



Power Generation Automatic Dispatch System for Energy Trading



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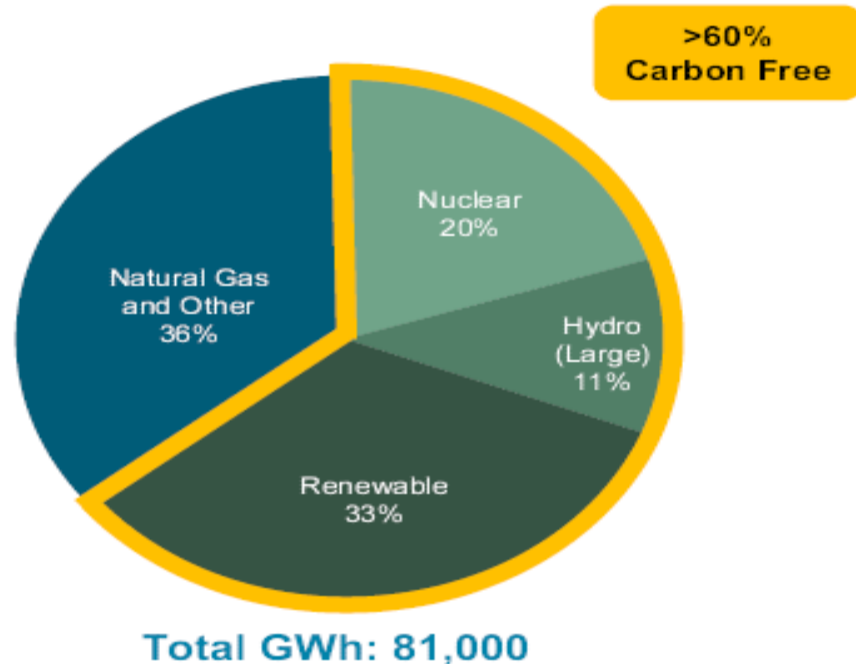


Generation Statistics



- 15 million customers
- > 18% renewables since 2012
- > 51% carbon free since 2012

2020 Projected Portfolio



PG&E in 2020: 33% Renewables

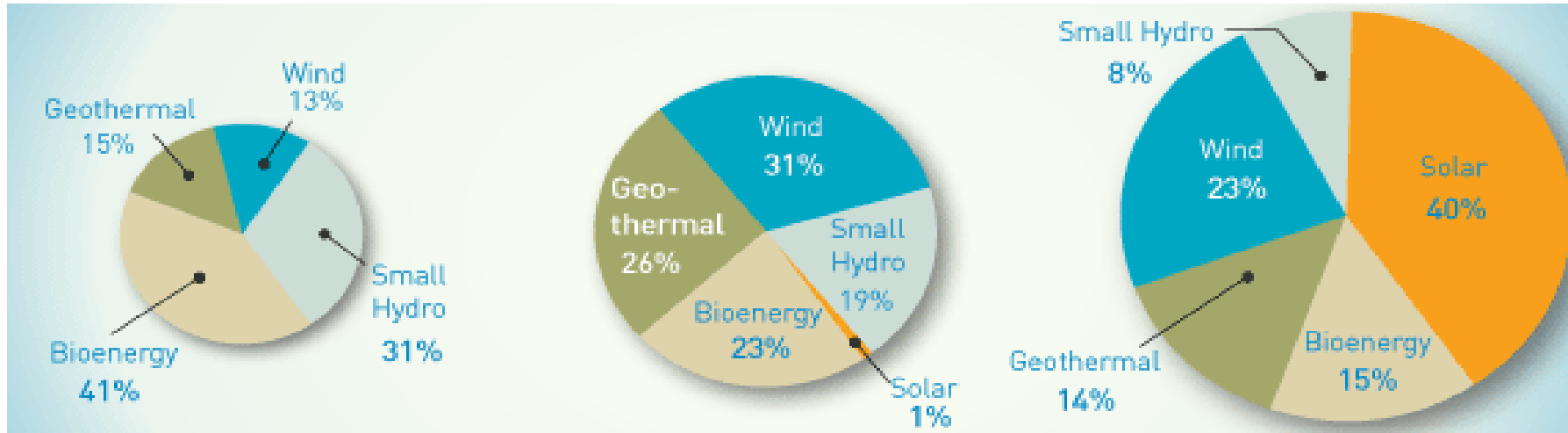
Solar PV, Solar Thermal, Wind, Small Hydro, Biogas, Biomass, Geothermal

Total Retail Sales

2002: 11%

2011: 19.4%

2020: 33%



CA ISO Balancing Responsibility



- Balances supply and demand for 38MM people
- Daily range is 22 to 44 GW-hrs
- Plans to reduce Green House Gas to 1990 levels by 2020
- Plans for 33% of load served by renewable generation by 2020

Automatic Generation Control System

CA ISO signal goes directly to a Generator Control System

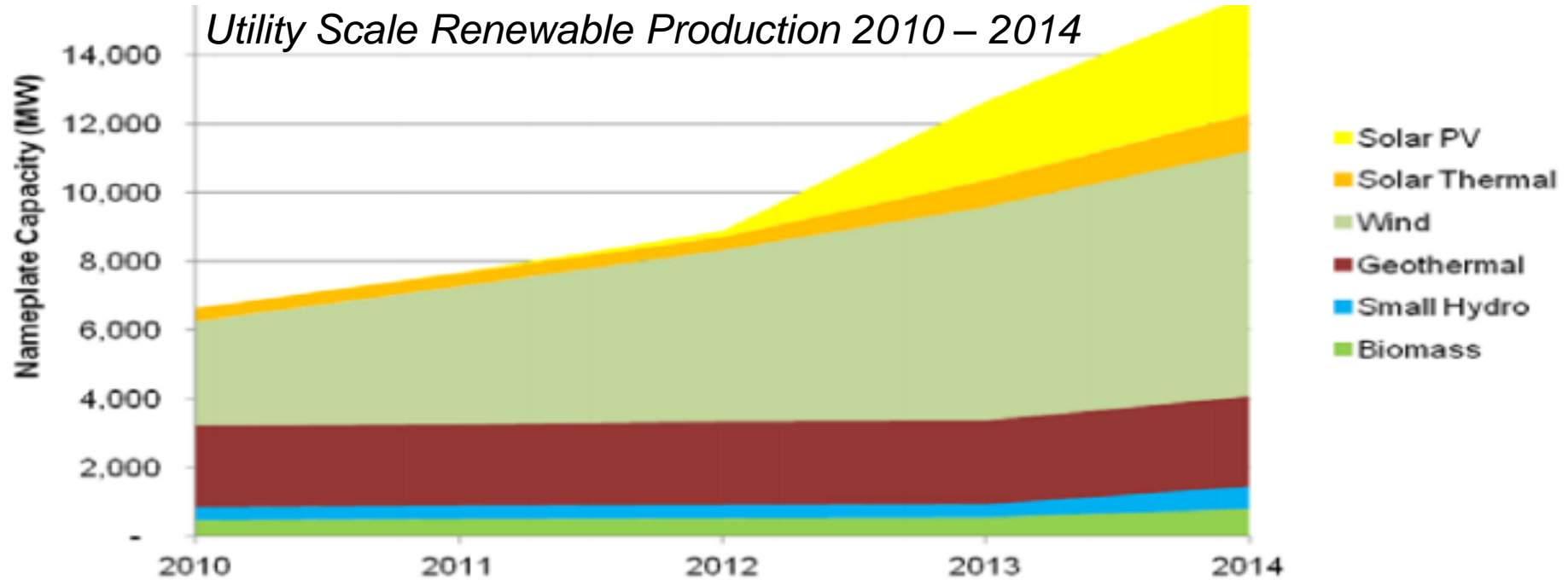
Current Technology: ICCP plus AGC

- Automatic Generation Control
 - Direct connect,
 - AGC signal updated every 4 seconds
- Inter-Control Center Comm Protocol



Real Time Market Today

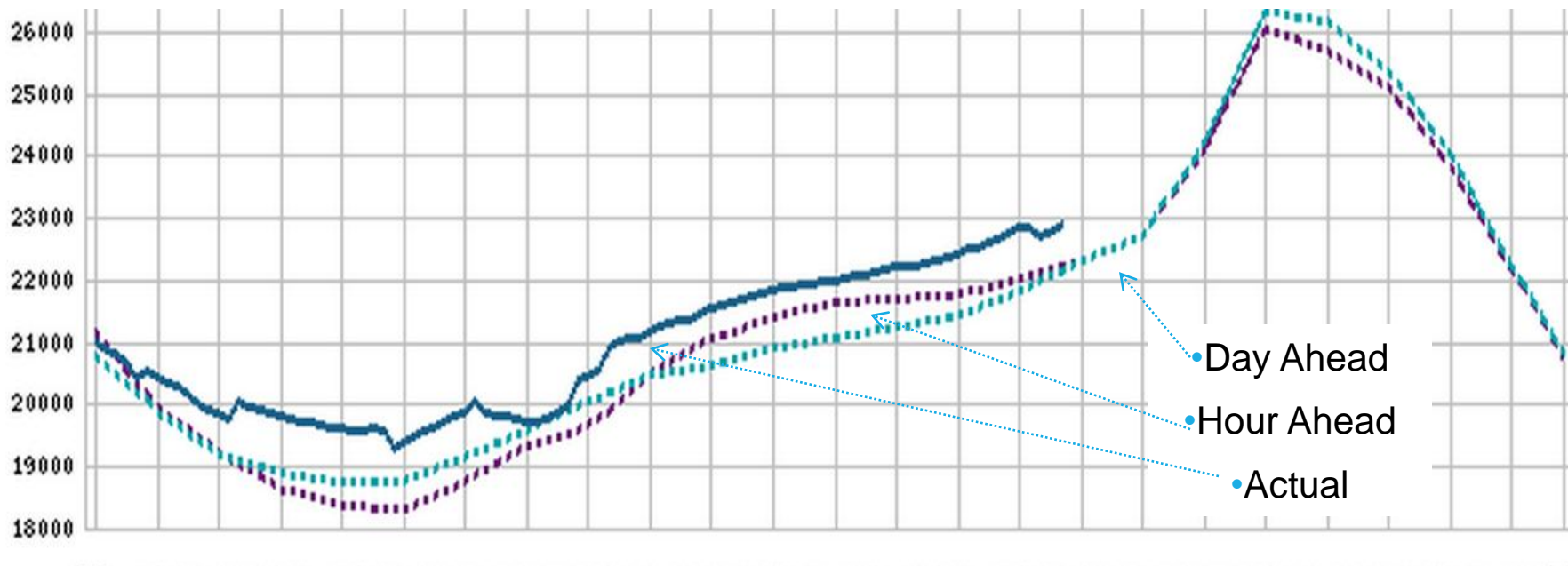
Many Small Generators



Automatic Dispatch System supplements AGC

ADS sends power instructions, not control signals

Instructions are Power Levels for short time horizons – day, hour, 5 minutes



Forecasts are sent as Dispatch Packets

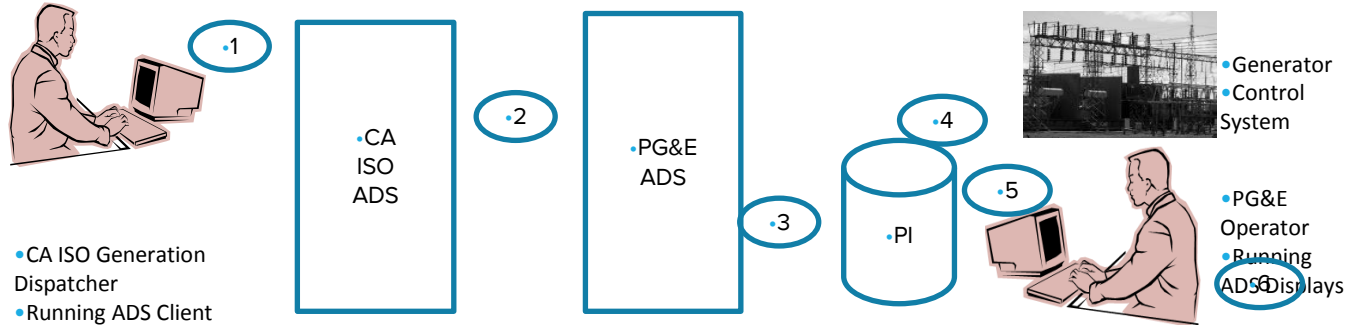


Dispatch Packet

Start time: 2006-10-13T14:10:00Z

Dispatch Operating Target: 12.0

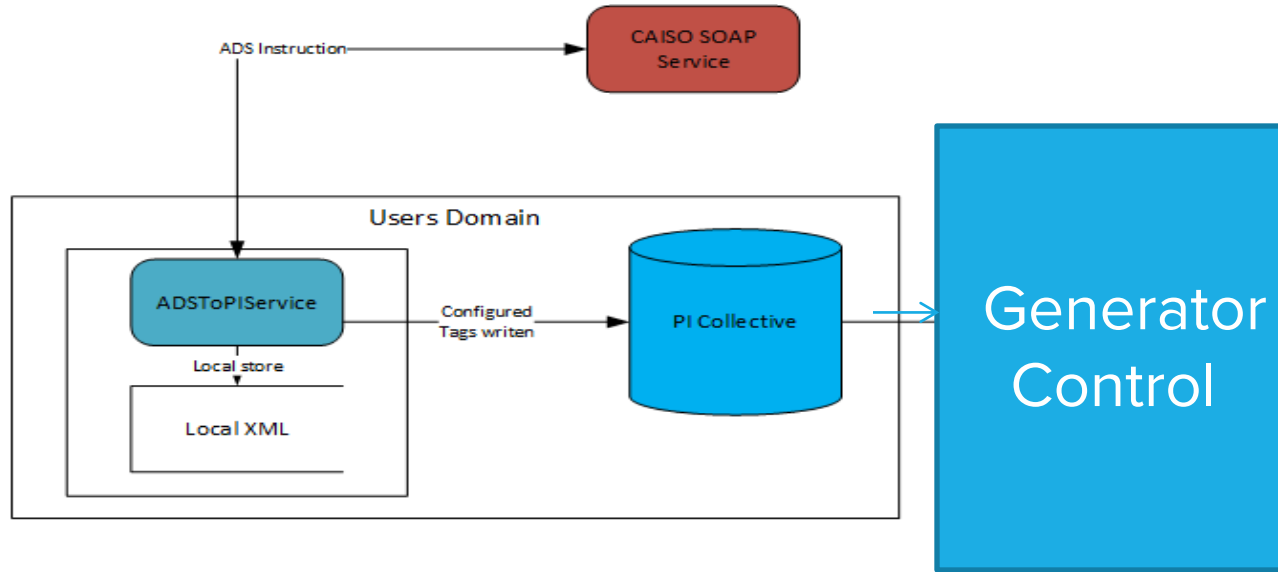
ADS Protocol



Typical Command Sequence

1. CA ISO Dispatcher instructs CA ISO ADS to send new power instruction
2. CA ISO ADS sends instruction to PG&E.
3. PG&E ADS web service requests the batch information.
4. PG&E ADS server periodically polls the CA ISO, requests the batch, interprets the batch, and stores the batch data into the PI Server. Poll rate is currently every 10 seconds.
5. PG&E Generator Control System receives the new Power target..

ADS Data Flow



- **Retrieval Security**
 - **X.509 V3 cert**
 - **Encrypted transport**
- **ADSToPIService**
 - **Heartbeat to monitor connectivity**
 - **Configurable**
 - **Polls Data**
 - **Multiple Sites**
- **PI System**
 - **Secure Transfer**
 - **Historical Data**

What is stored in the PI System?

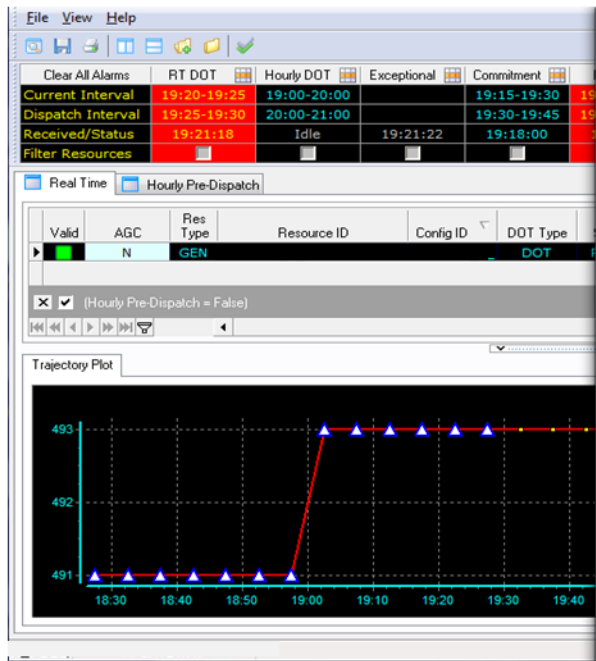
- Information for power generation purposes
- Information needed for historical reference
 - BatchUID
 - BatchType
 - BatchStartTime
 - InstructionType
 - InstructionStartTime
 - DOT (target generation for next start time)
 - PreGoTo (DOT from last dispatch)

Batch arrives HH:MM:SS	Batch start time (PI Point)	Dispatch Power Level (PI Point)	Pre- goto (Pi Point)
13:06:34	13:10:00	483	483
13:11:34	13:15:00	483	483
13:16:34	13:20:00	480	483
13:21:36	13:25:00	480.11	480
13:26:36	13:30:00	483	480.11
13:31:36	13:35:00	480	483
13:36:36	13:40:00	480	480

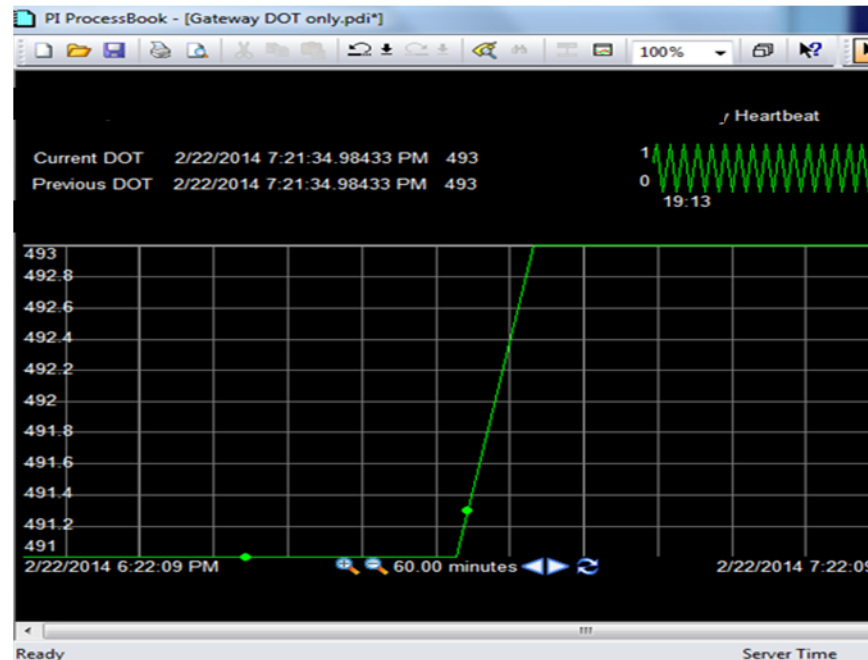
- All dispatch fields can be stored in PI by adjusting configuration of the service

End Result

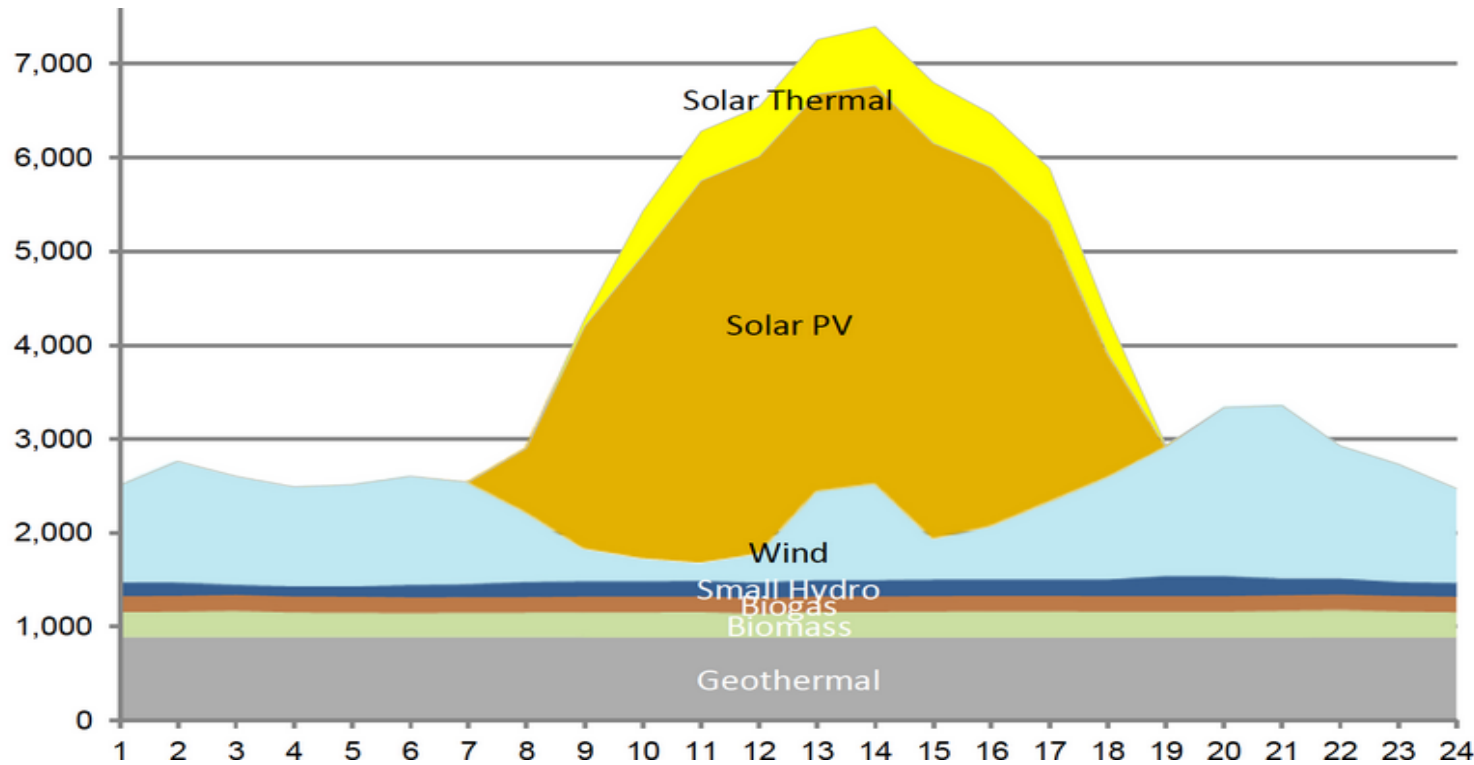
CA ISO Sent this



PG&E Delivered This



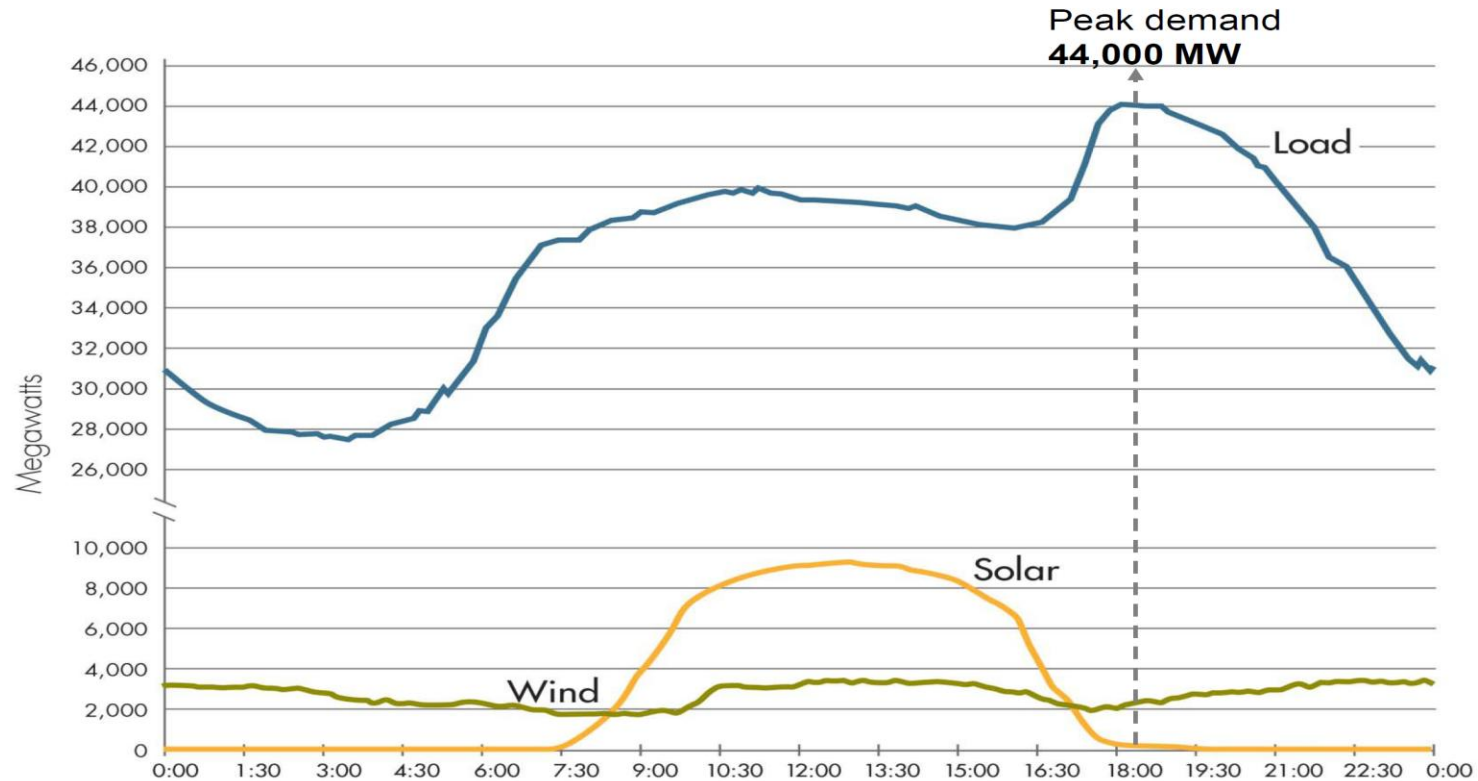
Automatic Dispatch for Renewable Generation



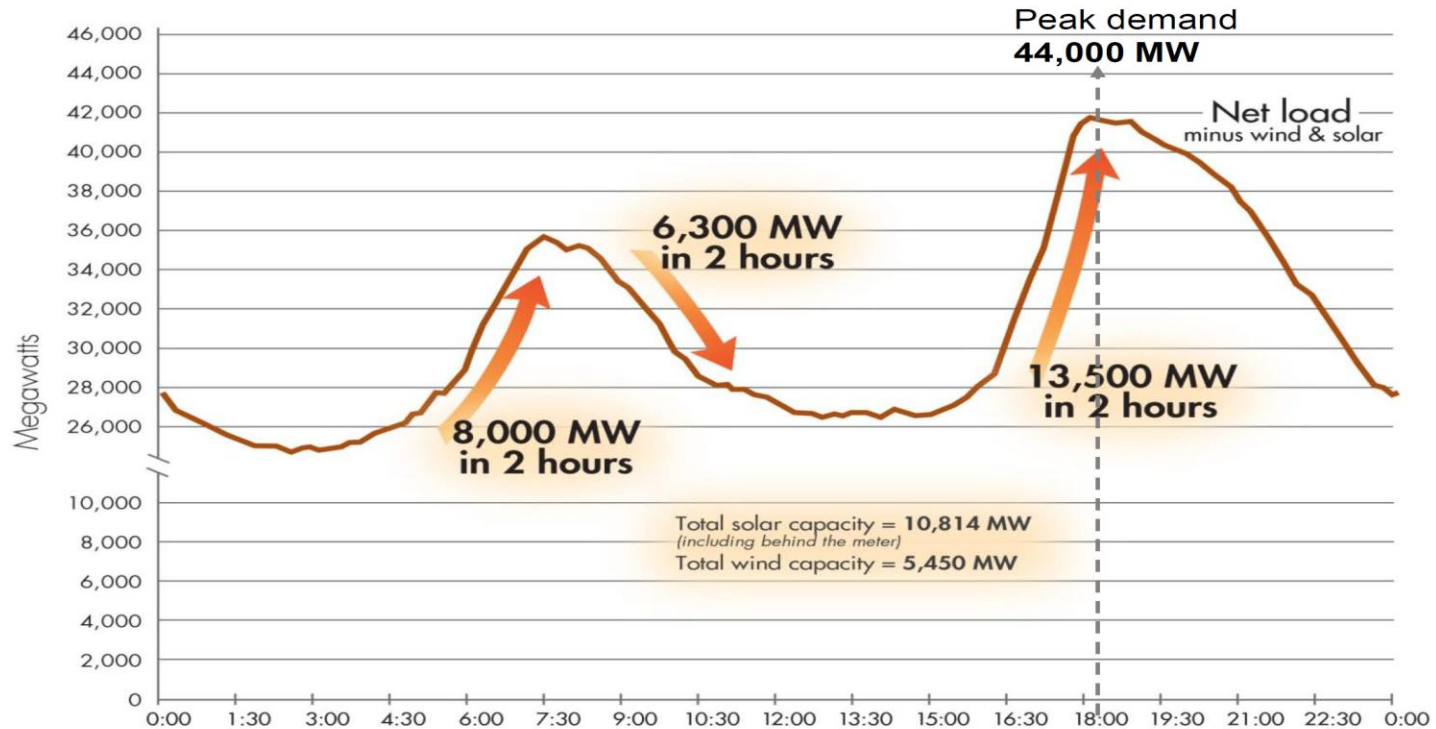
*Power
generated
MW vs.
time of day*

*Not at all
like
conventional
fuel
generation*

Forecast info: Demand, Supply Curves

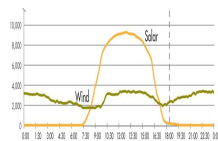


Net Load Forecast

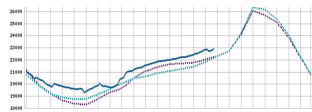


Schedule Generation using Forecasts

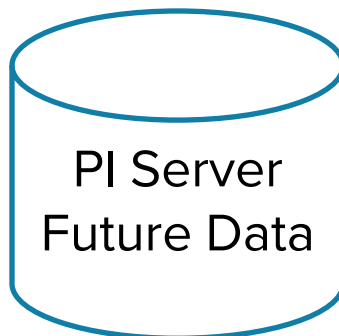
Solar and Wind
Forecasts @
Generating Station



Demand
Forecasts



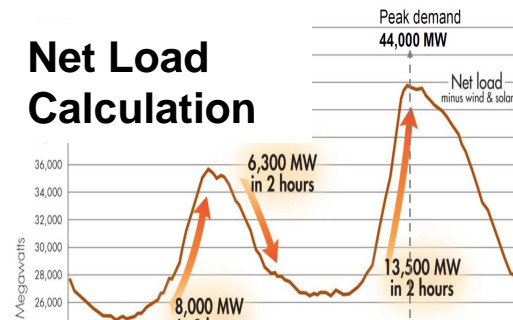
California ISO
Shaping a Renewed Future



AF



**Net Load
Calculation**



GeoThermal
Hydro
Control Rooms

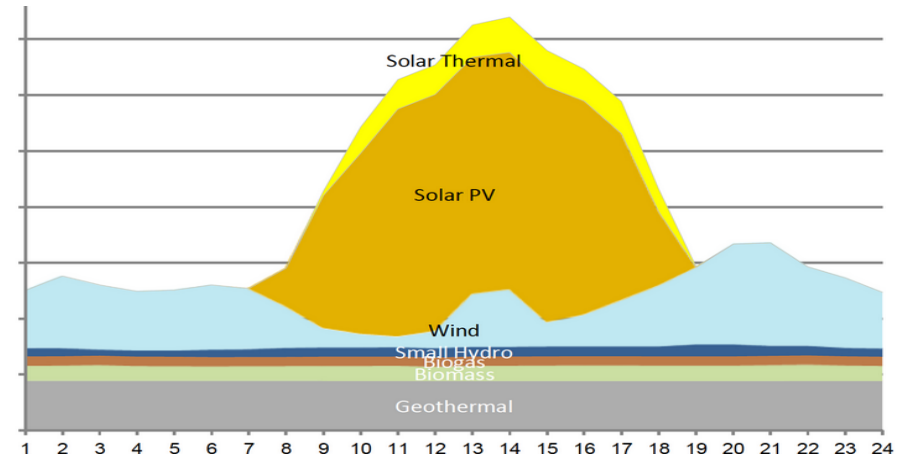


PI Server Future Data manages Forecast vs. Actual



Summary

PG&E delivers some of the nation's cleanest energy to our customers. More than 50% of our portfolio is from sources that are renewable and/or have no greenhouse gas emissions.



Business Challenges

- A. Minimize manual intervention in power generation

Solution Result

- A. Generation staff is concerned with reliability and cost rather than micro-managing supply with Demand

Questions?

- Please wait for the **microphone**
- State your **name & company**



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Thank You

*“Everybody talks
about the weather,
but no one does
anything about it.”*

—Mark Twain

Take-away:

“Create a good forecast and put it in PI Server Future Data”