WESTERN RESOURCE ADVOCATES

PROTECTING THE WEST'S LAND, AIR, AND WATER

Distribution Voltage Optimization

Energy Savings for All customers through Investment in Grid technology

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Distribution Voltages are Higher than necessary

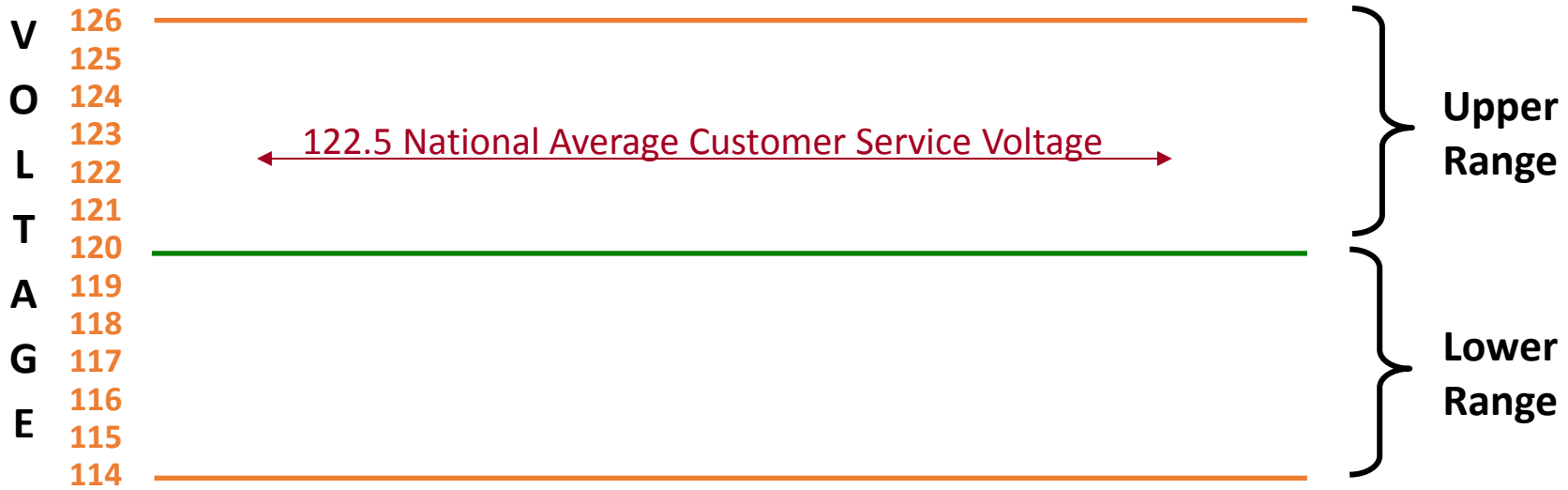
- **90%** of homes and businesses receive more voltage than they need.

-US Department of Energy

Average voltages are higher than necessary

National Standard - Service Voltage Range 126 - 114 VAC

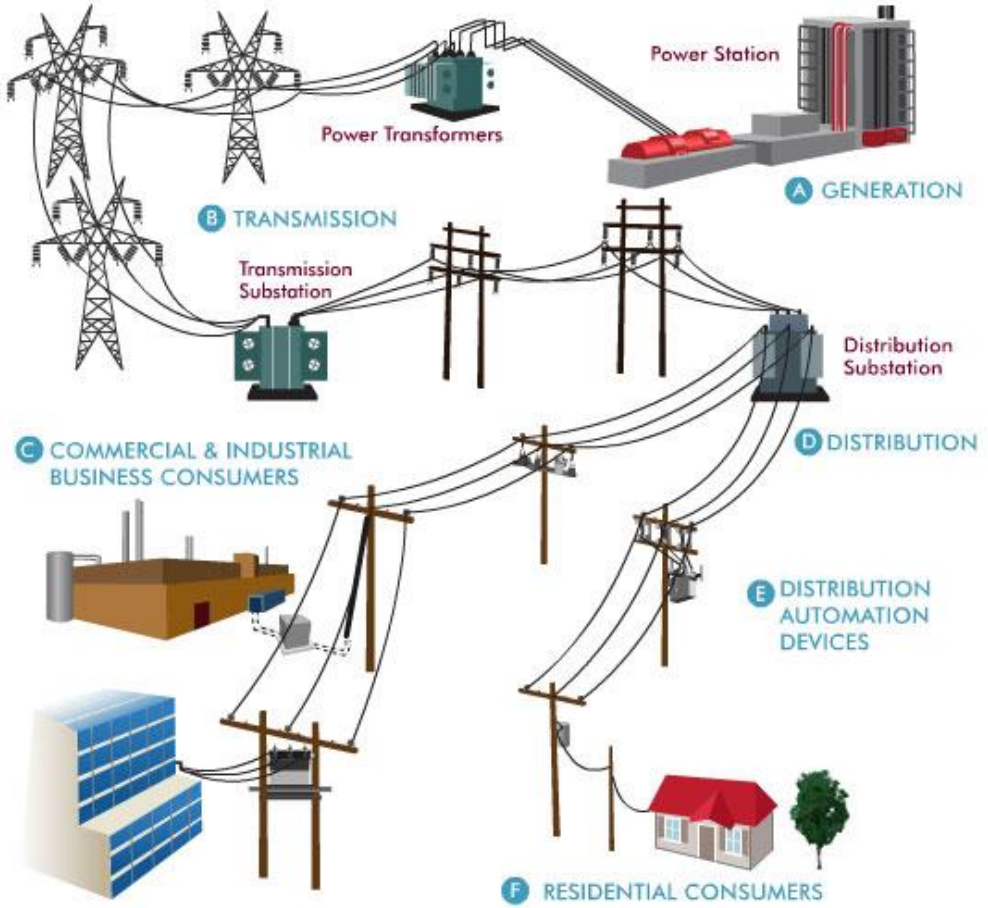
At customer wall outlet



How do excessive voltages waste energy?

A little physics

- Power = Voltage x Current (kW)
- Energy = Power x time (kW hours)



Why Do Utilities Run Voltages High?

- Lack of real time voltage measurements at customer meter
- Don’t want to get low voltage complaints
- Good metering with communication links was expensive in the past
- Lack of vendors for integrated solutions
- Lack of incentives for investments in improvements

The Solution

CVR – Conservation Voltage Reduction

Also called

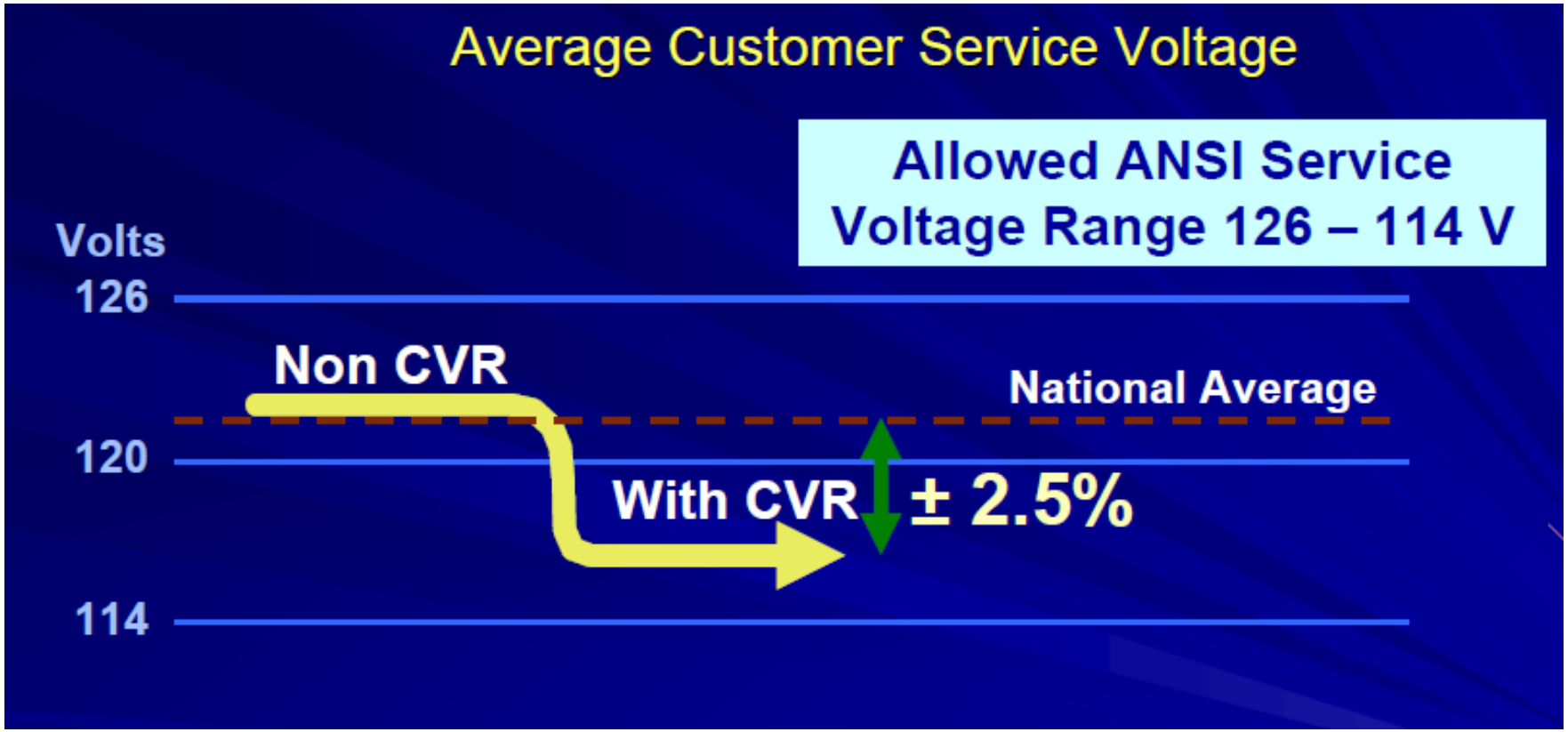
VVO – Volt/VAR Optimization

DVO – Distribution Voltage Optimization

Must be done with a software controlled system designed to do CVR

– not with traditional, manual CVR

What is CVR/DVO?



Use a lower voltage range on each feeder

How can voltage ranges be reduced?

Continuously monitor feeder voltages and use Capacitor Banks (CAP Banks), Voltage Regulators and Load Tap Changers (LTCs) to adaptively reduce voltages on each feeder at a substation

Equipment		Grid Locations	Grid Functions
Load tap changers		Substation transformers	Adjusts feeder voltages at the substation
Voltage regulators		Distribution feeders or substations	Adjusts voltages at the substation or along the feeder
Capacitor banks		Distribution feeders or substations	Compensates for reactive power and provides voltage support

Steps to Construct CVR

- Levelize the voltage along the length of each feeder
- Install voltage meters on each feeder
- Install a communication system for information and control
- Install automated controls at CAP Banks and Load Tap Changers
- Install CVR software to adaptively control voltages on feeders at each substation

Voltages on feeders change with load

- **Time of day** (morning, afternoon, evening, night)
- **Day of week** (weekday, weekend)
- **Season** (Summer, Winter, Spring/Fall)
- **Changes in usage** (PV systems, EV charging, Large TVs)

Modern CVR/DVO adaptively changes voltage

CVR system monitors voltages at multiple points on each feeder

Voltages levels are communicated to central system

Central system considers multiple factors and sends commands to equipment

Voltages are adaptively changed based on voltage levels

Measurement and Verification process monitors energy savings

Does CVR Actually Save Energy

Yes!

Pacific Northwest National Laboratory (PNNL)

- If CVR is implemented on every feeder in the US, annual energy consumption will be reduced by 3.04%

Pilot projects in multiple utilities have demonstrated energy savings and capacity reduction during peak hours

95% of energy savings is behind the customer's meter, reducing customer bills

Behind the Meter Energy Savings

Motors operate on frequency, not voltage - higher voltages merely cause resistive loss

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Air conditioners (compressors and blowers)
Refrigerators
Heater fans
Washer/drier motors

Lighting – reduction in voltage generally unnoticed as slight dimming in lights

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Reduction in energy use for virtually all lighting types

Generally, for each 1% reduction in voltage there is at least a 0.8% reduction in energy use

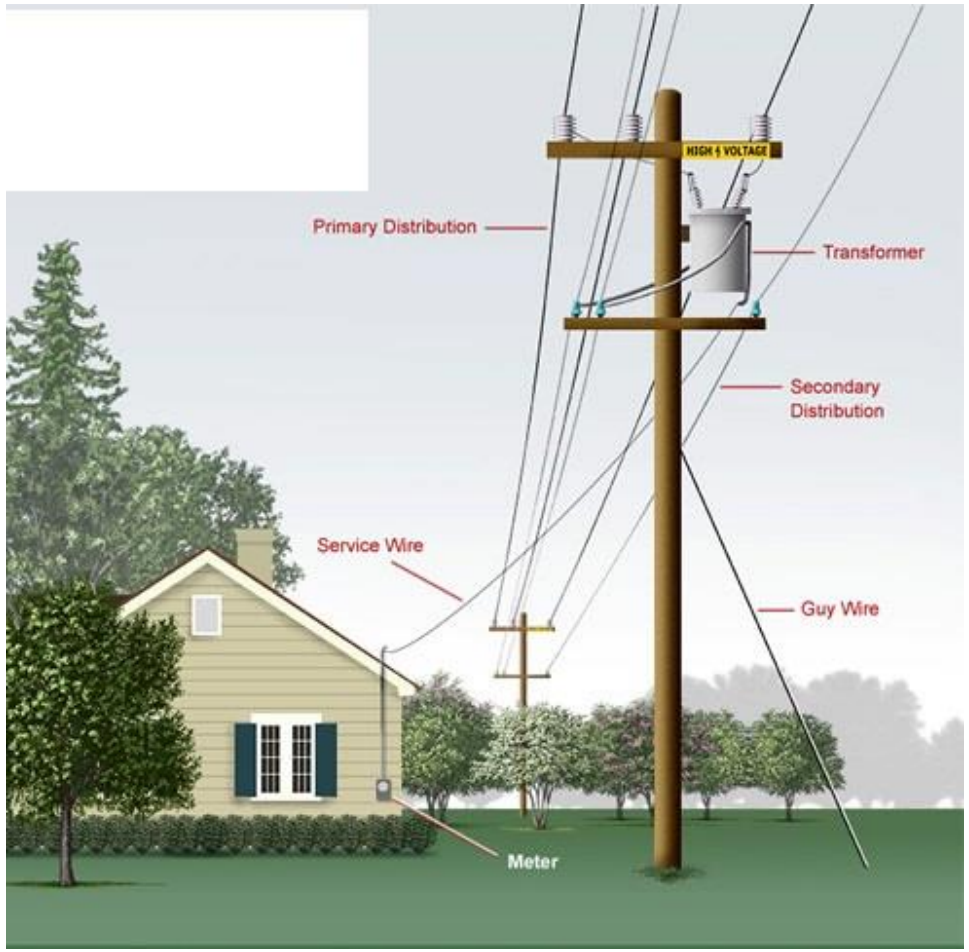
National average estimate of 2% - 3% reduction in ALL energy use

Additional Grid Benefits

- Reduces grid losses by a small amount
- Building block for other grid improvements
  - Automated Fault location
  - Automated fault Isolation
  - Increased reliability
- Integration of distributed generation
- Improved reactive power correction

Major Advantages for Customer

- Reduces energy use
- Reduces customer bills
- Provides DSM for all customer classes
- Increases rates by small amount, but more than compensated by decrease in energy charges
- Rate payer payback in about five years



PG&E

Major Barriers for Implementation

Requires a substantial investment by the utility

Reduces utility income in the short term

Needs incentives for utility investment

Needs ongoing incentives for efficient and innovative operation

Status in CO, NV and AZ

Colorado – Xcel Energy

- Piloted in 2007-2009
- Proposed implementation system wide - $94M investment
- PUC ruled DVO is DSM with some DSM incentives
- Investment waiting for better incentives

Nevada

- NV Energy - Large pilot underway in six substations and all subtending feeders

Arizona

- APS – Pilot on 17 feeders
- TEP – Pilot on 4 feeders

Questions??