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SCE's Experience Distribution Volt/VAR Control:

Irvine Smart Grid Demonstration

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Panel Session: Volt/VAR Control in the Era of the Smart Grid

Bryan Pham
Manager – Automation & Communications
Southern California Edison
Advanced Technology

IEEE PES Power & Energy Society®

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Southern California Edison

- 14 million customers: one of the largest utilities in US
- 50,000 square mile service area
- 125 years of service

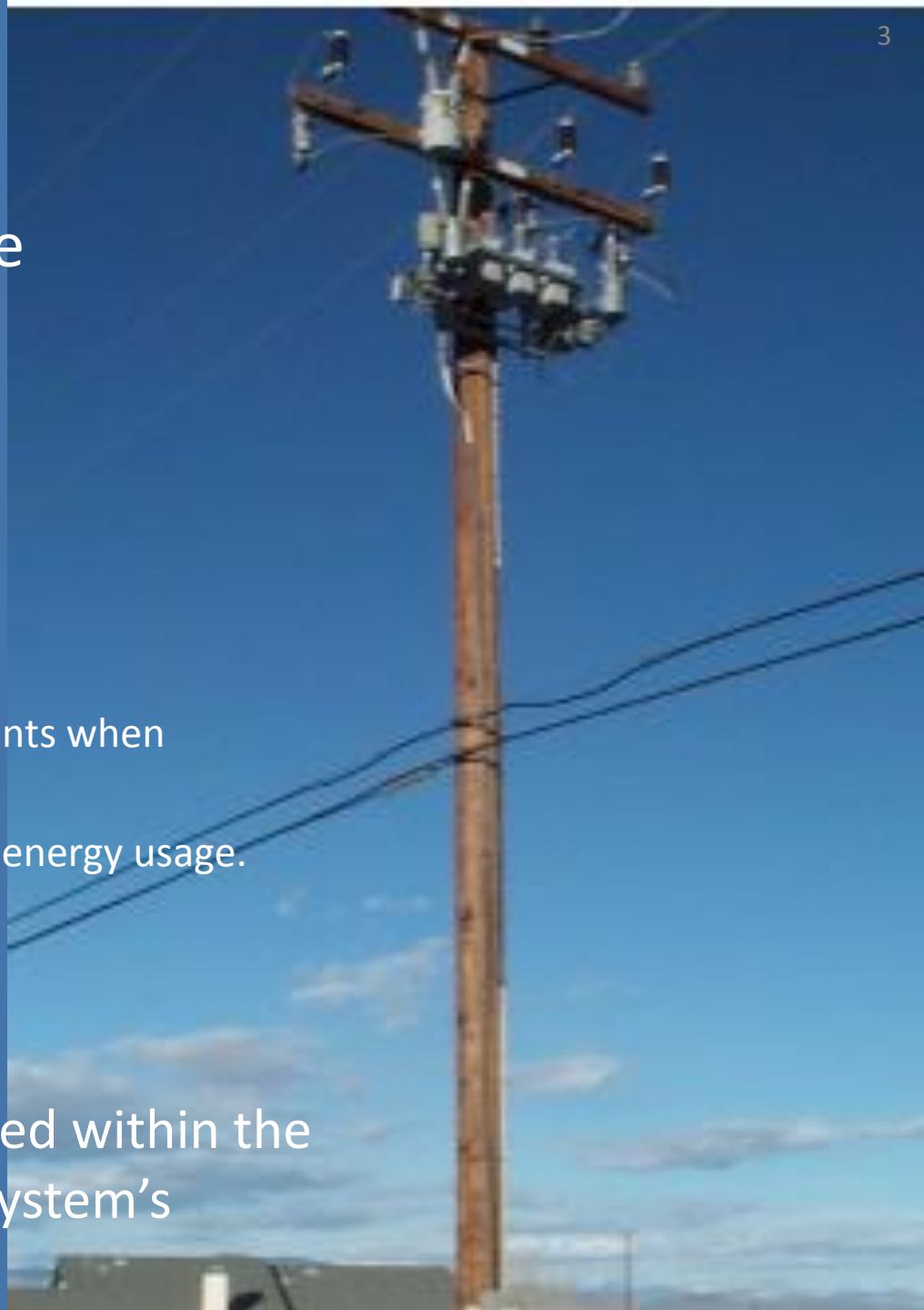
DVVC:

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.



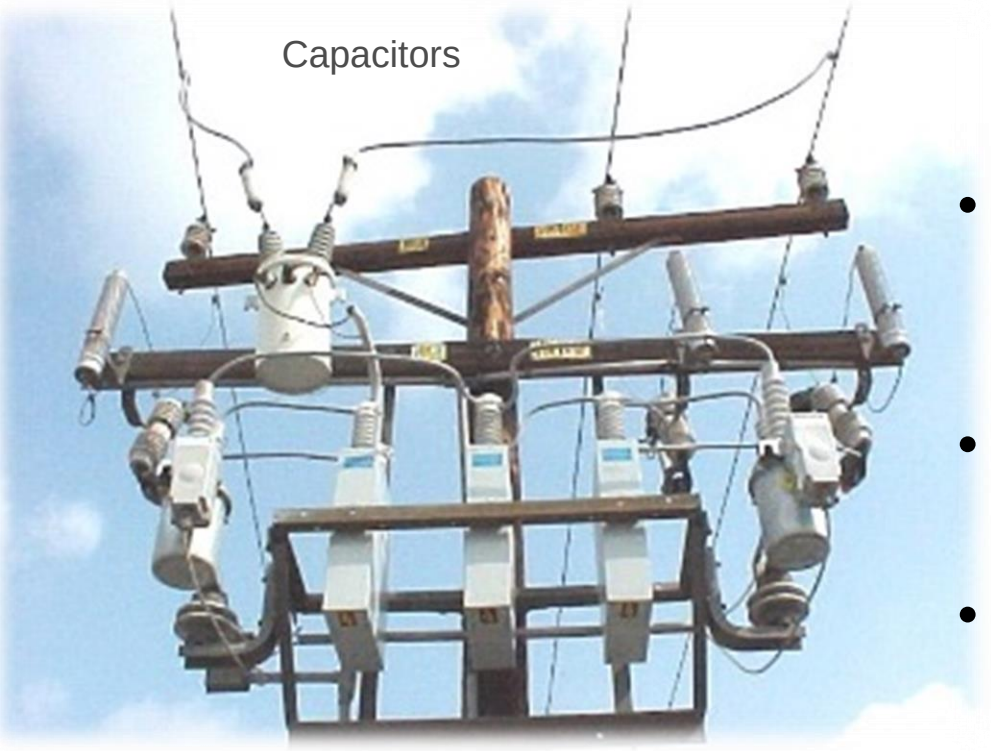
20+ Years of SCE Study

- 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

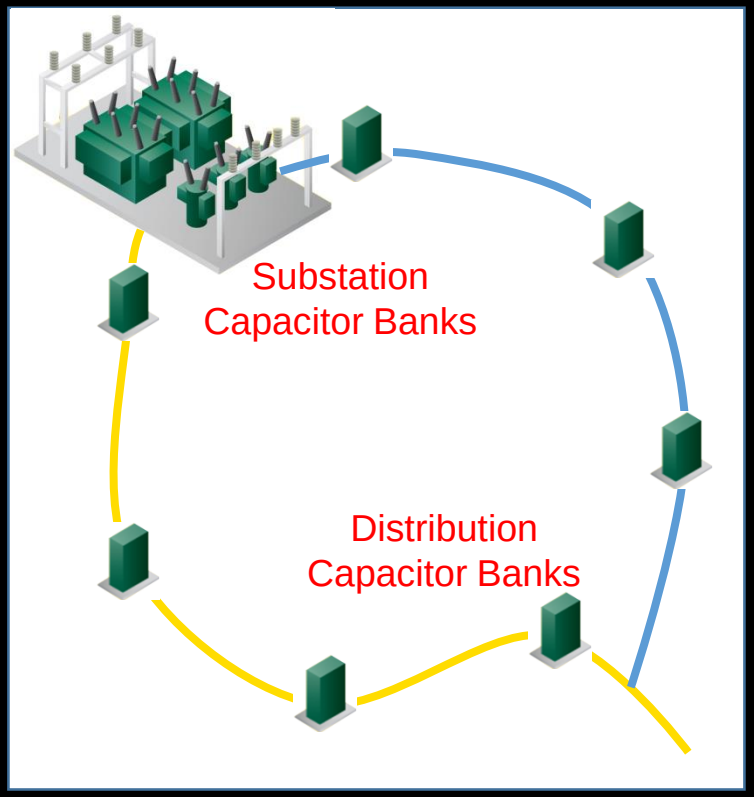


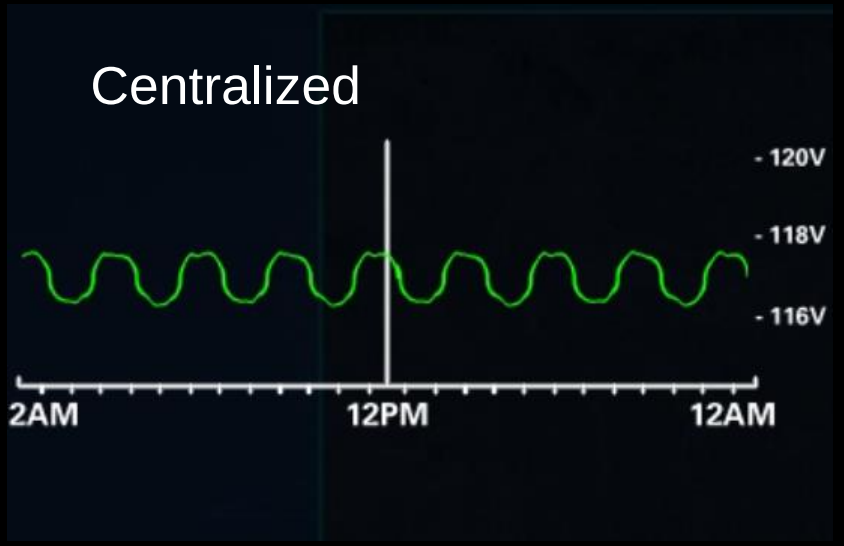
- Distribution voltage and VARs controlled with automated field & substation capacitors
- Control is automated, but each device acts autonomously
- Can lead to higher voltages and unnecessary energy consumption

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

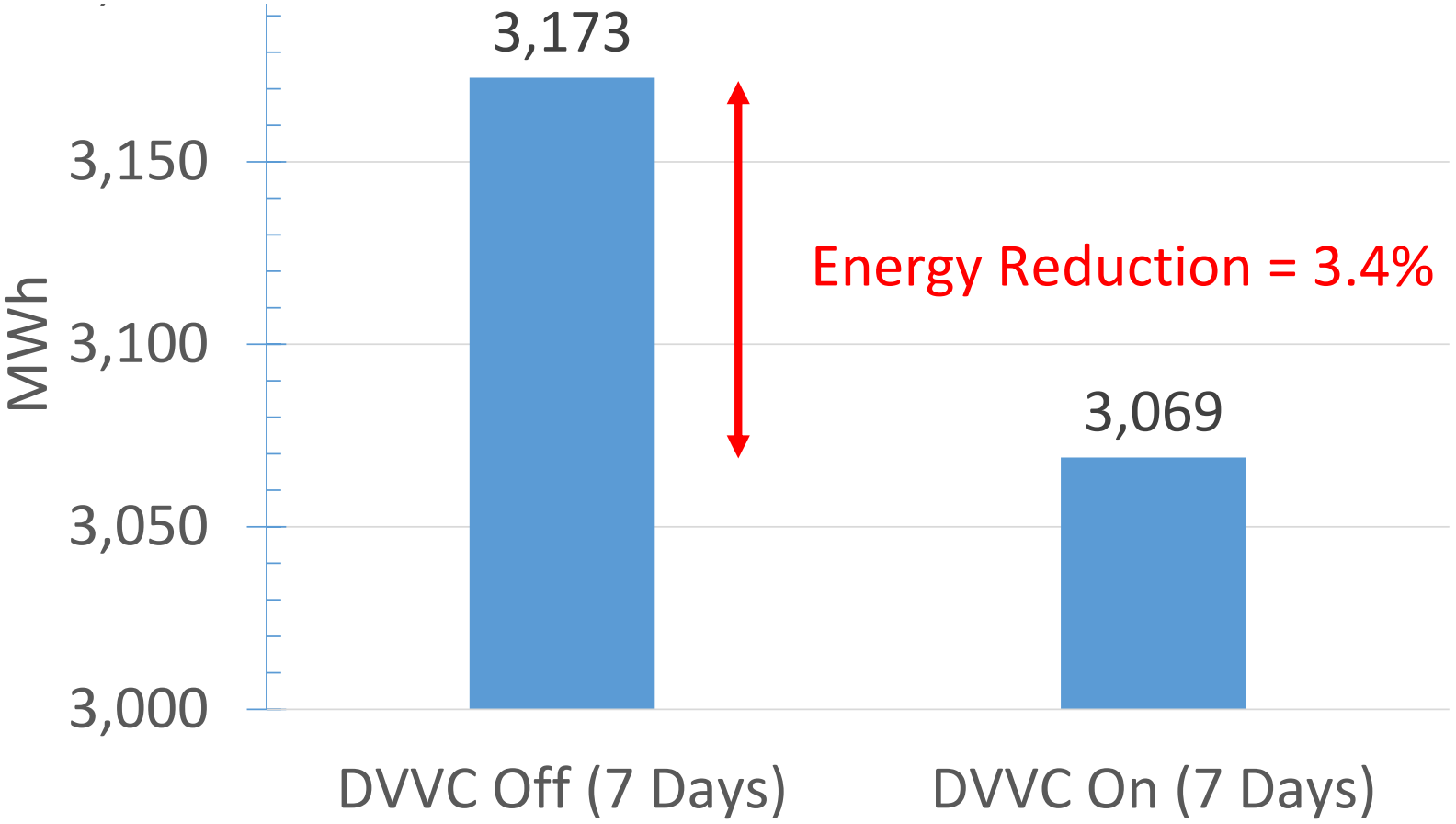
- University of California, Irvine campus and MacArthur Substation in Newport Beach
- ARRA partnership

ISGD Scope

Project Domains	Sub-projects
Smart Energy Customer Solutions	1. Zero Net Energy (ZNE) Homes through Smart Grid Technologies 2. Solar Shade-enabled Electric Vehicle Charging
Next Generation Distribution System	3. Distribution Circuit Constraint Management with Energy Storage **4. Distribution Volt/VAR Control (DVVC)** 5. Self-Healing Distribution Circuits 6. Deep Grid Situational Awareness
Interoperability & Cybersecurity	7. Interoperability and Cybersecurity 1. Secure Energy Network (SENet) 2. SA3 – IEC 61850 Substation Automation System
Workforce of the Future	3. Workforce of the Future

Sample ISGD Test Results

(8,000+ customers)



* 10/28/2014 - 11/10/2014

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

Testing for further benefits

Category	Benefit	Description	Potential Metrics
Compliance	Rule 2 voltage compliance	DVVC provides a mechanism for continuously ensuring Rule 2 compliance	• % time in/out of compliance
Operational Excellence	Reduced capacitor inspections	Loss of capacitor operability will be detected in real time; inspections can become targeted	• Inspection costs • Truck roll emissions
	Extended Transmission capacitor life	Transmission capacitor switching duty cycles should be reduced, extending equipment life	• Deferred Transmission capital investment
Capacity Investments	Reduced peak demand	If peak amps are reduced, loading limits on affected circuits would be reached further in the future	• Deferred Distribution capacity capital investment
Environmental	Reduced greenhouse gas emissions	Reduced usage should lead to reduced emissions; magnitude of the reduction will depend on future generation mix	• Reduced total CO_2 emissions

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.

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Thank you

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Bryan.Pham@sce.com

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