DOCKETED	
Docket Number:	18-IEPR-07
Project Title:	Doubling Energy Efficiency Savings
TN #:	223682
Document Title:	Conservation Voltage Reduction SCE's Experience Distribution Voltage & VAR Control
Description:	Presentation by Bryan Pham for June 7, 2018 IEPR Workshop on Doubling Energy Efficiency Savings
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Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	6/5/2018 10:45:58 AM
Docketed Date:	6/5/2018

Conservation Voltage Reduction

SCE's Experience
Distribution Voltage & VAR Control (DVVC)

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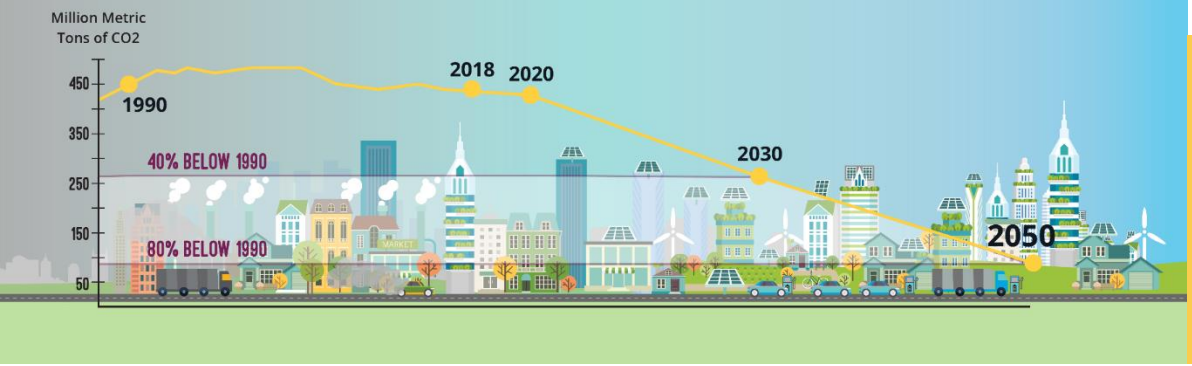
Safety & Reliability Demo

June 07, 2018 - CEC's Doubling Energy Efficiency Savings IEPR Workshop

EDISON INTERNATIONAL®

Southern California Edison in 2018

- 15 million residents in a 50,000 sq mile area
- 40% energy from carbon-free sources
- Joined open letter to support Paris Climate Accord
- Utility Dive “2017 Utility of the Year” for our 2017 Clean Power and Electrification Vision Plan



Supporting California’s 2030 greenhouse gas reduction goals

Distribution Voltage & VAR Regulation at SCE

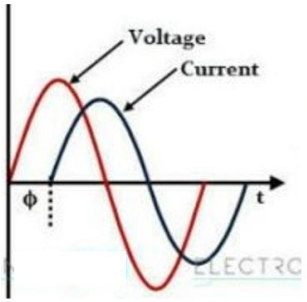
- Utilities required to maintain customer voltage within a specific range
- Voltage may vary depending upon a number of factors, such as transformer loading or where a customer is located on a distribution circuit
- Utilities generally regulates voltage & VAR by turning on or off capacitors[1] using a decentralized and unoptimized control scheme
- When multiple uncoordinated capacitors are turned on, it **causes higher than necessary customer voltage and energy consumption**

Capacitor

What is VAR (Volt Amp Reactive) ?

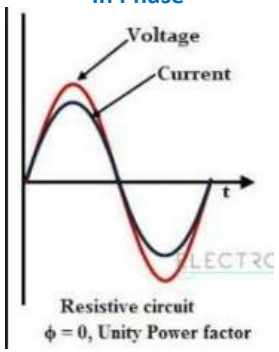
VAR consists of inductive & capacitive loads causing voltage & current to be "Out of phase"
Customer loads are mostly inductive

Voltage & Current
"Out of Phase"



Capacitor cancels inductive load to bring voltage & current "In Phase" for **maximum system efficiency**

Voltage & Current
"In Phase"



[1] Should the voltage on a circuit fall below a specified level for some reason, a device called a capacitor can provide a 1 to 2 volt rise at the field location; SCE has 14,000 distribution switched capacitors and over 1000 capacitors in our substations

Conservation Voltage Reduction – Energy Efficiency

25+ Years of SCE Study

- 1992: Distribution Capacitor Automation Project (D-CAP) demonstrated > 2% energy savings on 2 distribution substations
- 2015: Distribution Voltage & VAR Control (DVVC) was successfully demonstrated as part of the Department of Energy (DOE)-funded Irvine Smart Grid Demonstration (ISGD) project, resulting in more than 2% energy savings on the test circuits

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

Solving The Problem with a SCE-Patented Solution

- Distribution Voltage and VAR Control (DVVC) performs an optimization algorithm to dynamically control capacitors which reduces customer voltage and energy consumption
- Customer equipment & appliances are designed to be most energy efficient at lower operating voltage range. As a result, reduce voltage causes reduction in energy consumption
- Customers do not notice any difference in quality of service

Illustration of how DVVC works

DVVC Off

Customer Voltage **120 Volt**

DVVC ON

1% voltage reduction produces

1% energy savings

Reduce voltage from 120 V to 118.8V

Reduce energy 100 kwh to 99 kwh

Customer Voltage **118.8 Volt**

2015: **Innovative DVVC Optimization Algorithm**

SCE's DVVC Algorithm & System was successfully demonstrated as part of the Department of Energy (DOE)-funded Irvine Smart Grid Demonstration (ISGD) project, resulting in more than 2% energy savings on the test circuits.

- **SCE's patented DVVC capacitor optimization algorithm** was embedded in the Distribution Management System (DMS) to leverage modern control systems and higher computational power.
- This approach coordinates all field capacitors & substation capacitors by calculating numerous capacitor switching options to best optimize both **voltage and VAR.**
- Different Volt/VAR settings are **automatically and continuously adjusted** according to substation loads
- DVVC is also designed with a **Fail-Safe mechanism** to ensure adequate system voltage in the event of a control system or radio communication failure.
- SCE is in the process of determining whether if DVVC can be considered as an energy efficiency program.

What benefits does DVVC provide?

- 1-3% estimated reductions: Even at 1% energy reduction $NPV is significant.
- 2016 – 2018 - Commissioned DVVC at approximately 40% distribution substations

Category	Benefit	Description
Affordability - Less than one month payback	Customer energy cost savings	Reduction of energy through reduction of average voltage results in energy cost savings for our customers (based on avoided procurement and capacity costs)
Environmental	Reduced greenhouse gas emissions	Reduced energy usage leads to reduced emissions; magnitude of the reduction will depend on future generation mix
Operational Excellence	Improved asset management	Detect capacitor failure in real-time; inspections can become targeted, O&M decrease
DER Integration	Voltage regulation w/DERs	Future benefit: supports higher DER penetration levels by integrating capability of smart inverters to help manage voltage and power factor on the grid