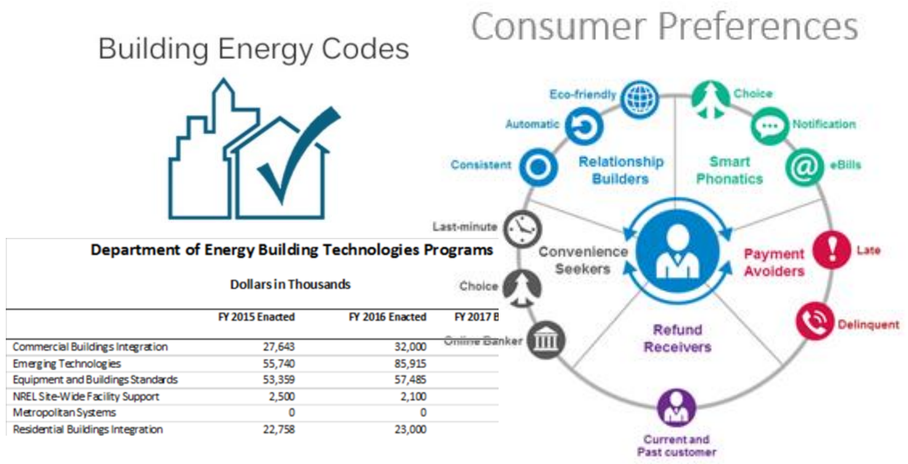
Distribution System Efficiency: Conservation Voltage Reduction (CVR)

Big Question: Is Conservation Voltage Reduction a viable and economical energy efficiency technique?

What is energy efficiency? Using less energy to provide the same service.



Department of Energy Building Technologies Programs

Dollars in Thousands

	FY 2015 Enacted	FY 2016 Enacted	FY 2017 B
Commercial Buildings Integration	27,643	32,000	
Emerging Technologies	55,740	85,915	
Equipment and Buildings Standards	53,359	57,485	
NREL Site-Wide Facility Support	2,500	2,100	
Metropolitan Systems	0	0	
Residential Buildings Integration	22,758	23,000	

Conservation Voltage Reduction:
CVR is a proven method to reduce energy and peak demand.
It controls the voltage on a distribution circuit to stay within the lower 5% of the ANSI standard voltage range (+/- 5% of nominal voltage) for that circuit.

Benefits of CVR:

- Improves the efficiency of many end-use appliances
- Power quality improvements and line loss mitigation
- Customer AND distributor see energy savings
- Cost effective, scalable, and controllable.
- Voltage regulation on high penetration DG circuits
- Reduces overall energy consumption

FACT: According to the DOE, 90% of homes and businesses receive more voltage than they need.

Where do I start and how does it work?

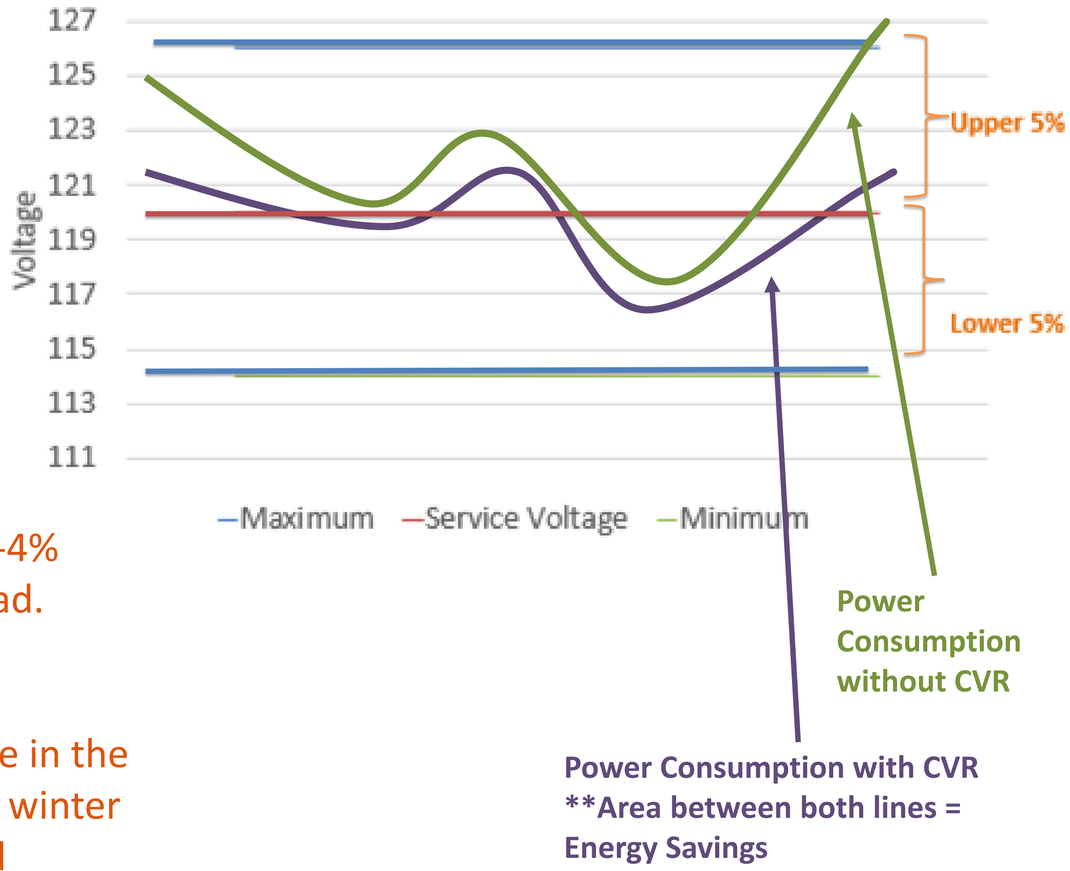
Where should I start?
Am I a good candidate for CVR?

- Short lines
- Moderate load on feeders
- A highly resistive load (mainly residential customers)
- High percentage of meter penetration

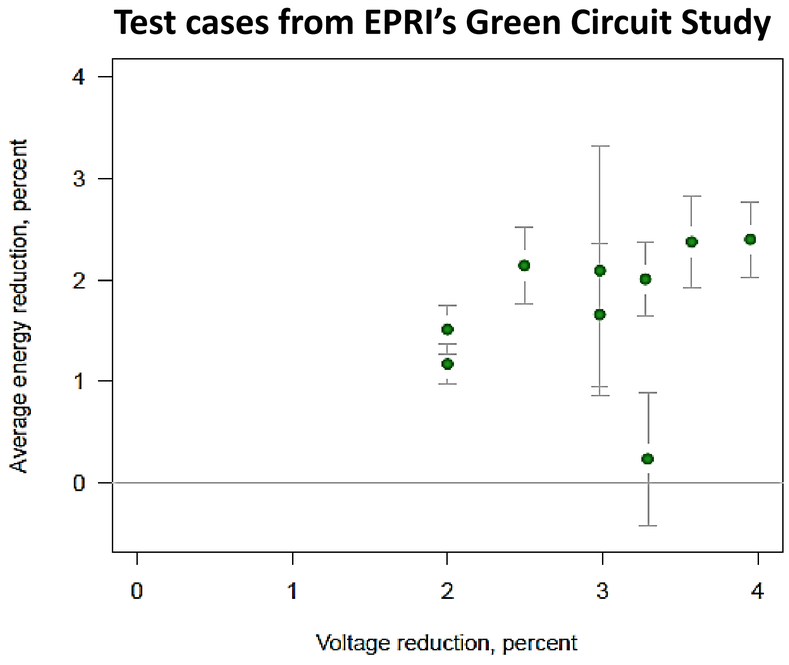
ANSI C 84.1 Voltage Range

Nominal Service Voltage	Desirable Range (Range A)	Acceptable Range (Range B)
120	126-114	127-110
208	218-197	220-191
240	252-228	254-220
277	291-263	293-254
480	504-456	508-440

Voltage Reduction Effects on Power Consumption



Test cases from EPRI's Green Circuit Study



Results from test analysis:

- Substation voltage reduction of 2-4% produces a 1.6-2.7% savings in load.
- A 1% change in voltage generally decreased load by 0.6-0.8%.
- Voltage reduction is most effective in the summer and least effective in the winter (when thermostatically controlled heating load (constant energy) is present).

City of Palo Alto (CPAU) DEED Project – Evaluation of Conservation Voltage Reduction

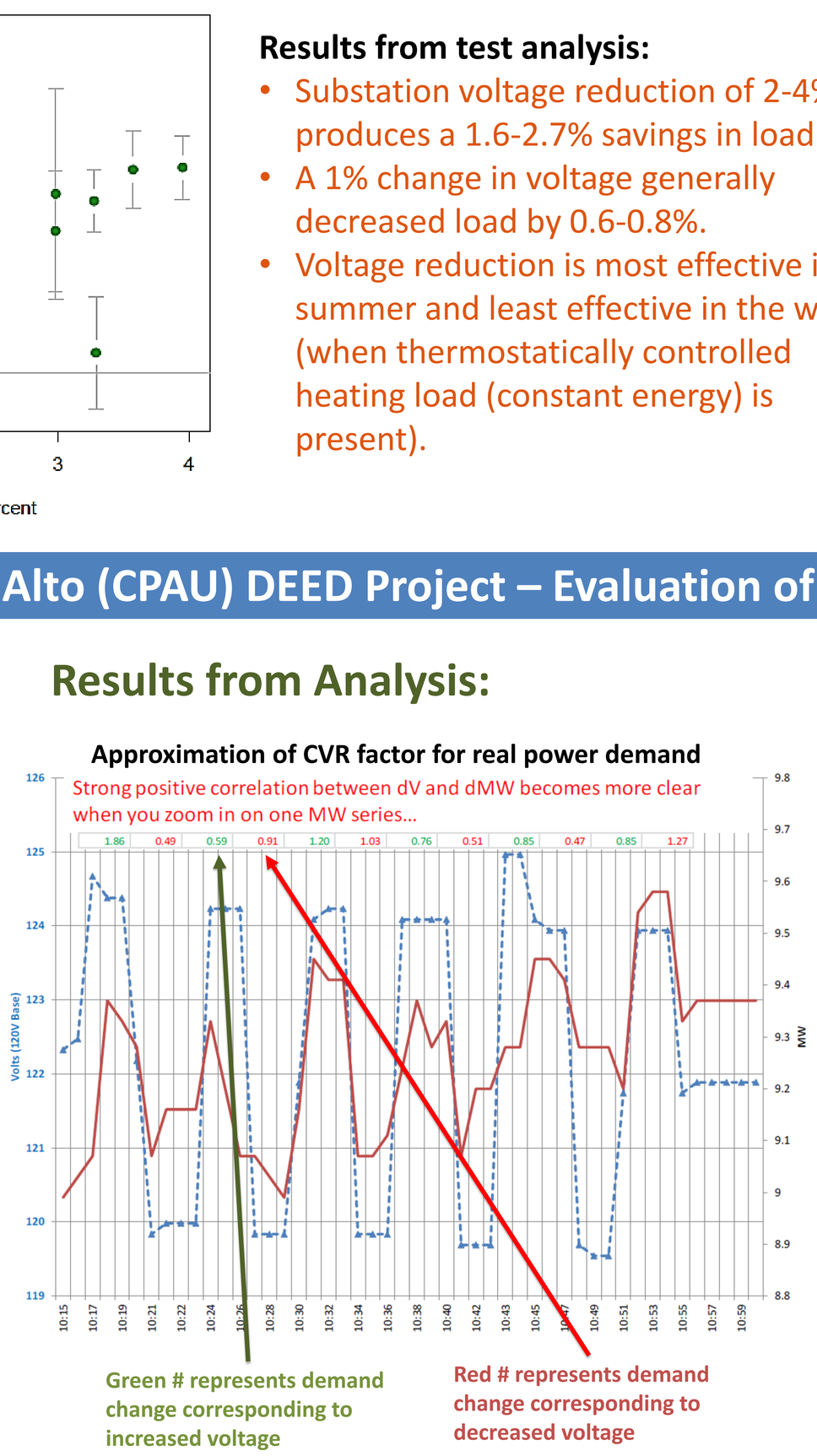
Preliminary Analysis:

Characteristics of City of Palo Alto:

- Serves 29,000 customers, 185 MW of peak demand across 25 square mile territory
- Relatively dense service area
- Majority of the main line feeders range around 1.3 miles
- One load tap changer on each transformer bank
- About 80% of load is light/medium commercial

Results from Analysis:

Approximation of CVR factor for real power demand



Day-in/Day-out testing outcomes:

- Substation voltage reduction of 1% produced approximately 0.5-1.0% savings in load.
- Reactive power was fairly stable throughout tests
- The results in real and reactive power from the experiment closely matched the results of the studies done by EPRI and others – this provided higher confidence in that CPAU's load characteristics will enable similar savings with CVR.

Takeaway from the study:

- The absence of end-of-line meter data for residential customers and of time series meter level load data made it difficult to generate a perfectly accurate representation of load allocation across each feeder.
- It was not possible to test for all load variations during the test sequence.

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