

RENEWABLES: Reliability And Operational Challenges (And Opportunities)

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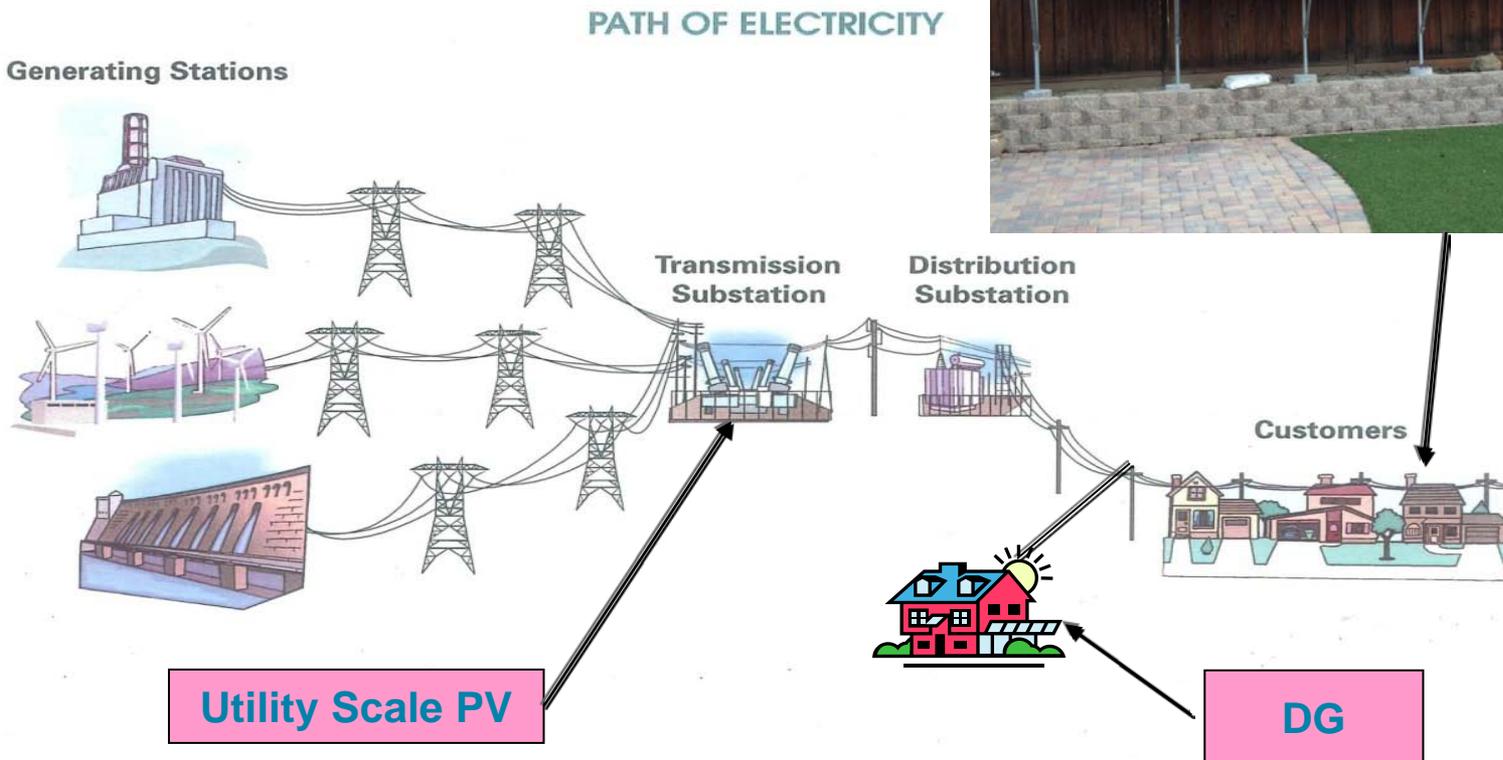


Challenge/Opportunity - Distributed Generation (DG)



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Distributed Generation (DG) – PG&E has more distributed solar customers on our grid than any other utility – and those numbers are increasing significantly.

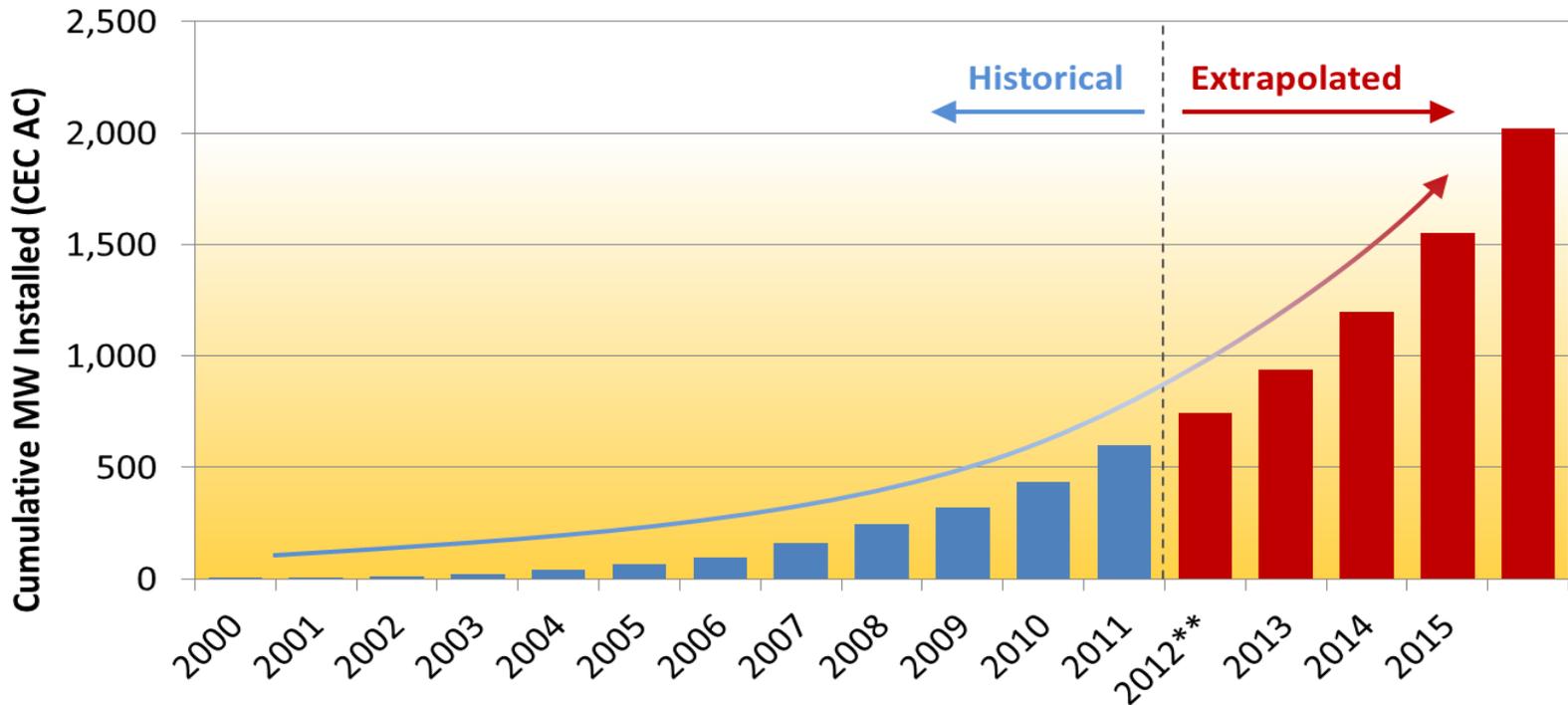




Challenge/Opportunity - Distributed Generation (DG)

More than 68,000 PG&E customers have onsite solar generation, and the amount is growing at a rate of more than 1,000 systems per month

**Customer-Side Solar Installations in PG&E Service Territory:
Cumulative Installed Capacity* (CEC AC; MW)**



* Includes Net Energy Metering (NEM) and non-NEM customer-side solar projects

** 'Actual' 2012 installations are as of July 2012; 'Extrapolated' value assumes same rate of installations through end of 2012.

*** Extrapolated according to annual growth rate observed between 2008-2011.



Challenge/Opportunity - California Solar Initiative

CA Solar Initiative (CSI) Reached 1,000 MW in 2011

Table 2: Solar Interconnections and Solar NEM Customers by Utility

	MWs Interconnected	Customers Interconnected	MWs on NEM tariffs	Customers on NEM Tariffs
PG&E	597 MW	60,329	559 MW	57,630
SCE	341 MW	28,446	311 MW	28,314
SDG&E	123 MW	15,499	121 MW	15,340
Total	1,061 MW	104,274	991 MW	101,284

Data is from December 2011. It Includes CSI, NSHP, ERP and SGIP data, but not POU or RPS data.

- Similarly, PG&E also has the highest customer adoption rates for plug-in vehicles.
- This is also occurring due to additions of many utility-scale renewables to our system.
- Close to 20% of our deliveries are now from renewables – and we have to hit 33% over the next seven years.



High DG Penetration – Risk Analysis

Risk/Mitigation Analysis Pointed Out Eight Gaps and Two Were Primarily Operational

Limited understanding of operational impacts of high DG penetration

and

Undetected installation of DG systems (DIY panels) create reliability and/or safety risks

Action Metrics:

- 1. Develop operational tracking metric for enterprise with proposed tipping point values**
- 2. Create an internal cross functional team to develop an action plan with timeline to study undetected systems on the grid**



High DG Penetration - System Studies

- **PG&E Funded Consultant Studies:** Two simulation-based studies by Quanta Technology:
 - Investigate distribution system impacts associated with distributed PV
 - Provide recommendations regarding PG&E’s interconnection guidelines
- **Collaborative Research Projects:** Funded by the California Solar Initiative (CSI) and others
 - UC-Irvine modeling- and simulation-based study
 - Customer-side energy storage PV & its impacts of the distribution system
 - An EPRI-led project involving National Grid, Excel Energy, and Detroit Edison to explore how utility-inverter communication can enable “smart” inverters to optimally provide grid support
 - SMUD and Hawaiian Electric Company study that targets testing and development of hardware and software for high-penetration PV
- **Benchmarking:** Compare, explore and learn from others on interconnection requirements and practices (such as DTT)

- More frequent steady state problems
- Primary overvoltage issues are more prevalent
- Minor line overloading issues are appearing
- Generally, still no issues with voltage recovery after faults and system transients causing disconnection of PV converters
- Voltage may rise above 1.2 per unit causing inverters to trip off frequently
- Potential conditions for sustained islanding and delayed tripping of PV inverters
- Some operational issues with capacitor banks turned off due to voltage rise and generation intermittency
- Significant numbers of tap changers operations caused by large range of voltage deviations



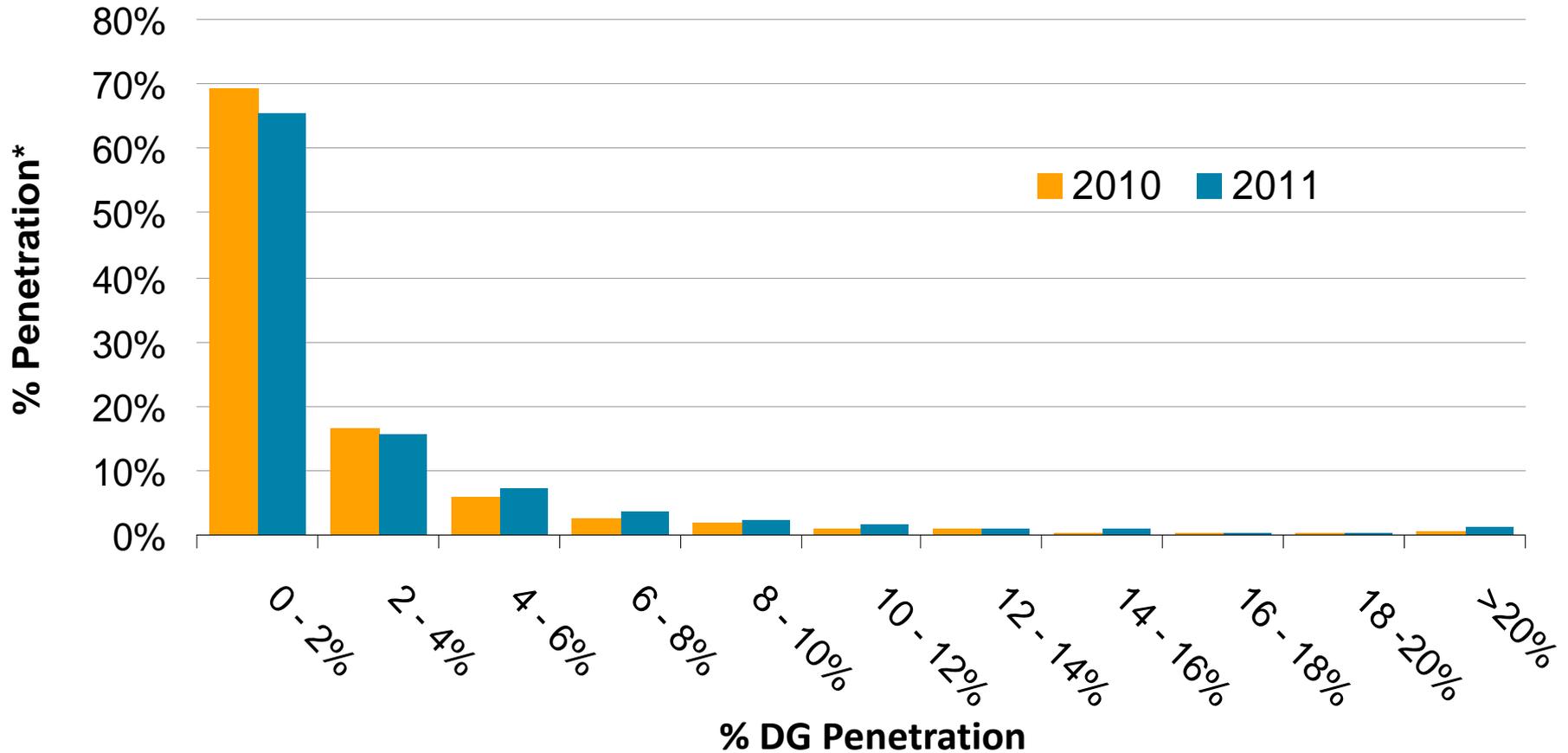
High DG Penetration - Mitigations

- Install PV inverters with dynamic voltage support capabilities
- Upgrade feeders with bi-directional relays
- Intelligent capacitor banks and LTC/voltage regulation control
- Feeder monitoring control and automation
- Communications-based tripping of large PV plants
- Distributed energy storage with integrated dynamic voltage support
- Pay close attention to residential PV proliferation on all feeder and keep detailed records of the number and installed capacity of PV systems per feeder

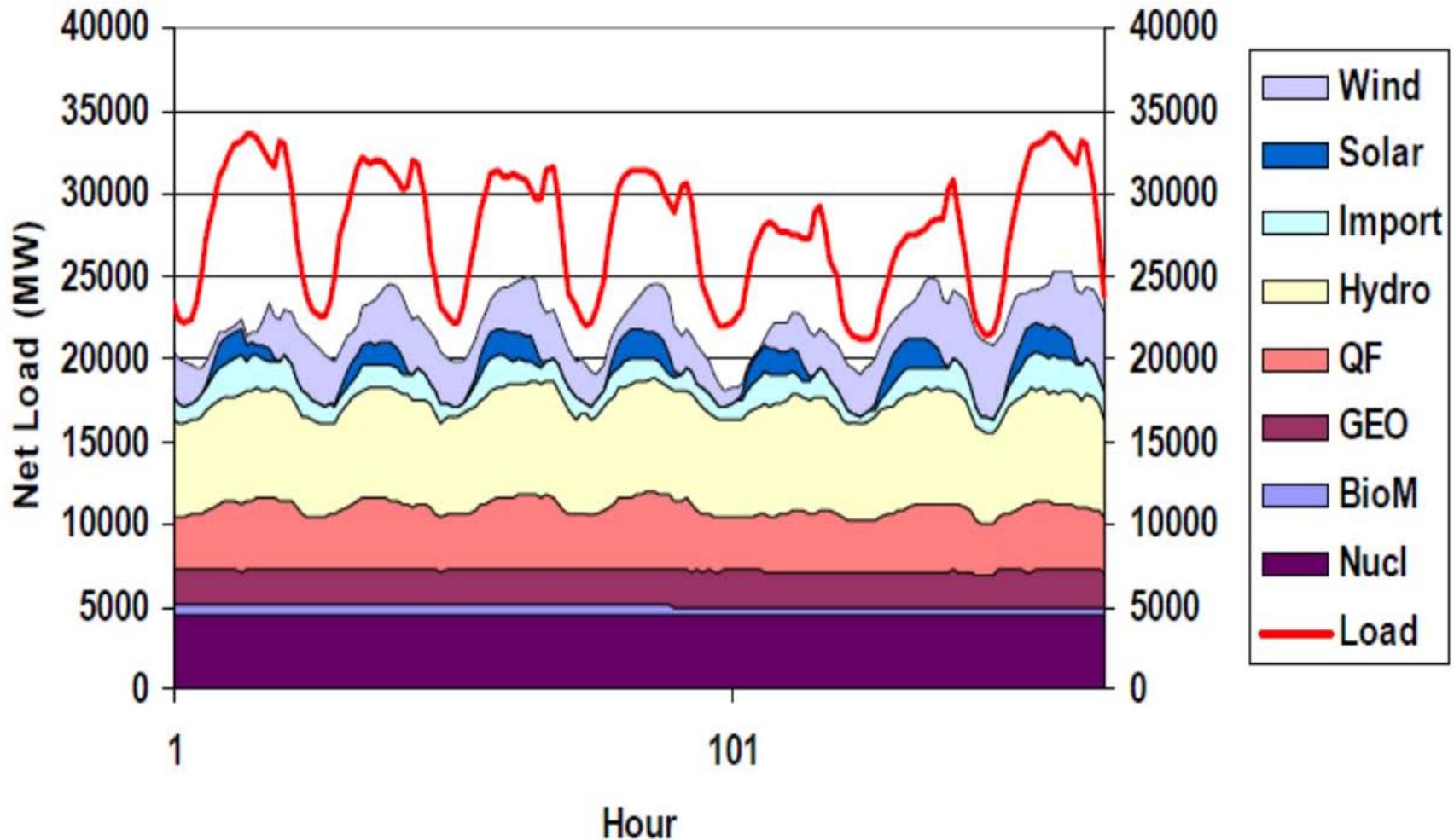


DG Tracking Metrics – Feeder Penetration

PV Penetration* on PG&E Feeders



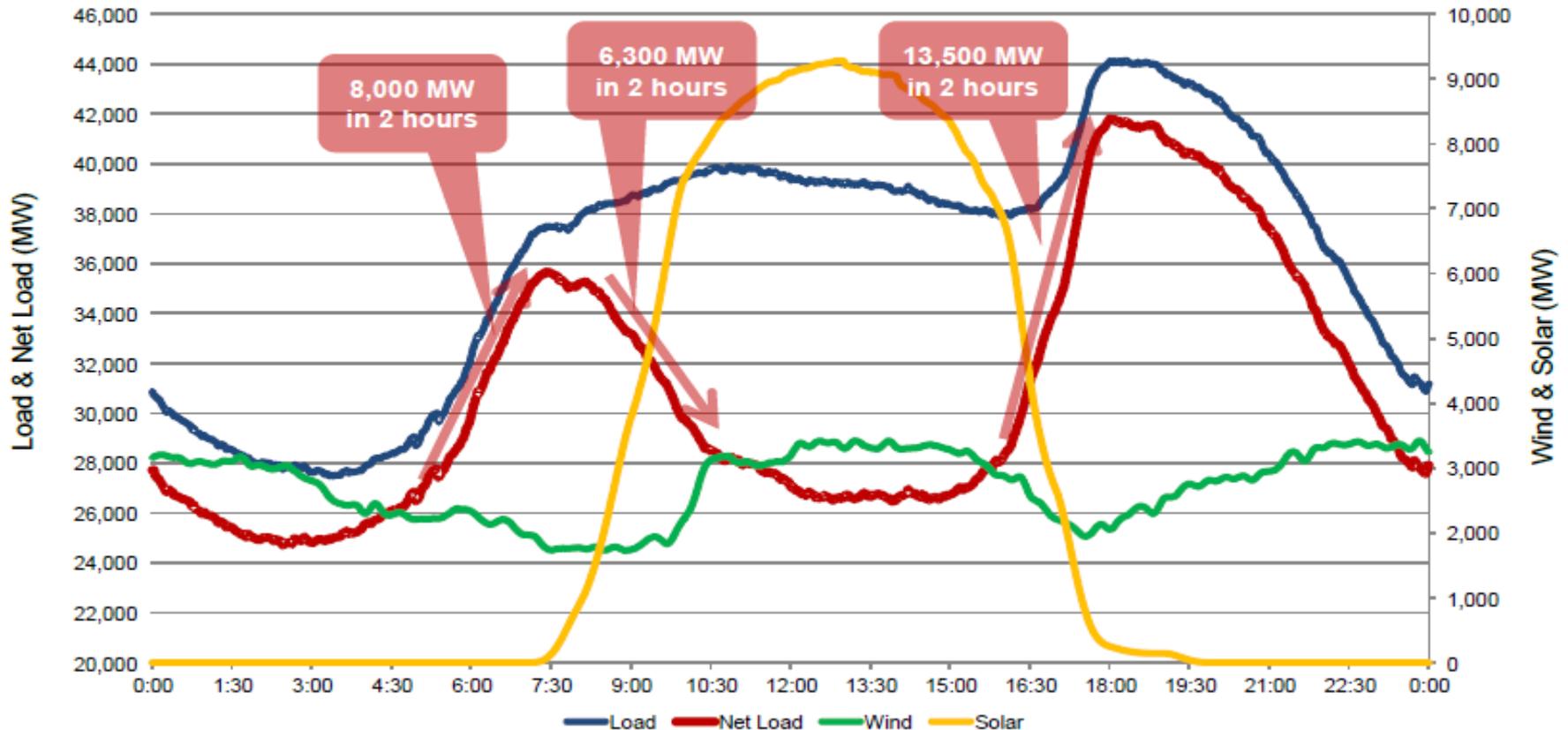
* % PV Penetration = Installed PV generation / Feeder Max Demand



Load and Non-Dispatchable Generation

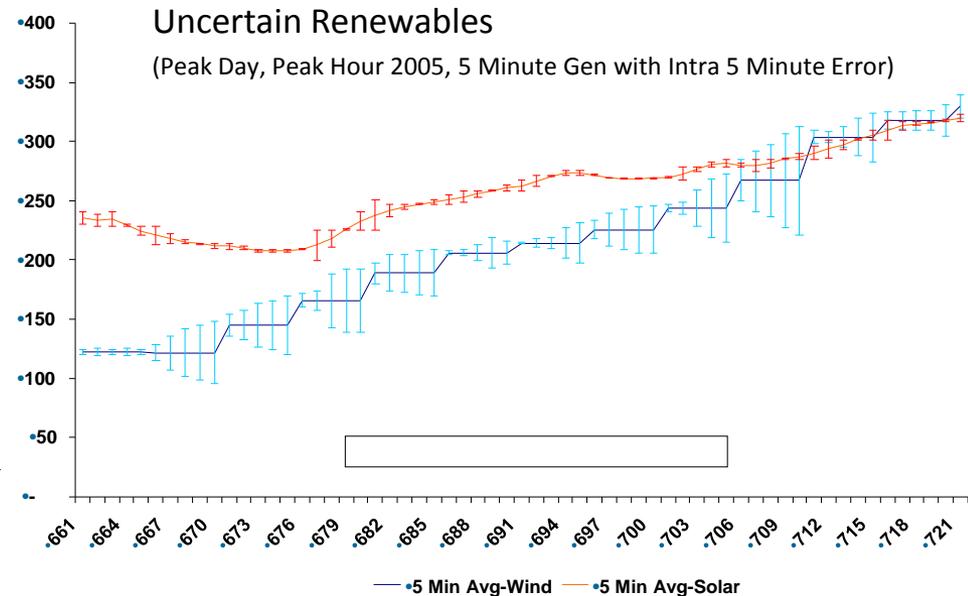
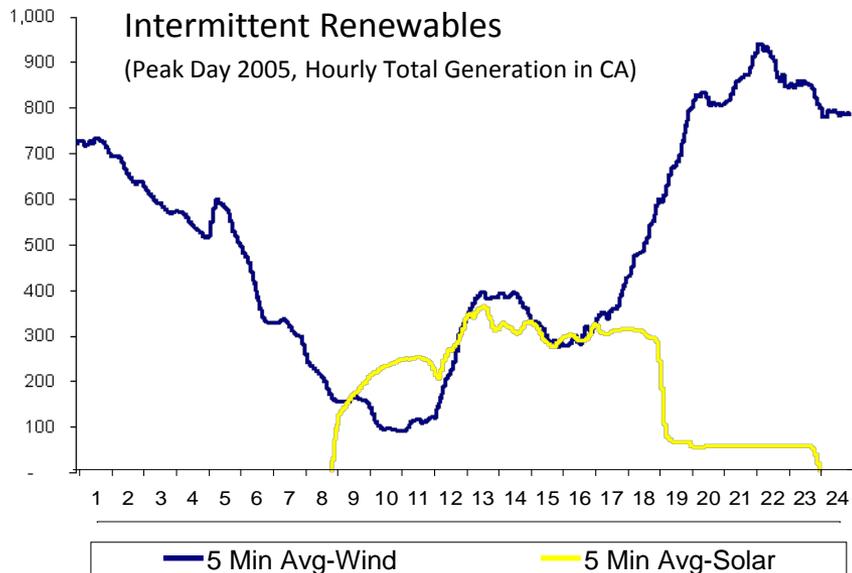
Large Amounts of Solar and Wind Resources will Greatly Increase Ramping Requirements

Load, Wind & Solar Profiles – High Load Case
Winter Profile 2020



Renewables Increase the Demand for Flexible Resources

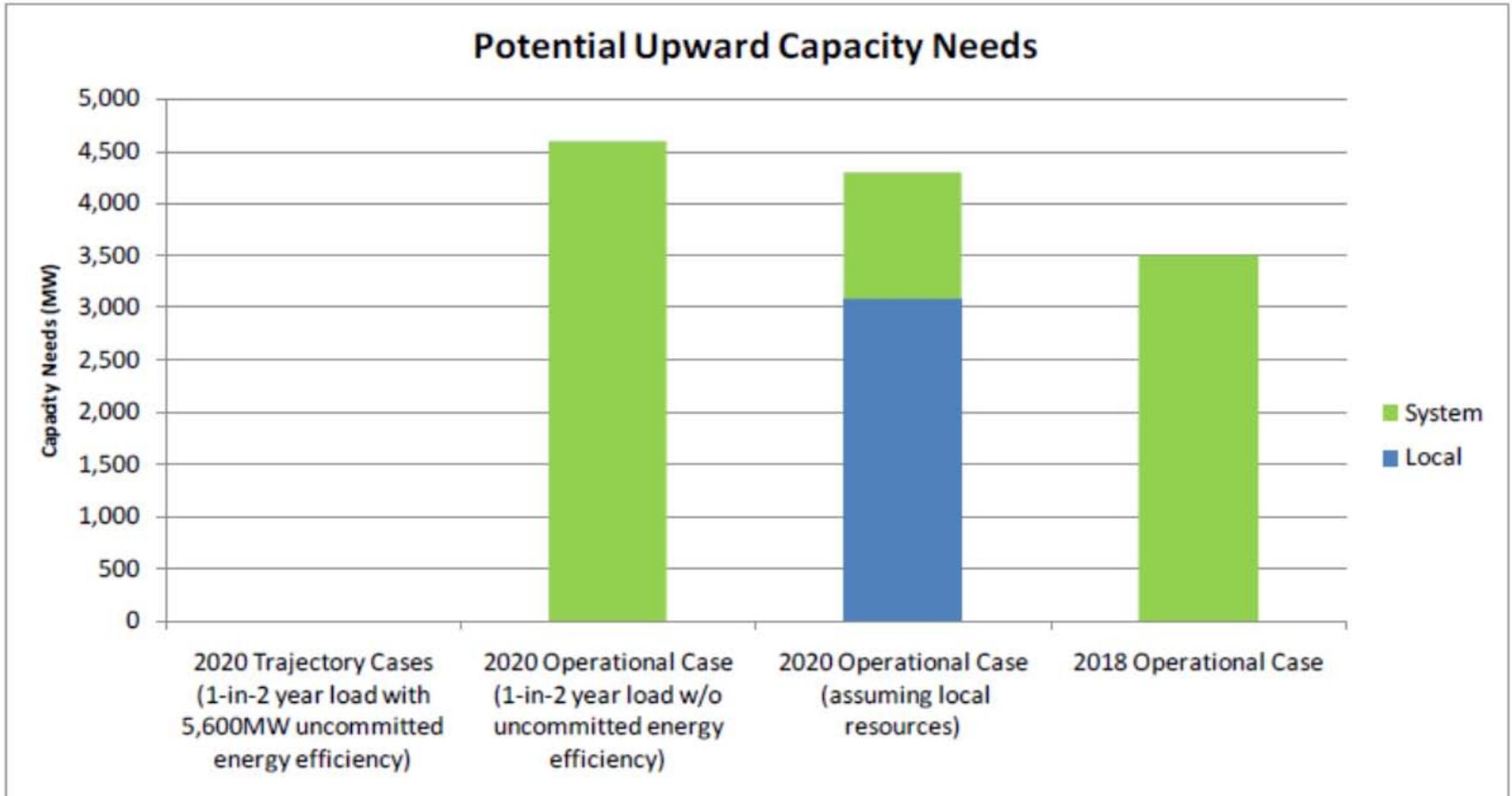
Renewables intermittency and unpredictability require flexible resources, in the form of ancillary services, to smooth generation



Non-intermittent renewables, such as biogas, or geothermal largely do not require additional ancillary services

Solar and wind are highly unpredictable, requiring significant ancillary services for integration, improved forecasting would reduce need

CAISO Identified the Need for 4,600 MW of New Flexible Resources by 2020





Other PG&E Initiatives

- Technologies like the **Smart Meter** are a key part of the solution. And in fact, PG&E has the largest deployment of advanced meters in the country.
- PG&E started our first major **battery storage** pilot – we’re operating a 2MW battery at our substation adjacent to our Vaca Dixon solar PV facility.
 - This is ideal for testing the use of energy storage at the substation level to manage this intermittent resource, and will also be used to provide the grid ancillary services and energy dispatch/storage depending on customer demand.



Other PG&E Initiatives

- PG&E is in the middle of a major **distribution automation** project, which is installing intelligent switches that can manage and re-route power flows automatically to make the system more resilient.
- PG&E is deploying **synchrophasors**, which is going to give us much better situational awareness of voltages and power flows on the transmission grid.
- PG&E began a 1st-of-its-kind public/private partnership with DOE's Lawrence Livermore National Lab called **California Energy Systems for the 21st Century**, a 5-year program that's giving us access to the Lab's super-computing capabilities and analytical expertise to help solve a number of issues, including integrating DG.

Questions?



This is your brain



This is your brain on Drugs

As a message to you, please don't take drugs. They're bad for you.