Challenges with Integrating Renewables

SDGE

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California's Growing Need for Flexibility

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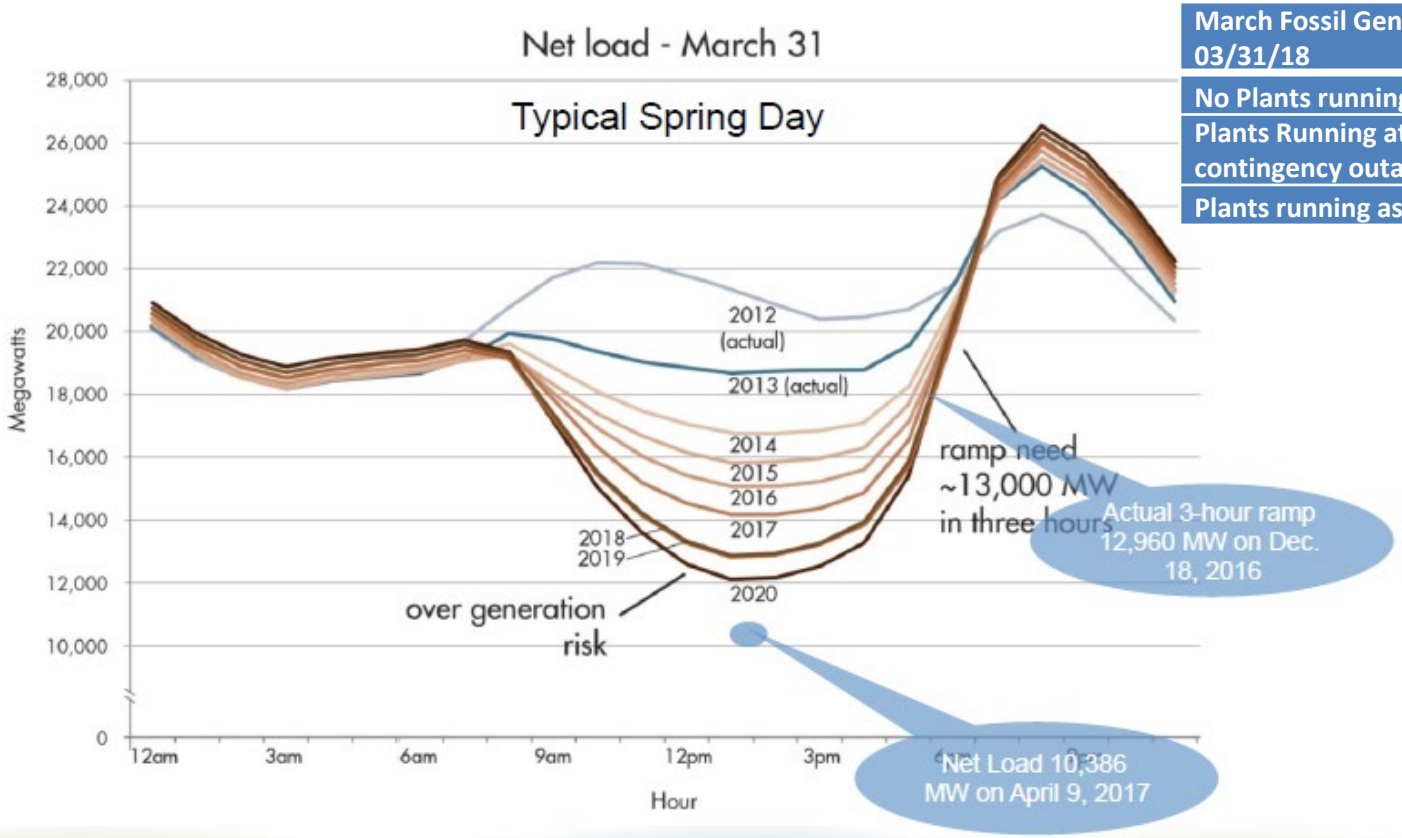
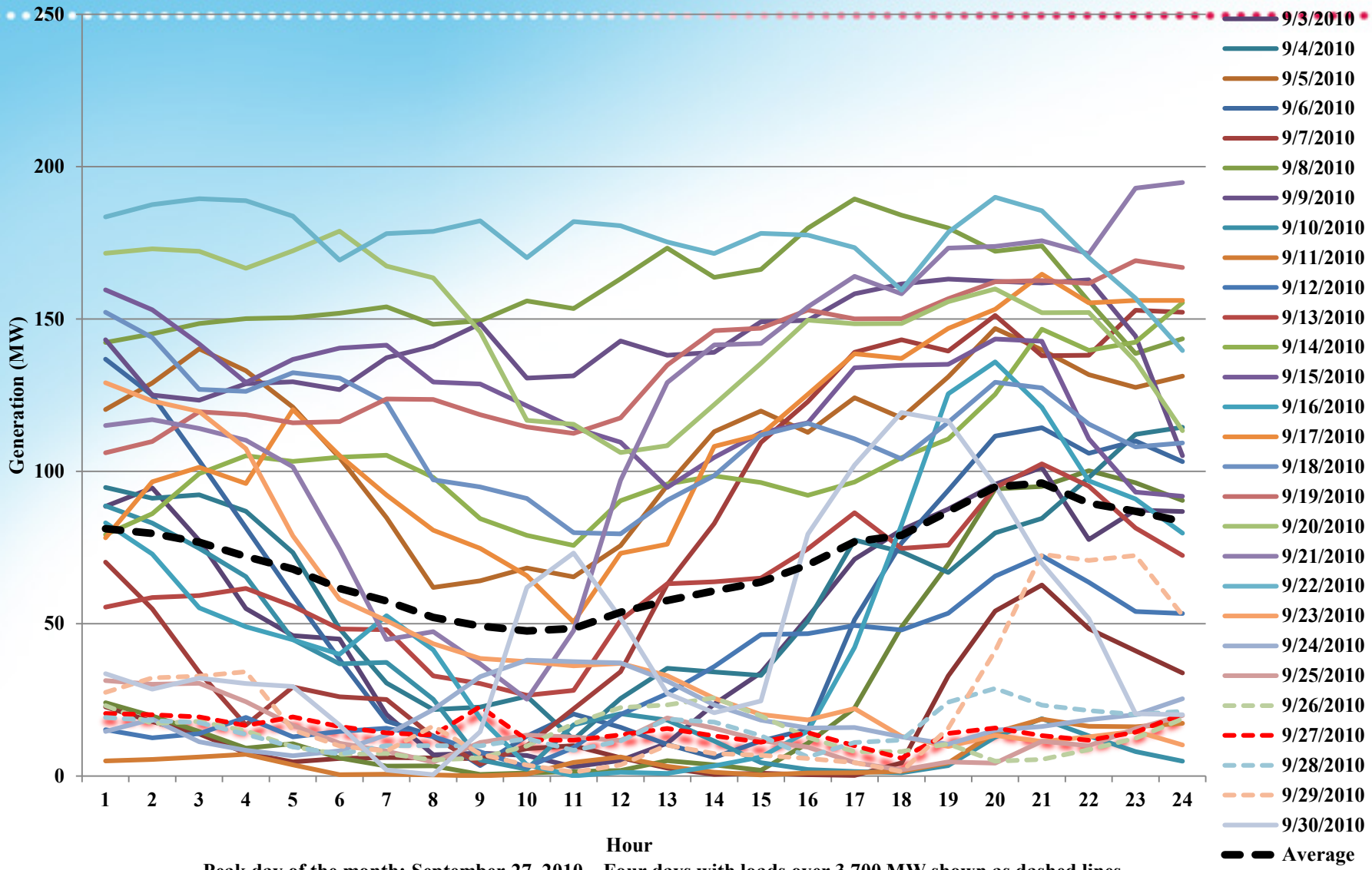
Recent events surpass previous forecasts of net load and afternoon ramp with high solar PV on the system.



March Fossil Generation Operations to 03/31/18	Days
No Plants running at peak	18
Plants Running at peak for pre-contingency outage mitigation	11
Plants running as scheduled	2

Daily Wind Power Generation
Hourly Data – September 2010

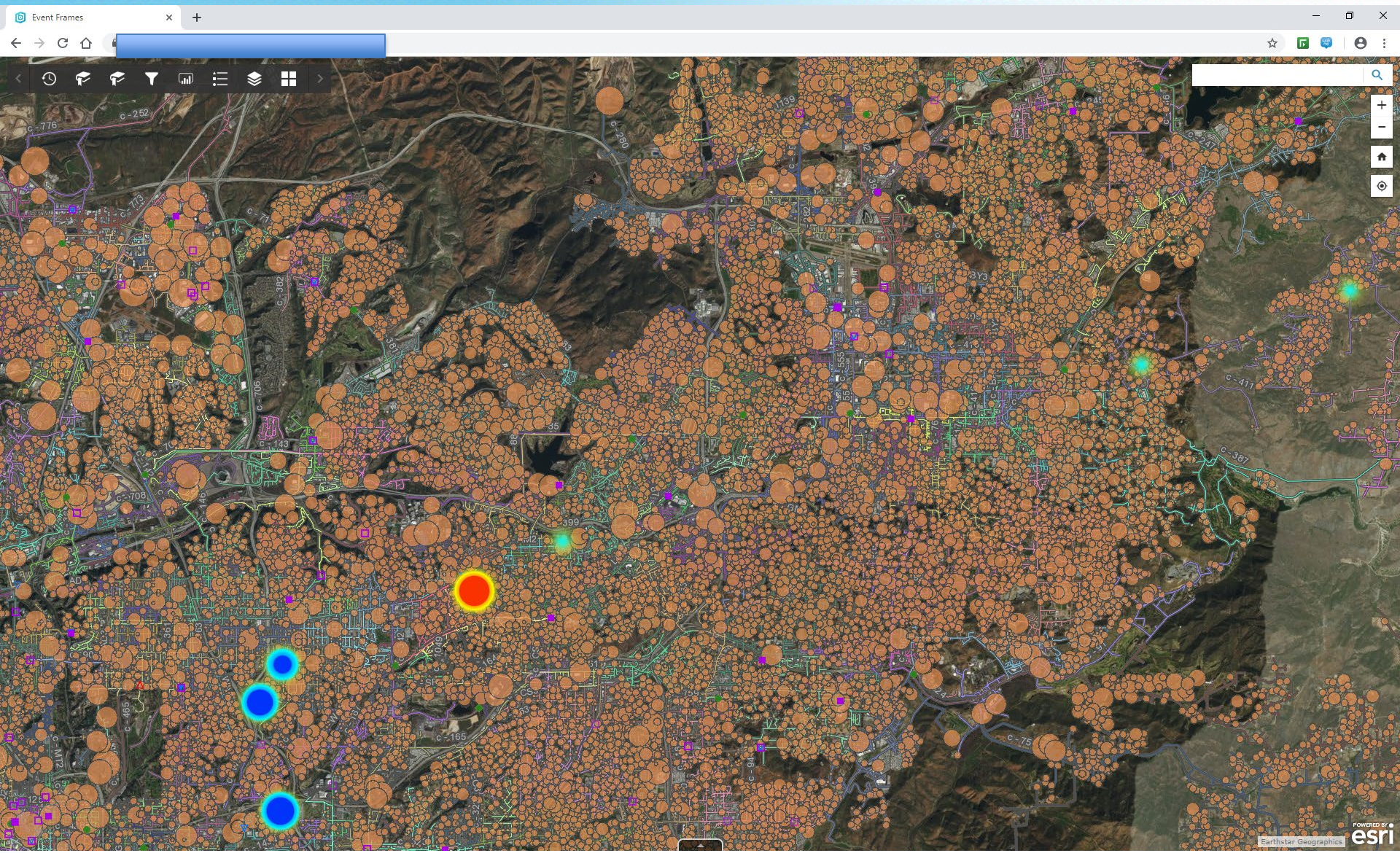


Peak day of the month: September 27, 2010, Four days with loads over 3,700 MW shown as dashed lines

DER's at SDG&E

- Provide customers with approximately **45% renewable energy** mix (California's leading utility
- **172,000+** private solar systems generating ≈1200 MW_{ACp}
- Approximately **47,000 plug-in electric vehicle, PEV's**, in the San Diego region
- **84 MW** of batteries installed
- **1.5** million smart electric meters (+~900k gas meters) serve over **3.4** million people

DER Deployment

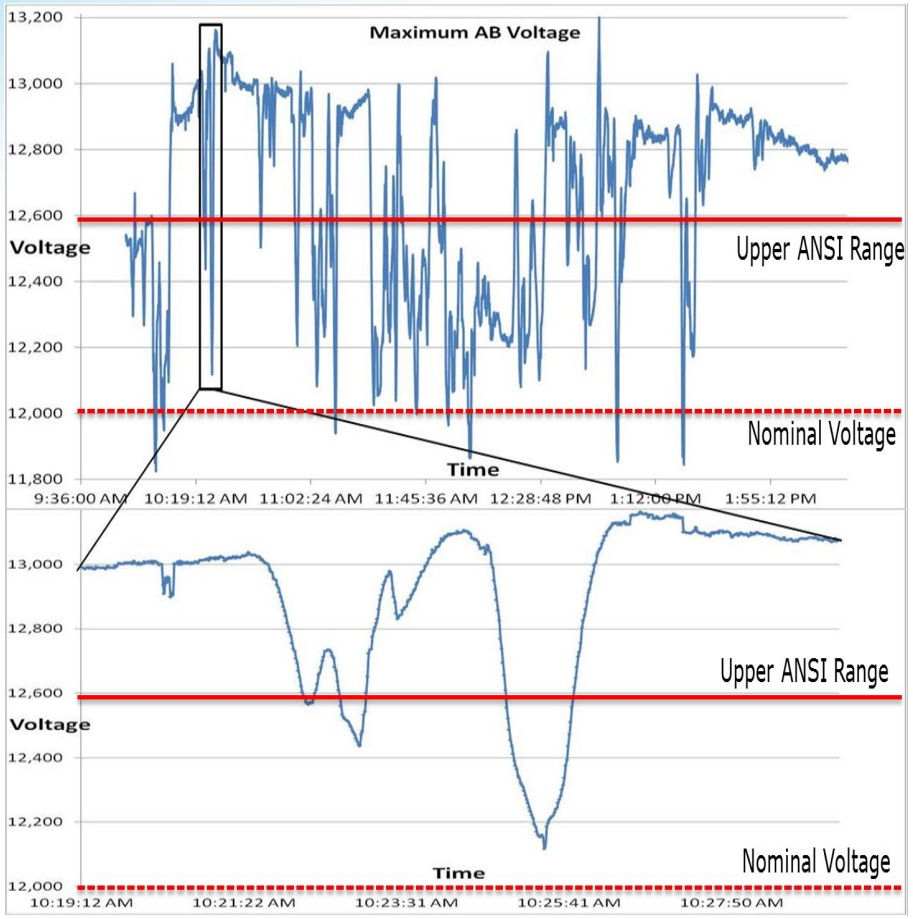


Solar PV Investment at SDG&E

- ~2,500 systems installed each month
- SDG&E invests ~$2M/year to expedite NEM interconnections

<u>Solar PV Distribution System Challenges</u>

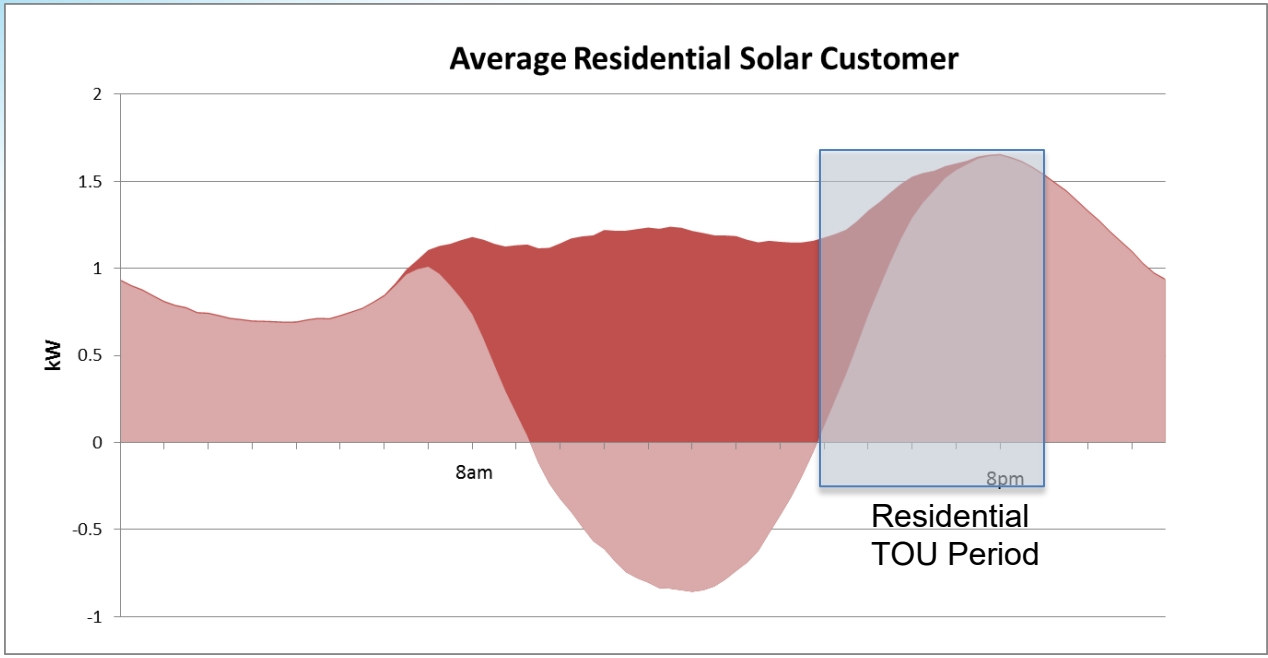
- **DER generation should have the same characteristics as traditional generation**
- Widespread PV penetration can lead to operational issues – Volt/VAr control, intermittency
- Smart inverters are a good first step
- Investment in Storage and EV can compliment PV



Residential Solar Customer

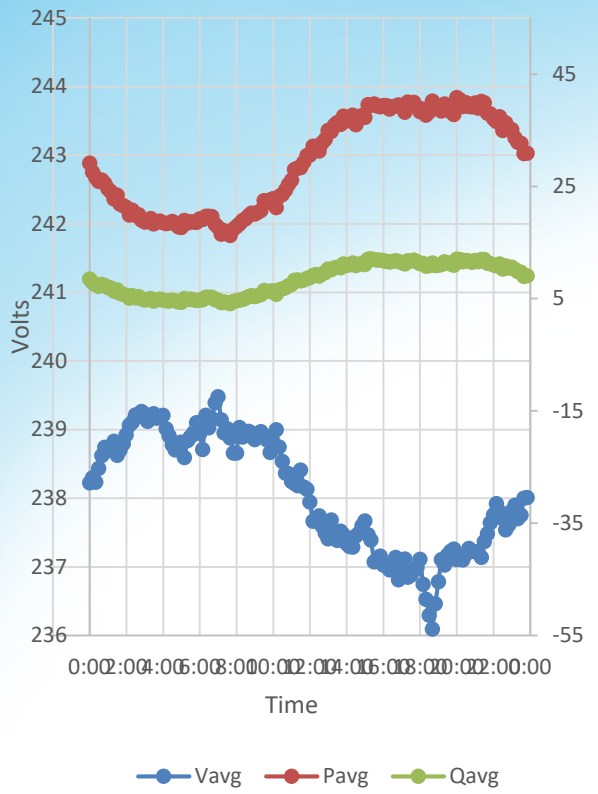
Key Takeaways:

1. Energy usage is not the key indicator to cost of service
2. Renewable energy has changed how and when people use energy
3. Residential customers with solar have maximum 15-min demands that are around 40% higher than those without solar
4. The majority of residential solar customers (67%) saw an increase in demand the second year after solar adoption

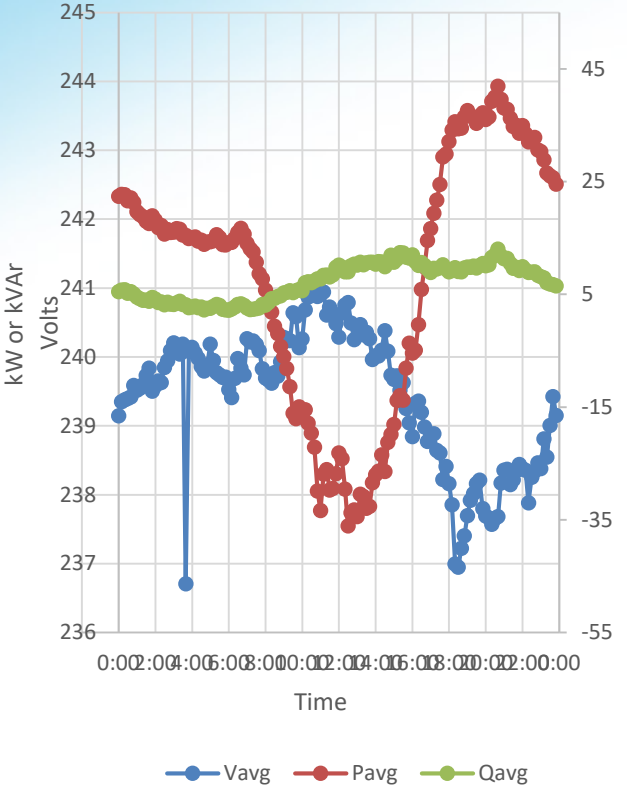


Residential Generation C701-537

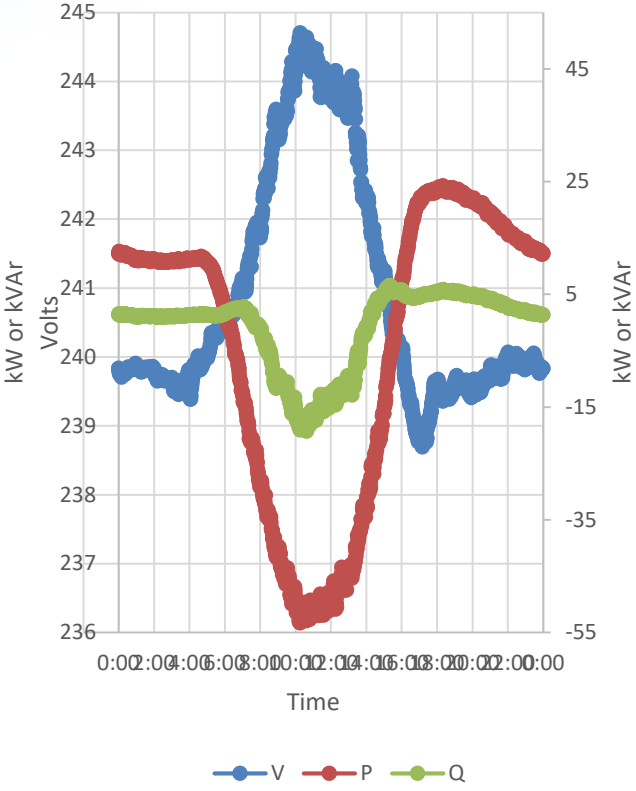
C701-537-1 Pre PV



C701-537-2, 71 kW @ PF=1, PV/kVA=0.95



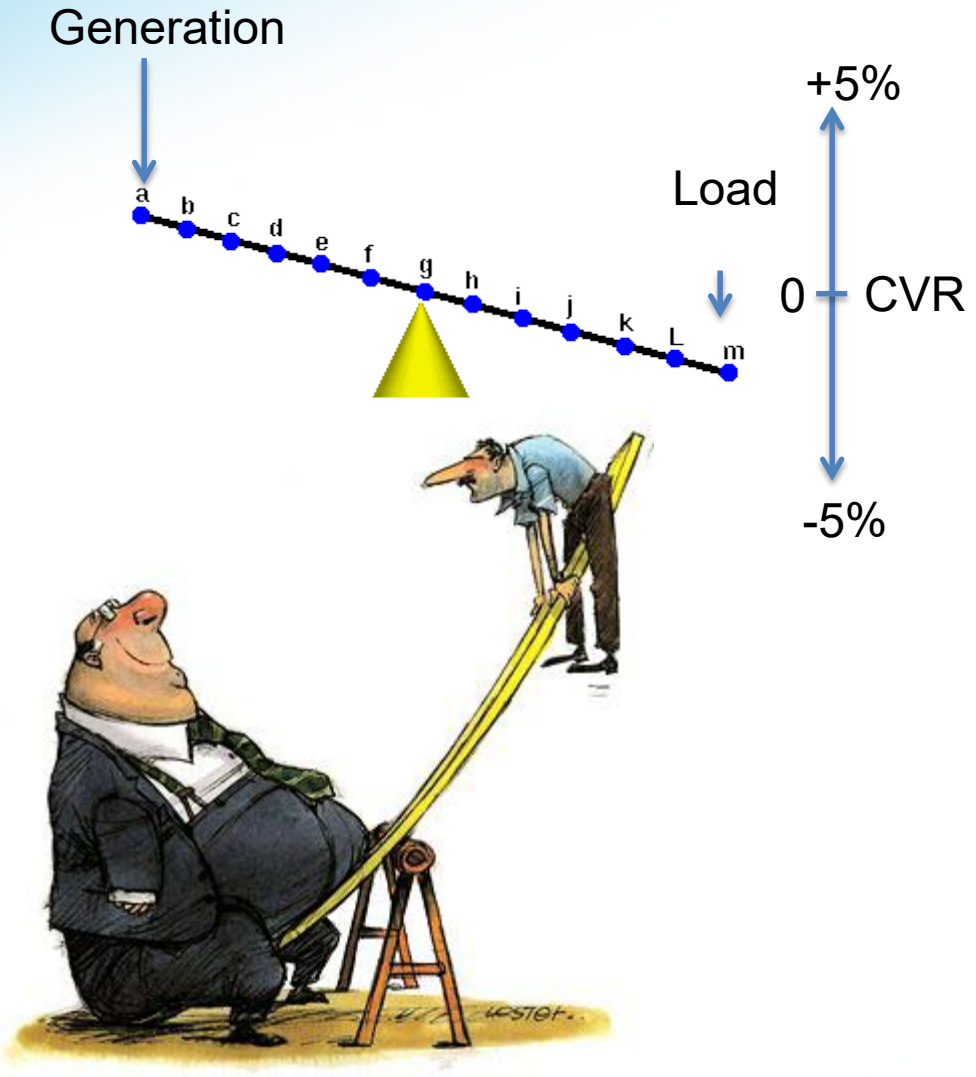
C701-537-3, 120 kW @ PF=1, PV/kVA=1.6



INTEGRATION OF DER

Factors Determining Impact

- **Location on the Circuit**
  - Near Substation vs End of Circuit
- **Circuit Rating**
  - 4 kV vs 12 kV
- **Type of Circuit**
  - Urban vs Rural
- **Circuit minimum loading**
  - High vs Low
- **Circuit X/R ratio at location**
  - High vs Low
- **Aggregate DG capacity**
- **Voltage Regulation Equipment**



Leveraging DER for Distribution Services Missing Process Steps

- **System to assign location id**
  - Distribution Interconnection System
  - System to track abnormal operation and assign temporary id
    - Advanced distribution management system
  - Participant group
    - Primacy determination
- **Plug & play DER**
  - A PV system from one manufacturer performs the same as another manufacturer
    - Same for energy storage and other DERs
  - Consistent predictable behavior
- **System to calculate available DER to mitigate need**
  - Link to hosting capacity line sections
  - Leverage customer generation GIS layer
  - Eliminate infeasible options
    - 1,200 kVAr cap bank ≈ 574, 4.8 kW PV systems, ± 0.9 pf, VAr priority & smart inverters, 2.76 MW total PV
    - Measurement error ± 2%
  - 3 phase unbalanced load flow analysis
  - Dynamic analysis
- **Forecasting a line section need based upon need or planned outage**
  - Real and reactive power
  - Voltage
    - AMI for operations, SCADA data
  - Latency issues
    - Forced outage requires real-time need determination and control
- **System to send need**
  - Communication to individual, plant level or aggregator via IEEE 2030.5
    - Edge device must be enabled to respond to commands
  - Cyber security
- **Measurement and verification methodology**
- **Compensation mechanism**
  - Tariff
  - Contract

Questions?

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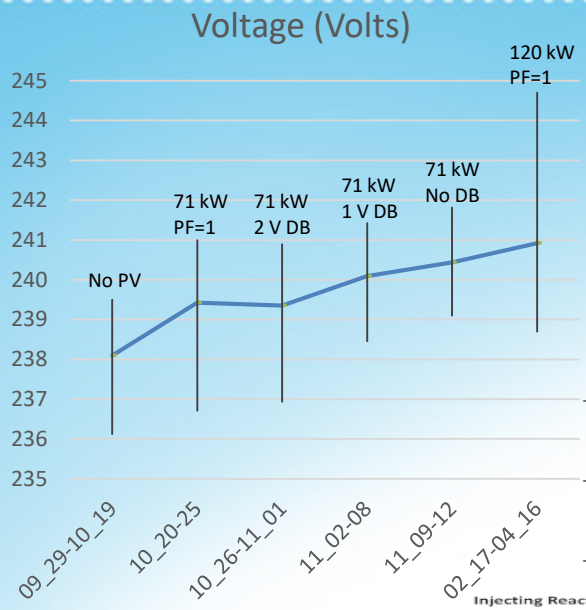
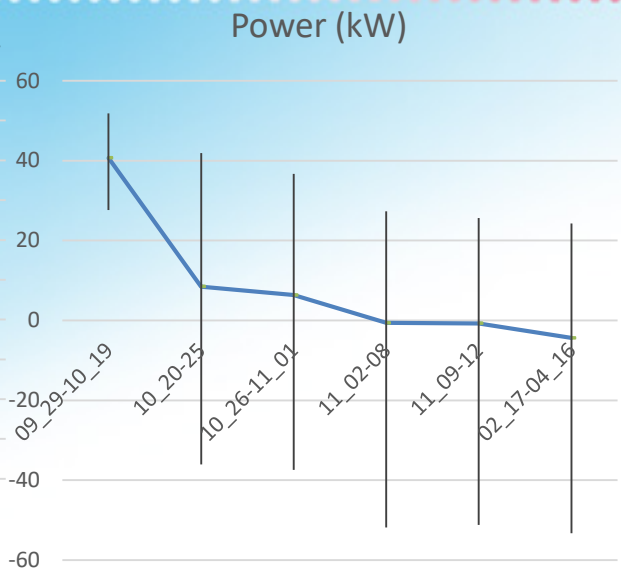
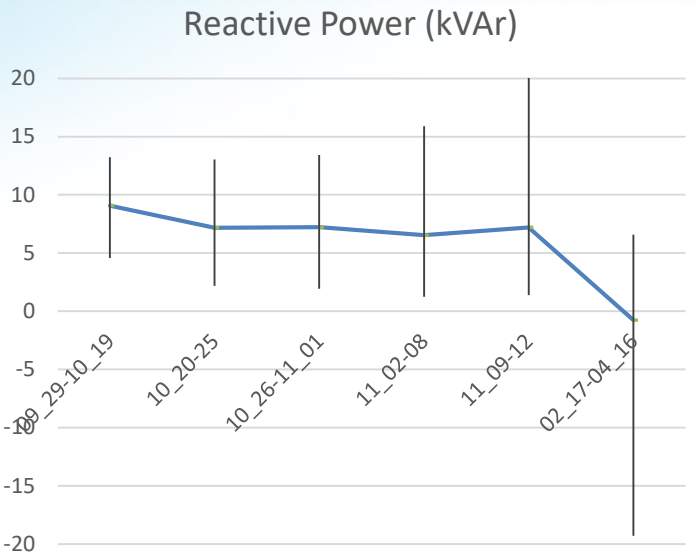
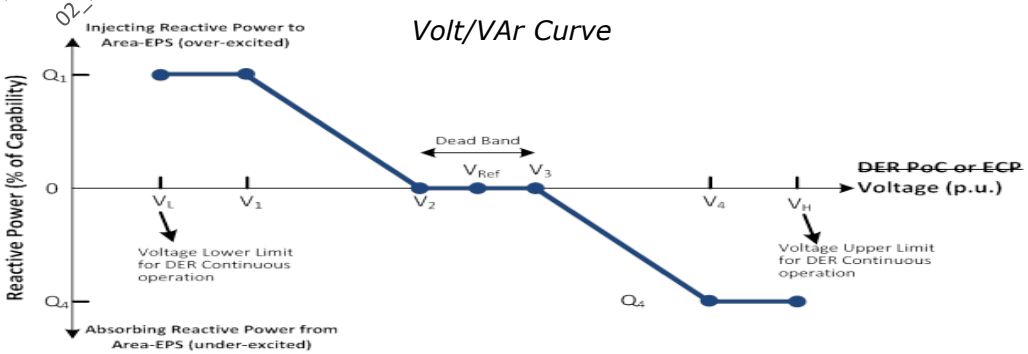
Residential Generation C701-537







Volt/VAr Curve



Voltage Range		P1		P2		P3		P4	
		V	Q_{AVAIL}	V	Q_{AVAIL}	V	Q_{AVAIL}	V	Q_{AVAIL}
ANSI Range A	126-114 V	95.0%	100%	98.3%	0%	101.7%	0%	105.0%	-100%
ANSI Range A	126-114 V	95.0%	100%	99.2%	0%	100.8%	0%	105.0%	-100%
ANSI Range A	126-114 V	95.0%	100%	100.0%	0%	100.0%	0%	105.0%	-100%