B O N N E V I L L E P O W E R A D M I N I S T R A T I O N

EfficiencyMATTERS

Post-2011 Jedi Training:
How ESUE can save your performance review

Presented by:
Steve Brooks, Energy Smart Utility Efficiency Project manager
BPA Energy Efficiency

Let’s take a trip in time!

The date is May 11, 2013

The Phone Rings

Your largest customer is on the phone

10:20
10:20
10:40
10:45
11:15
11:20
DELAYED
DELAYED
DELAYED
DELAYED
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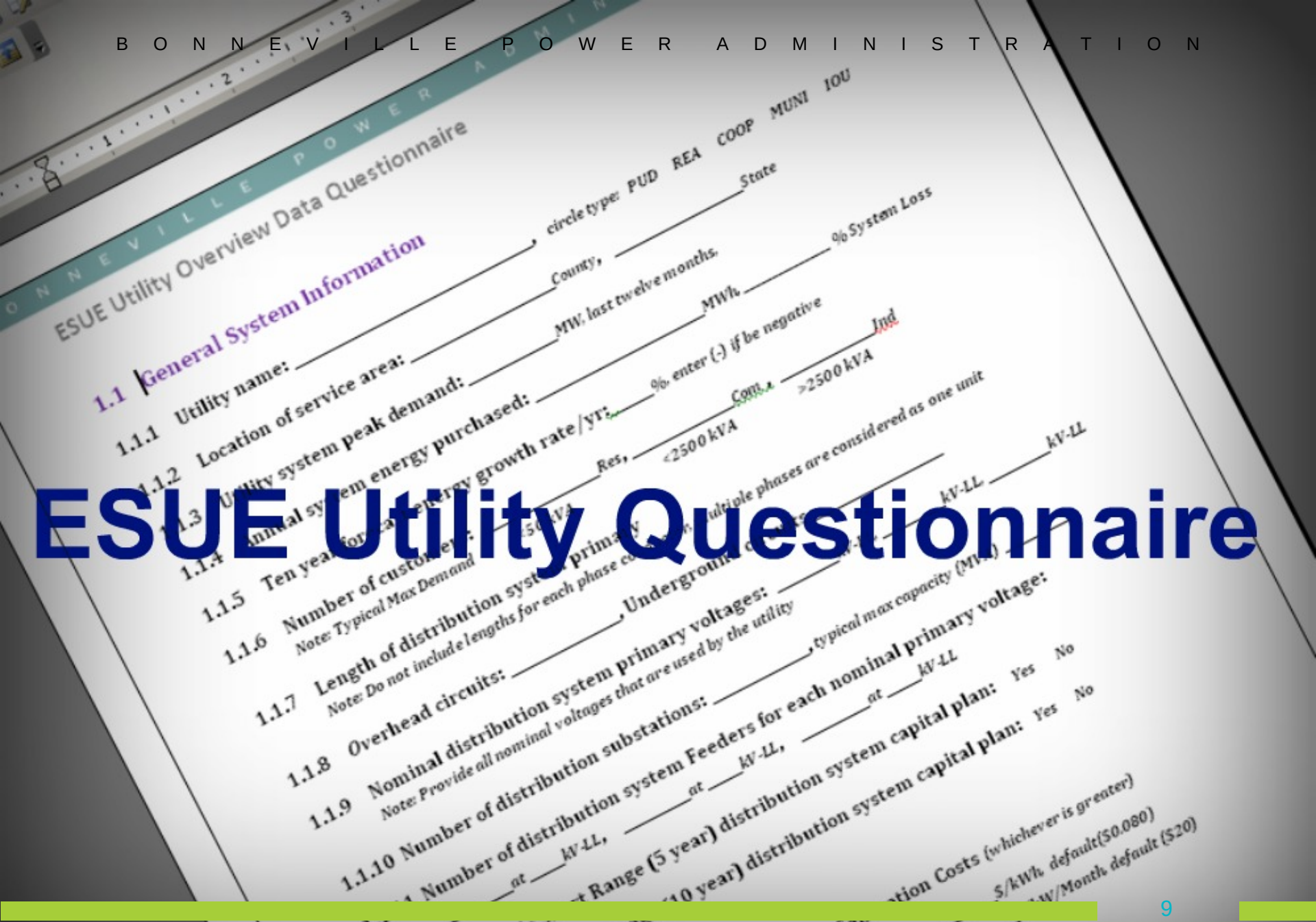
Your neck is on the line

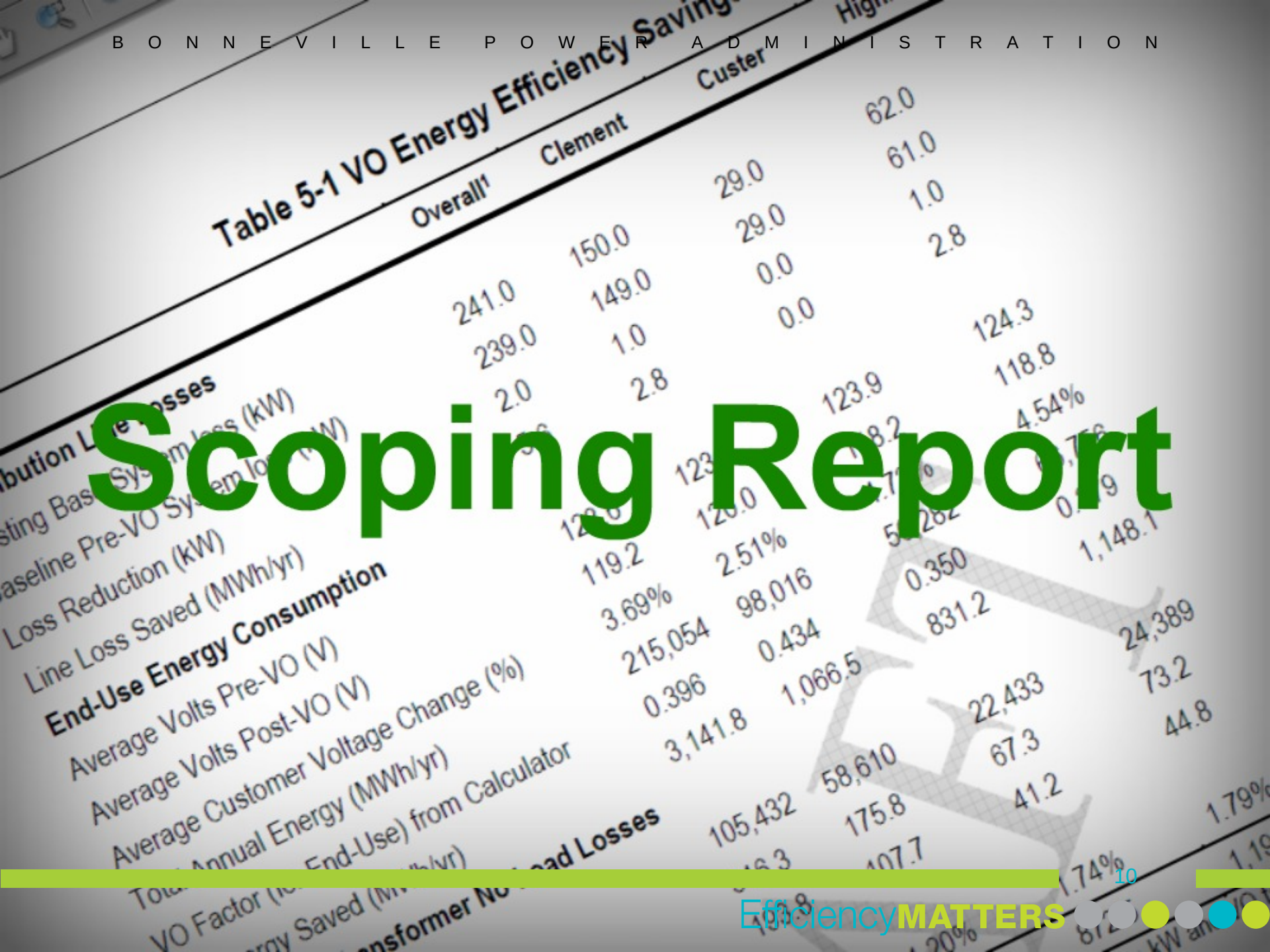
- Your General Manager gave you instructions to spend every penny of your EEI budget and not a penny more.

In Washington, you may have bigger issues.

ESUE Utility Questionnaire

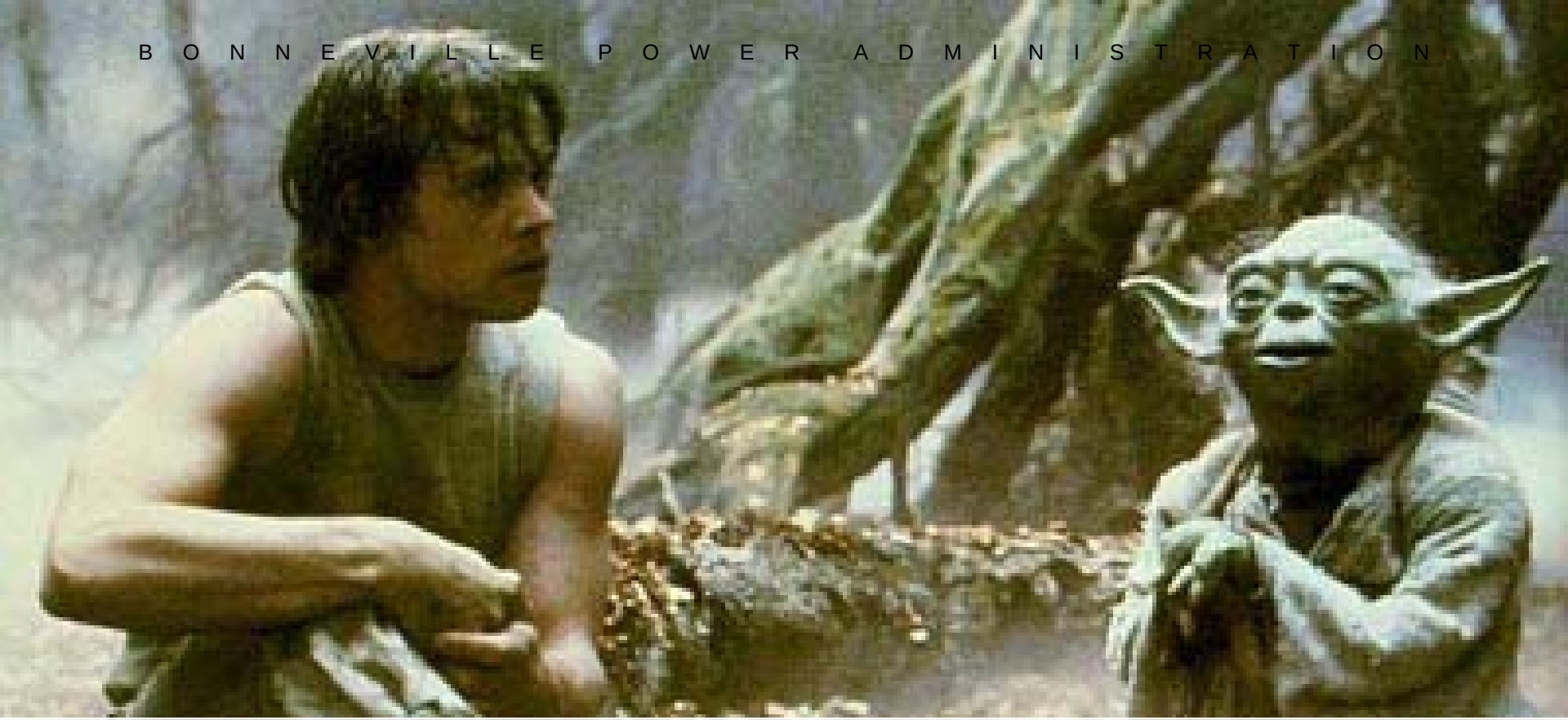


Scoping Report



T&D Plugged Away

You are a hero!



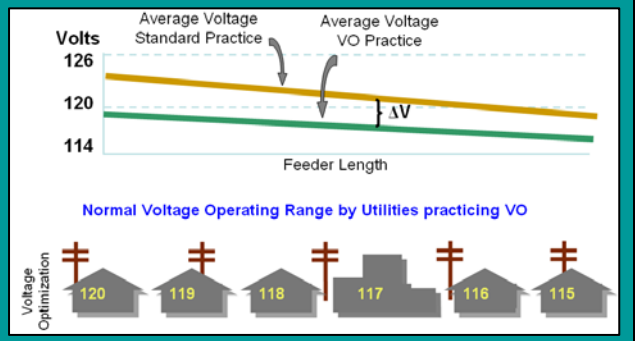
What is this **ESUE** you speak of?

Energy Smart Utility Efficiency

- Energy Smart Utility Efficiency is a custom project process combining **Electrical System Improvements** and **Voltage Optimization**.

System Improvements

+



Voltage Optimization

What Kind of System Improvements?

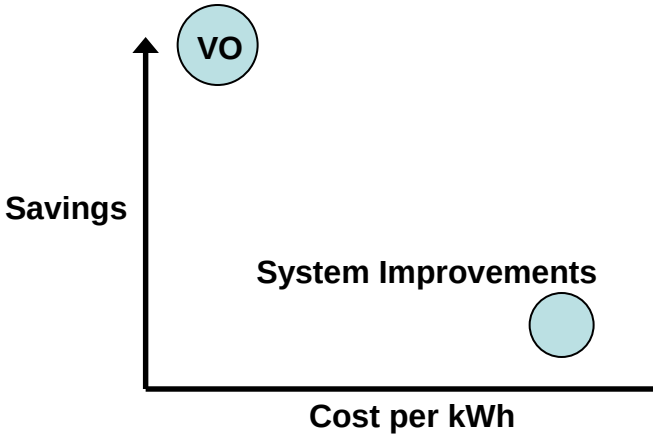
"Bread and Butter" System Improvements

System Improvements

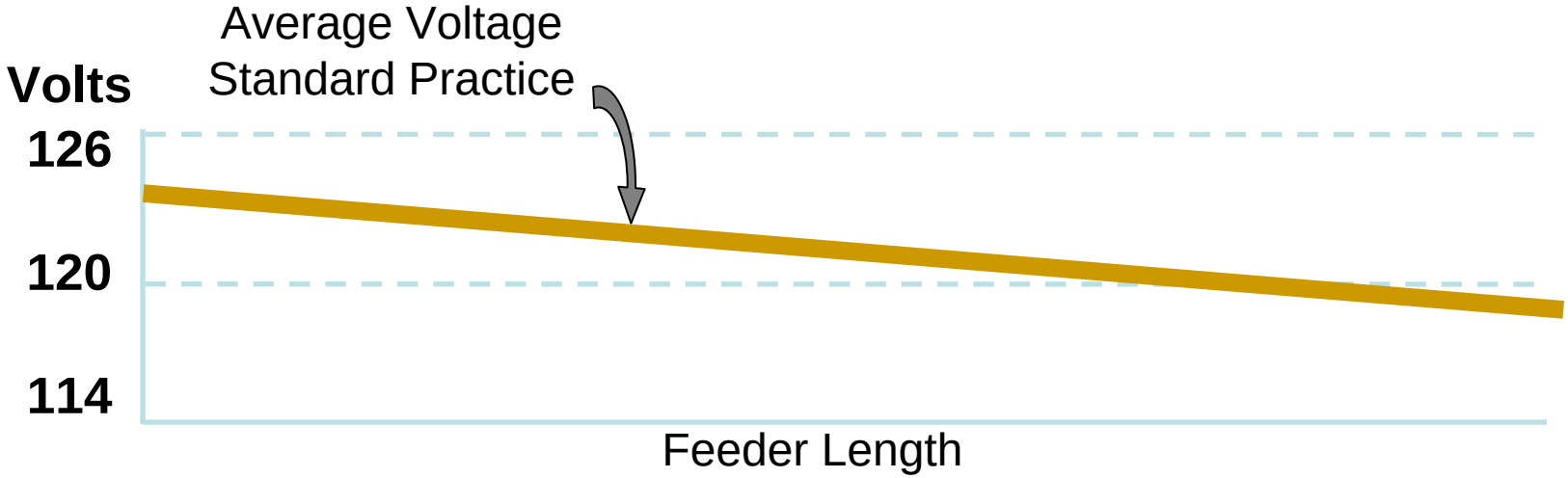
- **Examples**
  - Phase Upgrades
  - Load Balancing
  - Capacitors
  - New Circuits
  - Line-Volt Regulators

Combining System Improvements and Voltage Optimization

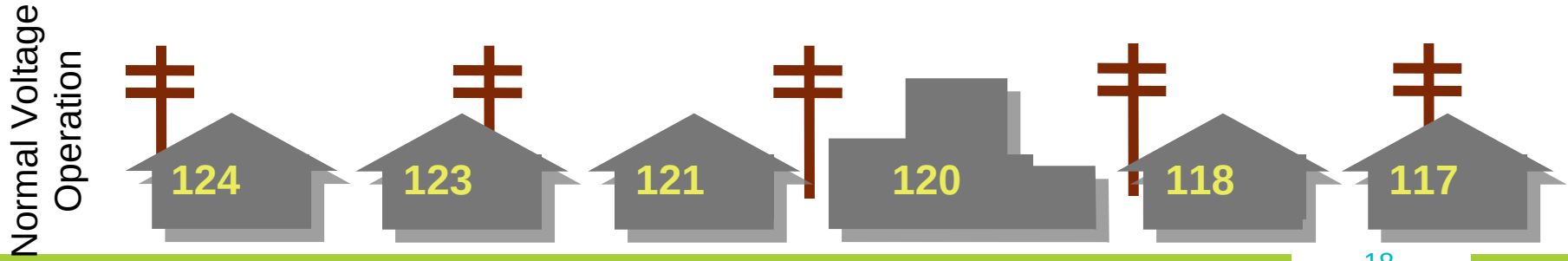
- Small incentives were barrier to distribution efficiency projects.
- Separately System Improvements and Voltage Optimization yield low incentive payments.
  - System Improvements
    - Incentive capped by savings
  - Voltage Optimization
    - Incentive capped by project cost



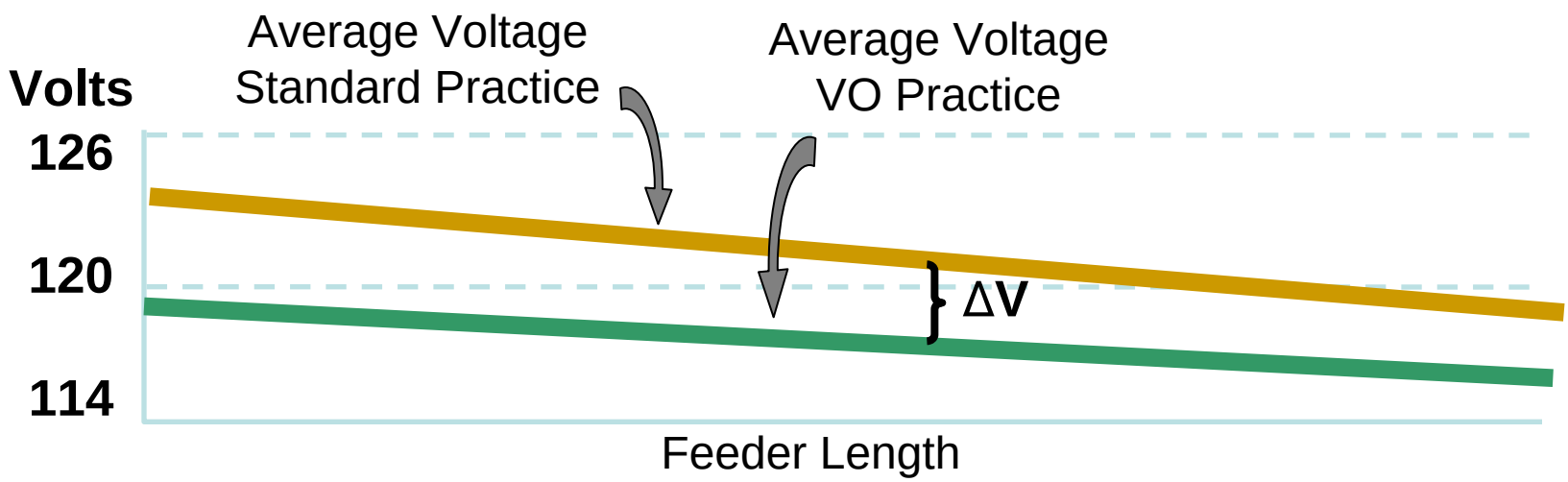
What is Voltage Optimization?



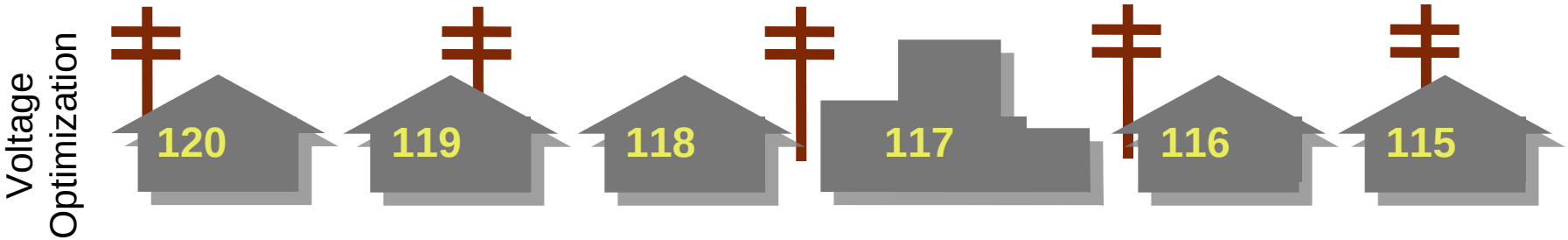
Normal Voltage Operating Range in Current Practice by Utilities



What is Voltage Optimization

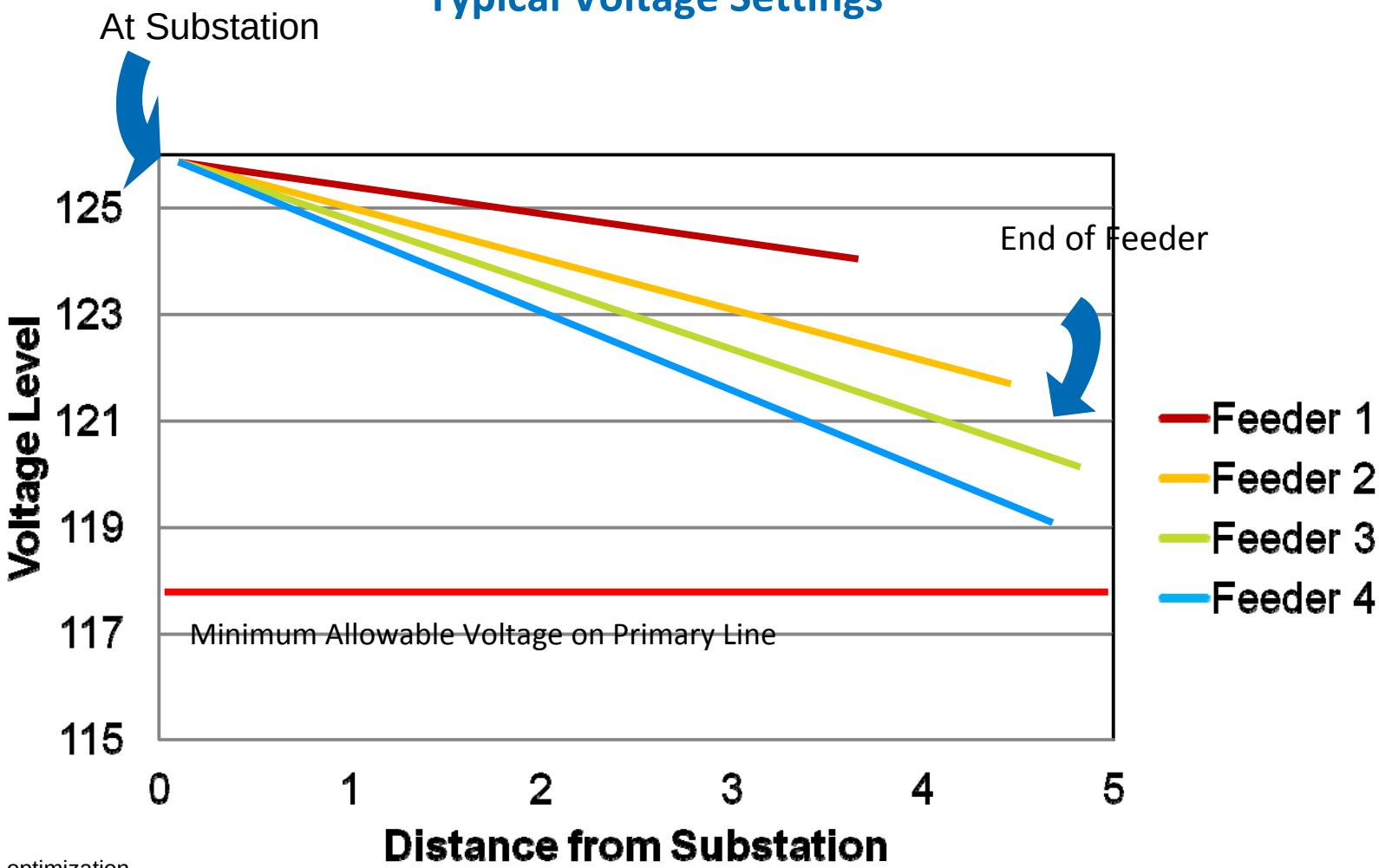


Normal Voltage Operating Range by Utilities practicing VO



Voltage Profile of Four Feeders Where the Voltage Control Is Bus-regulated

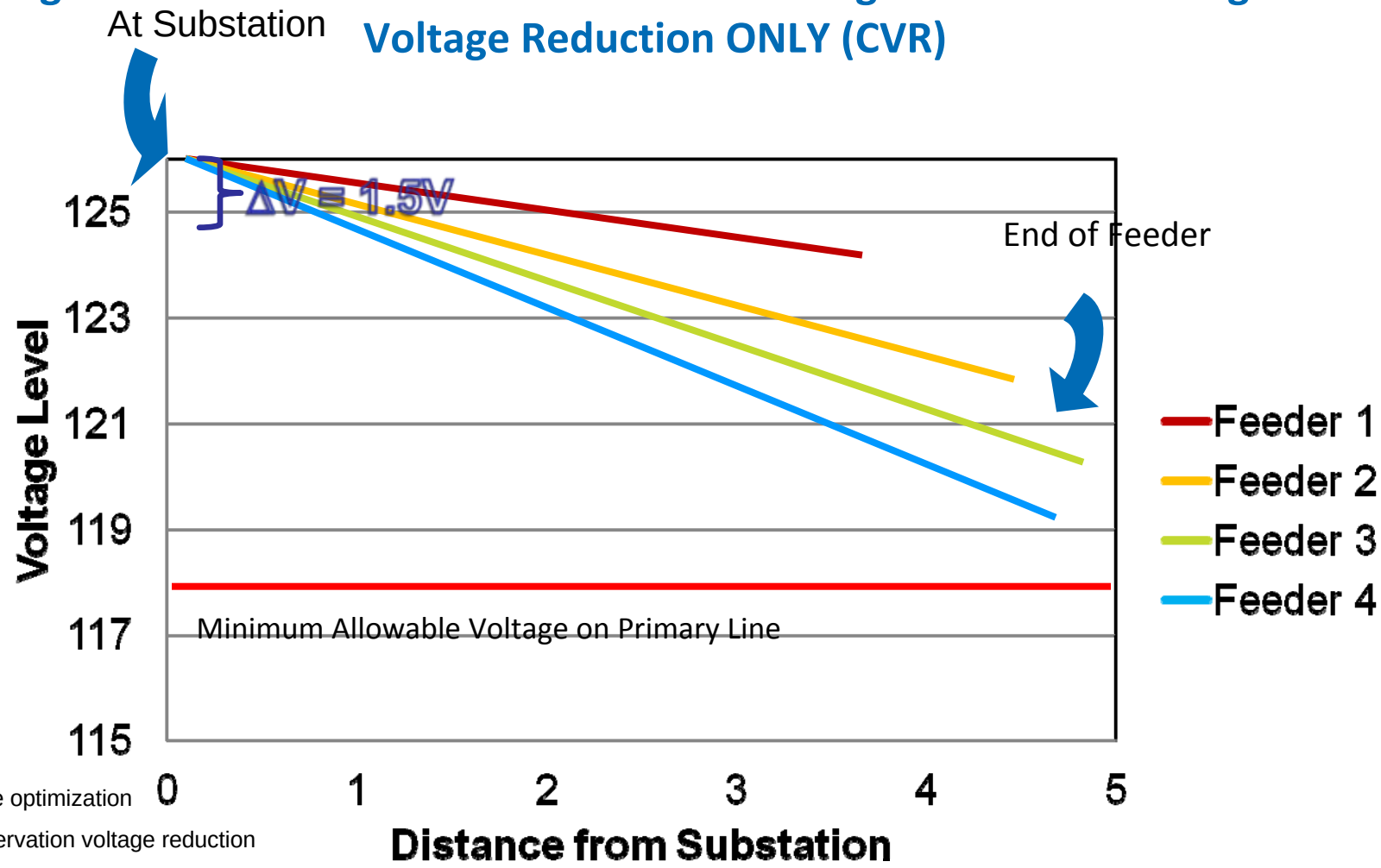
Typical Voltage Settings



VO = voltage optimization

Voltage Profile of Four Feeders Where the Voltage Control Is Bus-regulated

Voltage Reduction ONLY (CVR)



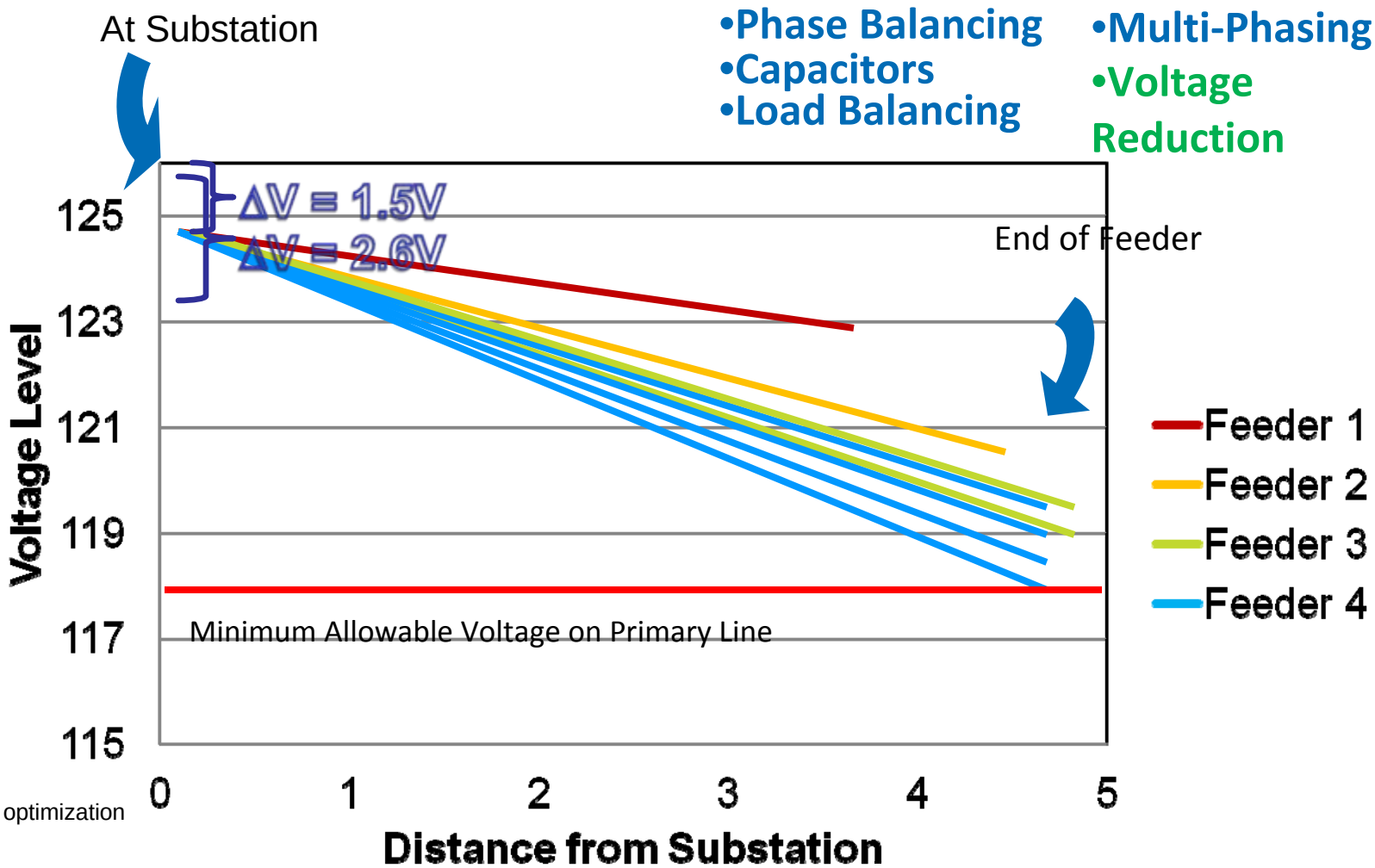
VO = voltage optimization

CVR = conservation voltage reduction

Voltage Profile of Four Feeders Where the Voltage Control Is Bus-regulated

Implementing VO (System Improvements & Voltage Reduction)

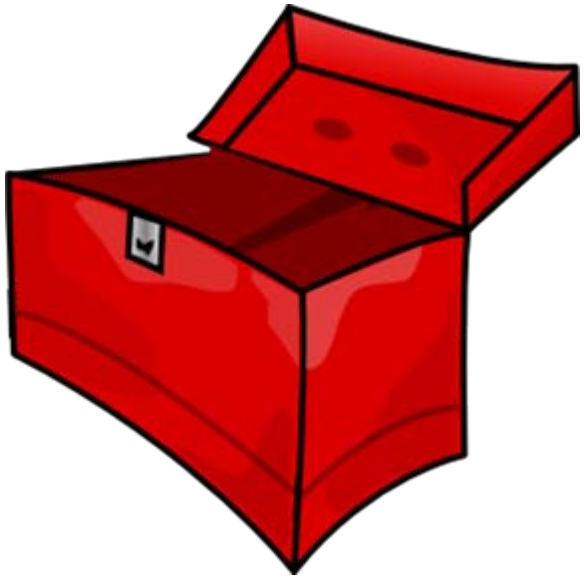
- Phase Balancing
- Capacitors
- Load Balancing
- Multi-Phasing
- Voltage Reduction



VO = voltage optimization

Toolbox

- Developing a toolbox for utilities to use to pursue distribution system energy efficiency.
- Three Tools for Distribution System Efficiency
  1. Simplified Protocols
  2. Technical Training
  3. Energy Efficiency Program



How **Simple** is **“Simple”?**

Calculating Energy Savings

$$E_{Saved} = (VO_f \times E_{Annual} \times \Delta V) + \Delta E_{XFMR_NL} + \Delta E_{Line\ Losses}$$

- VO_f is Voltage Optimization Factor from Simplified Voltage Optimization Protocols.
- E_{Annual} is annual energy consumption (metered).
- ΔV is change in voltage.
- ΔE_{XFMR_NL} is energy savings due to transformer no load losses.
- $\Delta E_{Line\ Losses}$ is line loss energy saved due to reduced current demands.

But what about the T&D Engineers?

Technical Training

Technical Training For Distribution Engineers

- Focus of training
  1. Technical explanation of Voltage Optimization
  2. Identifying Voltage Optimization Opportunity
  3. Initial steps for developing Voltage Optimization Projects

NWPPA
Northwest Public Power Association

BONNEVILLE
POWER ADMINISTRATION

Sign Up For Training

BPA – NWPPA Partnership

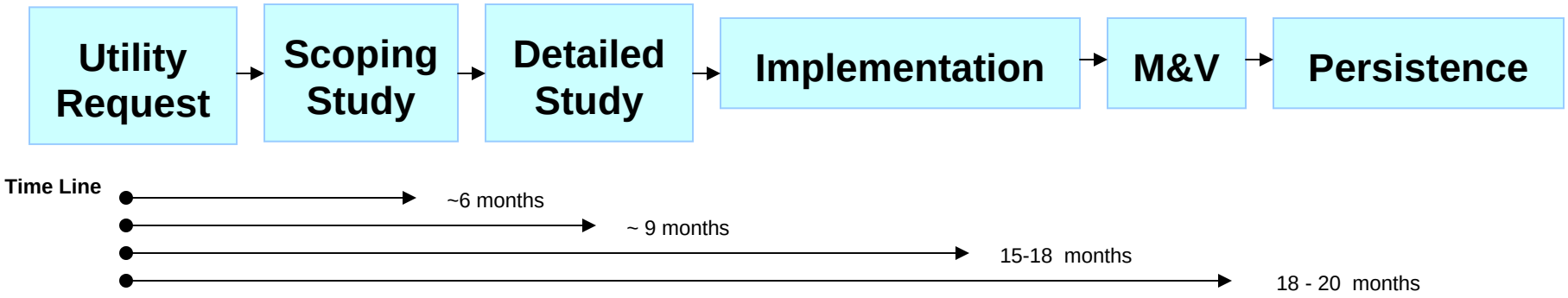
- Four Training Sessions in Spring 2011
  1. Idaho Falls – April 27, 2011
  2. Tacoma – May 11, 2011
  3. Spokane – June 8, 2011
  4. Portland – June 22, 2011

NWPPA
Northwest Public Power Association

BONNEVILLE
POWER ADMINISTRATION

How do I sign up?

The ESUE Process



To utilize Simplified VO protocol, ESUE project must follow a fairly standard project development process

Utility Request

Utility Request → Scoping Study → Detailed Study → Implementation → M&V → Persistence

Utility Identifies 3 substations (~12 feeders) to study.

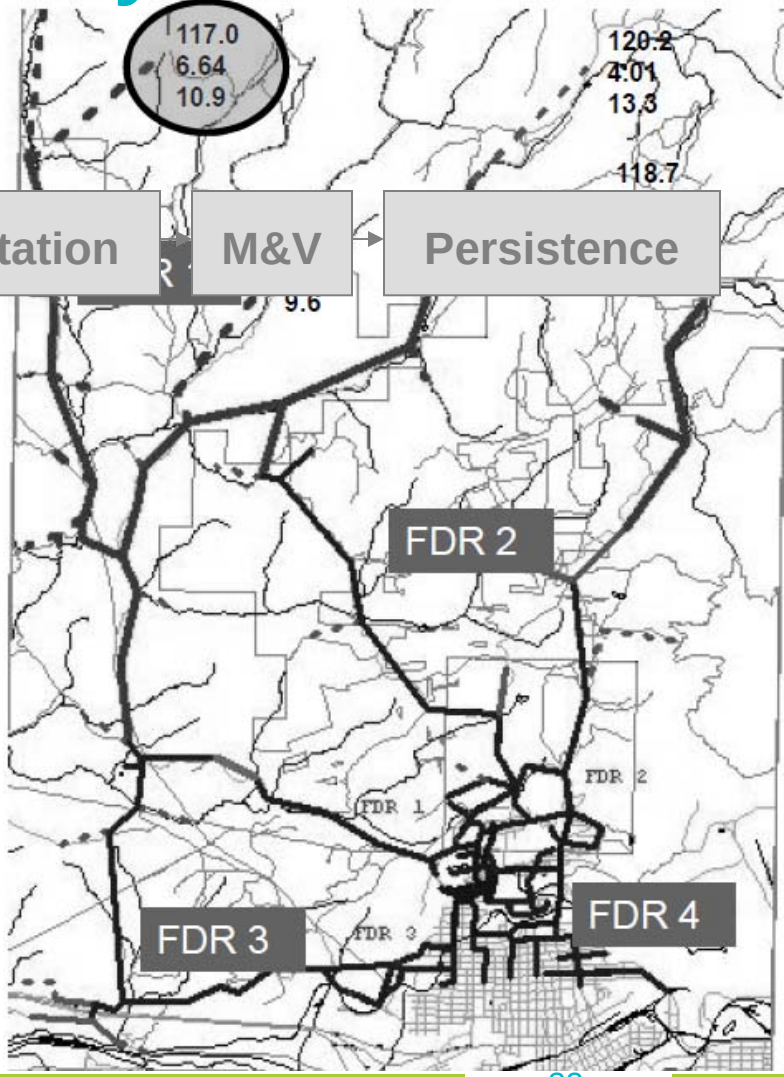
Utility gathers available information about existing distribution system.

Timeline: 1-2 Months for BPA to evaluate Utility request and contract Scoping Study.

Outcome: ESUE fits into Utility's conservation plan and selected feeders have voltage optimization potential.

Scoping Study

Utility Request → **Scoping Study** → Detailed Study → Implementation → M&V → Persistence



Utility and consultant work together to collect and analyze system models and readily available data.

Timeline: 4-6 months. Time required is a function of the extent of power flow modeling and system mapping available..

Outcome: Preliminary improvement plan including cost and energy savings estimates.

Utility Decision: Based on initial scoping study estimates, do you wish to continue.

Detailed Study

Utility Request → Scoping Study → **Detailed Study** → Implementation → M&V → Persistence

Metered data is used to refine energy savings estimates from scoping study.. Improvements narrowed based on Utility recommendation.

Timeline: 4-6 months. Function of the extent of power flow modeling and system mapping.
Outcome: Custom Project Proposal.

Implementation

Utility Request → Scoping Study → Detailed Study → **Implementation** → M&V → Persistence

Utility is project manager for implementation. Makes system improvements and initiates VO operational voltage control.

- **Timeline**
  - Depends on utility (staff commitments, schedule, what changes would be made.
- **Outcome**:
  - Distribution System upgrades complete, Voltage optimized.

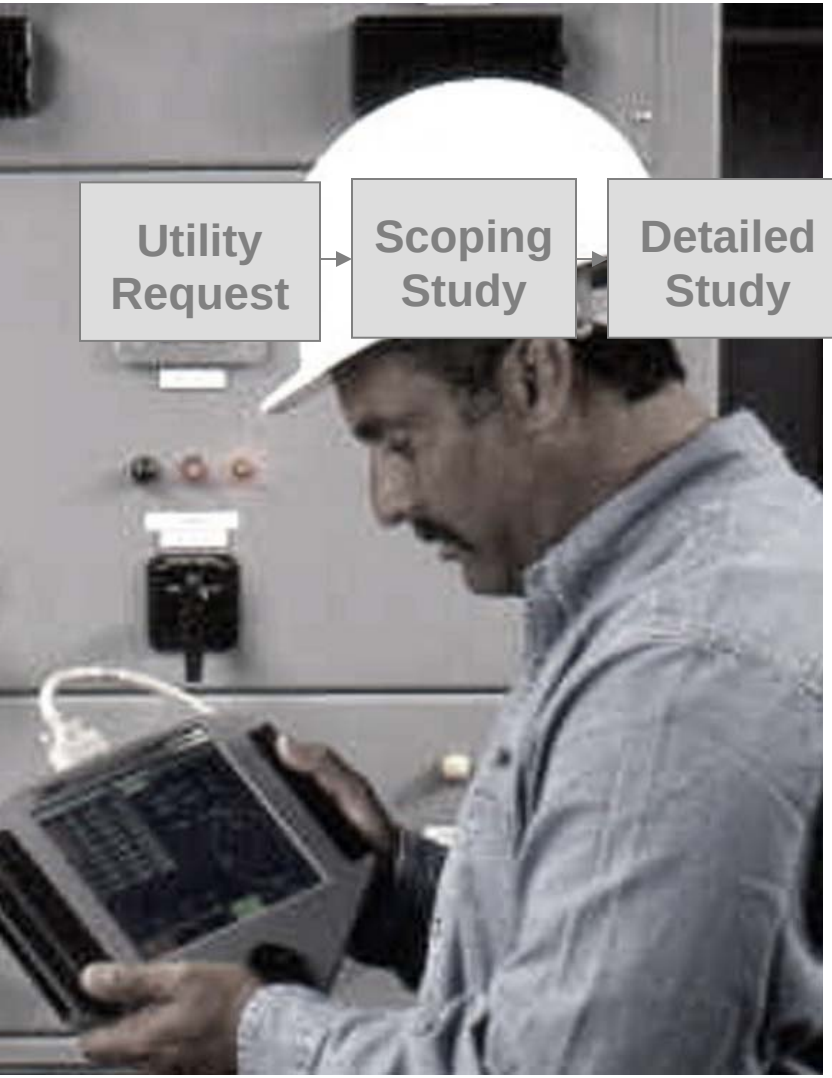
M&V

Utility Request → Scoping Study → Detailed Study → Implementation → **M&V** → Persistence

M&V is Post Implementation Measurement and Verification

- **Timeline**
  - 2-3 Months (Minimum 7 days of metering)
- **Outcome:**
  - Custom Project Completion Report. Energy Efficiency incentive is paid.

Persistence



Utility Request → Scoping Study → Detailed Study → Implementation → M&V → **Persistence**

Utility completes annual self-check to ensure:

1. Voltage control settings are still operating as desired.
2. Voltage control zone continues to meet minimum performance thresholds.

How well does it work?

BPA ESUE Scoping Study Results

Case Study	Project Energy Savings (MWhs)	Number of Substation/Feeders With Savings	Average Cost per Substation
CVR Only	6,571	9/35	$40,000
VO	11,880	17/62	$194,614
Increase Savings	4,802	8/27	

- Benefit of VO
  - Increases total energy savings by **80.8** percent
  - Benefit/Cost ratio ranges from 0.8 to 13.53 with weighted average at **4.45**

VO = voltage optimization CVR = conservation voltage reduction

BPA ESUE Scoping Study Results

Case Study	Project Energy Savings (MWhs)	Number of Substation/Feeders With Savings	Average Cost per Substation
CVR Only	6,571	9/35	$40,000
VO	11,880	17/62	$194,614
VO–Cherry Picking	10,424	15/54	$88,590
Increase Savings	3,852	7/21	

- Benefit of VO and Cherry Picking
  - Increases total energy savings by **58.6** percent (compared to no VO)
  - Benefit/Cost ratio would be **8.1**

VO = voltage optimization CVR = conservation voltage reduction

Who Benefits?

- Customers
  - Save energy without any required actions
  - **~$10** annual bill reduction per customer.
- Local Utilities
  - Costs utility **$0.065/kWh** to reduce losses
  - Reduces future impacts of tiered rates.
  - Project reduced capacity increased flexibility
  - Meet energy efficiency targets
- BPA
  - Acquires resource for **$0.02/kWh**.
  - Reduces new generation requirements
  - Meet energy efficiency targets

How to get in touch with Yoda

For more information, contact:

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(503) 230-4423

EfficiencyMATTERS

TACOMA POWER
TACOMA PUBLIC UTILITIES

Welcome to the Party T&D!

Soft starting an efficiency mindset and program

BPA EE Summit May 10-11, 2011

Connecting the Dots

- Early 2009 distribution efficiency headed for inclusion in the 6th Power Plan
- Management briefed and coupled with I-937
- Realization that conservation and distribution efficiency activity needs to be coordinated
- Conservation / T&D liaison tapped

A Whole New World for T&D

- T&D…think safety, reliability, power quality, compliance, manage budget, and…and…
- T&D resource opportunity!
- Do we have to do this?
- Conservation Speak – First year savings?
- Documentation for who?

Milestones

- Team relationships developed
  - Tacoma Power: T&D, Power Management and Conservation
  - Bonneville Power Administration and Contractors
  - Washington State State Auditor and Commerce
- Coordinated with T&D on
  - Efficiency target
  - Consultant agreements
  - Budget

Behind the Scene Roles

- Continuity during staff changes
- Finding a T&D champion
- In the communication loop with BPA/Consultant
- Helper when possible – play to your conservation strengths

Lessons Learned

- Distribution efficiency targets and customer conservation targets require coordinated planning

- Distribution efficiency is big, complicated, and new, – it required special utility start up attention

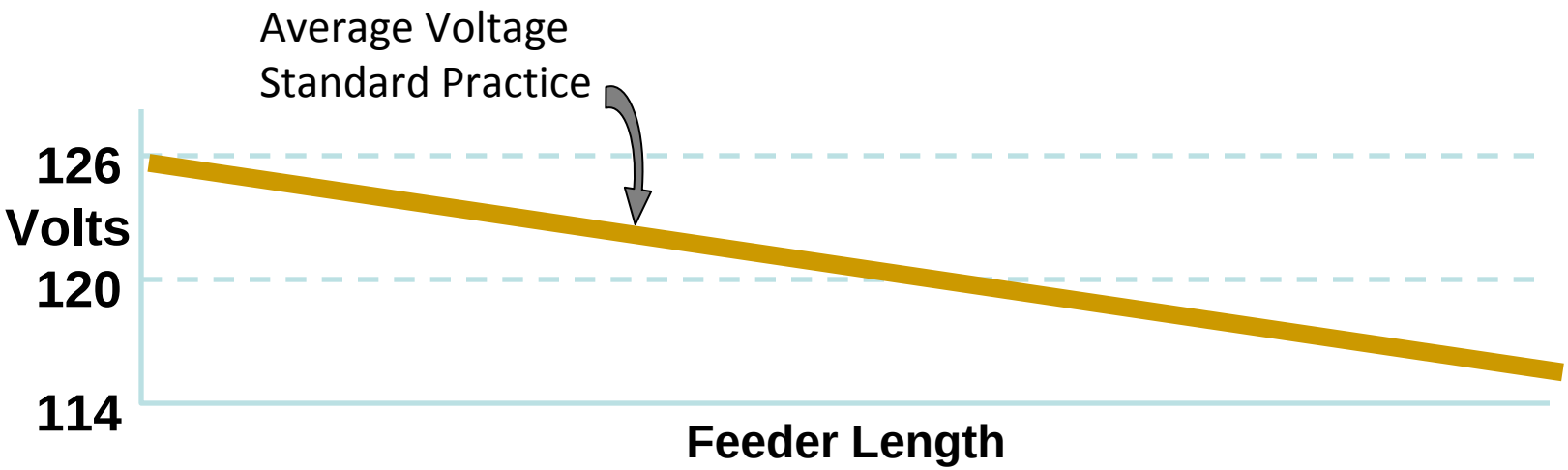
EfficiencyMATTERS

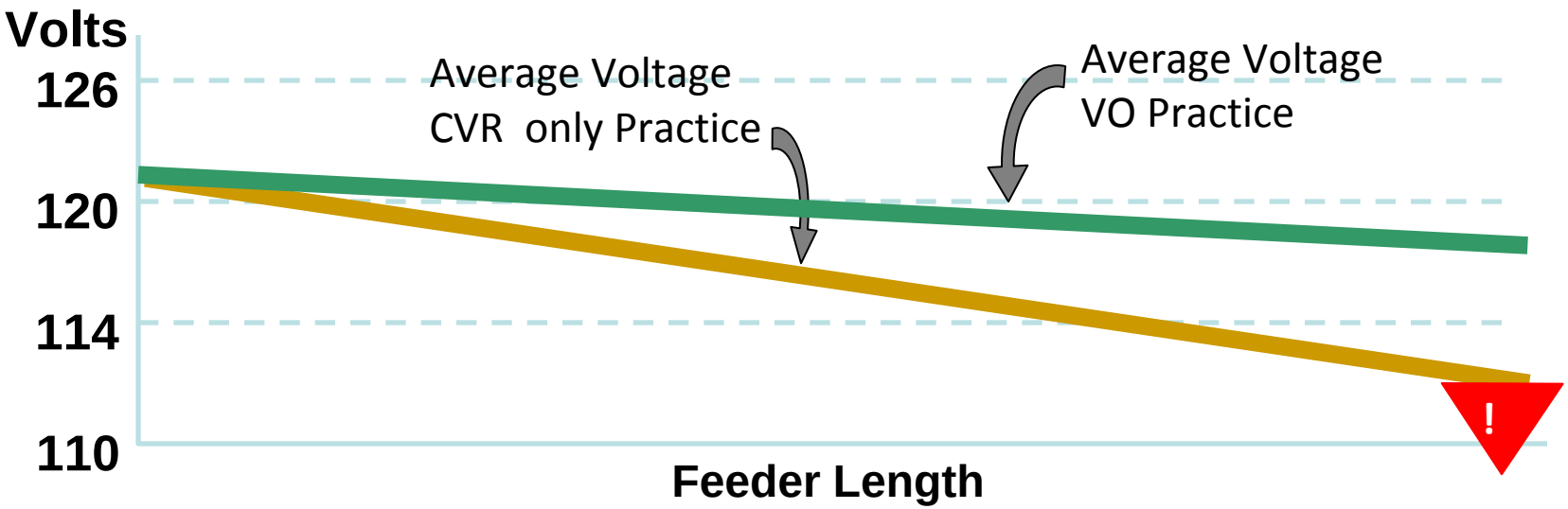
Cowlitz PUD

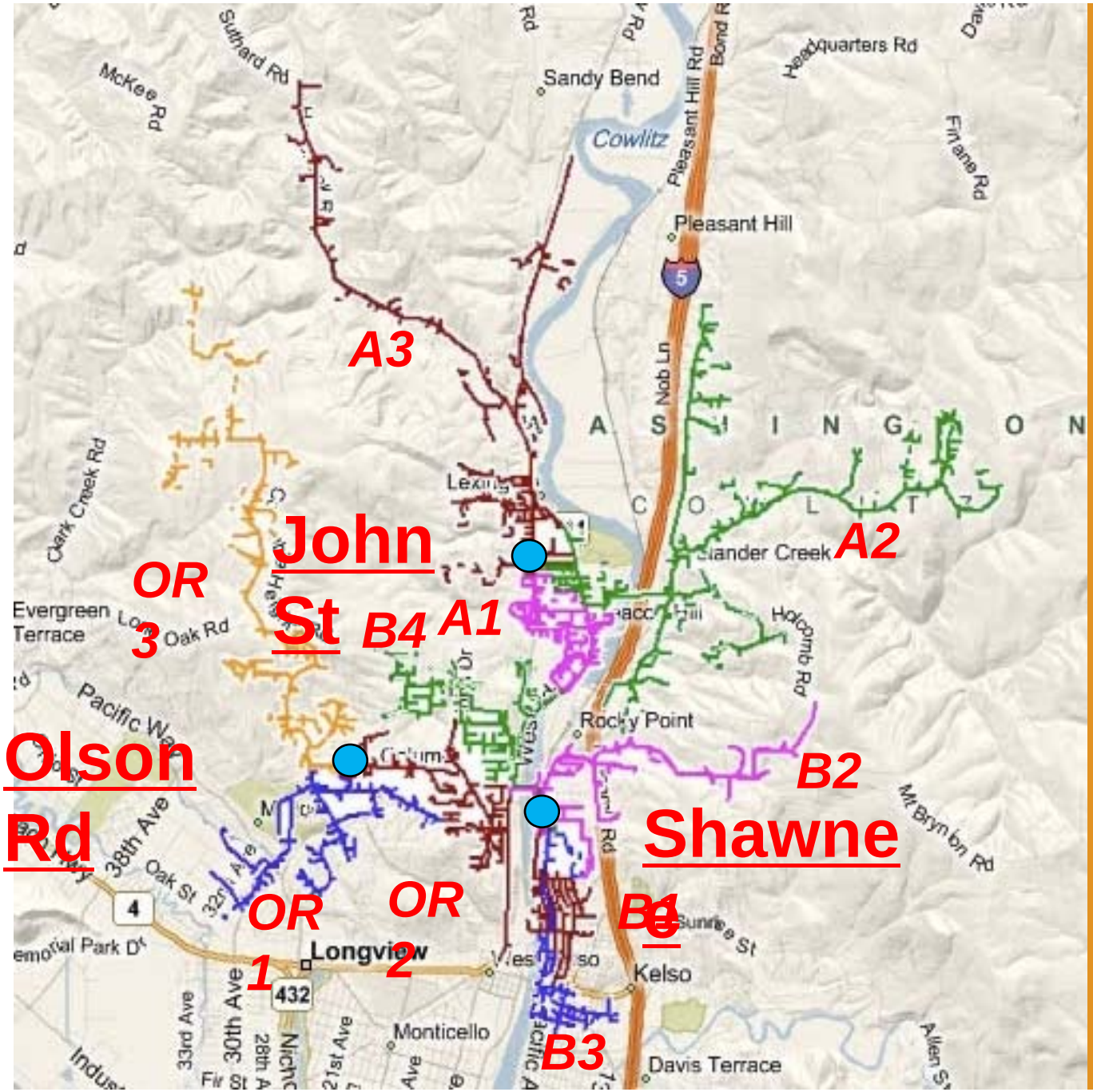
ESUE Scoping Study Results

CVR versus VO

(Conservation Voltage Reduction) (Voltage Optimization)







The Ten Primary Feeder Routes

Cowlitz County Population
101,254

Cowlitz PUD Customers
49,000

PUD Customers served by these three substations
5,870

Scoping Study Tasks

1. Review Utility Overview Questionnaire (6 pages)

   ASKS FOR: Feeder Loading; LTC settings; Equipment Stats; Annual Energy/Feeder;

   Your utility's Avoided Cost of Energy; and your utility's Cost of Debt & Cost of Equity.

2. Gather Additional Scoping Data Information

   Requires MW, Mvar & MWh metering in addition to Phase Amps

3. Perform System Modeling Using Software like: CYME
4. Assess Existing System Line Loss & Adherence to Thresholds
5. Identify System Improvement Recommendations with Costs
6. Identify Line Loss for Baseline Systems
7. Determine Baseline Pre-VO Primary Average Volts
8. Determine Post-VO Primary Average Volts
9. Determine SI & VO Energy Savings Potential (ΔE)
10. Provide Benefit Cost Evaluation for VO Project

Cowlitz PUD
Existing System Characteristics
from Amp Metering & Load Forecast Data

Cowlitz Distribution System (13 kV)							
Power Tranf	Peak MVA	PF at Peak	# of Customers	# of Feeders	Load Density	# of Line Regulators	Volt Control*
Sub Name:	John St						
12/16/20	15.1	97.29%	1,716	3	Rural 1 Urban 2	0	Fixed 125 V
Sub Name:	Olson Rd						
12/16/20	15.4	97.93%	1,756	3	Rural 1 Urban 2	0	Fixed 125 V
Sub Name:	Shawnee						
12/16/20	15.5	97.17%	2,398	4	Rural 1 Urban 3	0	Fixed 125 V
Total number of Customers = 5,870				Typical Primary Wire Size 336 and 1/0 AL			
System Load Factor = 0.380				Annual Energy = 151,398 MWh			

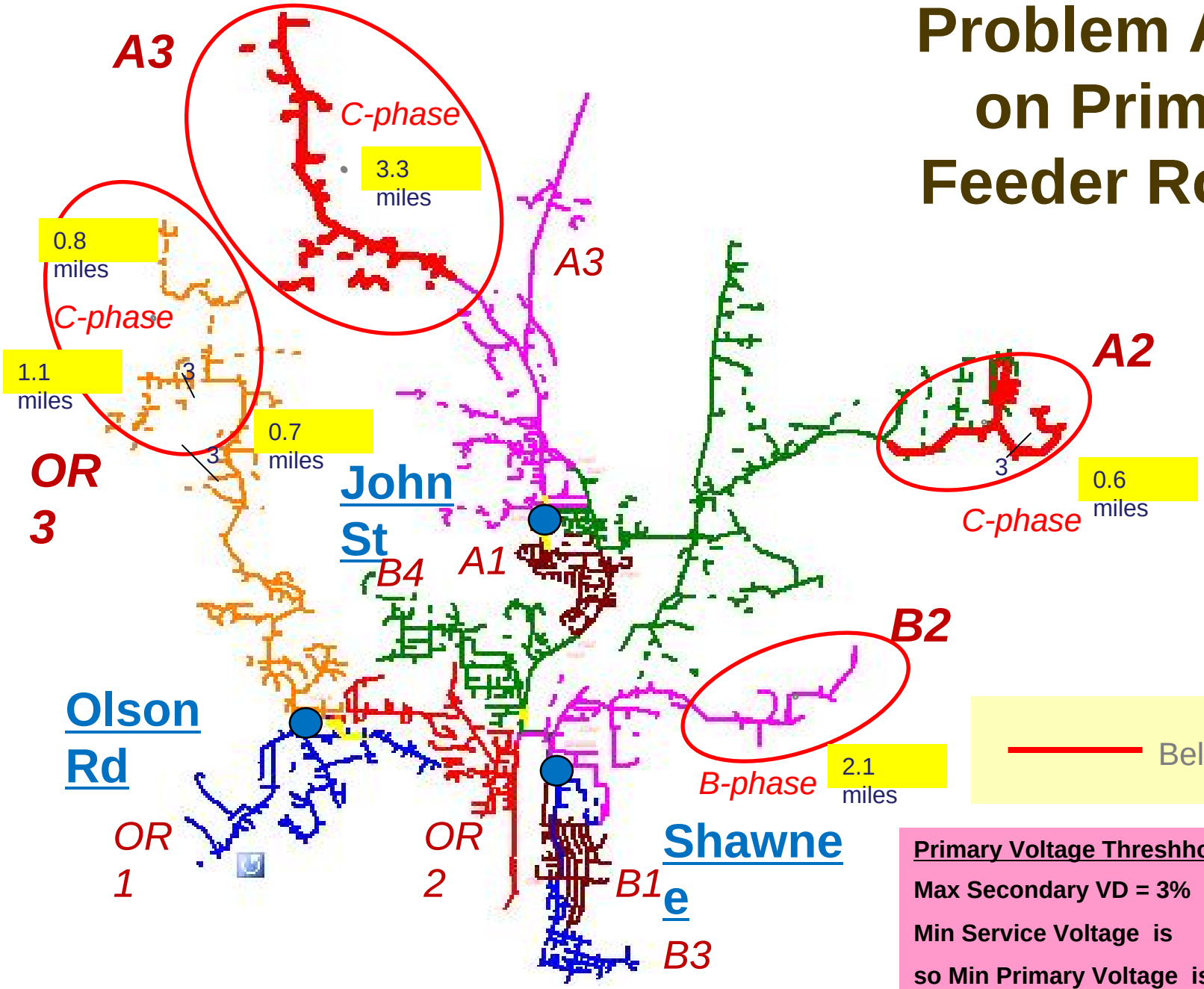
Cowlitz PUD has had a long standing LTC practice of No Line Compensation, i.e. R=0 & X=0

Feeder Conditions Today

FEEDER	Lowest Voltage Phase A	Lowest Voltage Phase B	Lowest Voltage Phase C	Minimum Phase Voltage	LTC Voltage Variation	% Voltage Drop Phase A	% Voltage Drop Phase B	% Voltage Drop Phase C	Maximum % Volt Drop	Neutral Current
JOHN ST-A1	**122.8**	**123.1**	**121.7**	**121.7**		**1.87**	**1.61**	**2.74**	**2.74**	**63.5 High**
JOHN ST-A2	**117.2**	**120.1**	**120.9**	**117.2 Low**		**6.54**	**4.08**	**3.46**	**6.54 High**	**20.0**
JOHN ST-A3	**123.7**	**115.5**	**123.9**	**115.5 Low**	**6.3 High**	**1.11**	**7.96**	**0.96**	**7.96 High**	**56.3 High**
OLSON RD-OR1	**122.8**	**122.9**	**121.3**	**121.3**		**2.97**	**1.77**	**3.07**	**3.07**	**62.0 High**
OLSON RD-OR2	**123.7**	**119.9**	**122.4**	**119.9**		**2.00**	**2.27**	**2.47**	**2.47**	**9.2**
OLSON RD-OR3	**117.2**	**122.3**	**122.0**	**117.2 Low**	**4.1 High**	**3.97**	**4.27**	**2.17**	**4.27 High**	**35.6 High**
SHAWNEE-B1	**122.8**	**123.7**	**123.1**	**122.8**		**2.07**	**1.07**	**1.57**	**2.07**	**18.5**
SHAWNEE-B2	**117.2**	**123.8**	**123.8**	**117.2 Low**		**3.27**	**0.97**	**0.97**	**3.27**	**42.2 High**
SHAWNEE-B3	**123.7**	**121.6**	**122.8**	**121.6**		**3.84**	**2.87**	**1.87**	**3.84 High**	**77.5 High**
SHAWNEE-B4	**123.7**	**121.6**	**120.4**	**120.4**	**5.6 High**	**2.37**	**2.87**	**3.87**	**3.87 High**	**27.0**

Low & **High** indicate values mostly outside ESUE Threshholds

Problem Areas on Primary Feeder Routes



Below 118.6 V

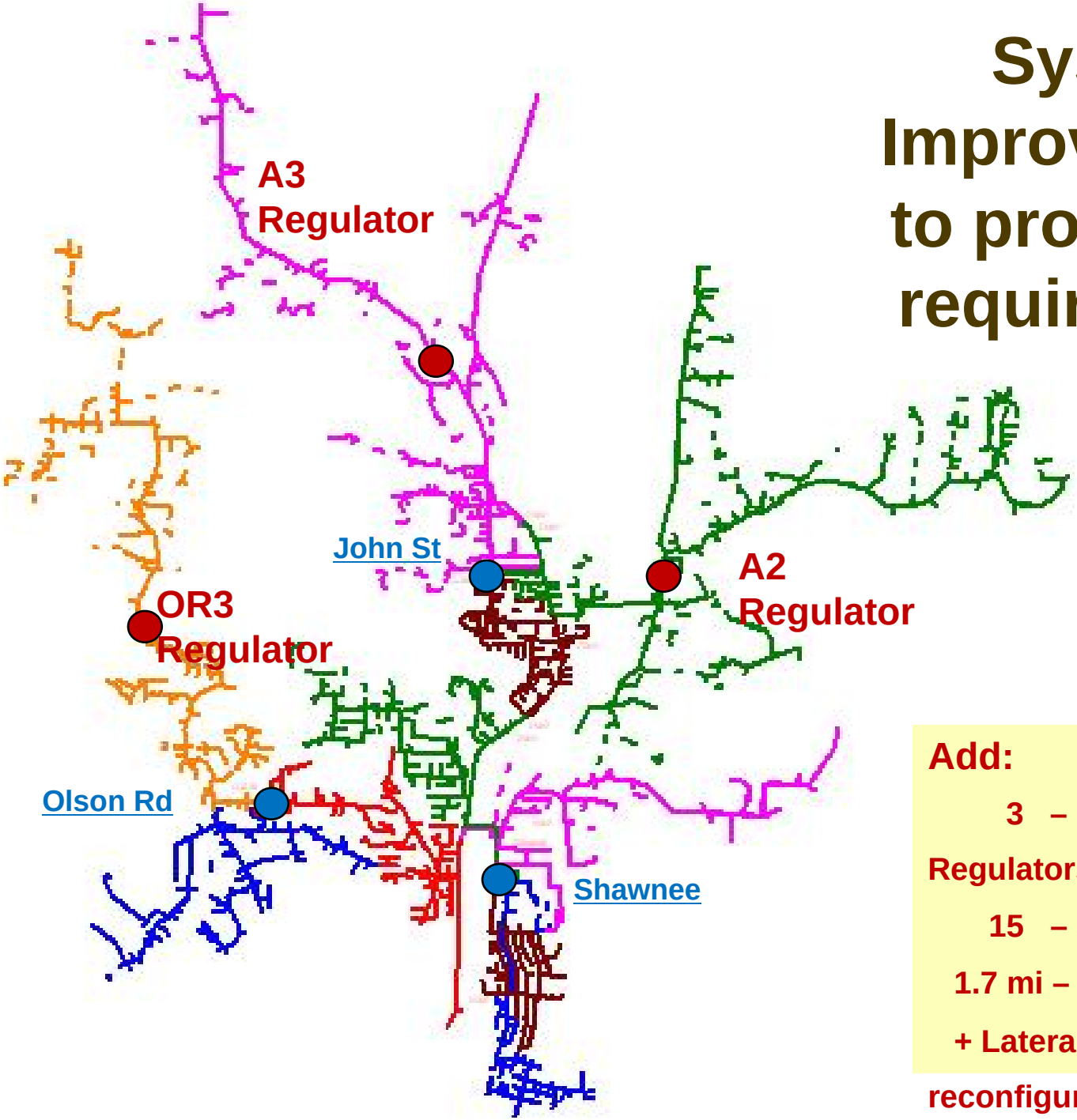
Primary Voltage Threshhold

Max Secondary VD = 3% or 3.6 volts

Min Service Voltage is 115.0 volts

so Min Primary Voltage is 118.6 volts

System Improvements to provide VO requirements



Add:

3 – Line Voltage Regulators

15 – 300 kVAr Cap Banks

1.7 mi – Reconductoring

+ Lateral tap reconfigurations

SI & VO Total Energy Saved

$$E_{Saved} = \Delta V \times VO_f \times E_{Annual} + \Delta E_{SI} + \Delta E_{NL}$$

MWH/yr	Overall	JOHN ST	OLSON RD	SHAWNEE	% of Total
Line Loss Reduction	**74.6**	**32.7**	**19.3**	**22.6**	4.70%
No-Load Loss Reduction	**110.5**	**39.4**	**32.9**	**38.1**	7.00%
VO Energy Savings (End-Use)	**1,352.3**	**413.3**	**477.2**	**461.8**	88.30%
Total Energy Savings (for Project)	**1,537.4**	**485.4**	**529.4**	**522.5**	1.00%
SI & VO Energy Reduction	**1.02%**	**0.99%**	**1.03%**	**1.02%**	

Benefit Cost Analysis

		Overall	John St	Olson Rd	Shawnee
Opt.A: BPA willing to Pay 1st Year	**$0.25/kWh**	**$384,323**	**$121,350**	**$132,353**	**$130,620**
Opt.B: BPA willing to Pay 1st Year	**70% of Cost**	**$331,800**	**$144,900**	**$107,100**	**$79,800**
BPA Incentive Payment–Lower of	**A or B**	**$331,800**	**$121,350**	**$107,100**	**$79,800**
BPA Levelized Cost / kWh saved	**$ / kWh**	**$0.020**	**$0.023**	**$0.018**	**$0.014**
Cowlitz PUD 1st Year COST + NPV Operations & Maintenance	**COST**	**$247,602**	**$131,680**	**$79,922**	**$59,550**
Cowlitz Levelized Cost	**$ / kWh**	**$0.015**	**$0.025**	**$0.014**	**$0.010**
NPV Annual VO Savings	**$ / yr**	**$64,710**	**$15,621**	**$22,766**	**$24,206**
NPV Avoided Power Purchase Costs		**$962,146**	**$303,798**	**$331,344**	**$327,004**
Cowlitz PUD Benefit Cost Ratio		**3.89**	**2.31**	**4.15**	**5.49**
Net Customer Bill Reduction / Yr	**Average**	**$11.47**	**$9.15**	**$12.65**	**$11.34**

SUMMARY for COWLITZ PUD

1 CVR alone is not a very good solution for most Feeders. Voltage Optimization is the Major missing piece.

2 Cowlitz PUD needs to improve the Balance, and tighten the Voltage Profile in its Feeders.

3 BPA's VO Program offers Financial Incentives to assist this Goal.

4 The Loss Savings from VO, not only assists BPA delay new generation capacity, but reduces Cowlitz PUD's energy purchases by $962,146.

5 The Engineering Department obtained approval from the General Manager and the Board of Commissioners.

6 BPA accepted Cowlitz PUD's request to participate in the VO Program.

7 The Scoping Study showed Cowlitz PUD qualifies for the VO Program. Cowlitz PUD has then applied for the VO Program and has been accepted into the program by BPA.

8 New Substation Metering has been installed and Cowlitz PUD is currently developing three VO scenarios for BPA.

NWPPA

NWPPA 2011 Engineering & Operations Conference and Trade Show

April 4-8, 2011
Silver Legacy Hotel
Reno, Nev.