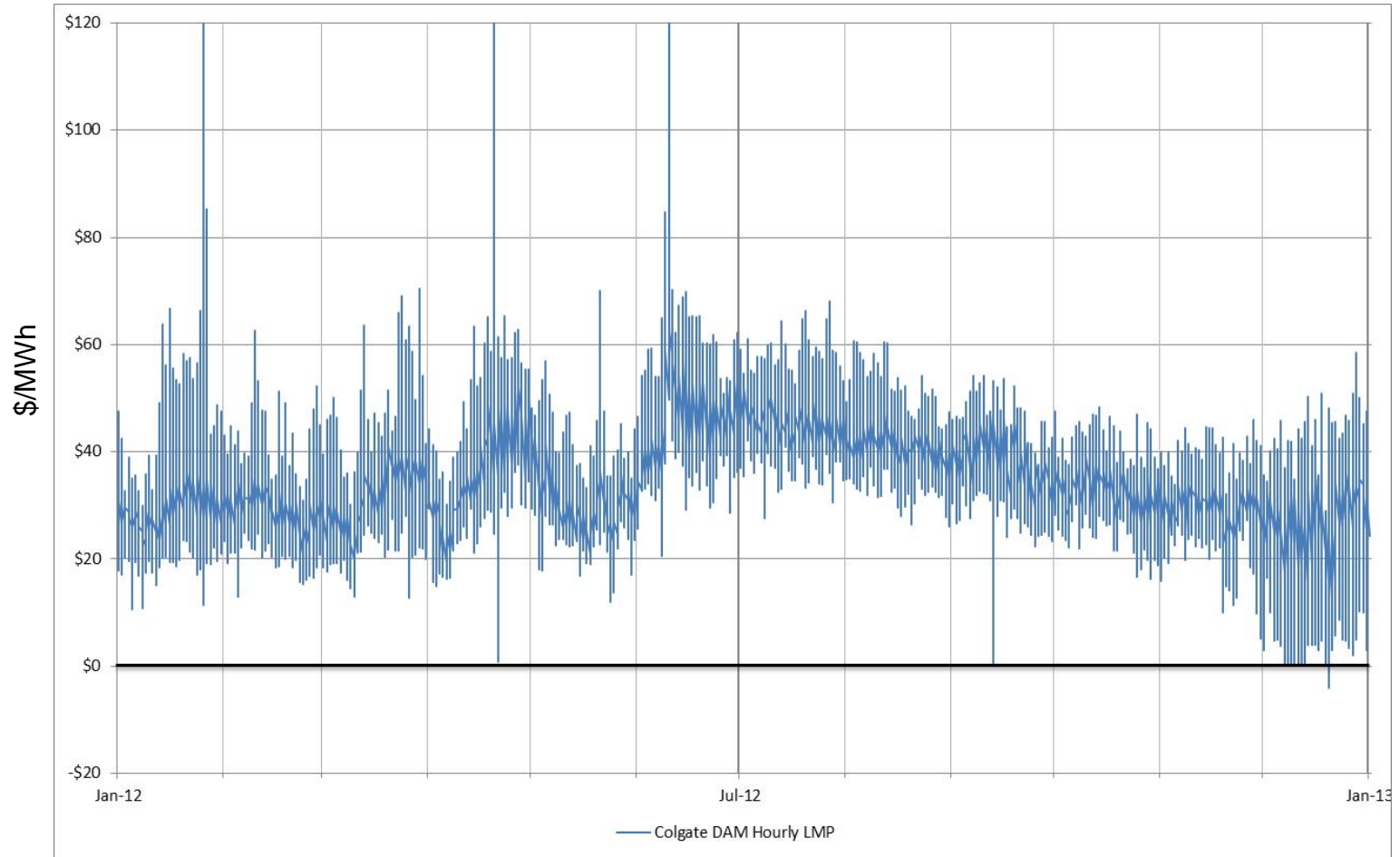
Historical Energy Prices



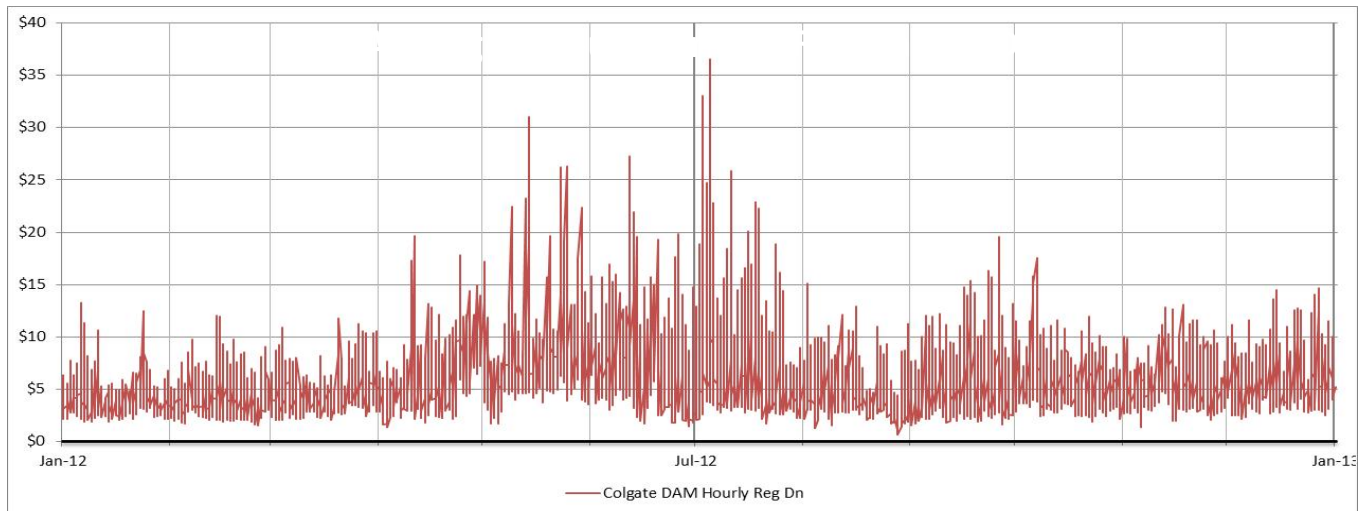
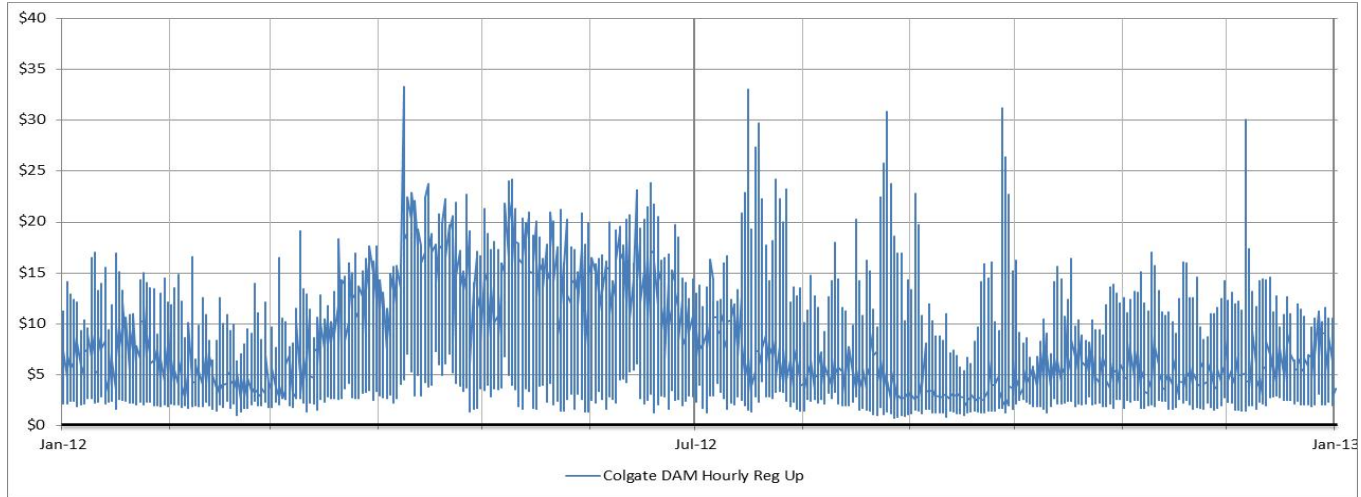
Historical AS Prices – Reg. Up



Simplified Energy Pricing for Analysis

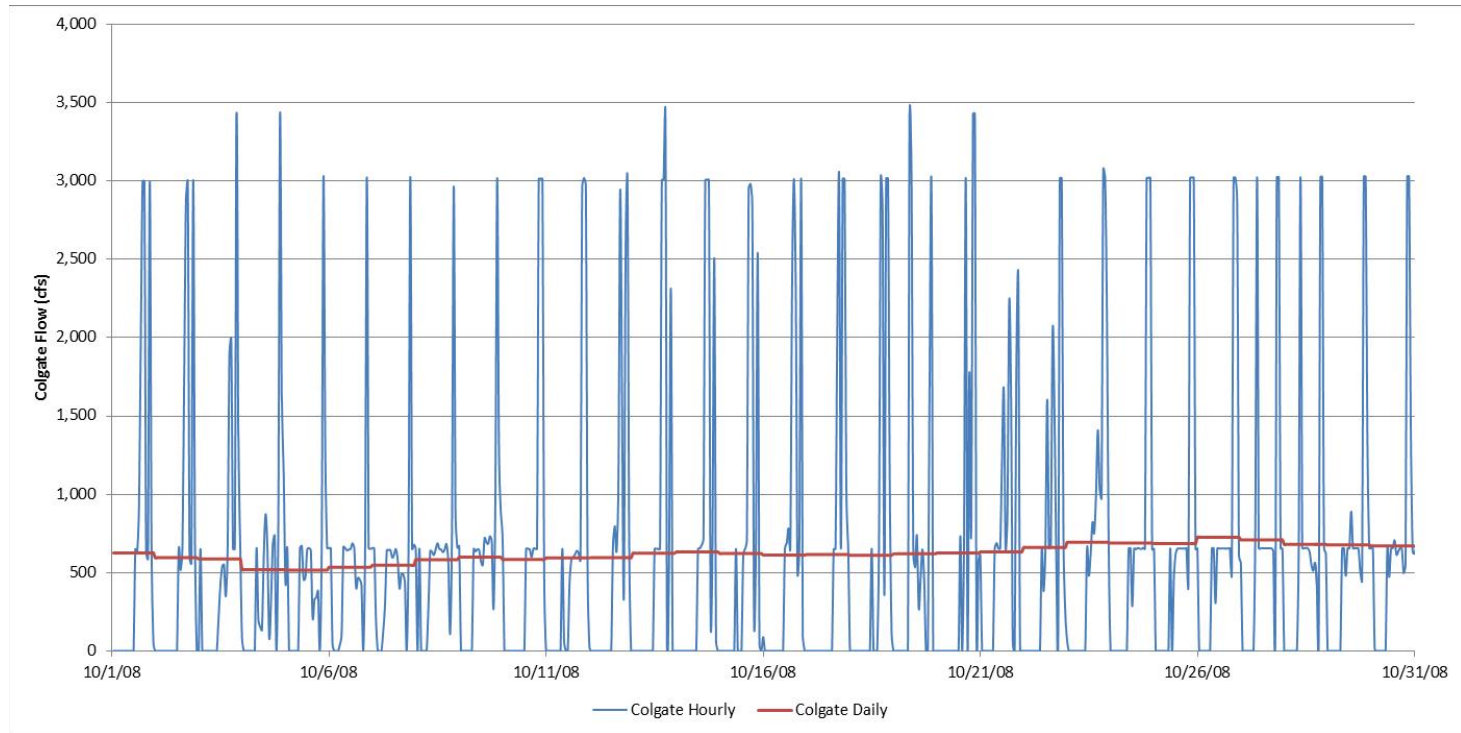


Ancillary Services: regulation

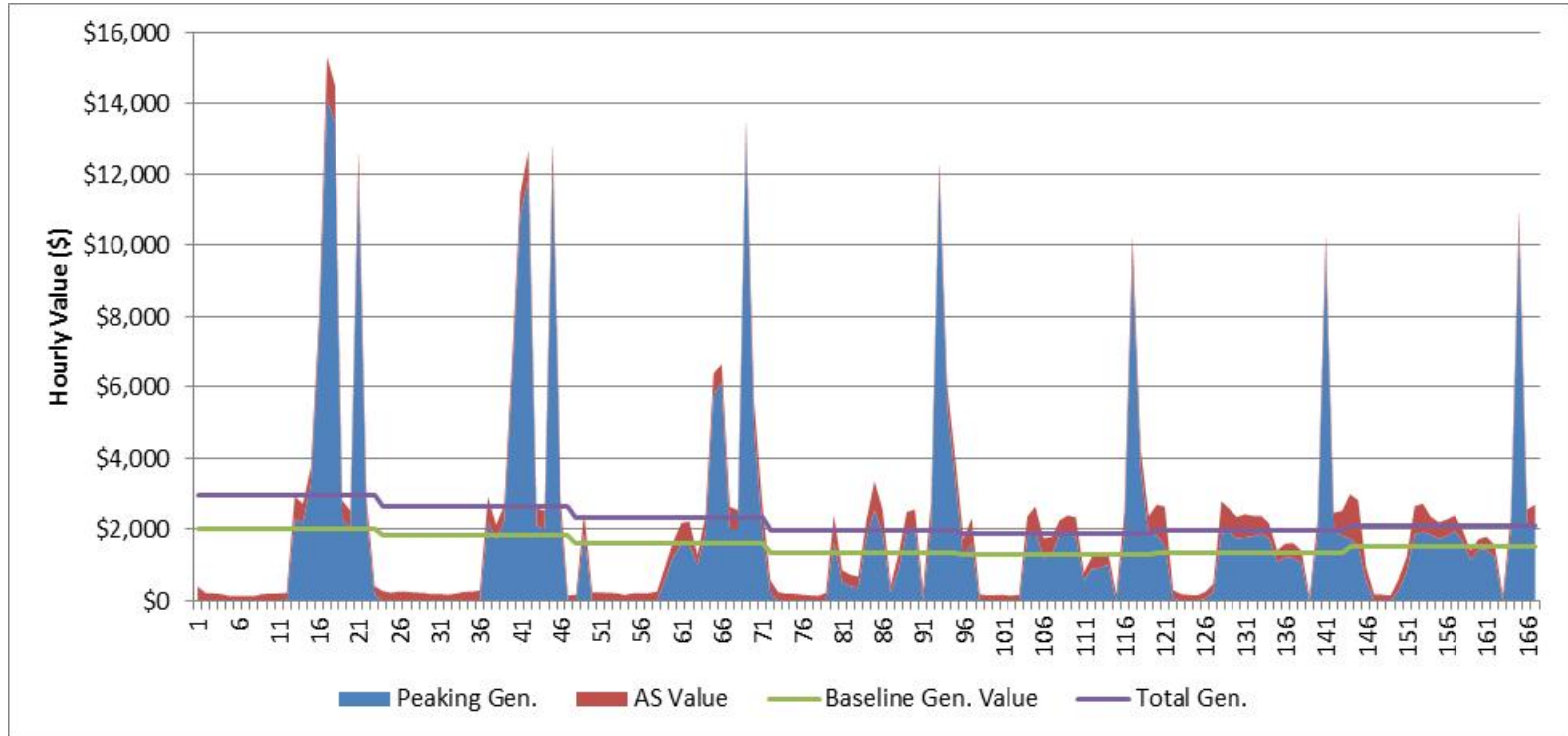


Getting from Modeling Output to Generation Value (from YSF analysis)

- Start with daily generation from YRDP model and solve for maximum total value for the day, using simplified historical hourly pricing, with some assumptions about constraints



Example Value Analysis (from YSF analysis)

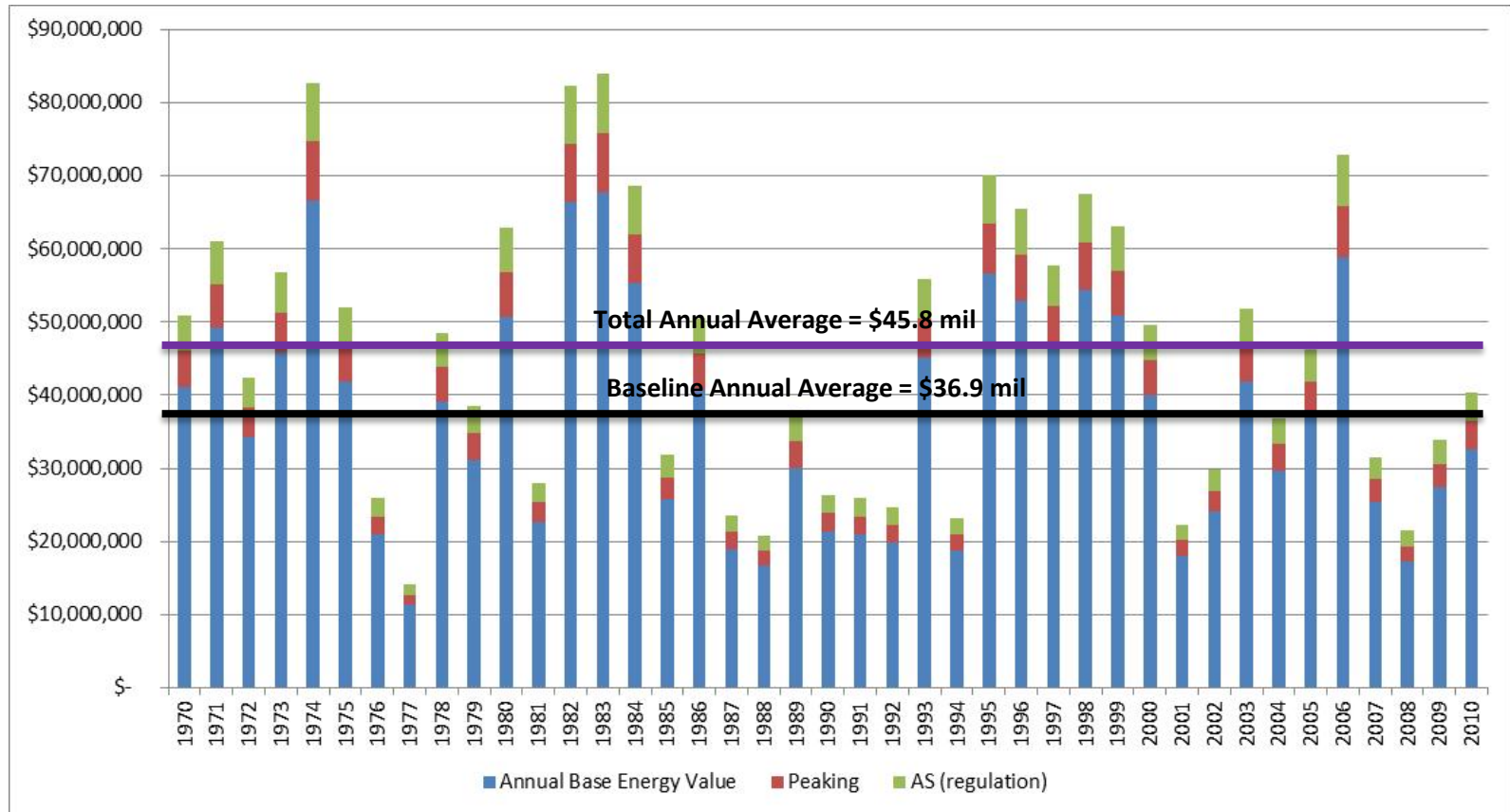


Added Value of Peaking and AS (from YSF analysis)

- Average Annual base generation Colgate: \$36.9 mil (nominal dollars)
- Average Annual increased Peaking Value: 12%
 - Assumes only limited by plant capacity
 - Assumes no limitation on one day fluctuation of Englebright
 - Assumes perfect knowledge of hourly market pricing
- Average Annual increased AS (regulation) Value: 12%
 - Limited to 60 MW maximum capacity of regulation
 - Assumes no impact to prices from bidding 60 MW
 - Assumes perfect knowledge of AS prices and energy prices
 - Does not include other “capacity” products due to uncertainty
- Total combined Peaking and AS value increase = 24%

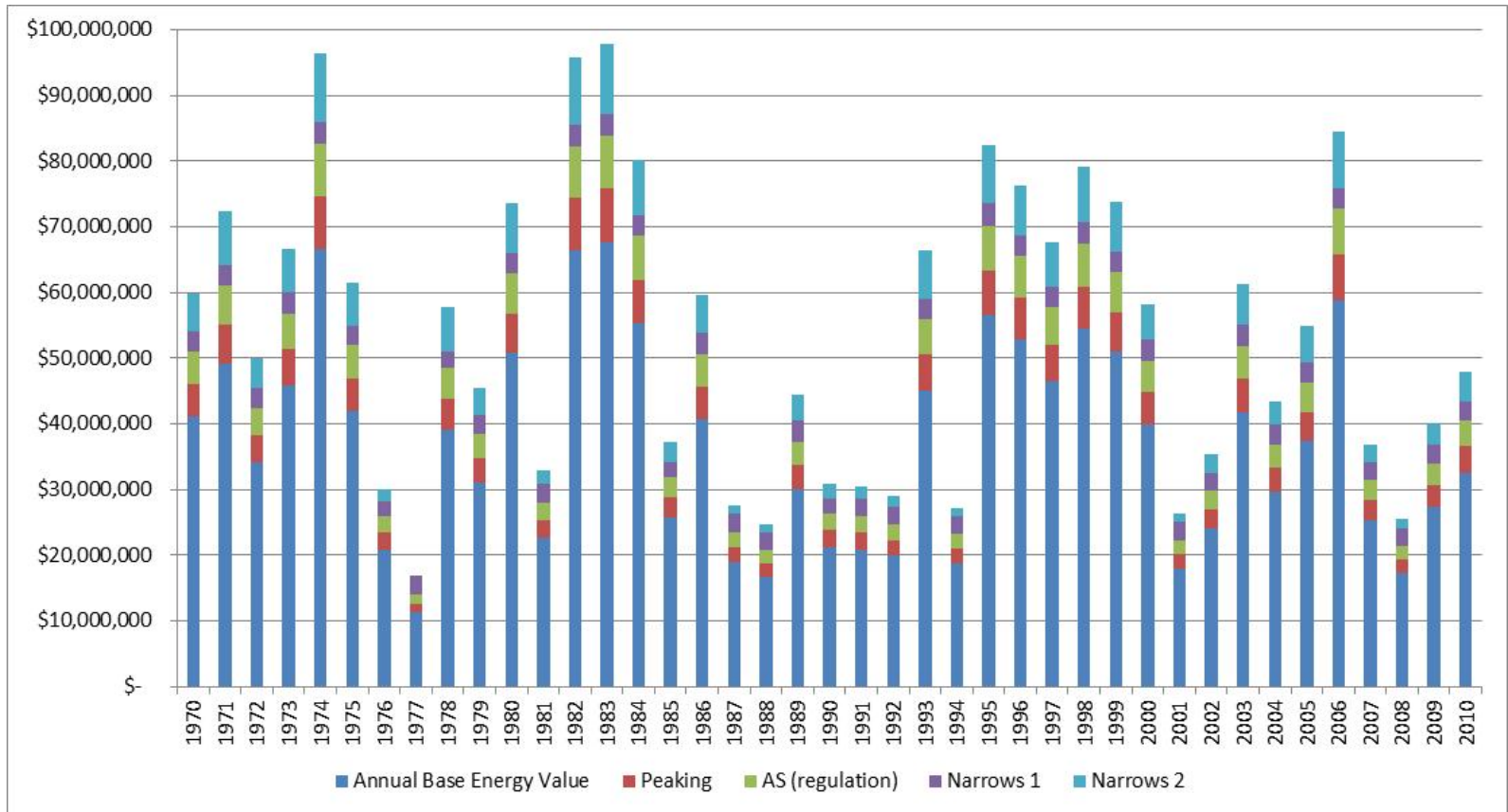
Results of analysis – Baseline Generation Value, Peaking and AS (from YSF analysis)

New Colgate Powerhouse: Baseline Generation Value, Peaking and AS



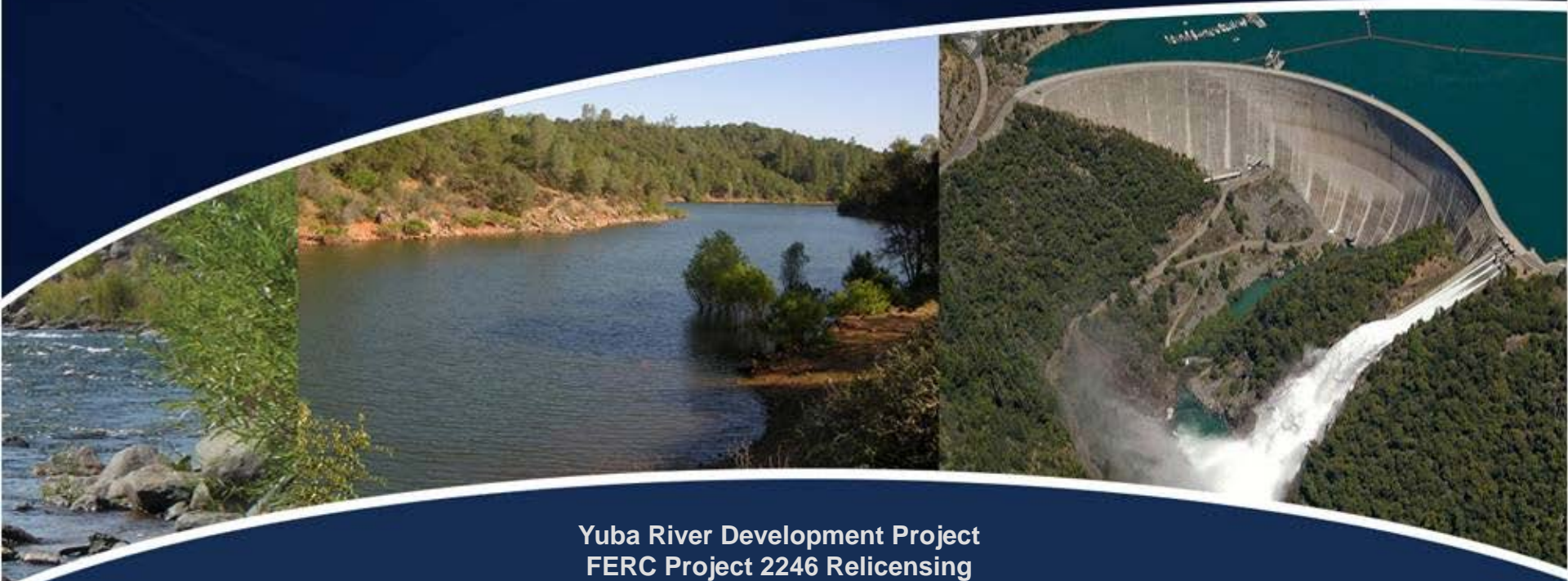
Results of analysis – Generation Value all Powerhouses (from YSF analysis)

Total Generation Value: New Colgate, **Narrows 1** & Narrows 2





Questions?



Yuba River Development Project
FERC Project 2246 Relicensing

Yuba Accord Development & Project Operations Overview

Thursday, March 14, 2013