SCE SmartGrid Communications
Architecture, Strategy, and Roadmap

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Southern California Edison Overview

- SCE provides power to:
  - Nearly 14 million people
  - 180 cities in 50,000 sq-miles
  - 11 counties

- To deliver that power it takes:
  - 16 utility interconnections
  - 4,990 transmission and distribution circuits
What is “Grid of the Future?”

- A network that uses information technology to deliver electricity efficiently, reliably, and securely.
  - Enables bidirectional flows of energy and uses two-way communication and control capabilities
    - Unlike today's grid, which primarily delivers electricity in a one-way flow from generator to outlet
  - It's been called
    - “SmartGrid”
    - “Electricity with a brain"
    - “Energy internet"
    - “Electronet."
Smart Grid = Electrical Infrastructure + IT

Source: EPRI® Intelligrid
Ambitious energy policies create operational challenges that require accelerated deployment of smart grid technologies

Environmental
- Senate Bill 1368: GHG Performance Standard
- Assembly Bill 32: 1990 Levels GHG
- Low Carbon Fuel Standard: 10% Reduction Carbon (Transportation)
- Executive Order 5-3-05: 80% Below 1990 Levels GHG
- Once Through Cooling

Renewable Energy
- 3,000 MWs of DG-PV (CSI)
- 500 MWs of PV (SPVP)
- 20% RPS
- Renewable Electricity Standard: 33%
- 100% of ZNE Residential Constructions
- 100% of ZNE Commercial Constructions

Customer Interface
- 1000 MW Cap on Reliability-based DR
- Net Surplus Compensation
- Mandatory TOU & Default CPP for 600,000+ Non-residential Customers
- Energy & Pricing Info
- 400k-1M Forecasted PEVs
SCE’s Smart Grid Strategy

Smart Grid Policy Drivers
- AB 32
- 33% RPS
- Once-Thru Cooling
- DG Programs
- PEV Adoption
- EE & DR Goals

Smart Grid Capabilities
- Demand Response
- Enhanced Customer Engagement
- PEV Integration
- DER Integration
- Advanced Outage Management
- Advanced Volt/VAR Control
- Wide-Area Monitoring
- Wide-Area Protection
- Wide-Area Control
- Adv. Equipment Monitoring
- Workforce Automation

Smart Grid Infrastructure

Management & Control Systems
- Wide-Area Control System
- Energy Management System
- Wide-Area Situational Awareness
- C-RAS Management System
- Distribution Management System
- Outage Management System
- Energy Service Provider Interface
- Geographical Information System
- SCE.com
- Advanced Load Control System
- Customer Information Systems
- AMI Back Office Systems

Communications Networks
- Substation LAN
- High Speed Backbone
- Field Area Network
- High Speed Wireless Protection
- AMI Network
- Premise Area Network

Field Devices
- Asset Monitoring Equipment
- Workforce Computing Devices
- Phasor Measurement Units
- FACTS Devices
- Distribution Switching Equipment
- Advanced Relays
- Energy Storage
- Distribution Volt/VAR Devices
- Smart Meters
- Customer Premise Devices

Security
## Guideline for Power System

<table>
<thead>
<tr>
<th>Application \ Attributes</th>
<th>Latency</th>
<th>Throughput</th>
<th>Coverage</th>
<th>Security</th>
<th>Priority</th>
<th>Availability</th>
<th>Real Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAS</td>
<td>&lt; 8ms</td>
<td>128 kbps per sub. (assumes 2 each 64 Kbps channels per RAS system)</td>
<td>66kV and above substations</td>
<td>High (AIC*-see definition below)</td>
<td>High</td>
<td>99.999-99.9999%</td>
<td>Yes</td>
</tr>
<tr>
<td>Tele-protection</td>
<td>&lt; 8ms</td>
<td>128 kbps per sub. (assumes 2 each 64 Kbps channels per transmission line)</td>
<td>66kV and above substations</td>
<td>High (AIC)</td>
<td>High</td>
<td>99.999-99.9999%</td>
<td>Yes</td>
</tr>
<tr>
<td>Distributed Generation (Transfer Trip)</td>
<td>&lt; 8ms</td>
<td>128 kbps per DG (assumes 2 each 64 Kbps channels per transmission line)</td>
<td>entire service area</td>
<td>Physical - No Cyber - Yes</td>
<td>High</td>
<td>99.999-99.9999%</td>
<td>Yes</td>
</tr>
<tr>
<td>C-RAS</td>
<td>&lt; 8ms</td>
<td>3 Mbps per sub. (assumes 2 each T1 circuits per sub.)</td>
<td>230kV and 500kV</td>
<td>High (AIC)</td>
<td>High</td>
<td>99.999-99.9999%</td>
<td>Yes</td>
</tr>
<tr>
<td>WASAS</td>
<td>&lt; 8ms</td>
<td>1.5 Mbps per sub. (assumes 1 each T1 circuit per sub.)</td>
<td>230kV and 500kV</td>
<td>Physical - Most Locations Cyber - Yes</td>
<td>High</td>
<td>99.999-99.9999%</td>
<td>Yes</td>
</tr>
</tbody>
</table>
## Guideline for Utility Operations (1/2)

<table>
<thead>
<tr>
<th>Application \ Attributes</th>
<th>Latency</th>
<th>Throughput</th>
<th>Coverage</th>
<th>Security</th>
<th>Priority</th>
<th>Availability</th>
<th>Real Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substation SCADA</td>
<td>&lt; 4 sec</td>
<td>&lt; 19.2 kbps</td>
<td>entire service area</td>
<td>Physical - No  Cyber - Yes</td>
<td>High</td>
<td>99.9-99.999%</td>
<td>Yes</td>
</tr>
<tr>
<td>Data Beyond SCADA</td>
<td>&lt; 1 min</td>
<td>1.5 Mbps per sub.</td>
<td>230kV and above plus few 115kV &amp; 66kV</td>
<td>Physical - Some Locations Cyber - Yes</td>
<td>Medium</td>
<td>99.9-99.999%</td>
<td>No</td>
</tr>
<tr>
<td>Substation Automation (HMI)- IED to HMI</td>
<td>&lt; 4 ms</td>
<td>100 Mb/s- 1Gb/s LAN</td>
<td>66kV and above substations</td>
<td>Physical - No Cyber - Yes</td>
<td>High</td>
<td>99.999-99.9999%</td>
<td>No</td>
</tr>
<tr>
<td>Switch center-EMS</td>
<td>&lt; 50 ms</td>
<td>6 Mbps per substation</td>
<td>Switching Centers, RCCs, GMCs</td>
<td>Physical - Most Locations Cyber - Yes</td>
<td>High</td>
<td>99.999-99.9999%</td>
<td>Yes</td>
</tr>
<tr>
<td>Distribution Automation</td>
<td>&lt; 2 sec</td>
<td>&gt;10 kbps</td>
<td>throughout entire service area</td>
<td>Physical - No Cyber - Yes</td>
<td>Medium</td>
<td>99.9-99.999%</td>
<td>No</td>
</tr>
<tr>
<td>Smart Metering (data collector to meters)</td>
<td>&lt; 40 ms</td>
<td>2 Mbps</td>
<td>throughout entire service area</td>
<td>Physical - No Cyber - Yes</td>
<td>Medium</td>
<td>99.9-99.999%</td>
<td>No</td>
</tr>
<tr>
<td>Smart Metering (data collector to meters)</td>
<td>&lt; 15 sec</td>
<td>150 kbps per meter</td>
<td>entire service area</td>
<td>Physical - No Cyber - Yes</td>
<td>Medium</td>
<td>99.9-99.999%</td>
<td>No</td>
</tr>
</tbody>
</table>
## SCE Substation Telecommunication Connections

<table>
<thead>
<tr>
<th>Category</th>
<th>Voltage</th>
<th>Number of Facilities</th>
<th>Telecomm Connection</th>
<th>Number of Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission (AA Substation)</td>
<td>500kV</td>
<td>8</td>
<td>No. of Substation with Fiber</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. of Substation with Microwave</td>
<td>7</td>
</tr>
<tr>
<td>Transmission (A Substation)</td>
<td>220kV</td>
<td>45</td>
<td>No. of Substation with Fiber</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. of Substation with Microwave</td>
<td>13</td>
</tr>
<tr>
<td>Sub-Transmission (B Substation)</td>
<td>115 kV</td>
<td>63</td>
<td>No. of Substation with Fiber</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. of Substation with Microwave</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. of Substation with Satellite</td>
<td>19</td>
</tr>
<tr>
<td>Sub-Transmission (B Substation)</td>
<td>66 kV</td>
<td>294</td>
<td>No. of Substation with Fiber</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. of Substation with Microwave</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. of Substation with Satellite</td>
<td>68</td>
</tr>
<tr>
<td>Distribution</td>
<td>&lt;66 kV</td>
<td>471</td>
<td>No. of Substation with Fiber</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. of Substation with Microwave</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. of Substation with Satellite</td>
<td>81</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>881</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Substation with Fiber</td>
<td></td>
<td><strong>271</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Substation with Microwave</td>
<td></td>
<td><strong>33</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Substation with Satellite</td>
<td></td>
<td><strong>166</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To ensure proper operation, rigorous technology evaluation must take place in a controlled environment before smart grid technologies are deployed on the grid.
SCE is conducting 2 smart grid demonstration projects funded by the **American Recovery and Reinvestment Act of 2009 (ARRA)**.

(1) **Irvine Smart Grid Demonstration (ISGD) project**

Demonstrate new smart grid technologies which can reduce energy costs and emissions.

(2) **The Tehachapi Wind Energy Storage Project (TSP)**

Evaluate a utility-scale, lithium-ion battery system to integration with large-scale, wind-powered electricity generation.
ISGD Location

[Map showing the location of ISGD with key markers: Irvine, UCI Campus, MacArthur Sub, Rommel 12 kV, Arnold 12 kV, Demo Center, Faculty Housing Smart Homes, Fashion Island, Turtle Rock, SNA Airport, and 405 Freeway.]
ISGD Scope
Tehachapi Wind Energy Storage Project
Summary

• SCEnet has been performing well for over 15 years but needs to evolve to support exponential growth in network traffic and future Smart Grid applications
• SCE’s **Unified Communication Architecture** anticipates all enterprise needs
• SCEnet2 provides evolution to an efficient and flexible packet-based network to provide a scalable foundation for future communication services.
  - New technologies and applications require a new approach
  - Exponential traffic growth demands elastic bandwidth capabilities
  - Optimized network characteristics meet high performance and low latency criteria
  - Flexible network to facilitate end to end Smart Grid connectivity
  - IP/MPLS/Ethernet over DWDM
  - LTE & WiMAX
• SCE is open-minded and explore new possibilities.
• “Utilities are trying hard to be first to be second” D. Chassin