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SCE HIGH PENETRATION SOLAR PV
CURRENT STATUS AND RESEARCH
SCE Service Territory

Overview

- 5 million customer accounts
- 2012 peak load: 21996 MW
- 50,000 mi² service territory
- Large solar potential

Distribution Infrastructure

- 810 distribution substations
- 4,350 distribution circuits
- 103,000 circuit miles
- 713,000 OH & UG distribution transformers
- 60,000 switches
- 13,000 capacitor banks
- 26,000 relays
- 7,000 circuit breakers
SCE Interconnected Distributed Solar PV*

- Residential: 199 MW
- Comm. & Ind.: 259 MW
- Agricultural: 13 MW
- Utility Owned: 63 MW
- Total PV: 534 MW
- Total NEM: 463 MW
- Avg. Residential NEM Size: 4.76 kW

* As of 12/31/12
SCE Preferred Interconnections & Installed PV

**LEGEND**
- **County Name** (Installed PV Capacity)
- Green: Preferred
- Red: Not Preferred

Ventura (34 MW)

Los Angeles (160 MW)

San Bernardino (68 MW)

Riverside (88 MW)

Orange (64 MW)

Not Pictured (54 MW)

*Sub-transmission network level view available at www.sce.com
Rule 21 Proceedings

- Phase 1
  - Significant progress in Rule 21 process
  - Revised Rule 21 will improve the interconnection process for all developers, particularly solar
  - Encourage developers to utilize pre-application process as well as the SCE interconnection maps when siting new projects

- Phase 2 (in progress)
  - Support additional improvements in the interconnection process
    - Distribution Group Study process will provide a more efficient study process and provides more equitable cost sharing among generators
Number of SCE’s Active Interconnection Requests

<table>
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<tr>
<th>Tariff</th>
<th>Requests</th>
<th>MWs</th>
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<tr>
<td>Rule 21</td>
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<td>Total Likely MW</td>
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Increasing Solar PV (Engineering)

- More Information
  - Lack of validated models (SC, harmonics, load flow)
  - Monitoring
    - Remote switching with high levels of DER and little information
- More Control
  - Use of resources to optimize voltage and VAR control
- Safety
  - Transient over-voltages created when interrupting DER
  - Anti-islanding performance with multiple DER and lightly loaded lines
- Power quality
  - Low Voltage Ride Through/Harmonics/Transient over-voltages
Increasing Solar PV (Financial)

- Customer costs
  - NEM creates a cross-subsidy where non-solar customers pay for solar customers’ infrastructure costs
  - High barrier cost of entry still exists although new financing options available

- Societal & utility costs
  - Larger generation tends to interconnect in rural areas where land is cheaper, but interconnection costs are higher
  - Some distribution circuits must be reconfigured to accept higher levels of PV
Current Research for Distributed Solar PV

- Collaborative efforts
  - Alternatives to the 15% Rule (EPRI)
  - Utility Scale Solar Forecasting (EnerNex/UCSD)
  - High-Penetration PV Integration (NREL)
  - Distribution Monitoring of Renewables Integration (CIEE)

- Internal research areas
  - SCE Inverter Testing
  - SCE Transient Monitoring of Solar PV Plants

- Still have additional data needs
  - Higher sampling, meters spread over distribution circuits to observe interactive effects of smaller sites
Future Research for Distributed Solar PV

- Distribution model for SCE territory
  - Develop and validate a model that will generate end-use (meter level) and aggregate (feeder level) load curves representative of all geographic and socioeconomic regions
  - Apply various technology (PV, Storage, EE, etc) adoption scenarios to the model to understand system effects

- Evaluate and demonstrate optimal distribution grid
  - Coordinated rules for customers to optimize use of resources and loads
  - Maximize efficiency and security by enabling flexible and secure use of resources/loads driven by market signals rather than regulatory process
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Q & A AND DISCUSSION