Northwest Power and Conservation Council



November 6, 2008

# MEMORANDUM

**TO:** Council Members

**FROM:** Charlie Grist

**SUBJECT:** Status of Assessment of Conservation Potential for Utility Distribution Systems

This presentation will provide an overview of the key findings of costs and savings potential for efficiency improvement on utility distribution systems. The measures we will discuss involve optimizing the performance of the system that moves power from substations to end-users. Savings from these measures occur both on the utility side of the meter as well as on the customer side.

This suite of conservation measures will be a new addition to the power plan. A recently completed study by R.W. Beck for the Northwest Energy Efficiency Alliance (NEEA) forms the basis of the analysis. The study took four years and included large-scale pilot demonstrations of several technologies and management practices. Findings from the study were used to develop regional costs and savings estimates, a how-to guidebook for utilities, and software to help utility managers and engineers identify and analyze savings opportunities.

Study findings indicate large savings potential, between 400 and 500 average megawatts by 2030 at low cost, below $50 per megawatt hour.

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# Distribution System Efficiency Potential & Conservation Voltage Reduction

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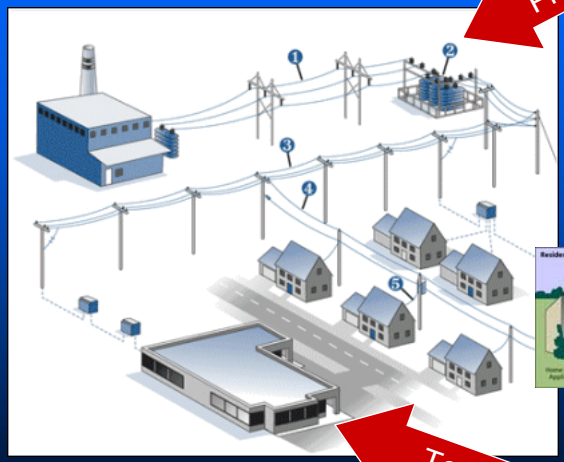
Power Committee

November 2008

NORTHWEST VI POWER PLAN

Northwest Power and Conservation Council

## Energy & Capacity Savings



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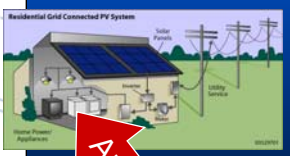


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NORTHWEST VI POWER PLAN

slide 2

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# Key Points

1. New measure for 6th Plan
2. Large savings potential
   - 2% of load or 400-500 MWa by 2030
3. Low cost
   - Half of it less than $30/MWh
4. Solid cost & savings estimate
5. Savings both sides of the customer meter
   - End User Savings & Reduced Utility Losses
6. Many non-energy benefits
7. Barriers to adoption are addressable



# The Standards

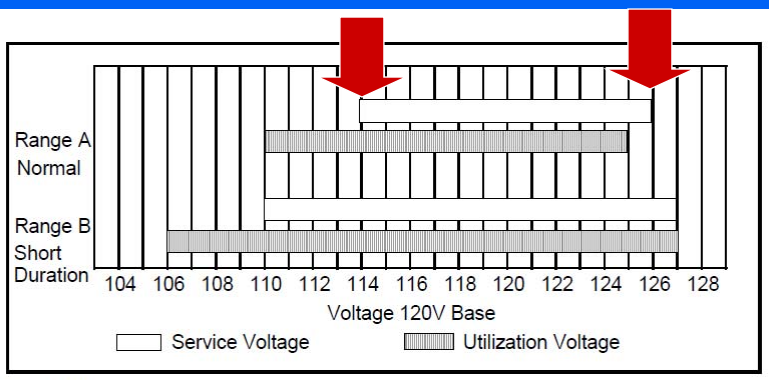
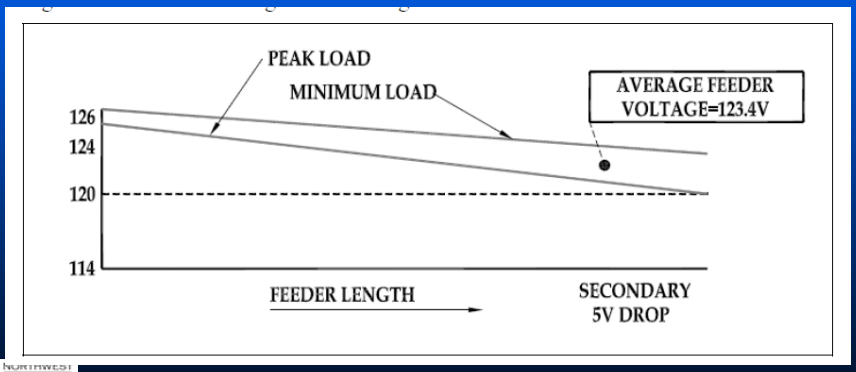



Figure 1-1
ANSI C84.1 Voltage Ranges

# Optimize System Voltage

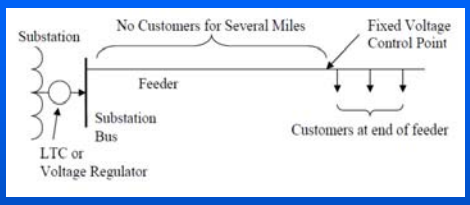
- Improve end-use equipment efficiencies
- Reduce losses along the way
- Improve effective capacity (kW) & reactive (kvar)






# Tools

- System Optimization
- Line Drop Compensation
- End of Line Voltage Feedback
- Home Voltage Regulation



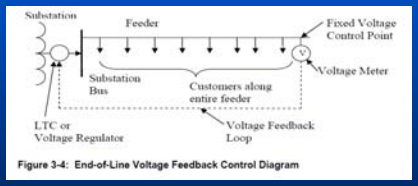



Figure 3-4: End-of-Line Voltage Feedback Control Diagram

## Source of Estimates

- NEEA study completed January 2008
- Four years & about $1 million
- R.W. Beck
- Pilot tests in 13 utilities in PNW



The following slides are from a presentation made to the Regional Technical Forum by R.W. Beck

# DISTRIBUTION EFFICIENCY INITIATIVE (DEI)
## Benefits on Both Sides of the Meter

RTF MEETING February 5, 2008

## Overview
## Key Project Elements

- Research Studies
  - Residential Homes (395 homes) Including In-Home assessments
  - Pilot Feeder Demonstration Projects
- Report of Findings
- Potential Northwest Region Savings
- Guidebook
- Software Tools

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Report, Guidebook, and Software Tools available at ww.rwbeck.com/neea

# Overview
## Participating Utilities

| Utility | DEI Participation |
|---|---|
| Avista Corp | Pilot Demonstration |
| Clark Public Utilities | Pilot Demonstration |
| Douglas PUD | Load Research<br>Pilot Demonstration |
| Eugene W & EB | Load Research |
| Franklin PUD | Load Research |
| Hood River | Load Research |
| Idaho Falls Power | Load Research |
| Idaho Power | Load Research<br>Pilot Demonstration |
| PacifiCorp | Load Research |
| Portland General Electric | Load Research |
| Puget Sound Energy | Load Research<br>Pilot Demonstration |
| Skamania PUD | Load Research |
| Snohomish PUD | Load Research<br>Pilot Demonstration |



# Overview
## Project Savings

**Summary of Voltage and Energy Results**

| Project | Voltage Reduction (ΔV) | $CVR_f$ (%ΔE/%ΔV) | Project Energy Savings (MWh)[1] | Percent Energy Savings |
|---|---|---|---|---|
| Load Research | 5.2 V (4.3%) | 0.569 [2] | 87 | 2.15% |
| Pilot Demonstration | 3.03 V (2.5%) | 0.69 | 8,476 | 2.07% |

- Project Savings 8,563 MWhr (1.88 aMW annually)
- 345 kWhr per residential home (Load Research project)
- Cost of less than 5 Mills ($0.001/kWhr)

## Summary
## Pilot Demonstration Project

- Controlled voltage at substation (day ON day OFF)
  - Used Line Drop Compensation
  - Used End of Line voltage feedback loop
- 6 Utilities, 10 Substations, 31 feeders
- Performed system improvements
  - Installed feeder meters
  - Phase balancing
  - Voltage regulators
  - Capacitors

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## Results of DEI Study
## Savings

**Potential Pacific Northwest Regional Savings**

| | Voltage Reduction Only (1-5 Mills) | Voltage Reduction and System Improvements [1] (2-15 Mills) | Voltage Reduction, Reconductoring and Voltage Regulators [2] (10-30 Mills) | Voltage Reduction with All Improvements and All Loads [3] (15-50 Mills) |
|---|---|---|---|---|
| Energy Savings (aMW) | 100-150 | 160-190 | 220-250 | 245-270 |

Notes:
1. System improvements include var management and load balancing, not including major utility loads that do not have low voltage regulation.
2. System improvements include var management, load balancing, voltage regulators, select reconductoring, and primary line multi-phasing and extensions, not including major utility loads that do not have low voltage regulation.
3. System improvements include var management, load balancing, voltage regulators, select reconductoring, and primary line multi-phasing and extensions and added low voltage regulation to major utility loads that today do not have low voltage regulation.

Savings Based on 2005 Non-DSI Loads

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# Results of DEI Study
## Savings

### Overall Load Research CVR factor Estimate[1]

| | CVRf | RP[2] | +/- |
|---|---|---|---|
| Energy (kWh) | 0.569 | 10.1% | 0.057 |

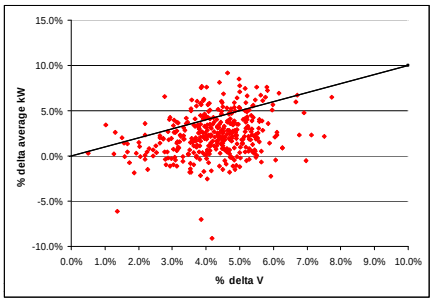
Notes:

1. This number is **not** the simple average of the by-utility or by-meter estimates. The method used to calculate this figure is discussed in Appendix A – Calculations Used in the Analysis, and will produce different results for an overall sample of sites than would be calculated taking a simple or weighted average of subsets of that sample.
2. Relative precision is a measure of the precision of an estimate. It is expressed as the ratio of the error bound of an estimate to the estimate itself. Thus, for an estimate x, a relative precision of 15% at the 90% level of confidence means that there is a 90% probability that the true value lies between 0.85x and 1.15x.

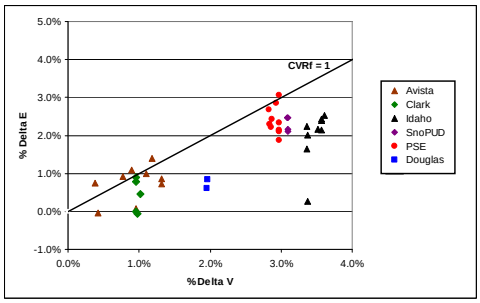


# Results of DEI Study
## CVR Factors

House-Level – CVR factor Energy

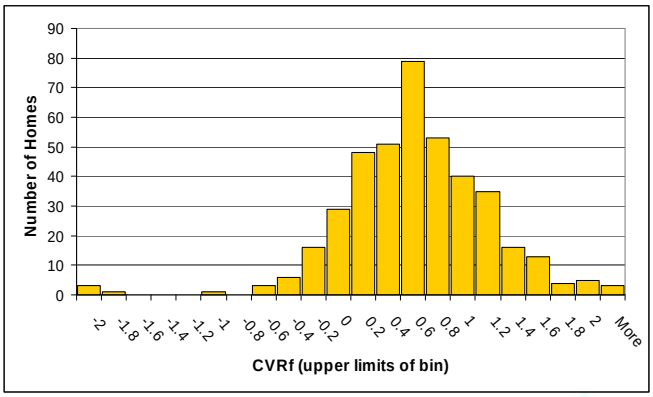



Feeder Level – CVR Factor Energy



## Results of DEI Study
## CVR Factors

CVR factor Distribution of Sample Homes

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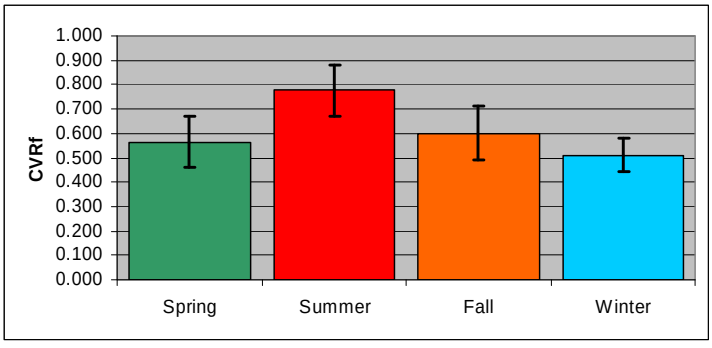
## Results of DEI Study
## CVR Factors

Load Research CVR Factor by Season w/ 90% Error Bounds

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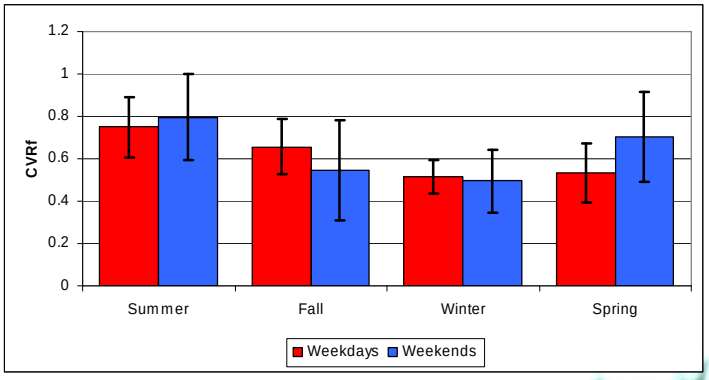
# Results of DEI Study
# CVR Factors

Load Research CVR Factor by Weekday by Season
w/ 90% Error Bounds

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# Results of DEI Study
# Project Conclusions

- Existing technologies can be use to achieve the majority of the potential energy savings economically
- New technologies are commercially available to help utilities optimize the performance of the distribution system and regulating the voltage
- Utilities could benefit from pooling resources from their energy efficiency group and distribution planning, engineering and operation groups
- Utilities need to develop long-term plans to optimize the efficiency of the existing electrical infrastructure
- New facilities being installed today should be designed to achieve the lowest life cycle cost
- Policies should be established to provide incentives for utilities to reduce electric system losses
- Policies should be established to provide a mechanism to reimburse utilities for lost revenue

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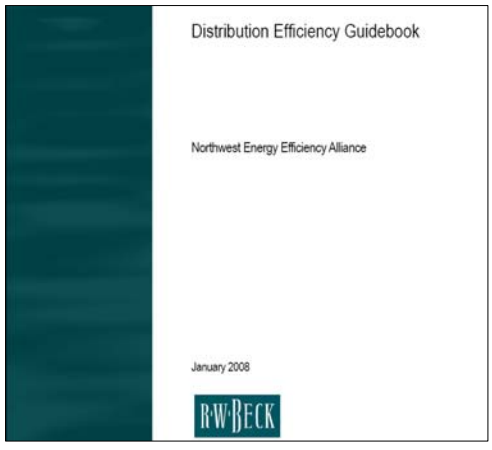
# Barriers to Adoption

- Working Between Departments in Utility
  - Business Practices between EE & Engineering
- Regulatory Issues
  - Utility losses are a pass-thru cost
  - Lost revenues



# DEI Study Guidebook

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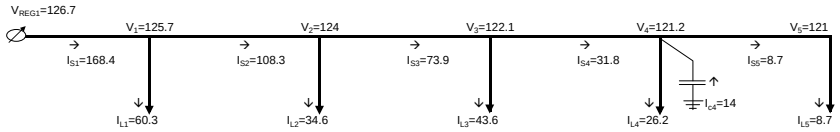
# DEI Study
# Software Tools

## LOAD FLOW

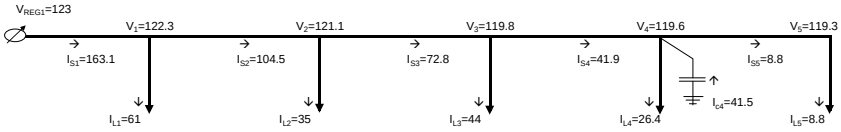
**LOAD FLOW DIAGRAM 1**

LINE: EXISTING
LOAD CASE: CASE 2--AT AVERAGE LOAD
BALANCED I^2*R LOSS (kW)= 62.2




**LOAD FLOW DIAGRAM 2**

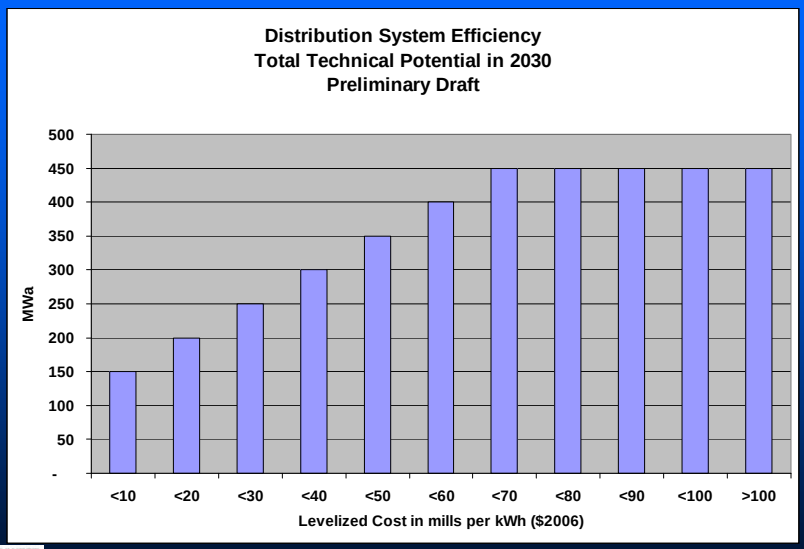
LINE: IMPROVED 3
LOAD CASE: CASE 2--AT AVERAGE LOAD
BALANCED I^2*R LOSS (kW)= 56.2




# The Oracle

- potential for "virtually free" (less than 0.1 cent/kWh) savings: from 92 - 145 AMW for the PNW; from 35 - 60 AMW for the publicly owned utilities. The resources available up to 1.0 cent/kWh was 142 - 230 AMW for the PNW; 51 - 95 AMW for the publicly owned utilities. An additional amount (from 170 - 268 and 65 - 112 AMW, respectively) is available at 5.04 cents/kWh, the figure specified by the Northwest Power Planning Council (NWPPC) as the cost-effectiveness threshold for conservation measures, compared to other generating resources. The total investor-owned utility portion of the resource available was estimated to range from 105 to 156 AMW.

24 BPA document "Assessment of Conversation Voltage Reduction Application in the BPA Service Region", 1987

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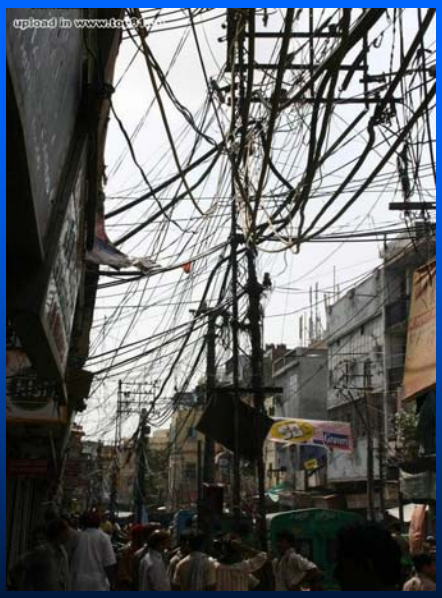

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