Smart Grid Voltage Optimization:

For EPA Clean Power Plan Compliance and Grid Resiliency

National Summit on Smart Grid & Climate Change

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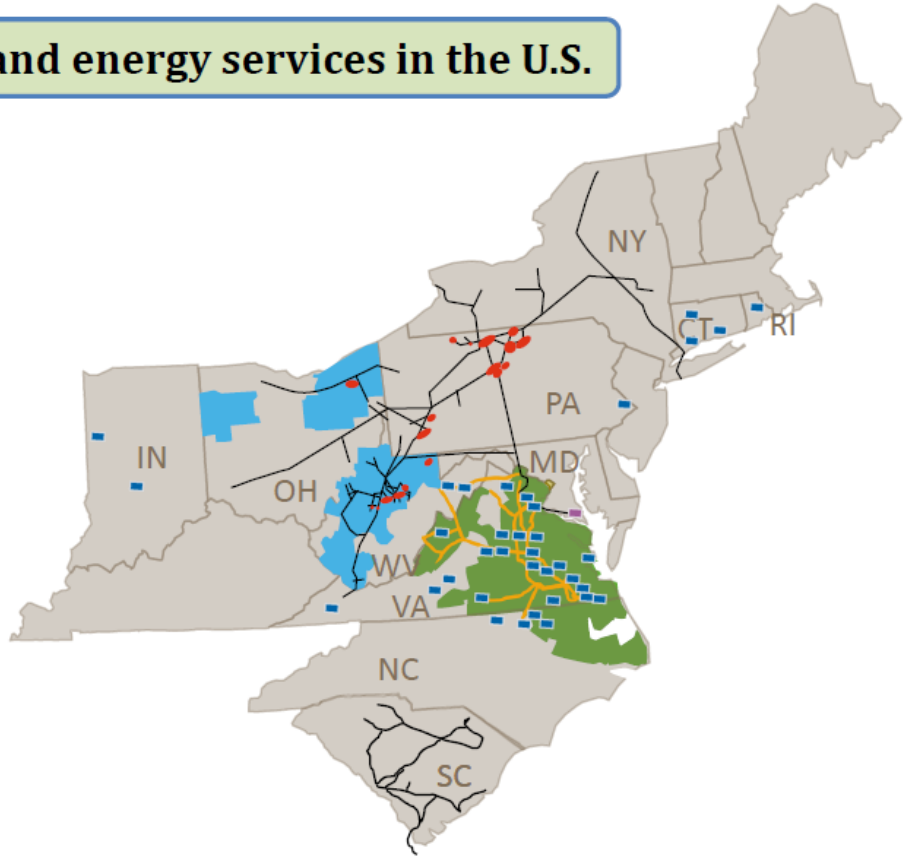
Alternative Energy Solutions
Dominion Resources, Inc.

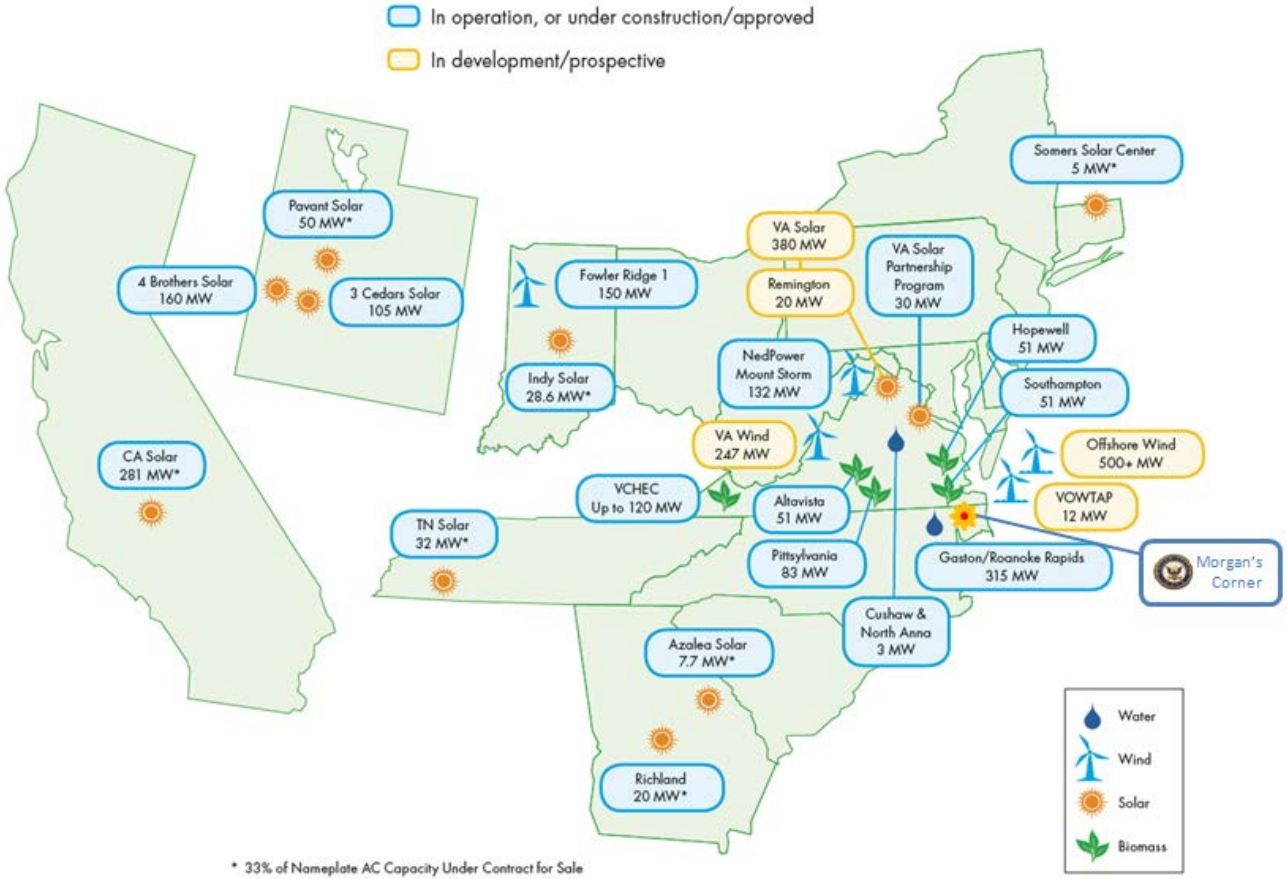
Dominion Resources, Inc.

Leading provider of energy and energy services in the U.S.

- 24,600 MW of electric generation
- 6,455 miles of electric transmission
- 12,200 miles of natural gas transmission, gathering and storage pipeline
- 928 billion cubic feet of natural gas storage operated
- Cove Point LNG Facility
- 2.5 million electric customers in VA and NC
- 1.3 million natural gas customers in OH & WV
- 1.2 million non-regulated retail customers in 13 states (not shown)
- 252 MW of contracted solar generation in 6 states (not shown)



Dominion Resources, Inc.
Renewable Energy Profile



Dominion Voltage Inc. (DVI)

Overview

- Subsidiary of Dominion Resources
- Deliver grid-side efficiency solutions
- Patented approach using AMI data
- Proven customer successes
- Partnerships with world class companies

Built with Utility Expertise

- Utility-scale distribution system
- State goal for verifiable energy savings

More Than Just Software

- Efficient business processes
- Complete grid-optimization program and tools
- Integrate seamlessly into existing systems

Practical Approach

- Delivers immediate value
- Captures greater and more sustainable savings
- Provides continuous improvement process
- Deployable and measureable circuit by circuit

EDGE ENERGY DISTRIBUTION & GRID EFFICIENCY

Every Day It Listens to Your Grid
Every Day It Learns
Every Day Your Grid Gets Smarter and Saves More

EPA Clean Power Plan Validates CVR for Compliance

EPA Clean Power Plan Final Rule:

*"[M]easures that improve the efficiency of the T&D system and/or reduce electricity use may be used…. to reduce [line] losses … and **T&D measures that reduce electricity use at the end-user, such as conservation voltage reduction (CVR)**".*

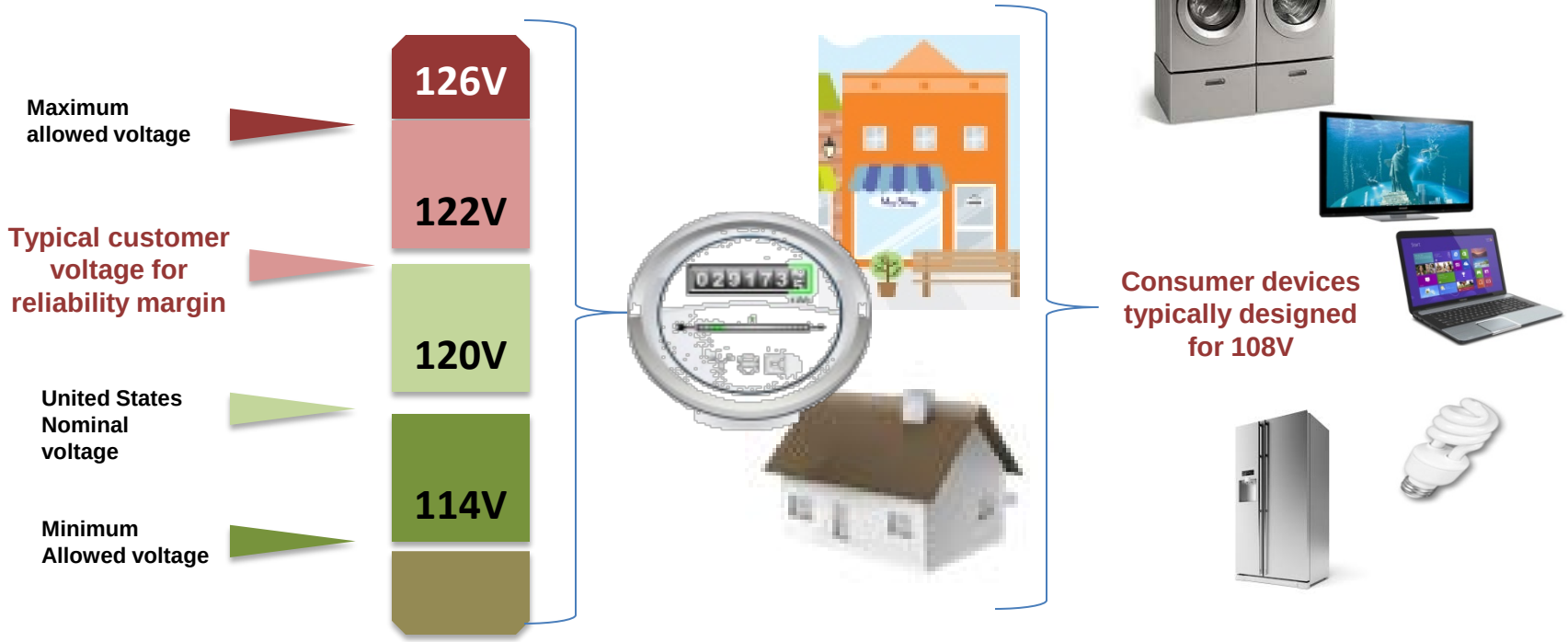
What Can CVR Do for a State's Implementation Plan?

DOE: *"When extrapolated to a national level, complete deployment of CVR … provides a 3.04% reduction in annual energy consumption."*

PNNL 19596, *Evaluation of CVR on a National Level*

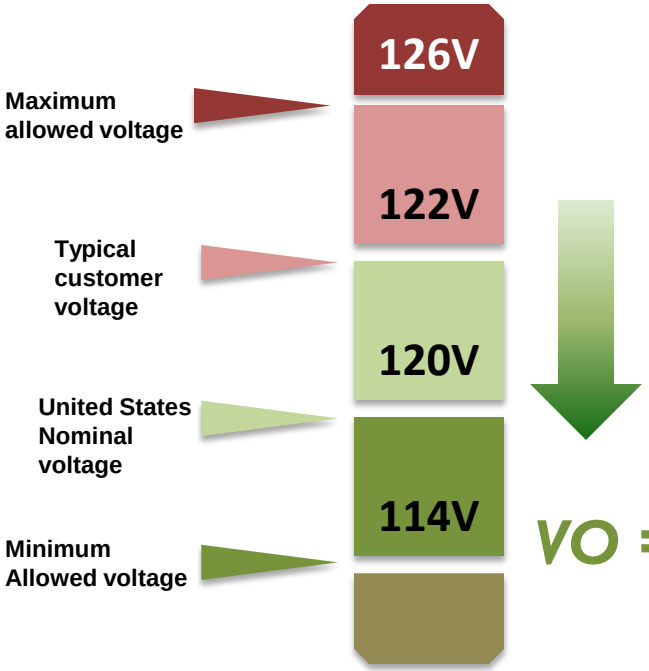
Voltage Standards

ANSI Standard for electricity delivery to customers' meters.



Conservation Voltage Reduction (CVR)
Lower Voltage Reduces Consumption

1% voltage drop = .6 to 1.2% kWh savings.
Excess voltage results in energy waste.

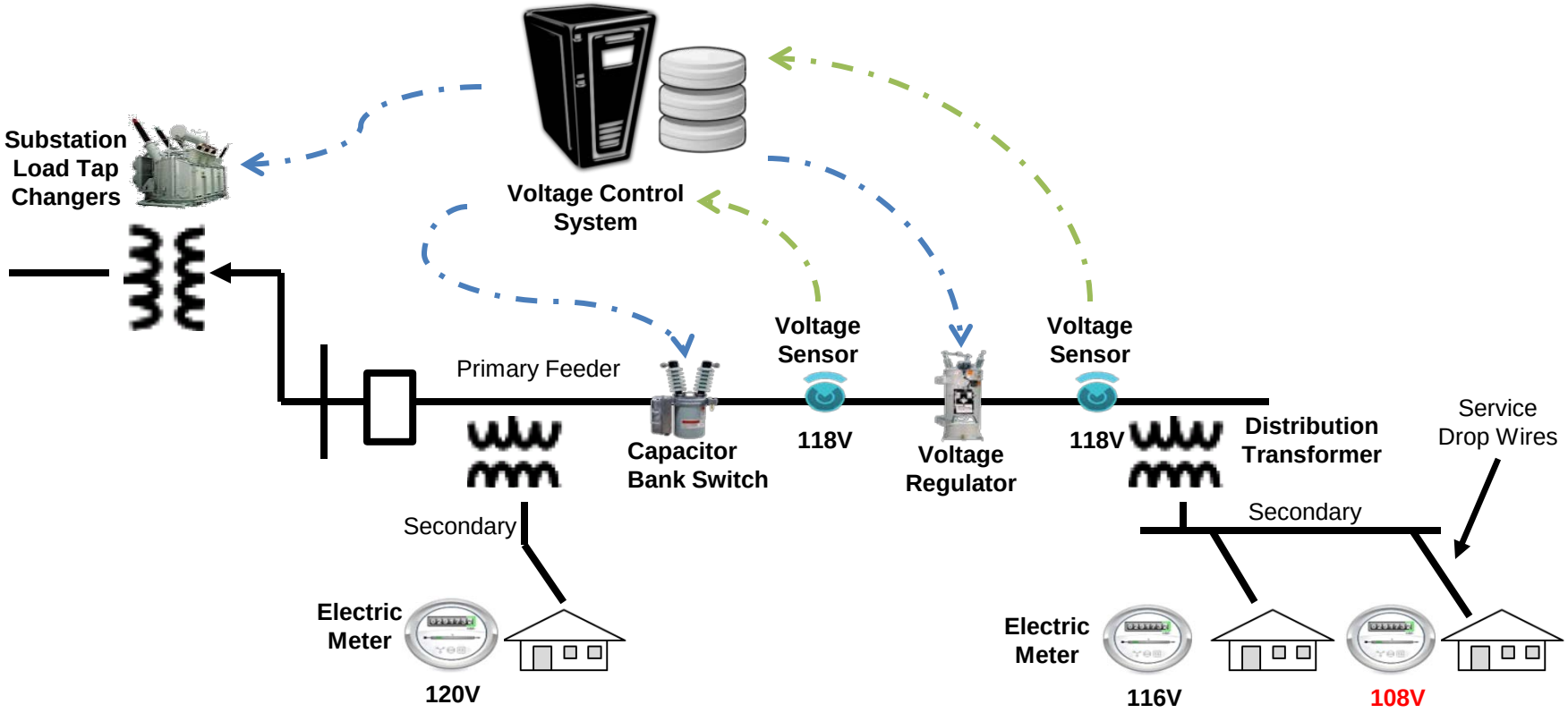


CVR + Smart Grid = Voltage Optimization

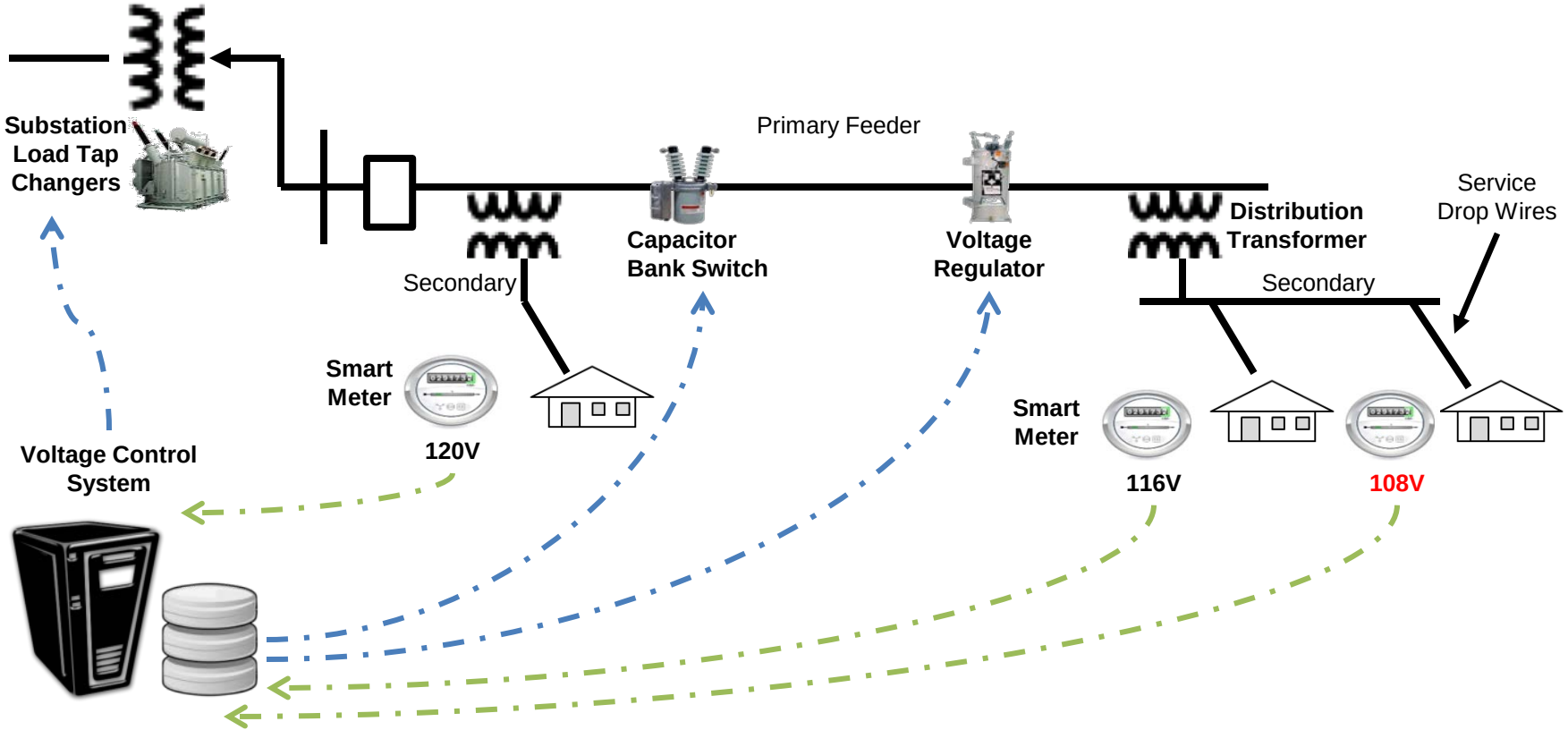
- **24x7 Optimization** *multiplies kWh saved on customers' bills.*
- **AMI visibility and communication** assures *ANSI compliance for all customers.*
- **Automated Voltage Control** *promotes grid resiliency and circuit stability.*

VO = 3% - 5% energy savings

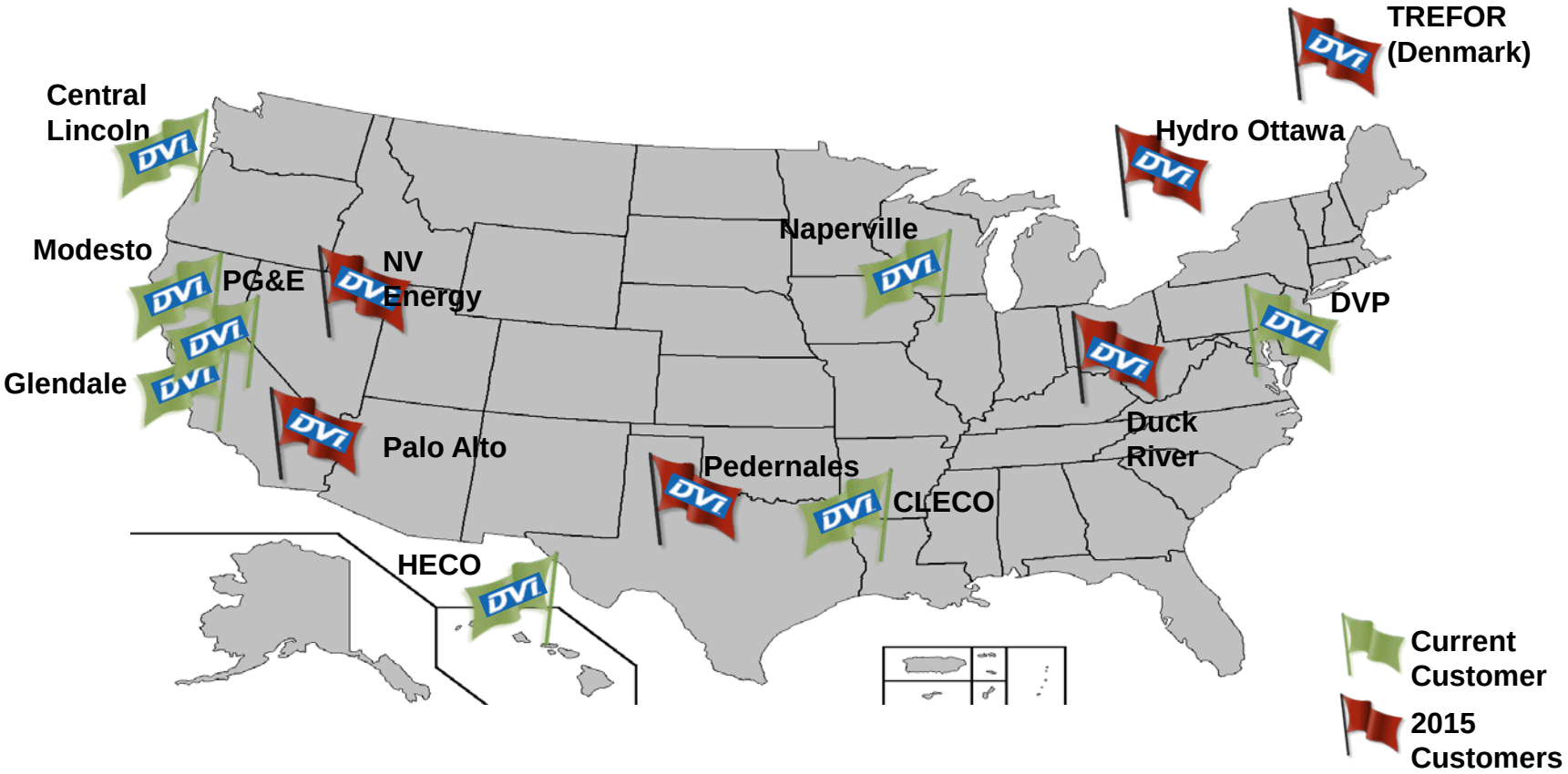
VO/CVR Technology
Primary Sensor Based



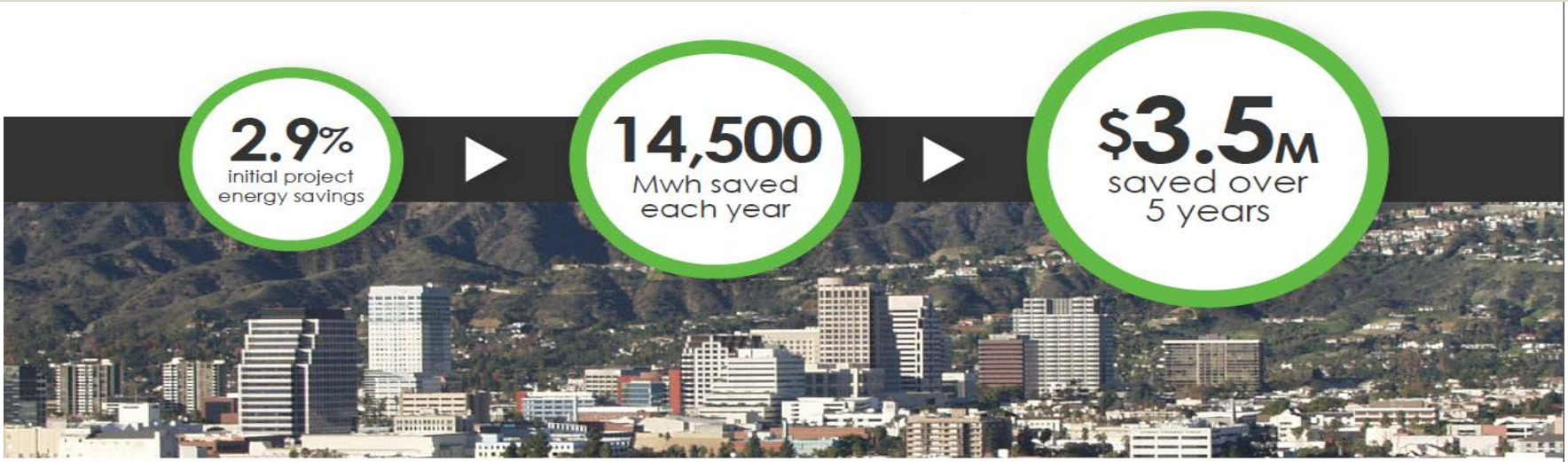
VO/CVR Technology
Smart Meter (AMI) Based



DVI VO Deployment



Glendale Smart Grid VO Project



- The initial VVO/CVR project was to control one circuit with 3,800 meters.
- Project generated 2.95% energy savings
- Glendale plans on deploying VVO/CVR on remaining circuits over the next few years
- Expected savings to be 14,500 MWh per year
- Avoided costs (savings) at $65/MWh expected to be $3.8M

Central Lincoln PUD - Oregon
DOE Smart Grid Investment Grant

- The VO project included one substation, two feeders and 1,400 meters.
- Project began in May for 6 months, during which voltage was reduced from 123.5 to 119.5V.
- Project resulted in 2.15% energy savings or 325 MWh/yr -- from 1 substation.
- Glendale plans on deploying VVO/CVR on remaining circuits over the next few years

"*All socioeconomic groups benefit* as the 2% customer savings occurred *without regard to homeowner or renter status* . . . results of the pilot project were so impressive, that Central Lincoln is undergoing plans for a full system wide implement."

From Central Lincoln DOE Report

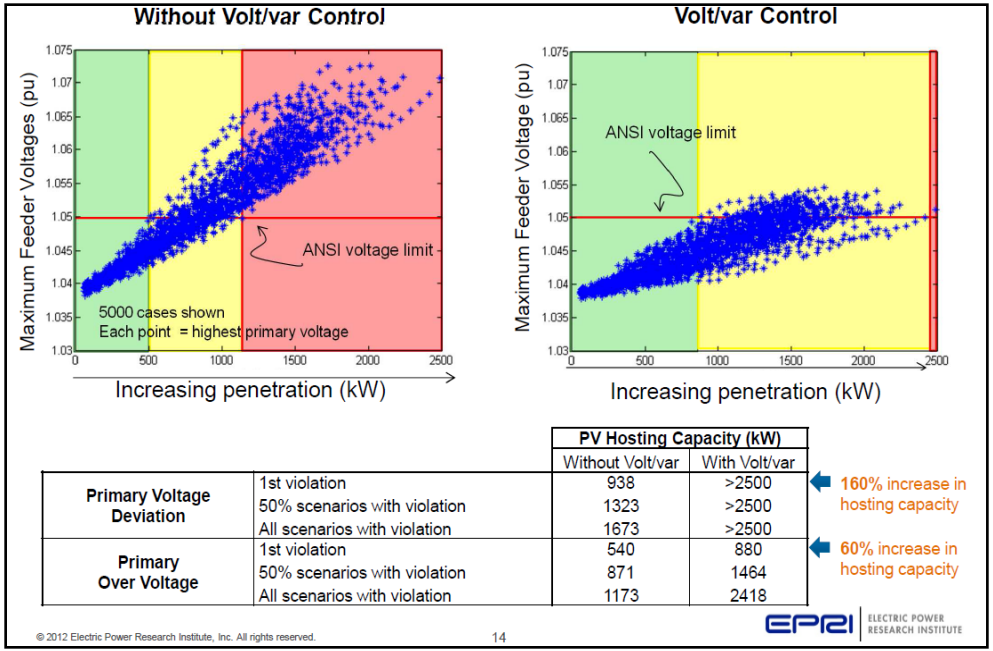
Volt-VAR Optimization (VVO) and CPP Renewable Energy Goals

VVO helps manage load swings caused by:

- Distributed solar generation
- Storage
-Electric Vehicles

VVO stabilizes circuits for more distributed solar

VVO can increase a circuit's hosting capacity by 2x or more.



		PV Hosting Capacity (kW)		
		Without Volt/var	With Volt/var	
Primary Voltage Deviation	1st violation	938	>2500	160% increase in hosting capacity
	50% scenarios with violation	1323	>2500	
	All scenarios with violation	1673	>2500	
Primary Over Voltage	1st violation	540	880	60% increase in hosting capacity
	50% scenarios with violation	871	1464	
	All scenarios with violation	1173	2418	

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EPRI ELECTRIC POWER RESEARCH INSTITUTE

From EPRI's Volt/VAR Research

CPP's Evaluation, Measurement and Verification (EM&V) Opened for Comments

- CPP requires energy efficiency energy savings be quantifiable, verifiable, enforceable, non-duplicative, and permanent.
- An EM&V plan must define a project's baseline and identify independent factors affecting savings.
- States looking to VO savings should file comments that:
  - ✓ EPA distinguish distribution efficiency from behind-the-meter efficiency methods;
  - ✓ EPA recognize rigorous statistical algorithms are available to measure VO within reasonable confidence total energy savings realized by the utility and customers.
  - ✓ EPA should allow SIPs to adopt certified EM&V software as alternative to EPA's Independent Verifier process.

Questions & Discussions