CVR as an Energy Efficiency Resource

Prepared for:

IL Stakeholder Advisory Group

Prepared by:

Applied Energy Group

Kelly Warner

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The AEG CVR Team

About AEG

Applied Energy Group (AEG) is a multi-disciplined, technical, economic and management consulting firm serving electric and gas utilities across North America. Founded in 1982, the company is headquartered in Islandia, NY and is a wholly-owned subsidiary of Ameresco (NYSE:AMRC).
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Energy Efficiency & Demand Response
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•Program Design and Implementation

Information Technology
•VisionDSM – industry leading program tracking software

Business Planning
- Strategic Planning
- Operational Excellence

Renewables and Distributed Generation
- Program Design and Management
- Technical Support

CVR Leadership Team

Kelly Warner – Executive Vice President

30+ years experience (15 as CEO of major consulting and energy services firms) spanning the value chain of the electric and gas utility industry

CEO of Deerpath Energy, Inc., KEMA Inc. and XENERGY Inc.

Ron Willoughby – Executive Consultant

38+ years experience in electric power systems planning and operation.

VP at KEMA; Director of technical services at Cooper Power Systems; Manager for Westinghouse's Advanced Systems Technology Group.

Agenda

CVR Technology Overview

- How it works
- Voltage reduction and end use load impacts

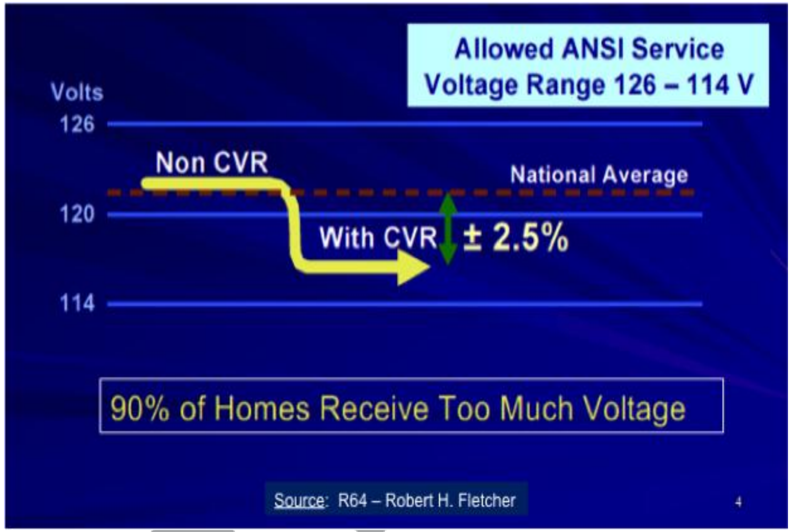
CVR as an EE Resource

- CVR Potential
- Economics
- Industry results

Knowledge Gaps and Issues to Consider

CVR - a technology whose time has come

- Proven technology used on a limited scale by utilities over the past 3 decades.
- Lowering voltages improves the efficiency of many end-use appliance
  - Most customers receive voltage at the high-end of the ANSI range.
- The intersection of interest in Smart Grid and Energy Efficiency are increasing awareness of CVR.
  - Low-cost, scalable, controllable
- Utility business case and regulatory constructs are holding back CVR's potential
  - Utilities incur the cost while customers receive the benefit
- When viewed as an EE resource, CVR has huge potential.



1. CVR is also referred to as Conservation Voltage Regulation, Conservation Voltage Optimization (CVO), or Volt/VAR Optimization (VVO).

Standard Voltage Regulation Using Substation LTC

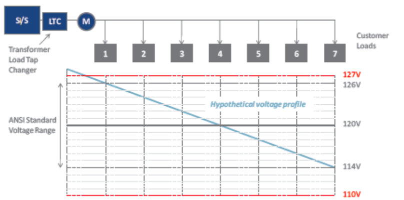


Figure 1. Hypothetical Feeder Voltage Profile with an LTC

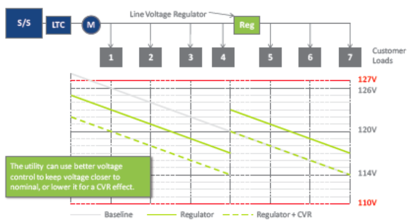


Figure 2. Hypothetical Feeder Voltage Profile with an LTC and Voltage Regulator

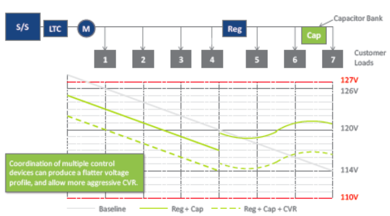
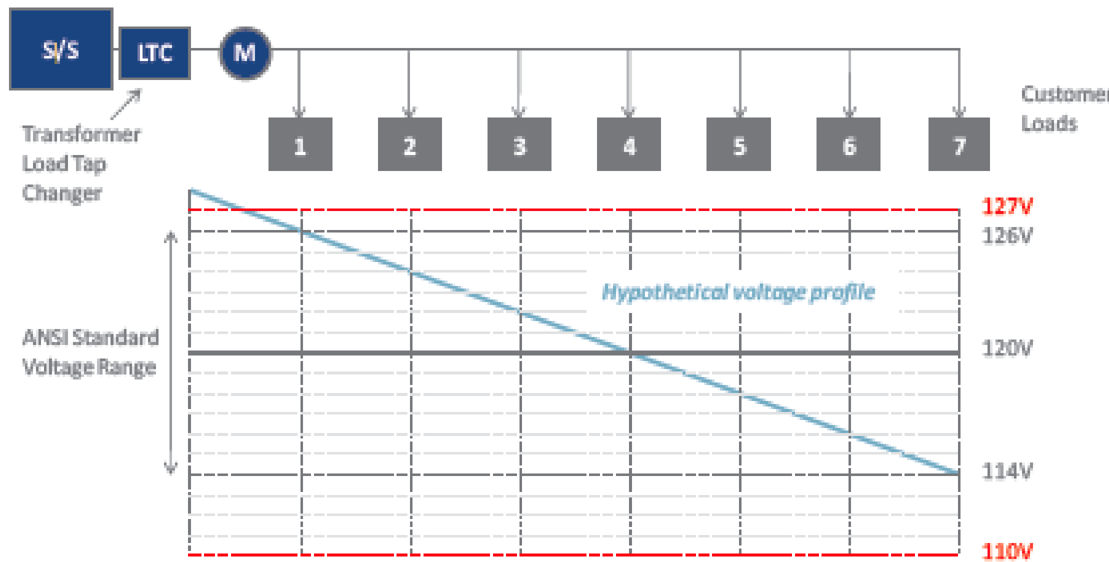


Figure 3. Feeder Voltage Profile with LTC, Voltage Regulator and Capacitor Bank



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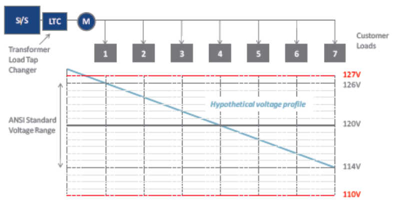
Source: Application of Automated Controls for Voltage and Reactive Power Management – Initial Results. DOE – Smart Grid Investment Grant Program, December 2012

Enhanced Voltage Regulation Using Downstream Voltage Regulators



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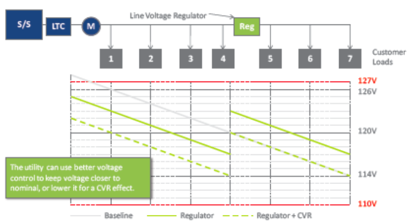

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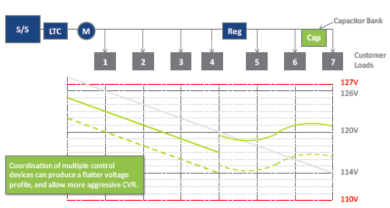

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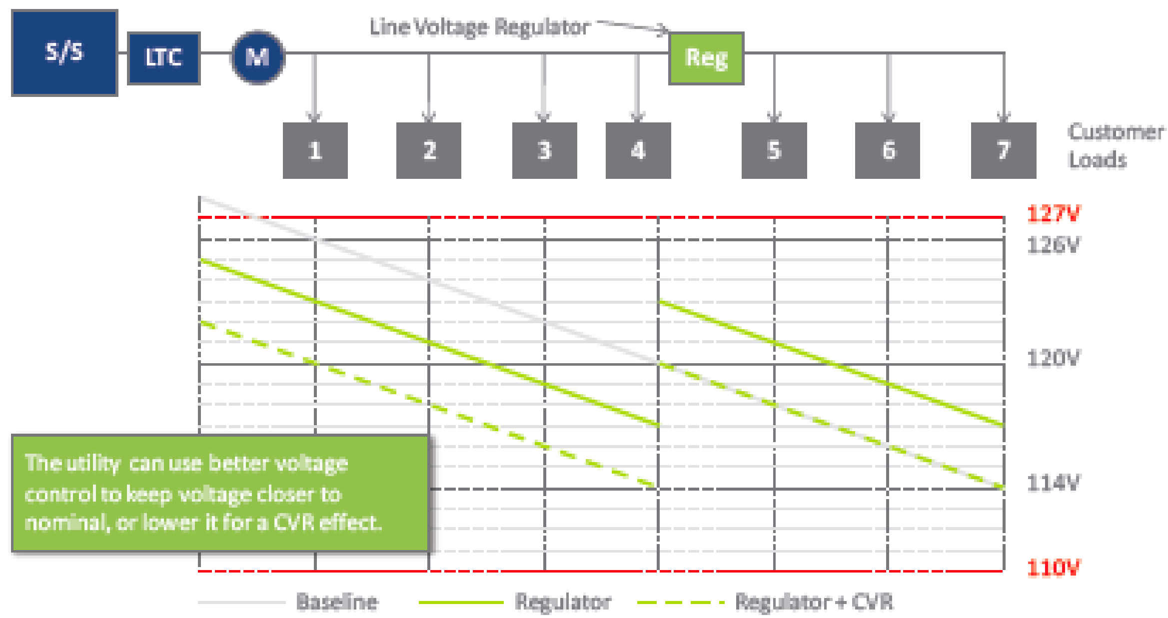

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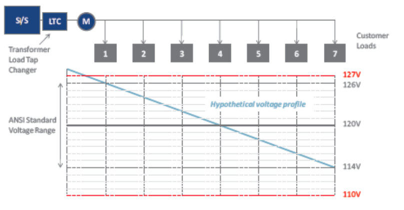
Voltage Regulation Using V-Regs and Capacitors



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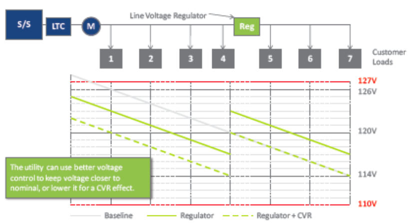

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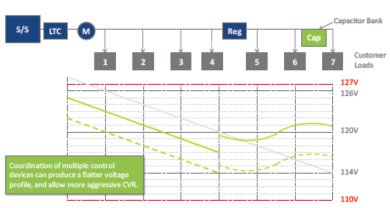

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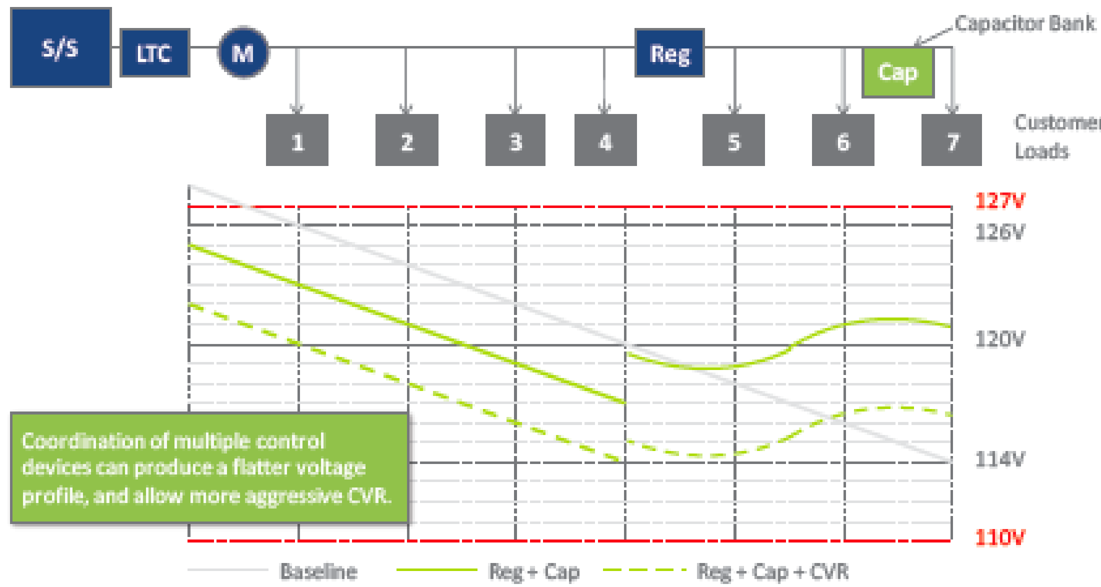

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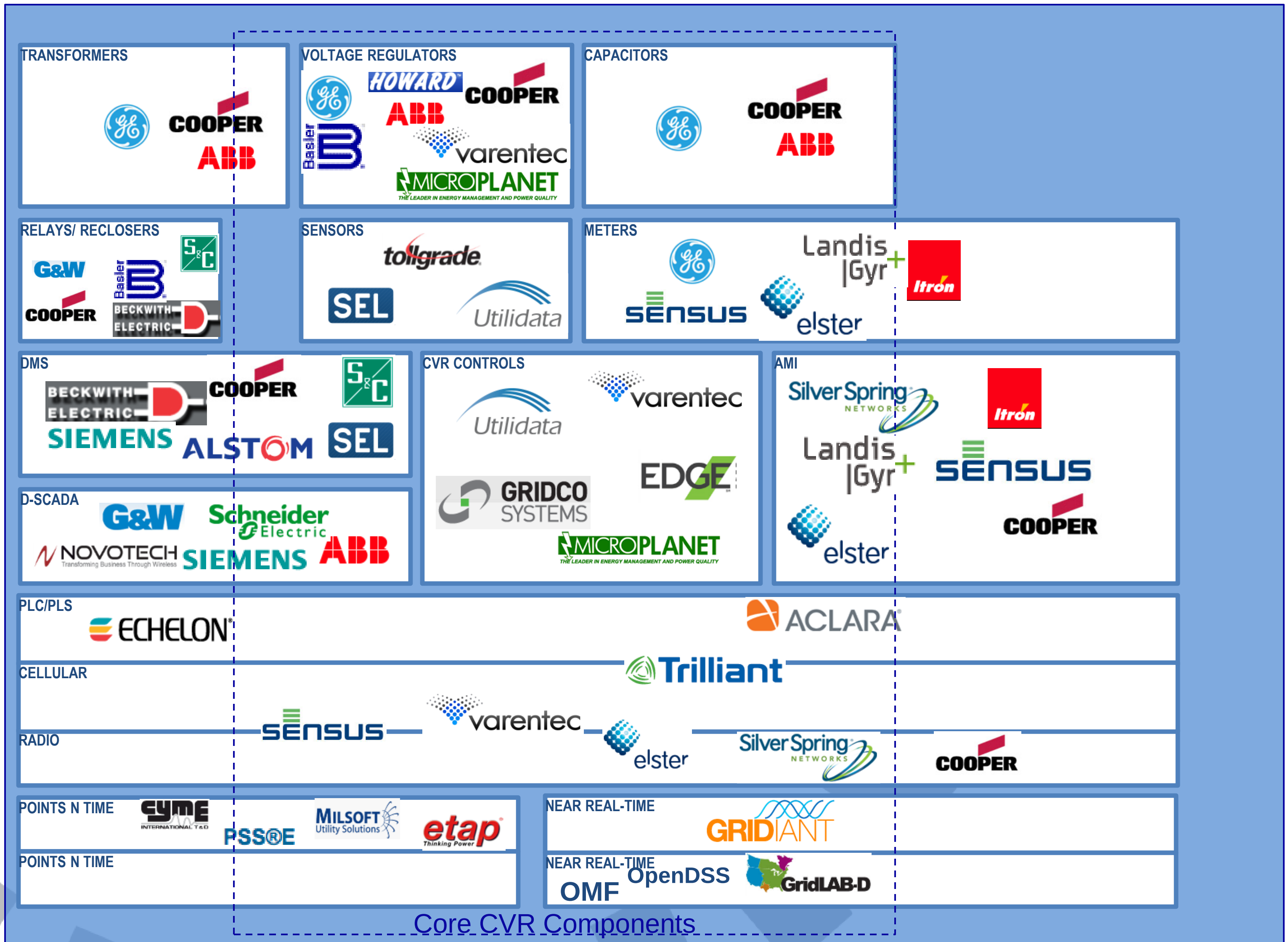
CVR Market Taxonomy

Devices

Software and Control Systems

Communication Infrastructure

COMMERCIAL - Planning Tools - OPEN



DA

Proprietary

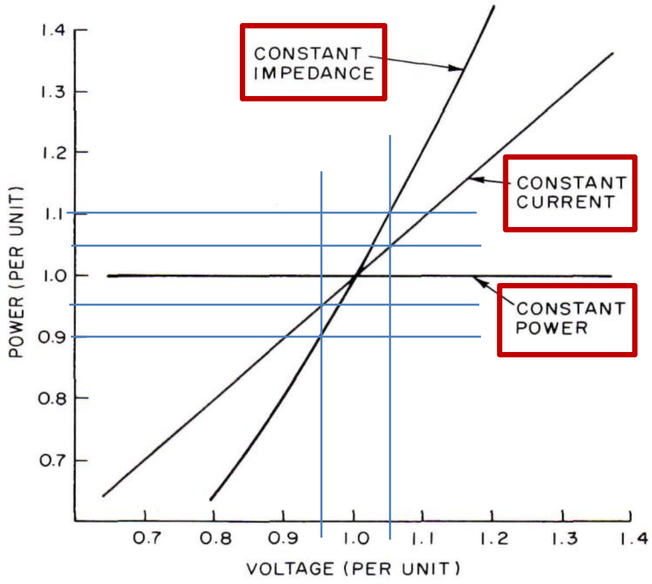
AMI

CVR Operating Models

CVR Strategy	Operating Model	Benefits
Emergency Load Relief	Short-term event-specific voltage reduction	System protection during emergency events
Substation Voltage Reduction	Continuous substation voltage optimization	Distribution systems energy savings at the sub-station
Peak Load Management	Economic dispatch model during high avoided-cost periods	Avoided high margin supply costs during peak periods
Customer End-use Efficiency	Continuous dynamic voltage control across an entire feeder	Customer energy and demand savings

Understanding how CVR affects customer loads is a critical step to using CVR as an EE resource

Load Types



- Voltage reductions affect end use loads differently.
    - Circuits w/ more constant impedance loads will show more savings than constant power loads.
- Assessing CVR potential is a function of knowing what types of loads are on each circuit.
- Targeting "high value" feeders is important. PNNL estimates that 40% of the feeders account for 80% of the CVR potential.

Reference: IEEE Brown Book, ANSI/IEEE Std 399-1980

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PNNL, PG&E, ConEd, and others have validated end-use impacts of voltage reduction.

Pacific Northwest National Labs has conducted significant lab tests and computer simulations of CVR affects on end-use power consumption

- End-use specific load impacts
- Efficiency potential
- Load Models

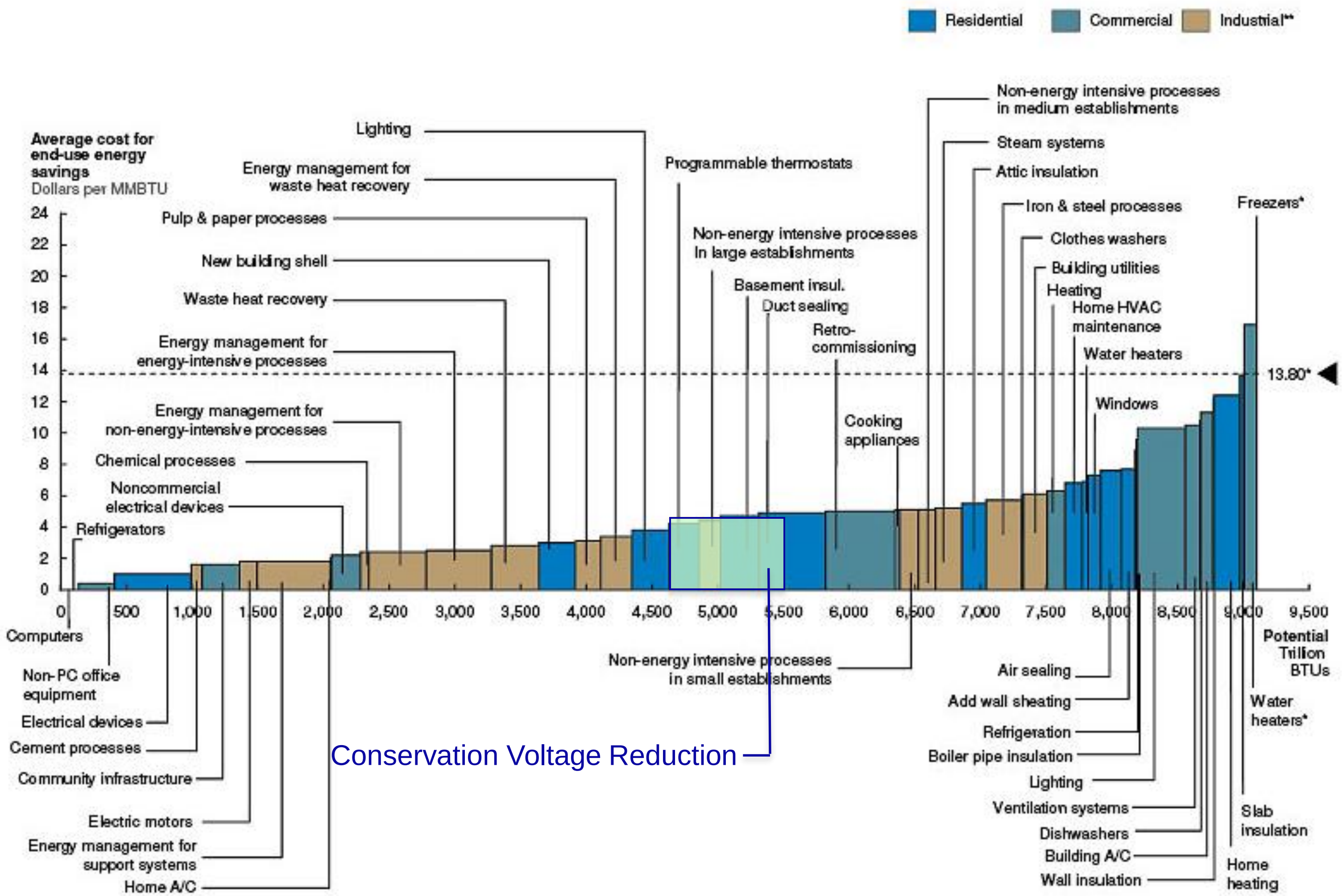
Powered-Down Appliances

118 VOLTS VS. 122 VOLTS

Appliance	Conserved power (watts)	Conserved power (percent)
INDUCTION MOTOR		
Fan	4.2	6%
DISPLAY		
CRT TV	2.1	4%
LCD TV	0	0%
Plasma TV	–2	0%
Desktop LCD	–0.6	–2%
LIGHTING		
13-W compact fluorescent lamp (CFL)	0.9	8%
20-W CFL	1	6%
LED (low quality)	0.2	6%
75-W incandescent	3.4	5%
42-W CFL	0.8	2%
LED (high quality)	0.1	1%
LED (medium quality)	–0.1	–1%

Source: Peter Fairly, IEEE Spectrum, Oct. 2010

CVR adds significantly to cost-effective EE resource potential, with a potential to save 750 Trillion BTU's at $4.40/MMBTU***.



* Average price of avoided energy consumption at the industrial price; $35.60/MMBTU represents the highest regional electricity price used; new build cost based on AEO 2008 future construction costs

** Our 49th source of savings, refining processes, offers no NPV-positive savings

Source: EIA AEO 2008, McKinsey analysis

*** extracted from Pacific Northwest National Labs "Evaluation of CVR on a National Level" July 2010

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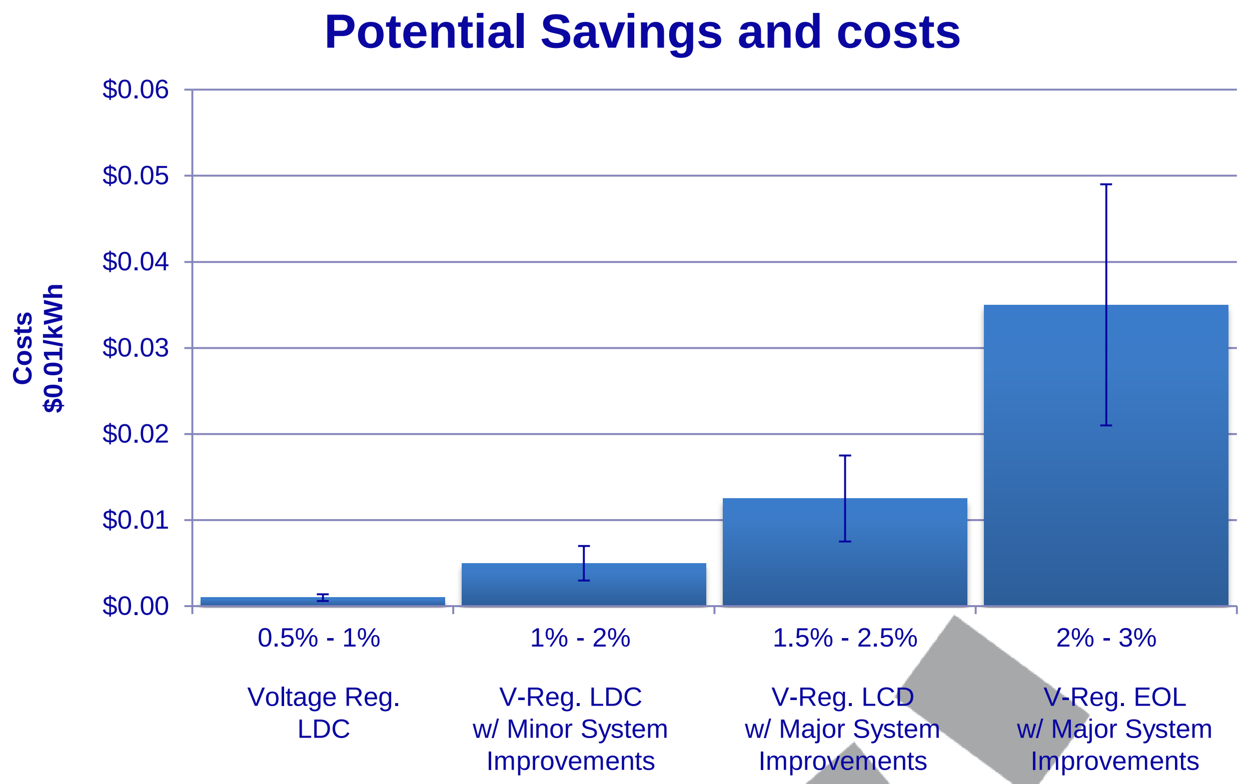
While low cost CVR options exist, deeper CVR deployments have the potential to generate significant savings at very reasonable costs



Source: Northwest Energy Efficiency Alliance, Distribution Efficiency Initiative Project Final Report. December 2007

CVR pilot project show promising results

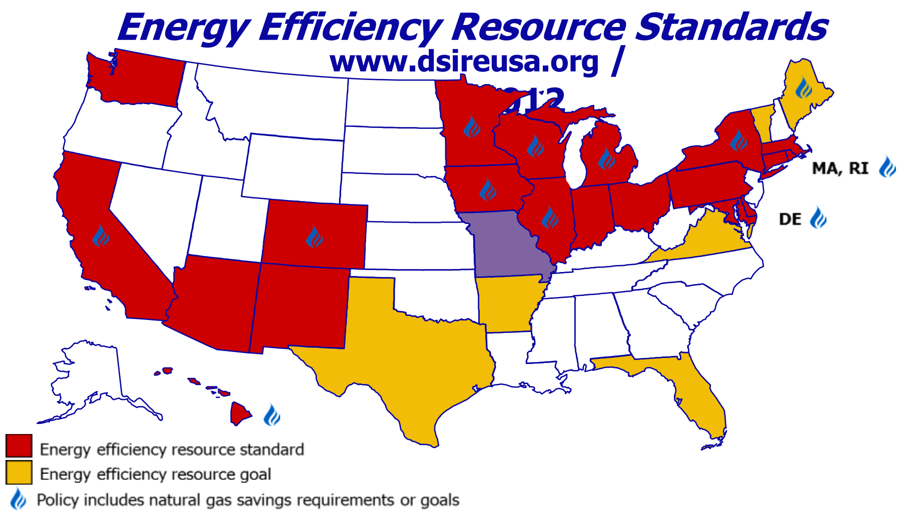
R#	Utility	Voltage Reduction (ΔV%) 120V base	ANNUAL SAVINGS from CVR			CVR Metrics			
			Energy Reduction (%)	MW	(MWH)	Total Resource Cost B-C Ratio	$/MHh	$/KW installed	CVRf = ΔE% / ΔV%
Energy Savings from CVR									
118	**Alabama Power (Note 3)**	3.62%	2.71%	0.33	1,705	1.8	$20.35	$487	0.75
118	**Alabama Power (Note 3)**	2.81%	2.47%	0.18	934	1.8	$20.83	$499	0.88
98, 115	**Avista Utilities**	1.40%	3.15%	0.33	1,729	0.8	$31.40	$752	2.25
100, 105	**Clark County PUD**	1.40%	0.82%	0.31	1,600	0.1	$203.93	$4,883	0.59
100, 106	**Cowlitz County PUD**		1.02%	0.30	1,545	0.2	$94.74	$2,269	
118	**Duke Energy (Note 3)**	1.89%	1.64%	0.21	1,087	4.0	$7.46	$179	0.87
118	**Duke Energy (Note 3)**	1.89%	1.73%	0.12	628	2.3	$12.91	$309	0.92
98, 114	**Flathead Electric**	3.33%	7.19%	19.10	99,367	2.5	$8.74	$209	2.16
Demand Response Savings from CVR									
63, 104	**City of Manassas**	2.50%	2.00%	2.72	0	20.1	NA	$55	0.80
R121	**Case Study [CONFIDENTIAL]**	5.00%	3.28%	13.12	0	1.9	NA	$206	0.66

Utility Early Adopters of CVR as an Energy Efficiency Resource

Utility	Program Attributes
PECO	First utility to receive regulatory approval to use CVR to achieve EE targets. 320,000 MWh 1st year savings achieved through CVR-lite (1/3 of 4yr goal). Deeper deployment in planning stages.
BPA	Extensive CVR R&D. Currently offering $0.025/kWh saved over 10 years. Extensive M&V
AEP	35 feeder pilot of advanced CVR. Motivated my Ohio SB 221 allowing distribution efficiencies to count towards EE goals
TVA	Commitment to spend $60M over the next 5 years for CVR EE incentives for member utilities.
SMUD	Large scale deployment of automation equipment targeting improved power factor, peak demand reductions, and EE
DOE - SGIG	26 utility CVR projects; 7 using CVR for EE

Regulatory	
NARUC	November resolution supporting Volt/VAR as an EE resource
OHIO	SB221 mandates EE; includes distribution efficiencies

Energy Efficiency Resource Standards and Regulatory Incentive Mechanisms are driving the market for EE. CVR has the potential to benefit from these activities.



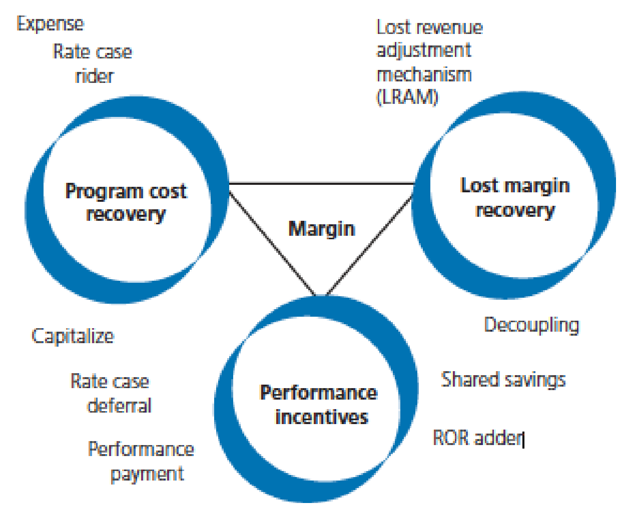
The EE industry has developed a wide range of performance incentives and cost recover mechanisms that reward utilities for achieving EE goals.

Ohio SB221 specifically defines grid activities such as CVR as EE measures that count towards a utilities EE goals.

NARUC recently passed a resolution to allow CVR to be included in EERS.

Over half of the States have EERS or EE resource goals.

In States with long-established EE programs, escalating goals and the impact of codes and standards are creating a need for new, innovative sources of cost-effective EE. CVR could be a very attractive option for highly-saturated EE markets.



Source: Aligning Utility Incentives with Investment in Energy Efficiency. November 2007. National Action Plan for Energy Efficiency

CVR has similar benefits to DSM when viewed across multiple stakeholder perspectives

Utility	Participating Customer	Rate Payers	Society
• Lower generation costs and carbon emissions • Better utilization of T&D assets • Deferred T&D capital investments • Cost-effective EE goal attainment	• High percentage of customers are participants • Energy savings and bill reductions • Equipment life extension • No action or investment required	• Average bills are lower • Potential negative impact on rates (based on marginal avoided cost structure). • Low cost EE goal attainment	• Carbon reductions • Positive environmental impacts • Positive societal economic impacts

CVR-C
CONSERVATION
VOLTAGE REDUCTION
CONSORTIUM

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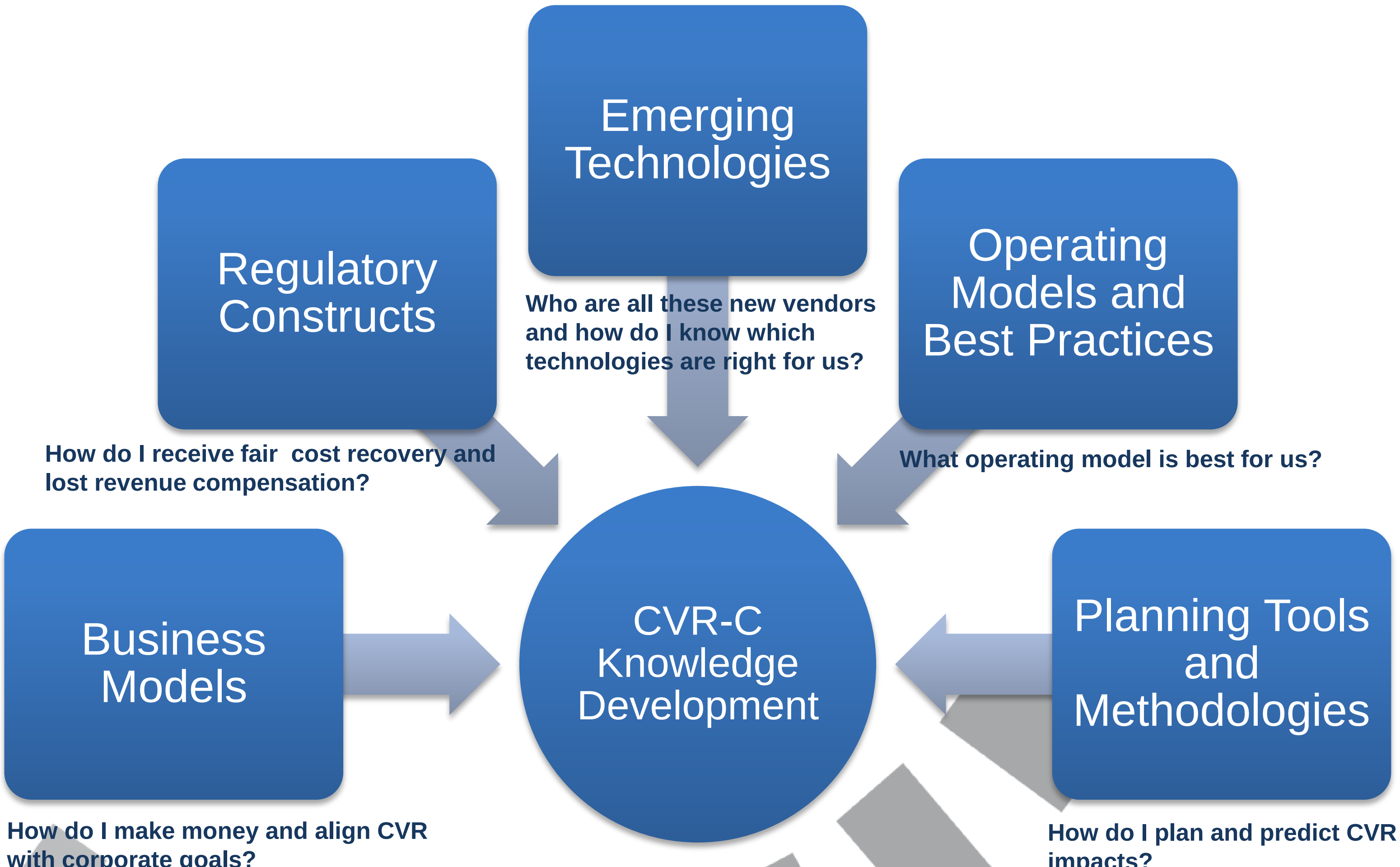
CVR-C Consortium: much to learn, much more to gain



Issues to Consider when addressing CVR as an EE Resource

Defining costs and benefits

- Costs – incremental, overlap w/ other SmartGrid investments, etc.
- Benefits – energy, peak, power quality, line losses, etc.

Incentive mechanisms to capture maximum savings potential

- Deep penetration per circuit
- Persistence of savings.

Funding mechanisms

- SBC, Ratebase, other?

M&V

- There are no formally established M&V protocols.
- Ensuring persistence of savings

Interaction with DG

- Voltage regulation on high penetration DG circuits

Thank-you!

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