SCE's Experience
Distribution Volt/VAR Control:
Irvine Smart Grid Demonstration

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- 14 million customers: one of the largest utilities in US
- 50,000 square mile service area
- 125 years of service
Control algorithm to achieve optimal voltage and VAR control on the distribution system

DVVC Objectives

Meet both voltage and VAR requirements when possible.
Minimize system average voltage, and energy usage.
Minimize capacitor switching.
Provide local “fail safe” backup.

The DVVC application is embedded within the new Distribution Management System’s Smart Applications.
20+ Years of SCE Study

- 1990s: “D-CAP” demonstrated > 2% energy savings on 2 distribution substations
- 2000s: Roll out of foundational infrastructure that enables DVVC and other advanced applications
- 2010s:
  - 2011 DMS Smart applications to include DVVC
  - ISGD demonstrates DVVC pilot with modern equipment
INDEPENDENT STUDIES BACK RESULTS

• DOE Evaluation of CVR on national level (2010)
  – 0.5-4.0% annual energy reduction per feeder
  – 3.04% energy reduction with complete (nationwide) deployment

• Navigant, prepared for BPA (2013)
  – 2.5% “reduction in energy consumption through advanced voltage controls”
Existing Volt/VAR Control

• Distribution voltage and VARs controlled with automated field & substation capacitors

• Control is automated, but each device acts autonomously

• Can lead to higher voltages and unnecessary energy consumption
DVVC Solution

DVVC centralizes control of field and substation capacitors to coordinate and optimize voltage and VARs across all circuits fed by a particular substation.

DVVC provides Conservation Voltage Reduction (CVR) – reduction of energy through reduction of average voltage.
Irvine Smart Grid Demonstration

- University of California, Irvine campus and MacArthur Substation in Newport Beach
- ARRA partnership
## ISGD Scope

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<thead>
<tr>
<th>Project Domains</th>
<th>Sub-projects</th>
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<tr>
<td>Smart Energy Customer Solutions</td>
<td>1. Zero Net Energy (ZNE) Homes through Smart Grid Technologies</td>
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<tr>
<td>Next Generation Distribution System</td>
<td>2. Solar Shade-enabled Electric Vehicle Charging</td>
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<td>Interoperability &amp; Cybersecurity</td>
<td>3. Distribution Circuit Constraint Management with Energy Storage</td>
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<tr>
<td>Workforce of the Future</td>
<td>4. Distribution Volt/VAR Control (DVVC)</td>
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<td>5. Self-Healing Distribution Circuits</td>
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<td>6. Deep Grid Situational Awareness</td>
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<td></td>
<td>7. Interoperability and Cybersecurity</td>
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<tr>
<td></td>
<td>1. Secure Energy Network (SENet)</td>
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<td></td>
<td>2. SA3 – IEC 61850 Substation Automation System</td>
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<tr>
<td></td>
<td>3. Workforce of the Future</td>
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</tbody>
</table>
Sample ISGD Test Results
(8,000+ customers)

Energy Reduction = 3.4%

- 56 MVA transformer bank serves inner operating bus
- 14 field capacitors (900, 1200 & 1800 kVAR)
- Seven 12 kV circuits
- 1 substation capacitor (6 MVAR)

* 10/28/2014 - 11/10/2014
## Testing for further benefits

<table>
<thead>
<tr>
<th>Category</th>
<th>Benefit</th>
<th>Description</th>
<th>Potential Metrics</th>
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<tbody>
<tr>
<td>Compliance</td>
<td>Rule 2 voltage compliance</td>
<td>DVVC provides a mechanism for continuously ensuring Rule 2 compliance</td>
<td>• % time in/out of compliance</td>
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<tr>
<td>Operational Excellence</td>
<td>Reduced capacitor inspections</td>
<td>Loss of capacitor operability will be detected in real time; inspections can become targeted</td>
<td>• Inspection costs</td>
</tr>
<tr>
<td></td>
<td>Extended Transmission capacitor life</td>
<td>Transmission capacitor switching duty cycles should be reduced, extending equipment life</td>
<td>• Truck roll emissions</td>
</tr>
<tr>
<td>Capacity Investments</td>
<td>Reduced peak demand</td>
<td>If peak amps are reduced, loading limits on affected circuits would be reached further in the future</td>
<td>• Deferred Distribution capacity capital investment</td>
</tr>
<tr>
<td>Environmental</td>
<td>Reduced greenhouse gas emissions</td>
<td>Reduced usage should lead to reduced emissions; magnitude of the reduction will depend on future generation mix</td>
<td>• Reduced total CO₂ emissions</td>
</tr>
</tbody>
</table>
Summary

• DVVC can reduce energy consumption without affecting customer service.
• 1-4% estimated reductions: Even at 1% energy reduction $NPV is significant.
• Cost and risk to deploy is low.
• Plan to fully deploy by 2020.
Thank you

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