Northwest Power and Conservation Council



January 9, 2008

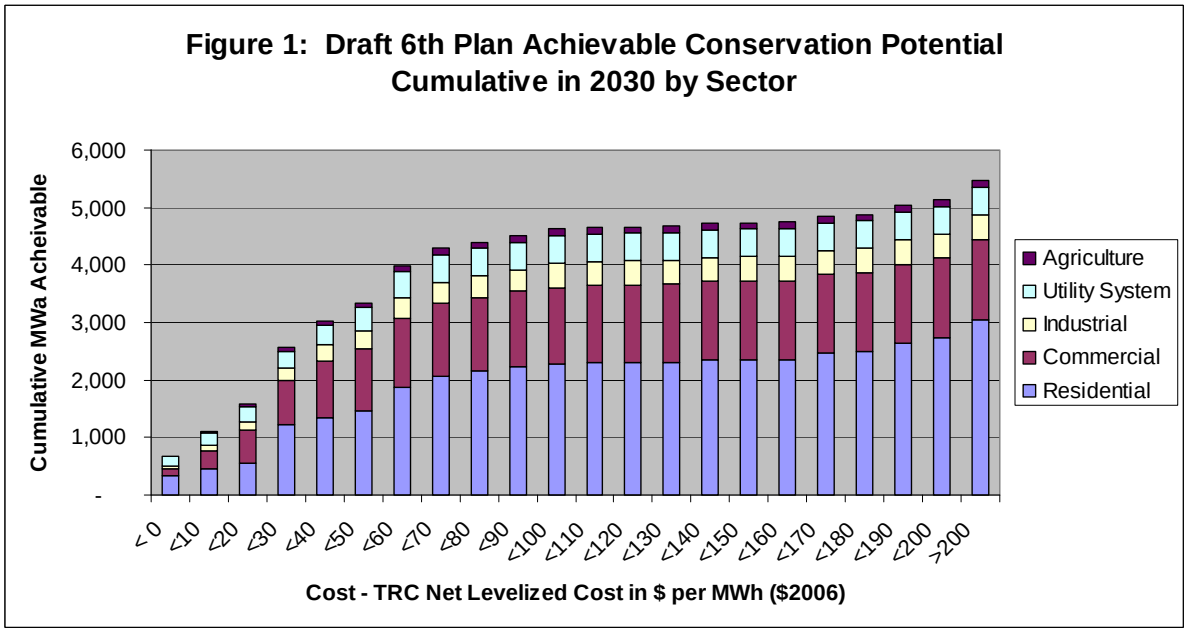
# MEMORANDUM

**TO:** Council Members

**FROM: Tom Eckman and Charles Grist**

**SUBJECT:** Draft 6th Plan's Assessment of Conservation Potential - Revised

Staff has completed its initial assessment of the technically achievable regional conservation potential. Figure 1 shows the results of this assessment. At levelized life cycle cost of up to $200 per megawatt hour (2006$) total technically achievable potential by the year 2030 is estimated to nearly 5500 average megawatts. For comparison purposes, the 5th Plan identified over 4700 average megawatts of technically achievable regional conservation potential at cost up to just under $120 per megawatt hour ($100 MWH in 2000$).[1] This data will now be used in the resource portfolio model to determine the amount of conservation that is cost-effective to target in the 6th Plan.




[1] Approximately 2600 MWa of the 4700 MWa was identified as being cost-effective to acquire by 2025.

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The 6th Plan's assessment reflects program accomplishments, changes in codes and standards, technological evolution and the overall adoption of more energy efficient equipment and practices since the 5th Plan was adopted in 2004. The two largest changes were the incorporation of utility conservation program savings and changes in federal standards for appliances. Staff forecast that by the end of 2009 regional conservation programs will achieve a total savings of 875 average megawatts.

Since the 5th Plan was adopted Congressed enacted the "Energy Independence and Security Act of 2007 (EISA). This legislation revised several existing federal efficiency standards as well as established new standards. The most significant impact of the standards imposed by EISA is its requirement that "general service lighting" (e.g., 40 - 100 watt lamps) be at least 30 percent more efficient beginning in 2012 and 60 percent more efficient beginning in 2020. The 5th Plan estimated that the conversion of standard incandescent bulbs used in the residential sector to compact fluorescent lamps (CFLs) could save the region 625 Average megawatts by 2025. While the EISA standard does not cover all incandescent lamps (e.g., lamps over 100 watts, 3-way lamps are exempt), it does cover 70-80 percent of the residential sector's applications. Consequently, roughly 75 percent of the savings from CFLs is now accounted for by a lower load forecast.

The third significant change in the Council's 6th Plan assessment of regional conservation potential is the identification of savings on the utility distribution system. Distribution system savings, including voltage management and system optimization, adds nearly 500 Average megawatts of low-cost conservation potential that was not in the 5th Power Plan. The fourth major adjustment resulted from a more in-depth analysis of the conservation potential in the industrial sector. Preliminary results show at least a doubling of the conservation potential identified in the industrial sector compared to the 5th Plan on a percentage basis.

In addition to these major adjustments, this assessment incorporates new conservation opportunities brought about by technological advances since the adoption of the 5th Plan. For example, recent advances in solid-state lighting (LEDs and OLEDs) and the arrival in the US market of ductless heat pumps both appear to offer significant opportunities for savings in some applications.

Staff will present of a summary of each of the major sectors findings at the meeting. A short synopsis of each of the major sectors follows.

Residential Sector - In the 5th Plan, the Council estimated that approximately 1600 average megawatts of conservation potential was technically available in the residential sector from improvements in lighting, appliances and water heating technologies at levelized cost of less than $100 MWH. Staff's preliminary estimate for the 6th Plan for these same end uses places the remaining technical potential at nearly 2300 average megawatts at an equivalent levelized cost. In the 5th Plan, nearly 1000 average megawatts of the technical potential had a cost of less than $50 MWH. Just under 1500 average megawatts of conservation potential have costs below this value in the current assessment. The largest increases in residential sector potential stem from the availability of ductless heat pumps, larger potential for the use of heat pump water heaters

resulting from the pending introduction of this product from three major manufacturers and cost reductions for high efficiency heat pumps.

Agriculture Sector - In the 5th Plan staff identified approximately 100 average megawatts of conservation potential available in the region through improvements in the irrigation system hardware efficiency improvements. Since the 5th Plan almost 685,000 acres have be added to the land irrigated by pressurized sprinkler systems. However, do to improvements in system efficiency and water management and weather conditions total estimated regional electricity use for irrigation decreased from 655 average megawatts to 645 average megawatts. After accounting for these changes staff estimates that approximately 90 average megawatts of conservation potential remain available through improvements in pump efficiency, leak reduction, conversion to lower pressure applications and better sprinkler/nozzle management practices at cost significantly below $100 per megawatt hour.

In addition to improvements in irrigation system hardware, better water management practices could also reduce the energy consumed in irrigation. Despite some of the limitations on the use of this measure due to state specific water laws, just over 20 average megawatts of conservation potential are available in the region through scientific irrigation water scheduling. More potential exists if mechanisms can be found to ensure that irrigation water savings on one farm are not "consumed" by additional irrigation on farms with junior water rights.

Non-irrigation "on farm" electricity use in the remainder of the agriculture sector is dominated by dairy milk production. According to the Department of Agriculture, the region produced approximately 20 billion pounds of milk in 2007. Idaho and Washington rank among the top 10 states in milk production and Oregon ranks 18th. Staff estimates that 2007 electricity use for dairy milk production was approximately 55 average megawatts. Many of the dairies in the region, and particularly in Idaho, were established and/or enlarged within the last decade. Consequently, many are already have installed energy efficient lighting, pumps and milk cooling equipment. Nevertheless, staff estimates that approximately five average megawatts of conservation potential are available through improvements such as variable speed drives on milking machine vacuum pumps, the use of flat-plate heat exchangers for pre-cooling milk prior to refrigeration and improved lighting.

Commercial Sector - Aggregate 6th Plan achievable conservation potential is similar to what was identified in the 5th Plan, about 1400 Average megawatts in both cases. However, the underlying elements are different. There is more conservation potential in lighting and less in heating, ventilation and air conditioning (HVAC). Updated analysis has reduced conservation potential for several key HVAC measures that appeared in the 5th Plan. But new technology and design practices in lighting offer more potential that identified five years ago. In addition, the 6th Plan assessment identified savings in areas not addressed five years ago including interior lighting controls, outdoor lighting, street and highway lighting and computer server rooms.

Nearly two-thirds of the conservation potential identified in the 6th Plan is lost-opportunity conservation and one-third is retrofit. The increase in lost-opportunity conservation is primarily due to a revised approach to modeling natural lighting stock turnover as a lost-opportunity conservation measure. Retrofit conservation is more expensive than the lost-opportunity conservation identified, thus overall costs of commercial conservation are lower than in the 5th Plan. Two-thirds of the conservation potential costs less than $30 per MWh.

Industrial Sector - In the 5th Plan, the industrial sector's potential was estimated to be five percent of 2025 sales, or 350 average megawatts. The Council, with the financial support from Bonneville contracted for an in-depth study of industrial-sector potential. This research indicates that a more realistic review of conservation options in this sector could achieve a percentage savings of about 10 to 15 percent of projected industrial sales. While savings fractions are higher than in the last plan, forecast industrial loads are lower. We are still finalizing the industrial conservation savings estimates and the industrial sector forecast. We expect savings potential to be in the range of 400 to 600 average megawatts at costs up to $100 per megawatt hour.

Utility Distribution System - The assessment of savings from the utility distributions system is a result of a Northwest Energy Efficiency Alliance project focused on improving the efficiency of utility distribution systems. Based on the results of a pilot program in six utilities across the region, it appears that reductions in line losses through better voltage regulation and equipment that is more efficient and system configuration changes could result in 450 Average megawatts savings by the year 2030. Costs range up to $70 per megawatt hour.

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# 6th Plan's Assessment of Regional Conservation Potential

## Conservation Resource Cost and Availability

January 13, 2009

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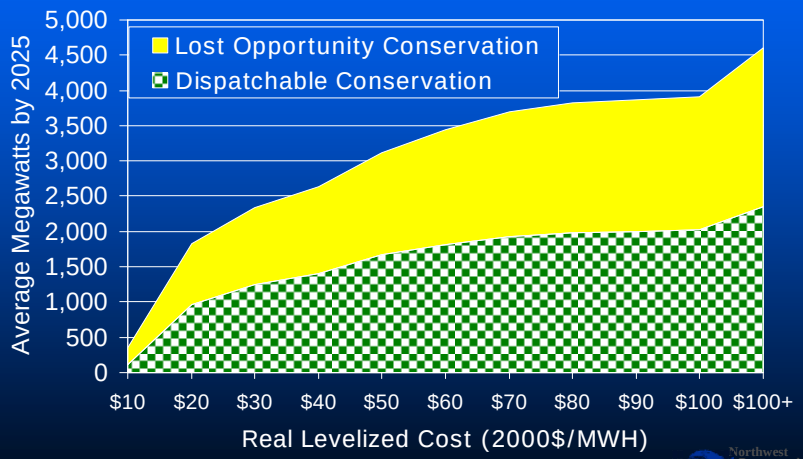
# 5th Plan Identified Nearly 4,600 MWa of "Technically Available" Conservation Potential

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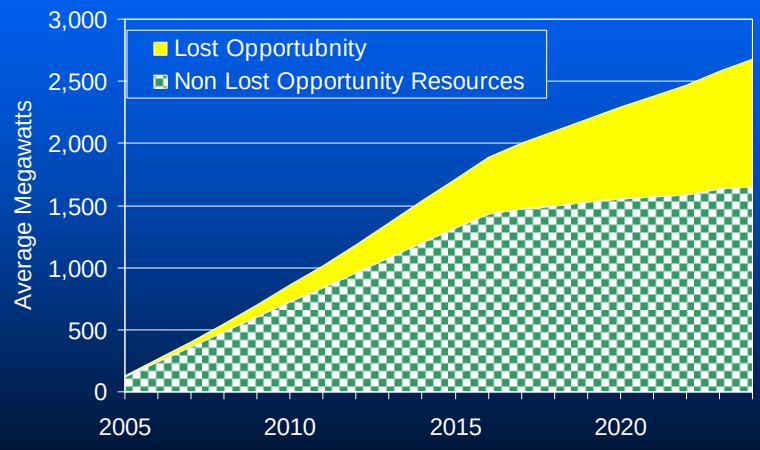
# 5th Plan Targeted 2700 MWa Over 20 Years



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# Adjustments to 5th Plan's Conservation Resource Potential

- Reductions in Available Potential
  - Program Accomplishments
  - Changes in Law
    - » Federal Standards for general service lighting
    - » State Building Codes
  - Changes in Markets
    - » Improved "Current Practice" due to Energy Star, LEED, Programs, Market Transformation
    - » Other Changes to Federal Standards (10 adopted, 21 under revision, and 12 with effective dates by 2014)
  - Changes in Forecast
    - » Less new commercial floor area
    - » Lower industrial forecast



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## Adjustments to 5th Plan's Conservation Resource Potential

- Increases in Available Potential
  - Changes in Scope
    - » Distribution System Efficiency Improvements
    - » Consumer electronics (TV's, set top boxes)
    - » Irrigation Water Management and Dairy Farm
  - Changes in Data and Technology
    - » Detailed Industrial Sector Potential
    - » New Measures (e.g. ductless heat pumps, solid state lighting)



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## Impact of Adjustments

- 5th Plan's Estimate of Achievable Conservation Potential
  - Reduced by 875 MWa for program accomplishments
  - Reduced by 450 – 500 MWa for impact of codes & standards
  - Increased by 400 – 500 MWa for Utility Distribution System Efficiency Improvements
  - Increase by 100 - 200 MWa for Industrial Sector Efficiency
  - Increased by 2800 MWa from new efficiency options



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# Residential - What's Covered

- Water Heating
  - High Efficiency Tanks
  - Heat Pump and Solar Water Heaters
  - 2.0 GPM Showerheads
  - GFX Wastewater Heat Recovery
- Appliances and Lighting
  - Clothes Washers
  - Clothes Dryers
  - Dishwashers
  - Refrigerators
  - Freezers
  - Microwaves & Ovens
  - Solar Photovoltaic Systems (On site use)
- **BIG EXCEPTION – Home Electronics (but we'll have it soon)**



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# Residential - What's Covered (cont)

- Space Conditioning
  - Thermal Shell Improvements (e.g. insulation, high efficiency windows)
  - Duct Sealing
  - Heating System Conversions to Air-Source Heat Pumps, including "ductless" systems
  - Heat Pump System Efficiency Upgrades
  - Central Air Conditioning Efficiency Upgrades
  - Room/Window Air Conditioning Efficiency Upgrades
  - Heating and Air Condition System "Commissioning"



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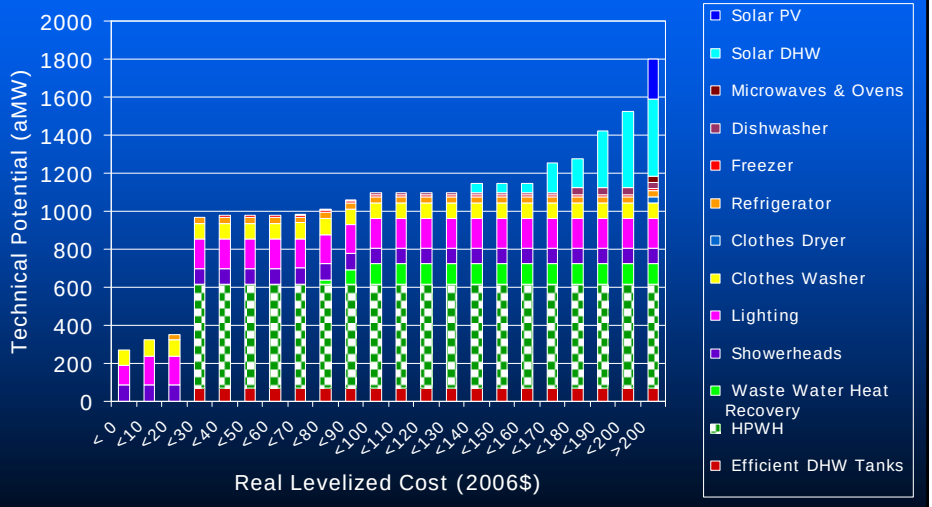
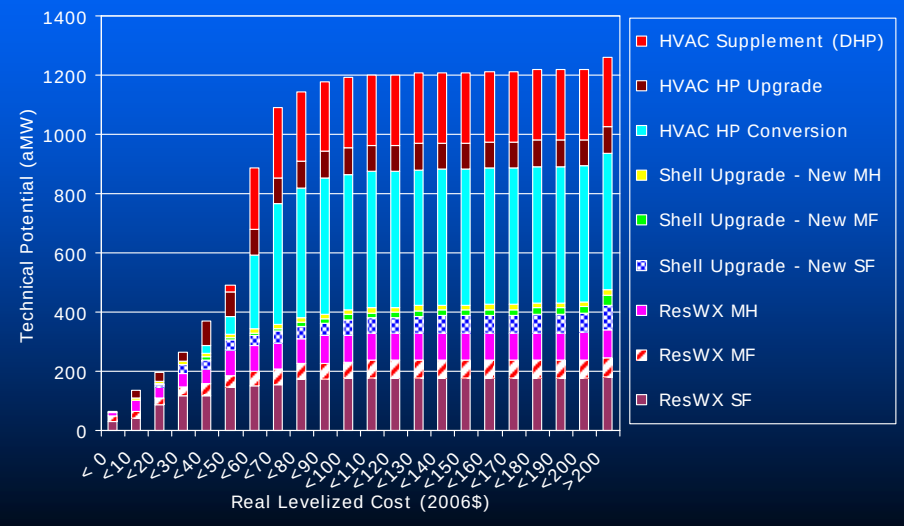
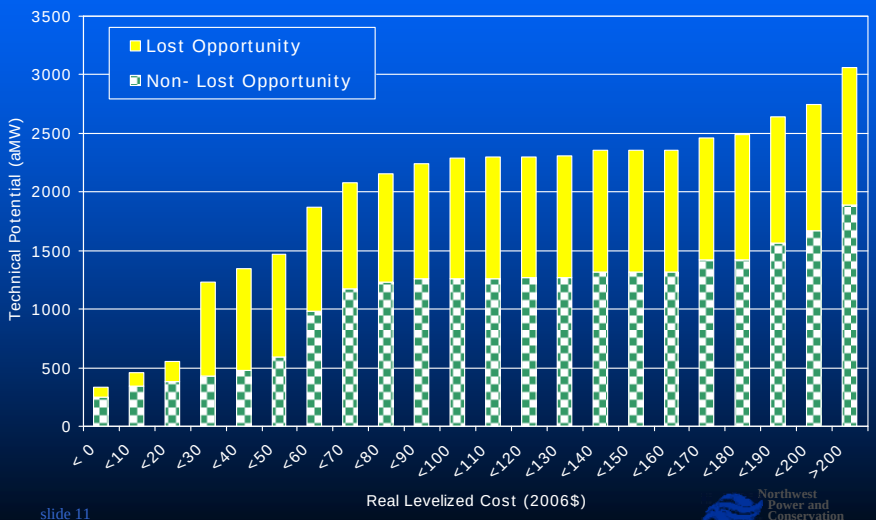
## Preliminary Draft 6th Plan Residential Water Heating, Lighting and Appliance Supply Curve




## Preliminary Draft 6th Plan Residential Space Conditioning Supply Curve



## Preliminary Draft 6th Plan Residential Supply Curve for Lost-Opportunity and Non-Lost Opportunity Conservation

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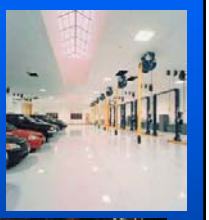
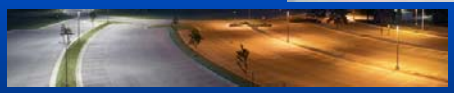
## Commercial Sector What's Covered: Lighting

- Lighting Power Density
- Daylighting with Skylights
- Daylighting with Windows
- Lighting Controls Interior
- Exit Signs
- Exterior Building Lighting
- Street and Roadway Lighting
- Parking Lighting
- LED Traffic Lights
- Signage







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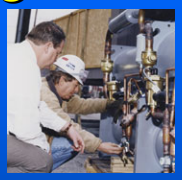
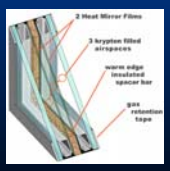
# Commercial Sector
# What's Covered: HVAC

- Premium HVAC Equipment
- Variable Speed Chiller
- Controls Commissioning
- Package Roof Top Optimization & Repair
- Low Pressure Distribution
- Demand Control Ventilation
- Electrically Commutated Motors
- Evaporative Assist Cooling
- Glass
- Roof Insulation



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# Commercial Sector
# What's Covered: Process

- **Municipal Sewage Treatment**
- **Municipal Water Supply**
- **Network PC Power Management**
- **Packaged Refrigeration Equipment**
- **Commercial Clothes Washers**
- **Cooking Equipment**
- **Office Equipment**
- **Computer Servers and IT**
- **Demand Control Ventilation Restaurant Hood**
- **Demand Control Ventilation Parking Garage**
- **Grocery Refrigeration Bundle**
- **Plug Load Sensor**
- **Premium Fume Hood**
- **Pre-Rinse Spray Valve**
- **Grocery Refrigeration Bundle**








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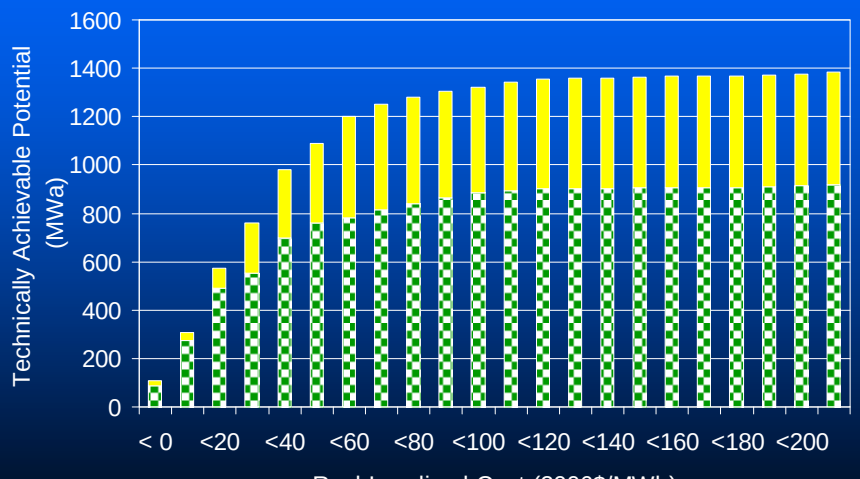
## Preliminary Draft 6th Plan Commercial Supply Curve for Lost-Opportunity and Non-Lost Opportunity Conservation

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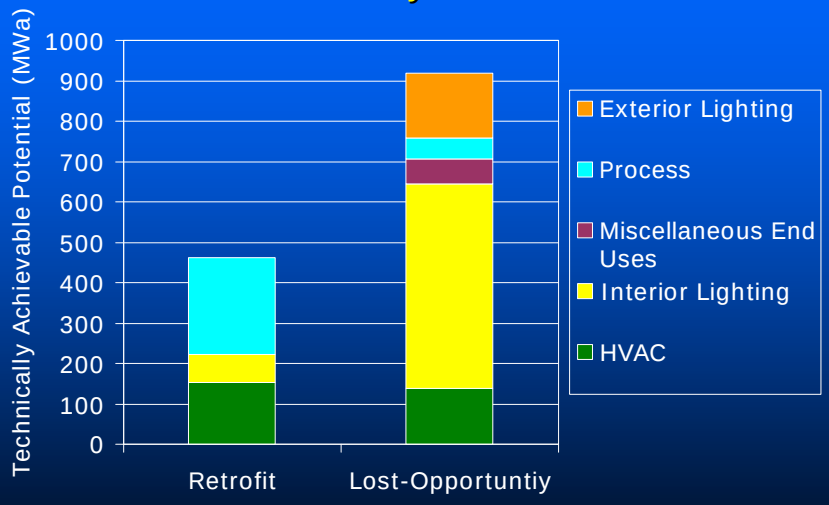
## Commercial Sector Achievable Savings Potential by End Use

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# Non-DSI Industrial Sector – What's Covered:

- Air Compressor Demand Reduction
- Air Compressor Equipment
- Air Compressor Management
- HighBay Lighting
- Lighting Controls
- Motors: Efficient Rewind VSD Controls
- Motor Management Program
- Fan Efficient Centrifugal
- Food: Fans and Blowers
- Other: Fans and Blowers
- Fan ASD Control
- Premium Pump
- Pump ASD Control
- Transformers
- Synchronous Belts
- Food: Cooling and Storage
- Food: Refrig Storage O&M
- Metal: New Arc Furnace
- Paper: Medium Consistency Pump
- Mech Pulp: Refiner Replacement
- Mech Pulp: Premium Process
- Mech Pulp: Refiner Plate Improvement
- Kraft Pulp: Effluent Treatment System
- Kraft Pulp: Efficient Agitator
- Paper: Efficient Pulp Screen
- Paper: Premium Fan
- Paper: Material Handling
- Wood: Replace Pneumatic Conveyor
- Wood: Hydraulic Press
- Cold Storage Retrofit
- Cold Storage Tuneup
- Fruit Storage Refer Retrofit
- CS Retrofit -- CO2 Scrub
- CS Retrofit -- Membrane
- Fruit Storage Tuneup
- Grocery Distribution Retrofit & Tuneup
- Generic O&M

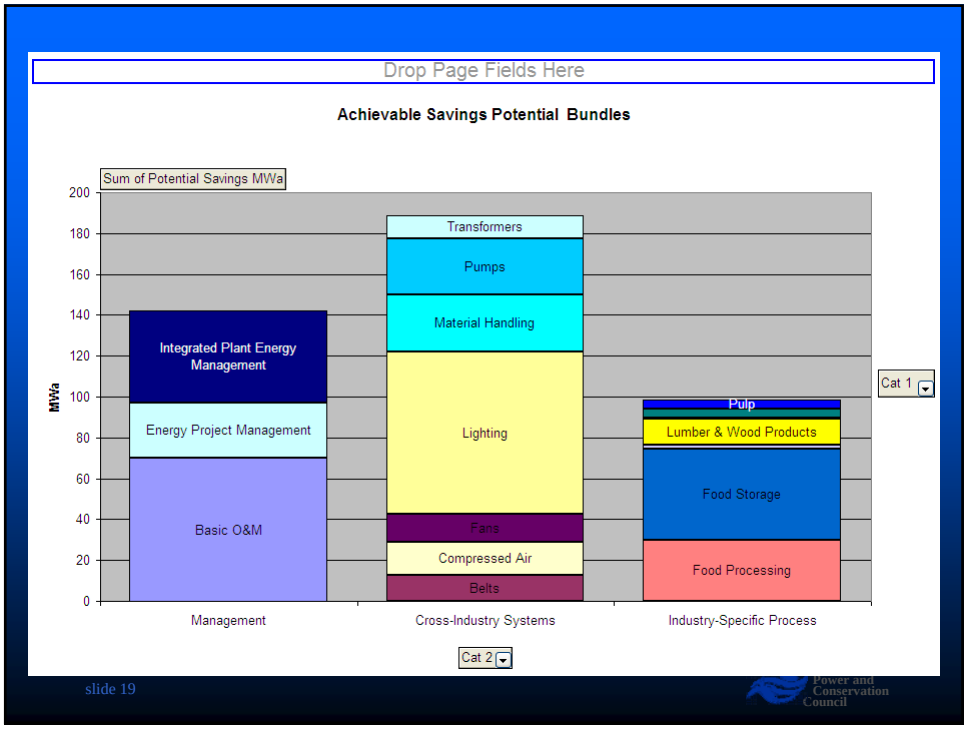




# Industrial Energy Savings Potential

## An Act in Three Parts

- High-Efficiency Equipment
  - Cross-industry systems (pumping or lighting)
  - Industry-specific (refiner plates in mechnical pulping)
- Systems Improvement
  - Optimization, demand management, sizing
- People
  - Operational & Business Practices


Drop Page Fields Here
Achievable Savings Potential Bundles
Sum of Potential Savings MWa
MWa
200
180
160
140
120
100
80
60
40
20
0
Integrated Plant Energy Management
Energy Project Management
Basic O&M
Transformers
Pumps
Material Handling
Lighting
Fans
Compressed Air
Belts
Pulp
Lumber & Wood Products
Food Storage
Food Processing
Cat 1
Management
Cross-Industry Systems
Industry-Specific Process
Cat 2
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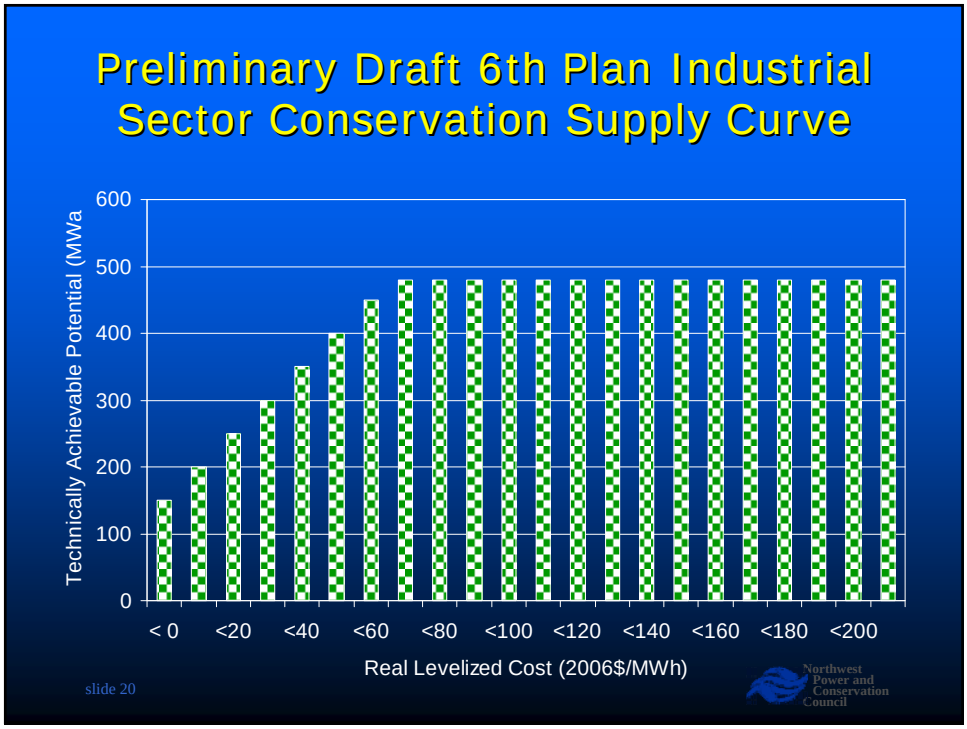
Preliminary Draft 6th Plan Industrial Sector Conservation Supply Curve
Technically Achievable Potential (MWa
600
500
400
300
200
100
0
< 0
<20
<40
<60
<80
<100
<120
<140
<160
<180
<200
Real Levelized Cost (2006$/MWh)
slide 20
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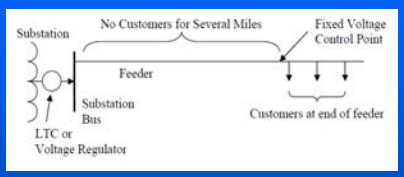
# Utility Distribution System Efficiency What's Covered

- System Optimization




- Line Drop Compensation

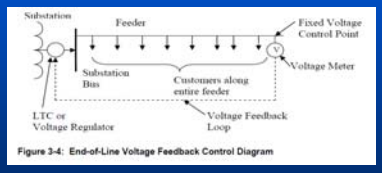


Figure 3-4: End-of-Line Voltage Feedback Control Diagram

- End of Line Voltage Feedback
- Home Voltage Regulation



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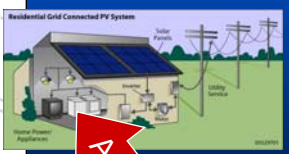
## Energy & Capacity Savings

From Here




And In Here

To Here



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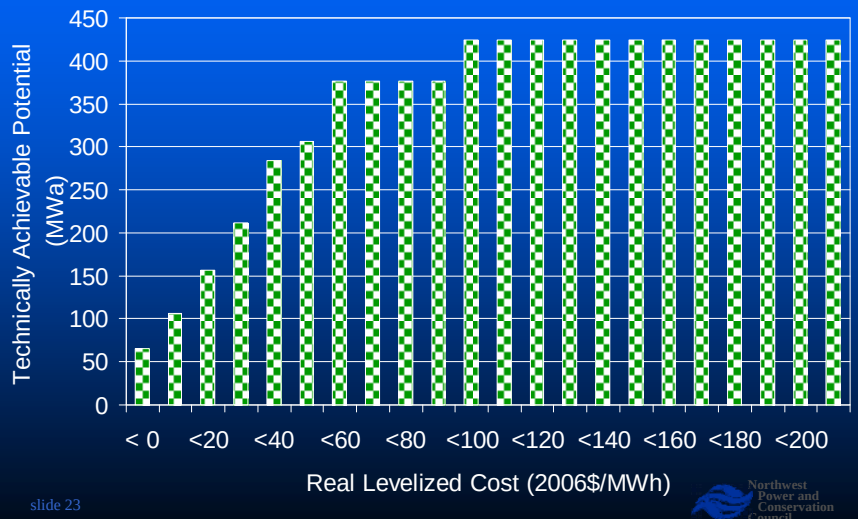
## Preliminary Draft 6th Plan Utility Distribution System Conservation Supply Curve

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## Agriculture - What's Covered

- Irrigation System Efficiency Improvements
  - Conversion of Center Pivot, Wheel Line and Hand Line to Lower Pressure Delivery Systems
  - Improvements in pump efficiency
  - System leak reduction
  - Improved sprinkler and nozzles
- Irrigation Water Management
  - Scientific Irrigation Water Scheduling
- Dairy Farm Milk Production

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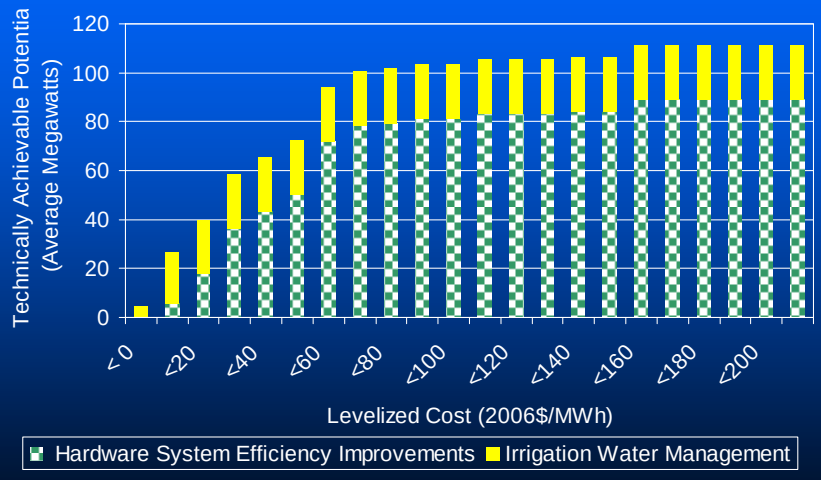
# Irrigation Sector Conservation Potential



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# Dairy Milk Production Conservation Potential

- "On farm" dairy milk production is the largest single use of electricity in agriculture sector after irrigation
- New Measure for 6th Plan
  - Current conservation programs are targeting savings from dairies, but no regional estimate of savings potential

*Average dairy uses 800 – 1200 kWh/cow-yr*

*There are approximately 885,000 milking cows in PNW*



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## Dairy Milk Production – What's Covered

- Variable speed drive on milking machine vacuum pump
- Flat Plate Heat Exchanger for milk pre-cooler
- Energy efficient lighting
- Refrigeration heat recovery



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## Dairy Milk Production Conservation Technical Potential

| State | Retrofit Potential (aMW) | Lost-Opportunity Potential (aMW) | Total Potential (aMW) |
|---|---|---|---|
| Idaho | 2.6 | 0.4 | 3.1 |
| Montana | 0.3 | 0.0 | 0.3 |
| Oregon | 0.5 | 0.3 | 0.8 |
| Washington | 1.3 | 0.0 | 1.3 |
| Total | 4.7 | 0.8 | 5.5* |

*Real Levelized Cost of Savings <$10 MWH (2006$)



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# IS THAT AS GOOD AS IT GETS?



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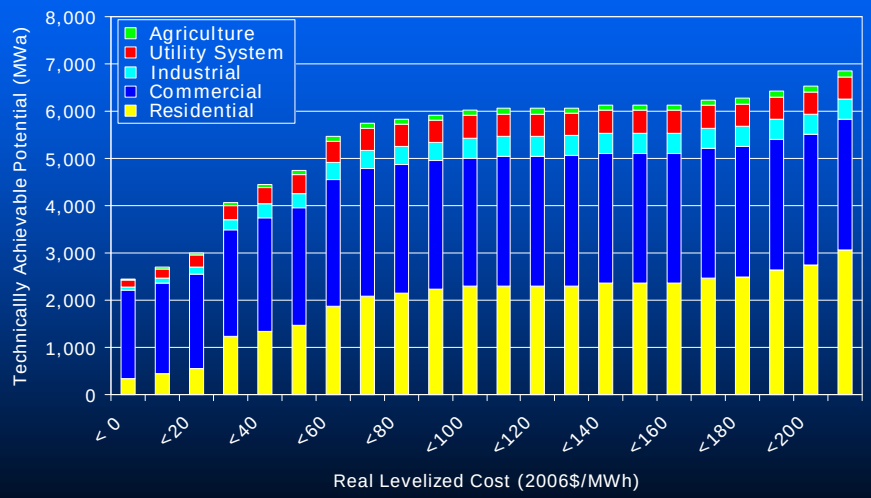
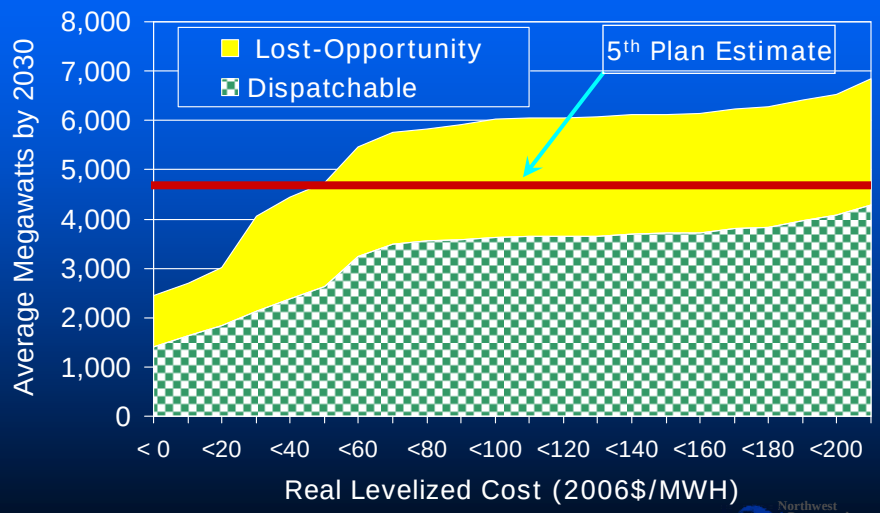
## Draft 6th MWa of "Technically Available" Conservation Potential by Sector



## Draft 6th MWa of "Technically Available" Conservation Potential

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## Background Slides

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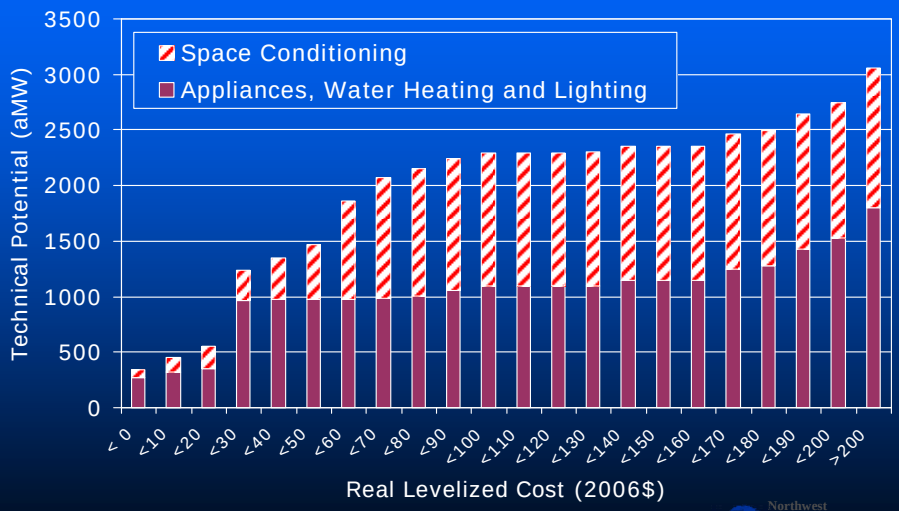
# Preliminary Draft 6th Plan Space Residential Sector Supply Curve




slide 33

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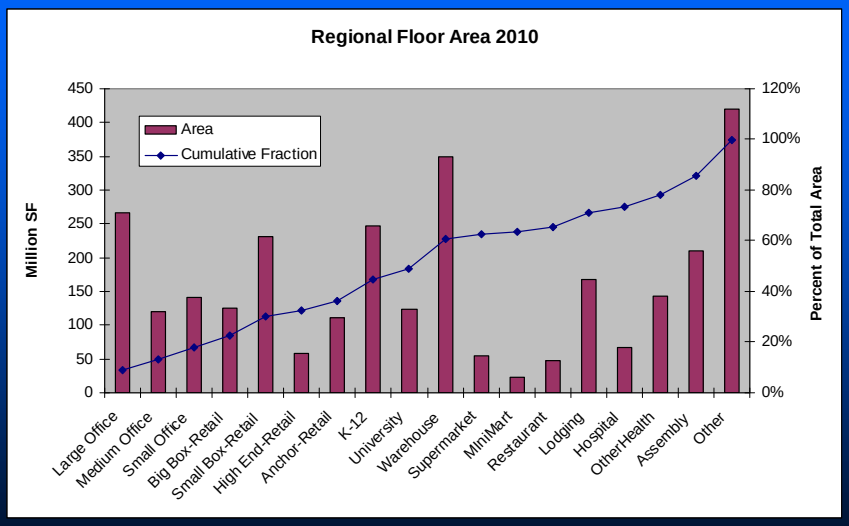
# Commercial Sector Floor Area

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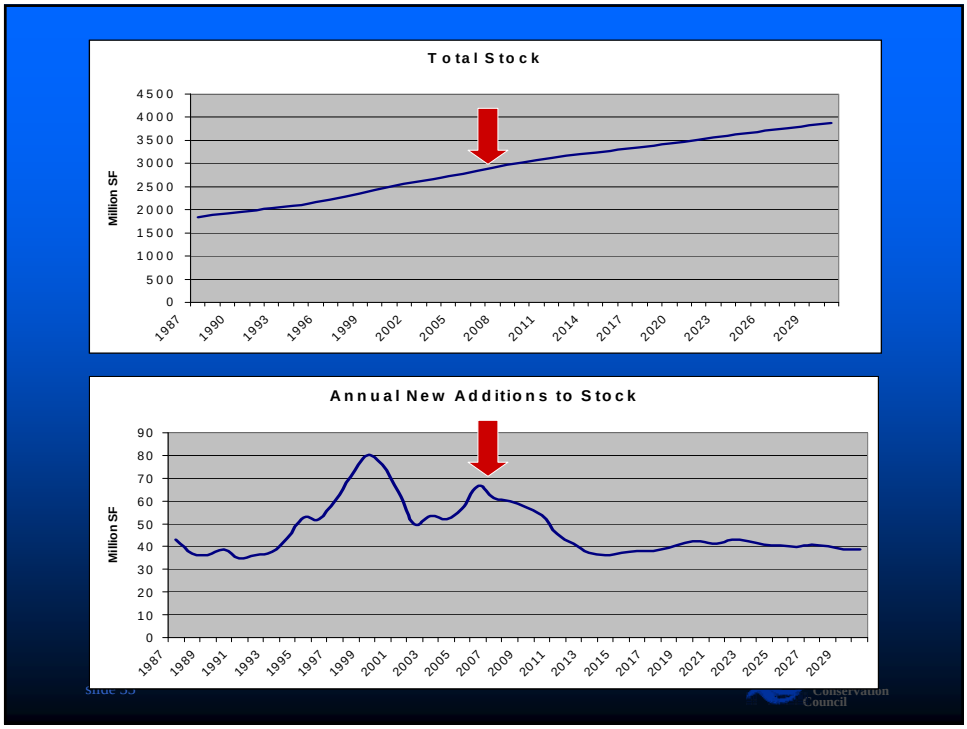
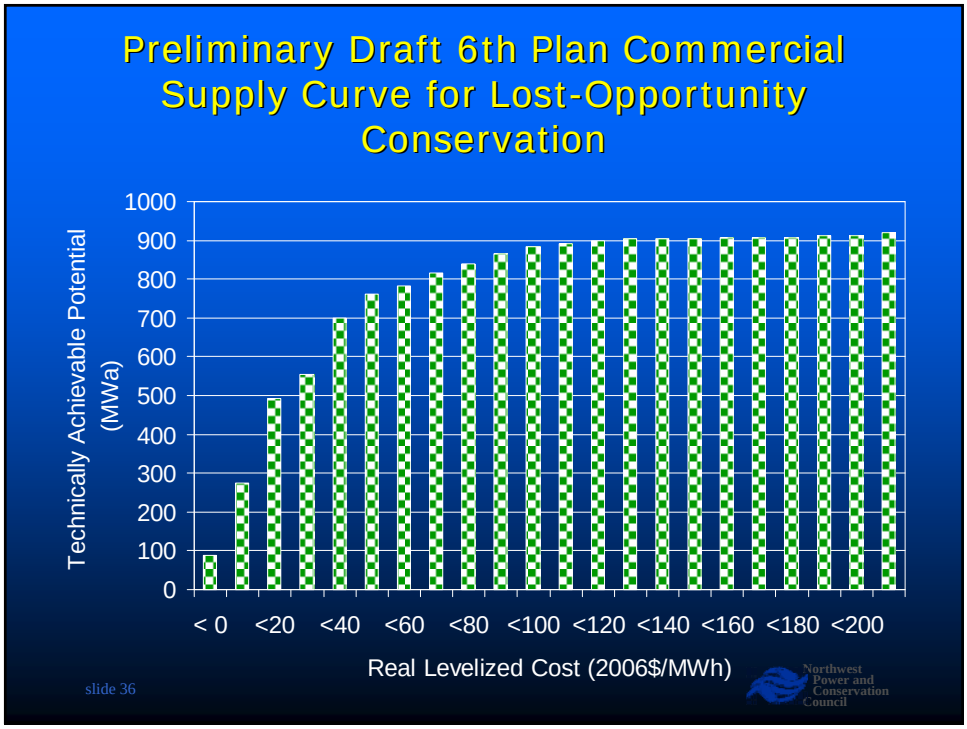

Total Stock
Million SF
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
2026
2029
Annual New Additions to Stock
Million SF
90
80
70
60
50
40
30
20
10
0
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
2019
2021
2023
2025
2027
2029


Preliminary Draft 6th Plan Commercial Supply Curve for Lost-Opportunity Conservation
Technically Achievable Potential (MWa)
1000
900
800
700
600
500
400
300
200
100
0
< 0
<20
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<60
<80
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<120
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<160
<180
<200
Real Levelized Cost (2006$/MWh)
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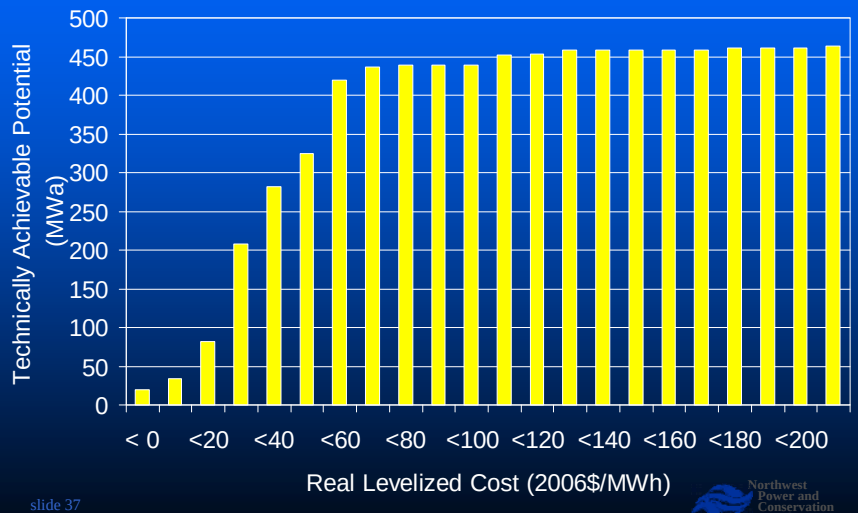
## Preliminary Draft 6th Plan Commercial Supply Curve for Non-Lost Opportunity Conservation




slide 37

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## 6th Plan Industrial Conservation Potential

slide 38

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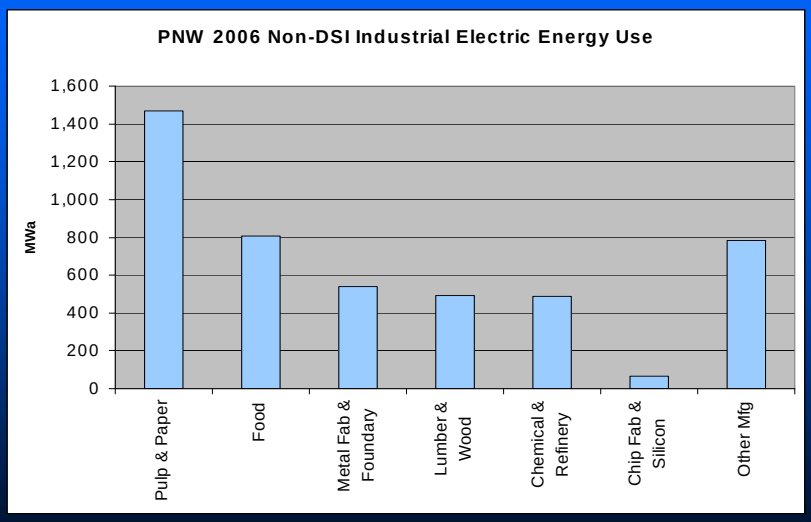
## PNW Non-DSI Industrial Electric Load 2006
## 4640 MWa

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## Distribution System
## Efficiency Potential & Conservation
## Voltage Reduction

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# The Standards

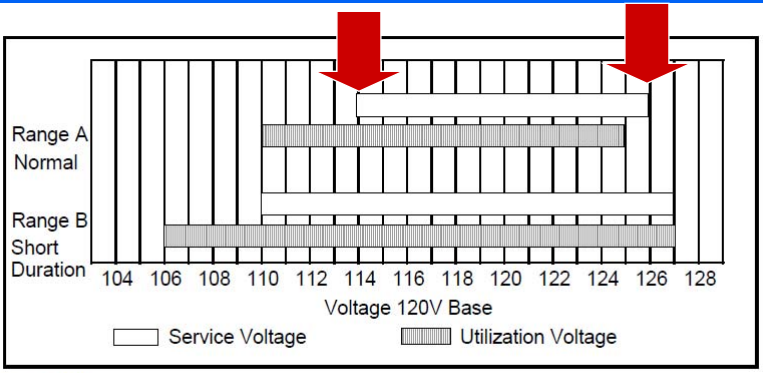


Figure 1-1
ANSI C84.1 Voltage Ranges



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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



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## Source of Estimates

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





## 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

# Irrigation Water Management Resource Potential

- Resource Definition
  - Scientific scheduling of irrigation water applications based on soil moisture measurement and plant moisture requirements
- New Measure in 6th Plan
  - Post 5th Plan's adoption, Bonneville funded research to estimate potential savings from improved water management
  - Research indicated that through "scientific irrigation scheduling" pumping energy use could be reduced by approximately 10%



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# Irrigation Water Management – Issues

- Applicability
  - Energy Savings from irrigation water management require that the unused water not be applied elsewhere in the system
  - Except for the Columbia Basin Project, Western water law does not prohibit the "use" of the saved water from surface water
  - This limits applicability of irrigation water management to just 16% of the region's irrigated acreage
- The large non-energy benefits from better irrigation water management are already increasing its adoption
  - Improved crop yields
  - Reduced erosion
  - Reduced ground water pollution
  - Reduced fertilizer use



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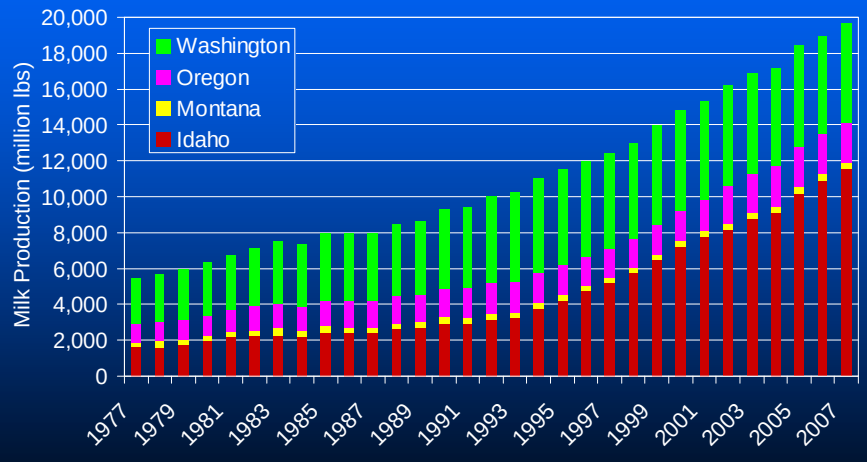
# PNW Milk Production Has Double Since 1990
## (Idaho Production is up 400%)




slide 47

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