

Demand Forecast Advisory Committee
Meeting 2
in Preparation for the Seventh Power Plan

June 26, 2014
Tom Eckman
Charlie Grist
Massoud Jourabchi

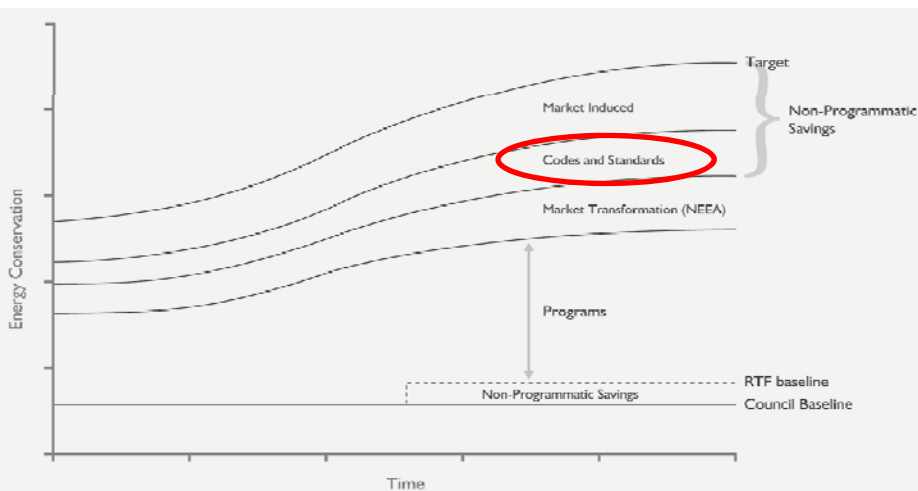
Agenda

- **Welcome and introductions**
- **Impact of Federal Standards on future loads** **1:40 to 2:40**
- **New data on load shape of appliances** **2:45 to 3:15**
- **Next steps in 7th Plan development** **3:15 to 3:30**

Overview of Federal Appliance Standards and Their Impact on Regional Loads

June 26, 2014

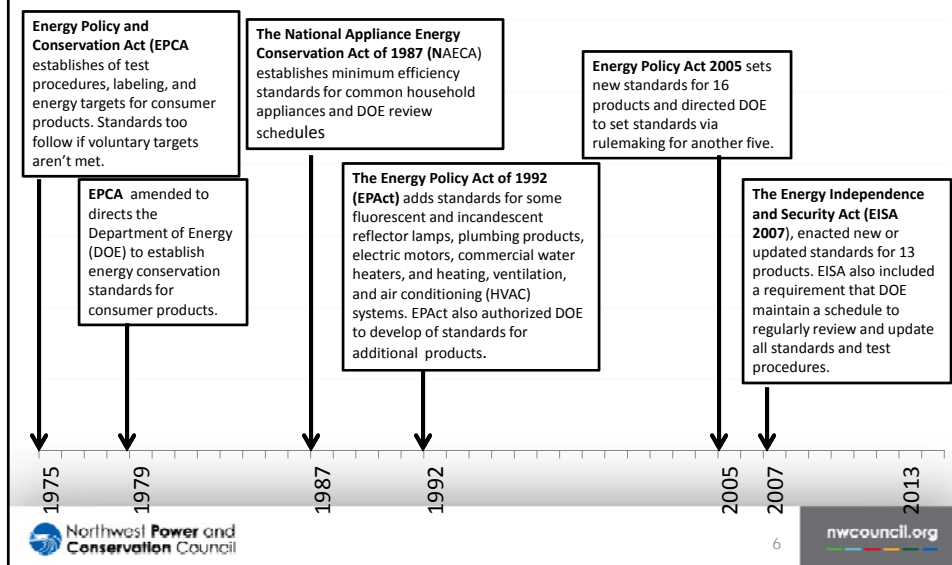
Savings from Many Mechanisms

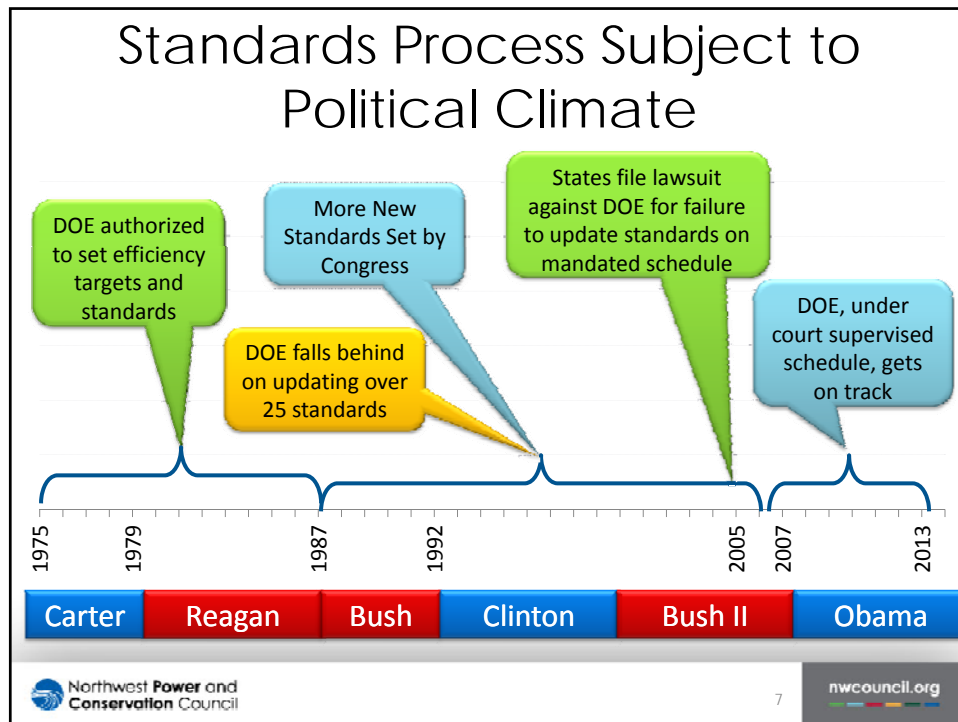


Today's Presentation

- Short history and “primer” on federal efficiency standards for appliance, equipment and lighting
- Why standards are important mechanism for capturing savings
- Historical and projected impact of federal efficiency standards on regional loads

Legislative History of Federal Appliance Standards





Current Status

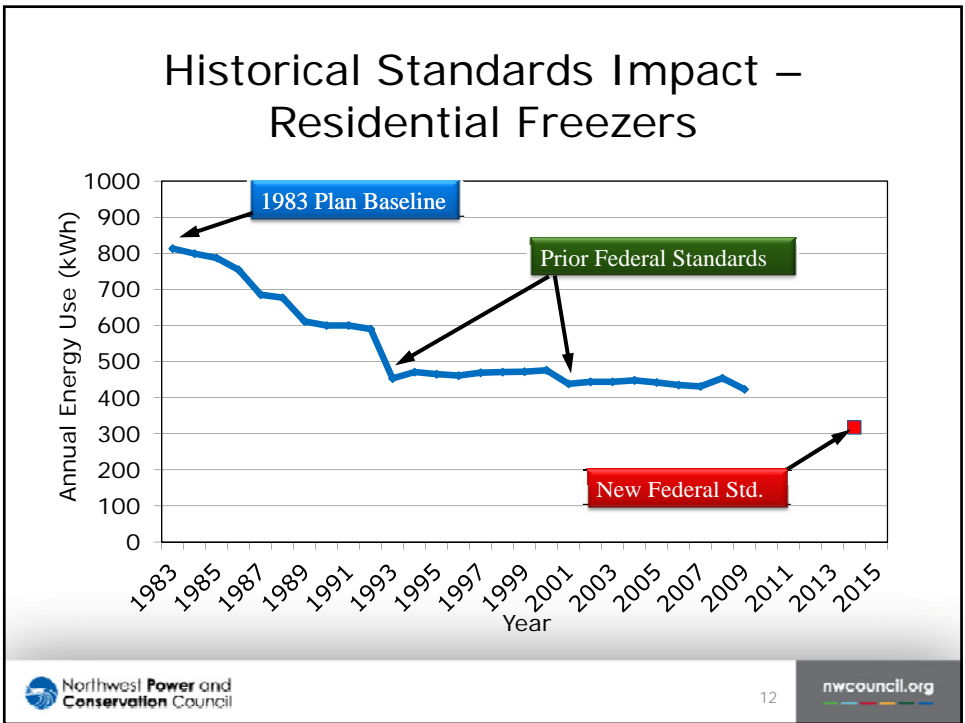
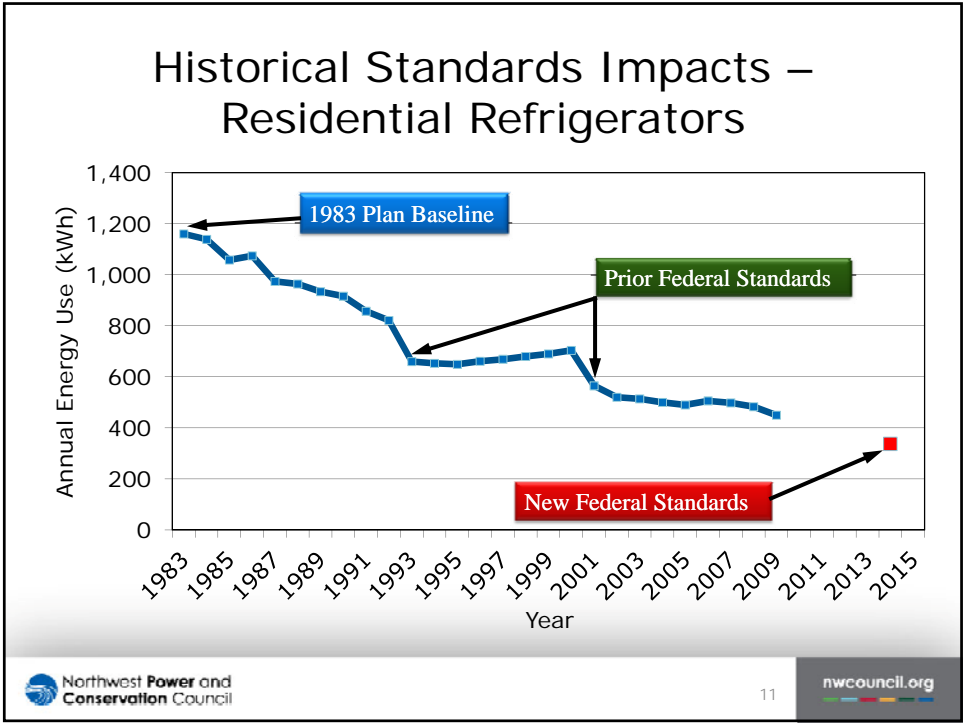
- **Currently there are minimum energy efficiency standards for more than 50 categories of appliances and equipment.**
- **Products covered by standards represent about 90% of home energy use, 60% of commercial building use, and 29% of industrial energy use.**
- **DOE must now review each product standard every six years to determine whether it should be revised**

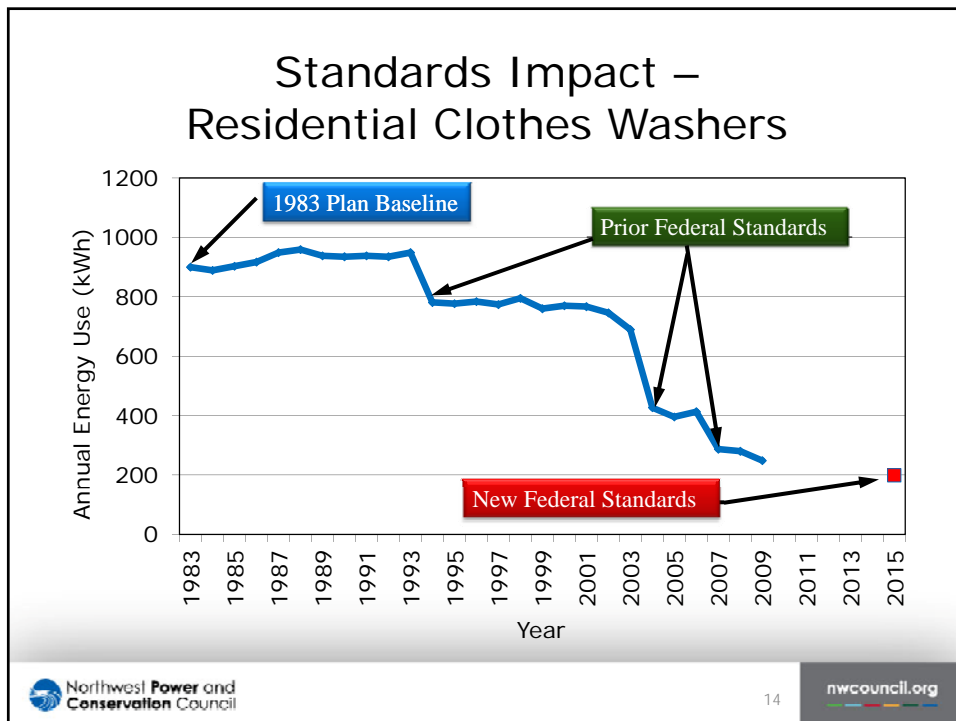
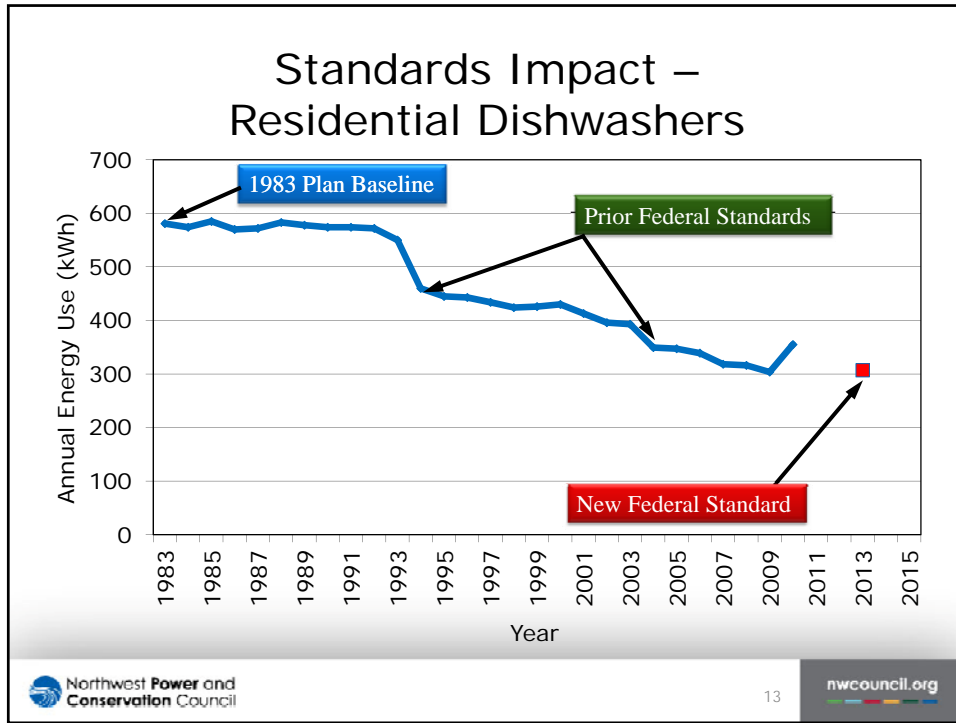
Major Product Categories Covered by Federal Efficiency Standards

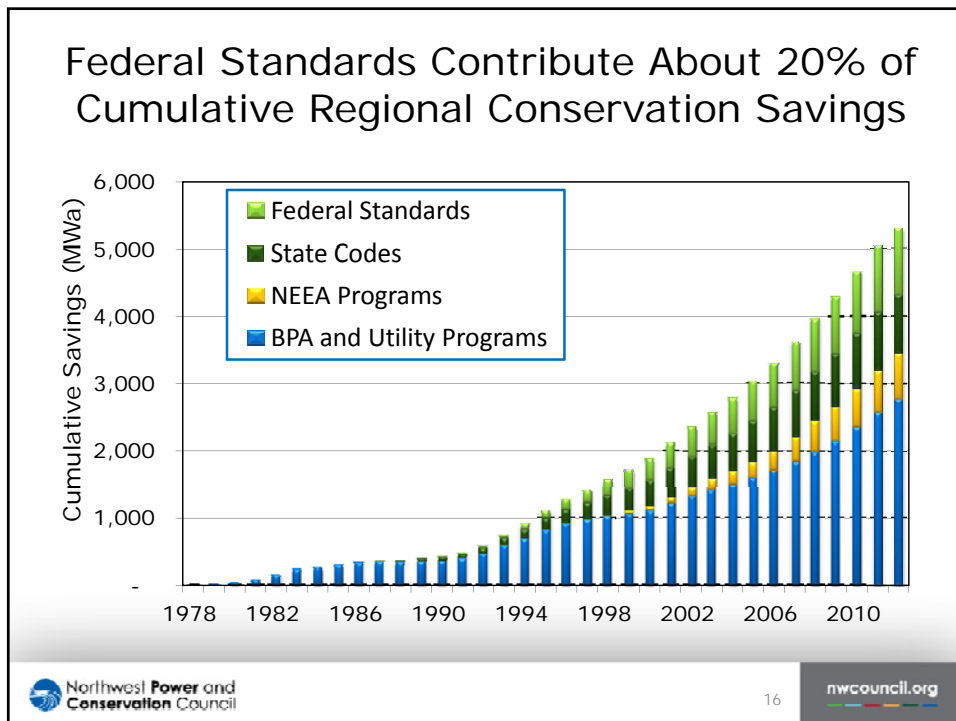
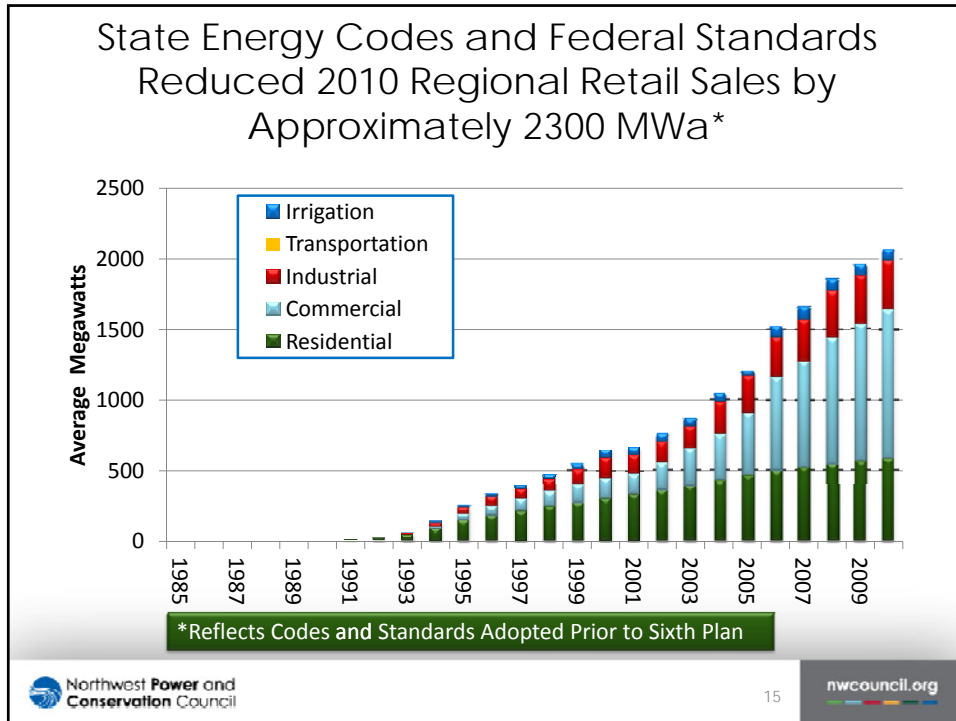
- Battery Chargers and External Power Supplies
- Ceiling Fan Light Kits
- Residential & Commercial Clothes Washers
- Commercial Ice Makers
- Commercial Packaged Air Conditioners and Heat Pumps
- Commercial Packaged Heating and Cooling Equipment
- Residential & Commercial Refrigerators & Freezers
- Commercial Warm Air Furnaces
- Residential & Commercial Water Heaters and Unfired Water Heater Tanks
- Compact Fluorescent Lamps
- Dehumidifiers
- Direct heating equipment
- Electric Motors
- Exit Signs
- General Service Fluorescent Lamps and Ballasts
- General Service Incandescent Lamps
- Incandescent Reflector Lamps
- Low & Medium Voltage Transformers
- Metal Halide Lamps Fixtures
- Pool heaters
- Refrigerated Beverage Vending Machines
- Residential Central Air Conditioners and Heat Pumps
- Residential Clothes Dryers
- Residential Dishwashers
- Residential Furnaces & Boilers
- Residential Ranges and Ovens
- Room Air Conditioners
- Single Packaged Vertical Air Conditioners and Heat Pumps
- Torchiers
- Traffic and Pedestrian Signal
- Walk-in Coolers and Walk-In Freezers

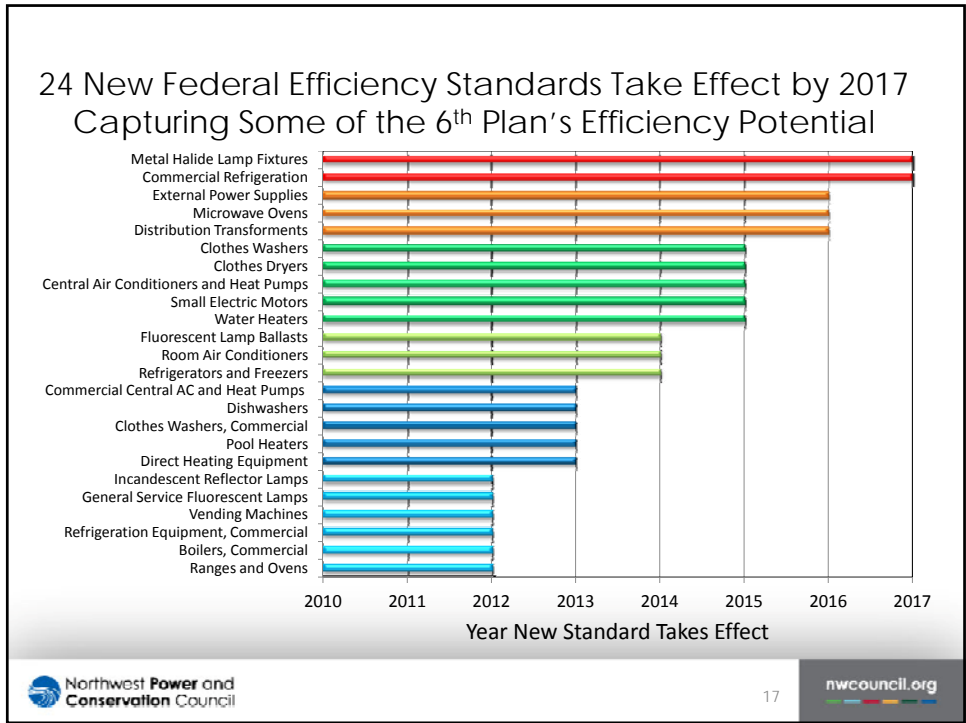
Why Federal Efficiency Standards Are Valuable

- **Lower Cost** – Standards produce savings at lower “total cost” because they avoid program administrative costs.
- **Larger Savings** -- Standards effect the entire market while programs effect only a portion of the market resulting in greater total savings for comparable improvements in efficiency
- **Greater Equity** -- The “compliance cost” of meeting a standard is borne by the consumers who benefit from the increased efficiency.









And There Are More on the Way — DOE 2014 Rulemaking Schedule

Date	Product	Rulemaking Stage
Published 02/03/14	Battery Chargers and External Power Supplies**	Final rule ✓
Published 06/25/14	Commercial Furnaces**	Proposed rule or neg. determ.
	Commercial Packaged A/C and Heat Pumps**	Proposed rule or neg. determ.
Published 01/28/14	Commercial Water Heaters**	Proposed rule or neg. determ.
	Furnace Fans**	Final Rule ✓
	IRLs (Certain ER, BR, and Small Diameter)**	Proposed rule
Published 03/31/14	Packaged Terminal A/C and Heat Pumps**	Preliminary analysis
	Residential Boilers**	Preliminary analysis
Published 05/09/14	Automatic Ice Makers	Proposed rule
	Dehumidifiers	Preliminary analysis
June	Metal Halide Lamp Fixtures	Final rule ✓
	Ceiling Fans and Ceiling Fan Light Kits	Preliminary analysis
July	Commercial Refrigeration Equipment	Final rule ✓
	General Service Fluorescent Lamps and IRLs	Proposed rule
August	Commercial Clothes Washers	Proposed rule
	Wine Chillers and Misc. Refrigeration Products	Preliminary analysis
September	Walk-in Coolers and Freezers	Final rule ✓
	Automatic Ice Makers	Final rule ✓
October	Electric Motors	Final rule ✓
	Commercial Furnaces*	Final rule
November	Commercial Packaged A/C and Heat Pumps*	Final rule
	Commercial Water Heaters*	Final rule
December	IRLs (Certain ER, BR, and Small Diameter)	Final rule
	Commercial and Industrial Pumps	Proposed rule
January	High-Intensity Discharge (HID) Lamps	Proposed rule
	Residential Boilers	Proposed rule or neg. determ.
February	Fans and Blowers	Proposed rule
	Single Package Vertical A/C and Heat Pumps	Proposed rule
March	Packaged Terminal A/C and Heat Pumps	Proposed rule
	Vending Machines	Preliminary analysis
April	General Service Fluorescent Lamps and IRLs	Final rule

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Impact on Northwest

- Council staff is working Bonneville and its consultant to estimate the impact of standards adopted since the Sixth Plan
- Objective of analysis
 - Determine contribution of standards savings toward achievement of the Sixth Plan conservation targets for 2010 – 2015
 - Determine implications for the Seventh Plan's forecast of post-2015 load growth and remaining conservation potential

Analytical Approach

- Focus on federal standards not included in Sixth Plan baseline
- Target analysis on standards with largest impact
- Collect data on actual units shipped and their efficiency
- Account for interactions between standards, state energy codes and utility programs to avoid “double counting” of savings
- Determine “net impact” of standards

Impact Analysis Focuses Analysis on These Standards

Residential

- Residential Dishwashers
- Residential Clothes Washers
- External Power Supply
- Residential Refrigerators and Freezers
- Residential Water Heater
- Residential Heat Pumps
- Torchieres
- Ceiling Fan Lighting Kits

Commercial/Industrial

- Walk-in Coolers and Freezers
- Commercial Refrigeration Products
- Commercial Clothes Washers
- Pre-rinse Spray Valve
- Commercial CAC and Heat Pumps
- Packaged Terminal AC and HP
- Illuminated Exit Signs
- Electric Motors
- Distribution Transformers

Lighting

- Metal Halide Lamp Fixtures
- Mercury Vapor Lamp Ballasts
- Fluorescent Lamp Ballasts
- General Service Fluorescent Lamps
- General Service Incandescent Lamps
- Incandescent Reflector Lamps
- Candelabra & Intermediate Base Incandescent Lamps
- Medium Base Compact Fluorescent Lamps
- High Intensity Discharge Lamps

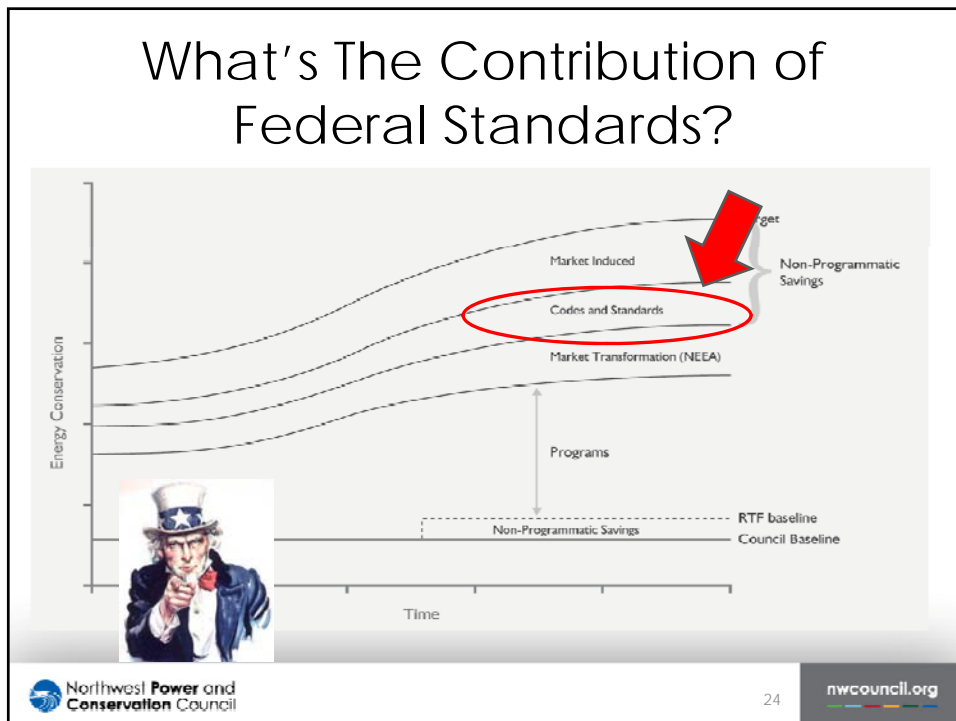
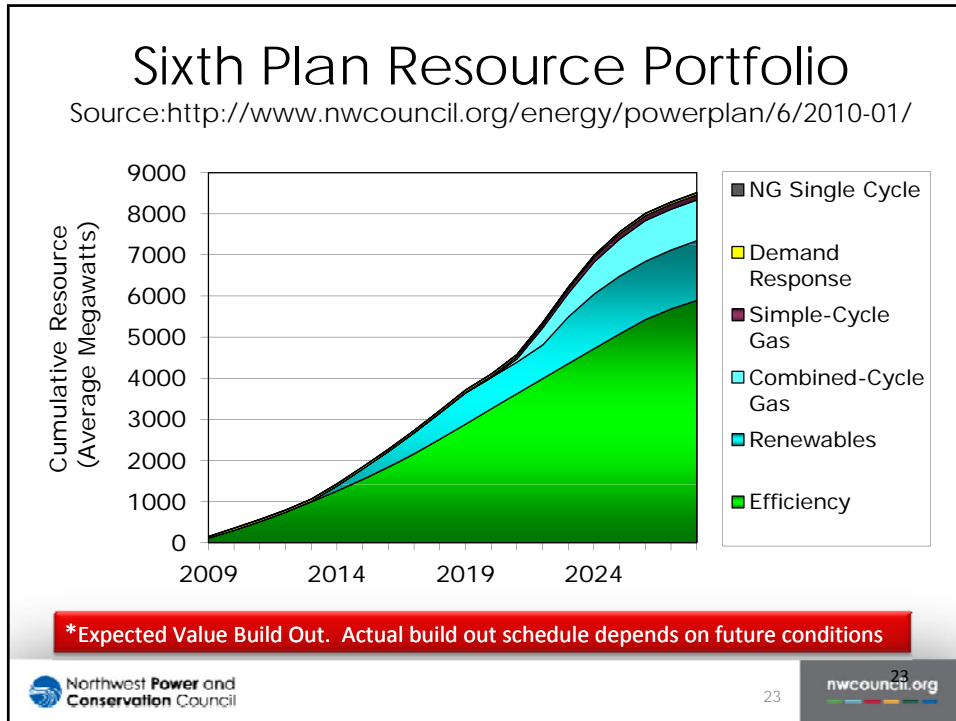
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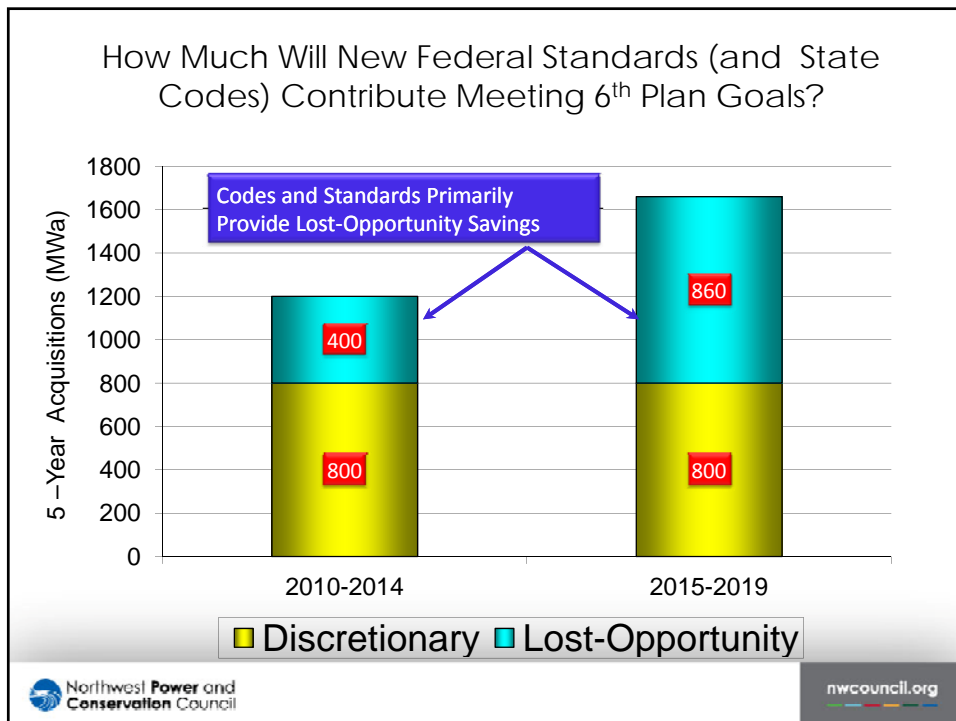
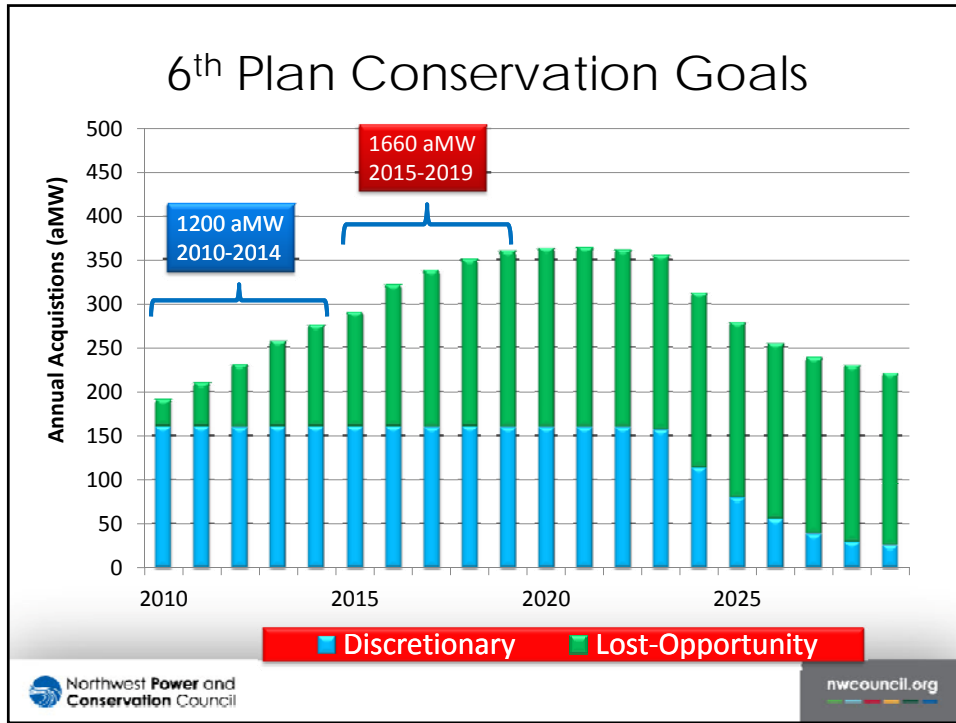
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Contribution of Federal Standards Toward 6th Plan Efficiency Goals

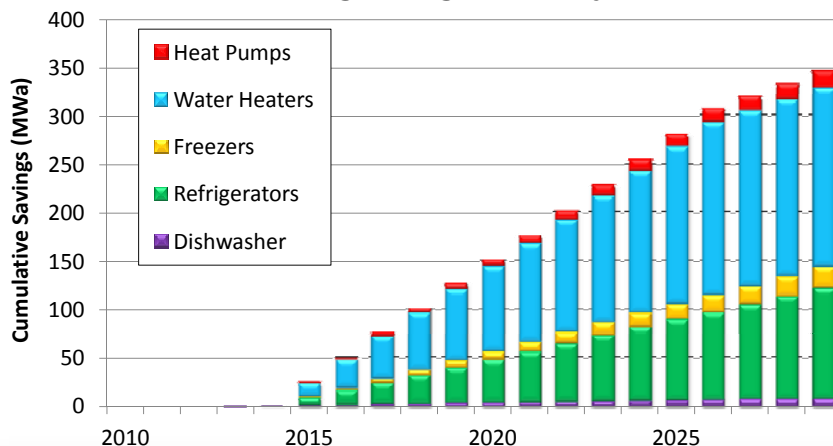
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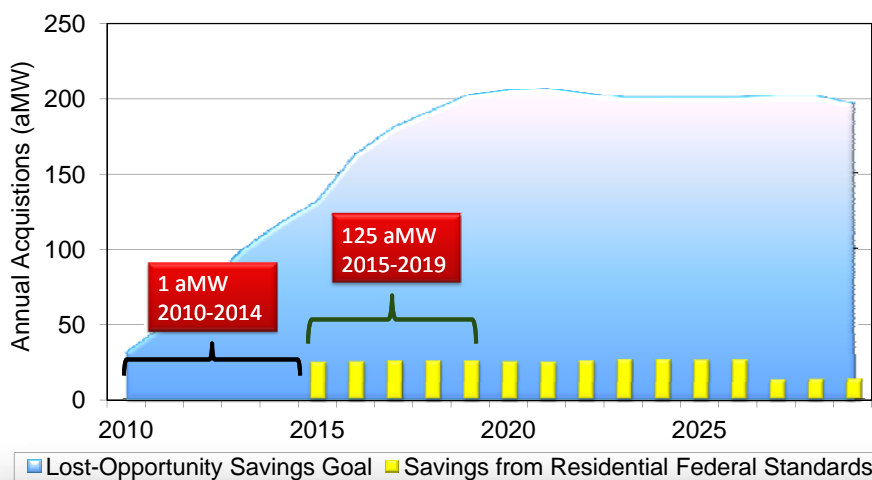


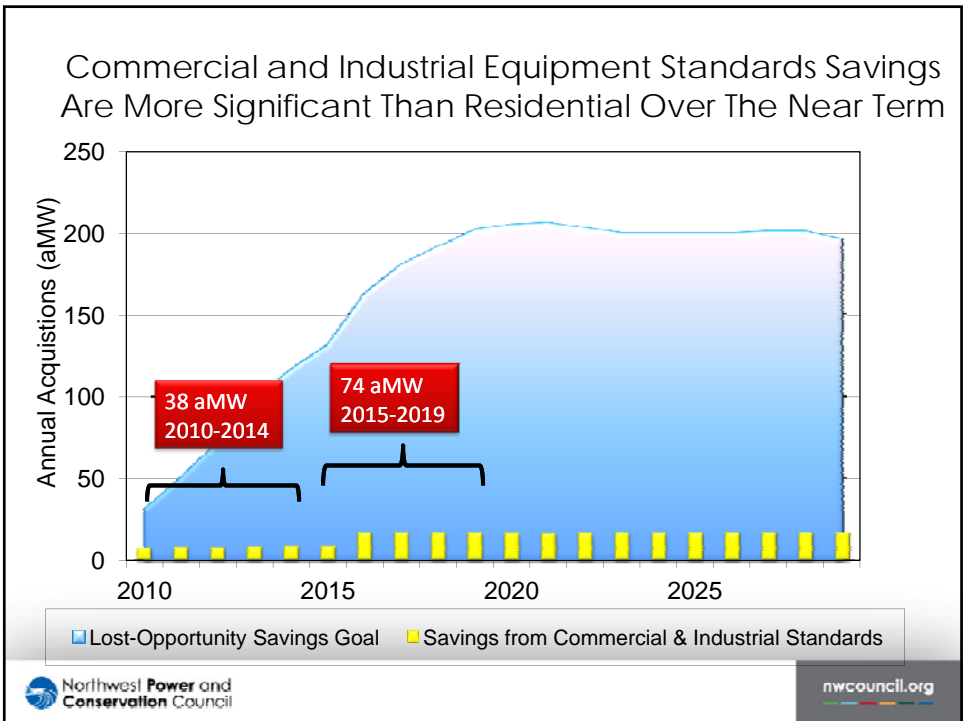
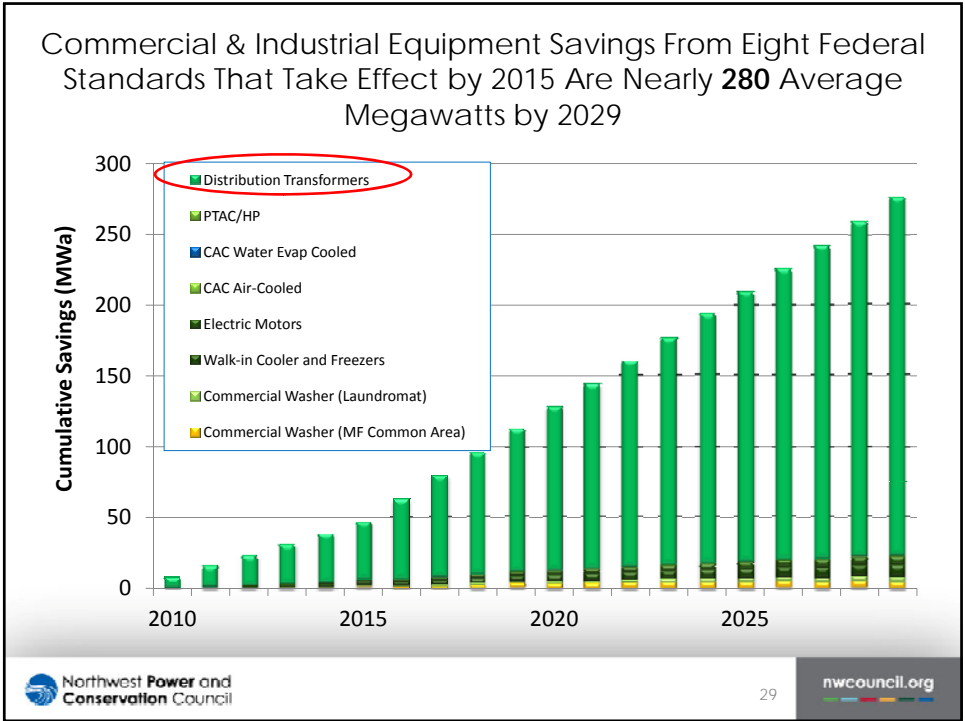


Residential Appliance and Equipment Savings From Five Federal Standards That Take Effect by 2015 Are Just Under **350** Average Megawatts by 2029



However, The Estimated Contribution of Residential Appliance and Equipment Standards Savings to Sixth Plan Conservation Goals Is Small Over The Near Term

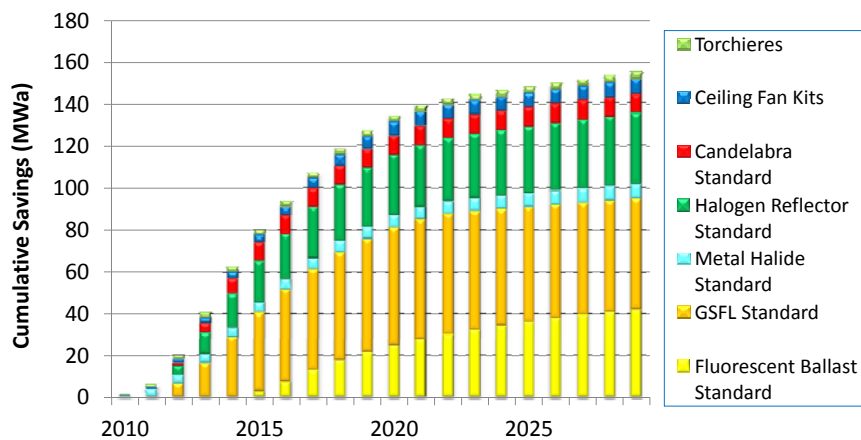




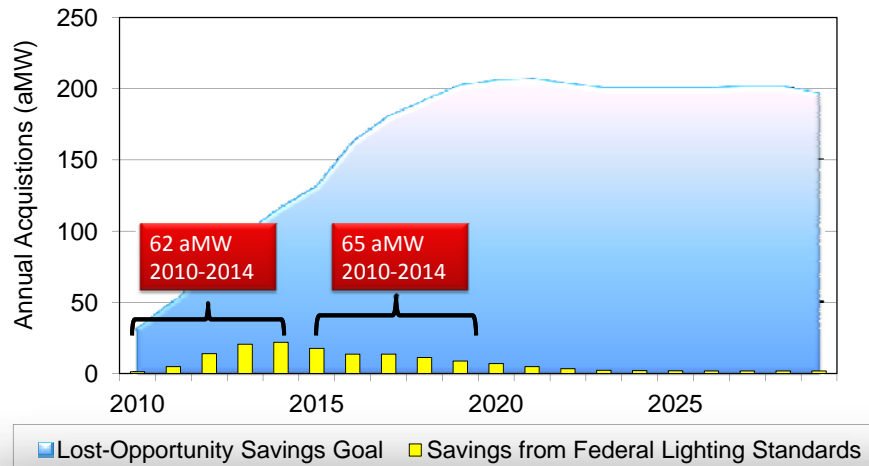
Lighting Standards

- **Lighting Standards in Sixth Plan forecast**
 - General Service Incandescent (2012)
 - Mercury Vapor (2008)
- **Seven Standards since Sixth Plan (Effective Dates)**
 - General Service Fluorescent Lamps (2012)(2014)
 - Fluorescent Ballasts (2015)
 - Metal Halide Fixtures (2012)
 - Halogen Reflector Lamps (2012)
 - Candelabra Lamps (2012)
 - Ceiling Fan Light Kits (2010)
 - Torchieres (2010)

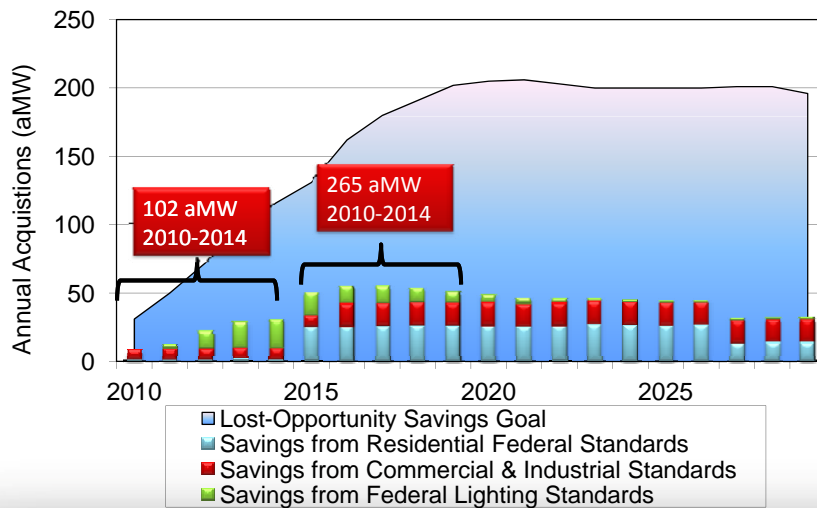
Lighting Savings From Seven Federal Standards That Take Effect by 2015 Are Over **155** Average Megawatts by 2029

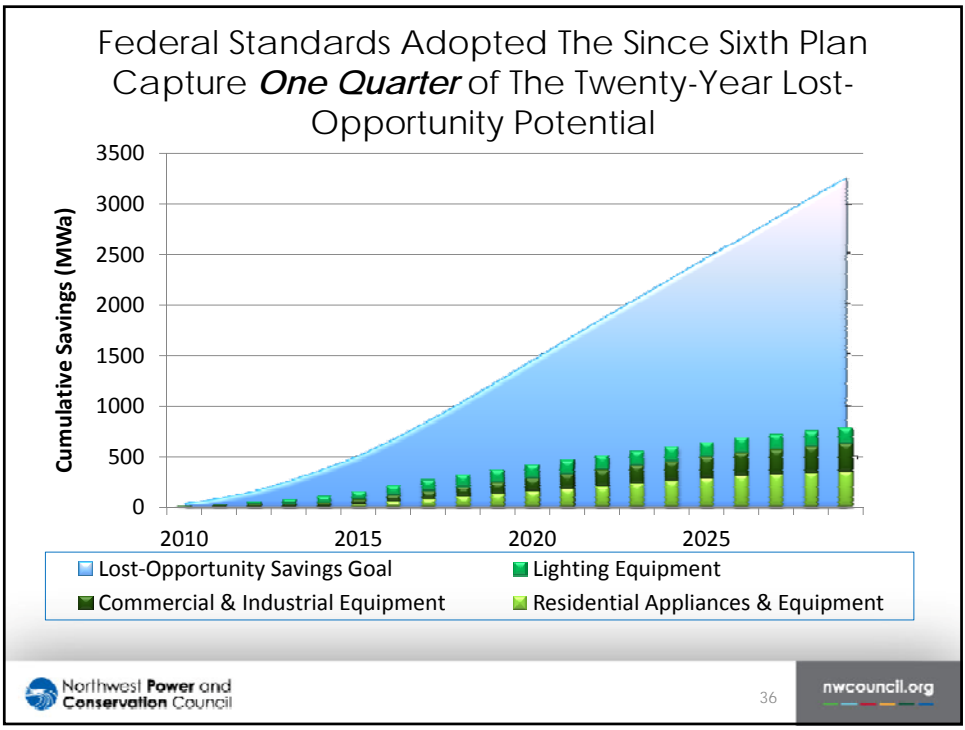
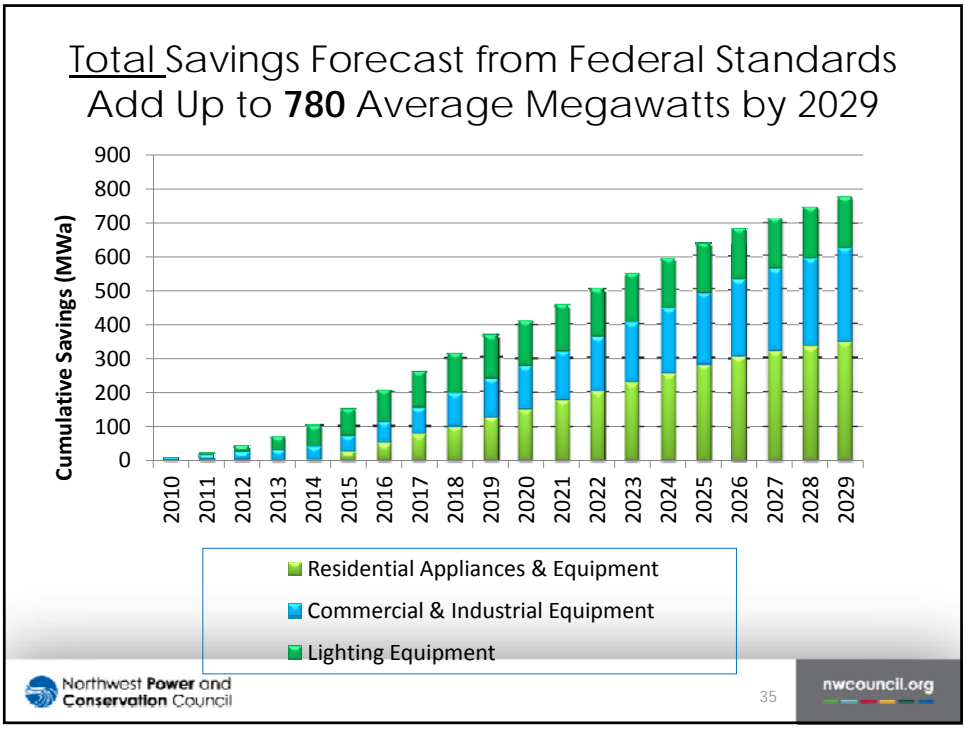


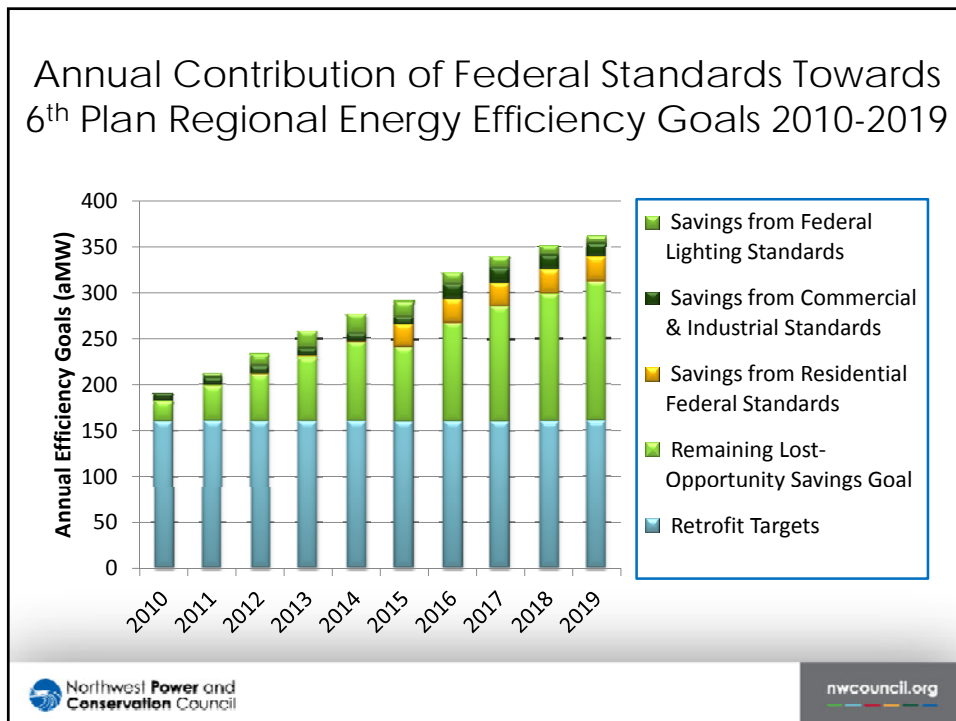
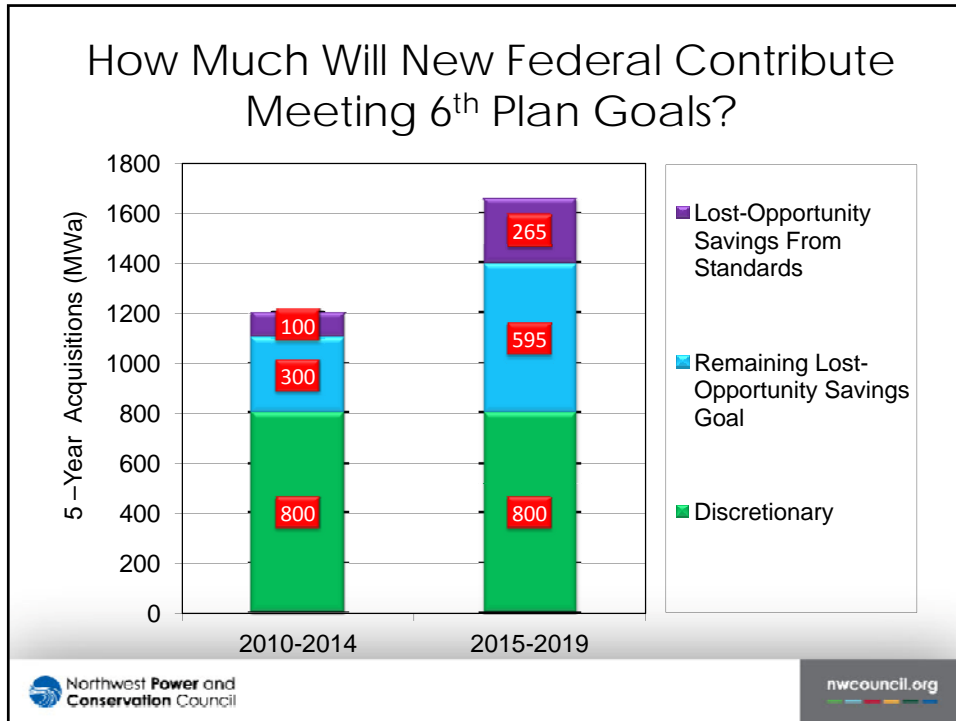
Federal Lighting Standards Have the Greatest Near-Term Impact (Because Lighting Equipment Has a Short-Lifespan)

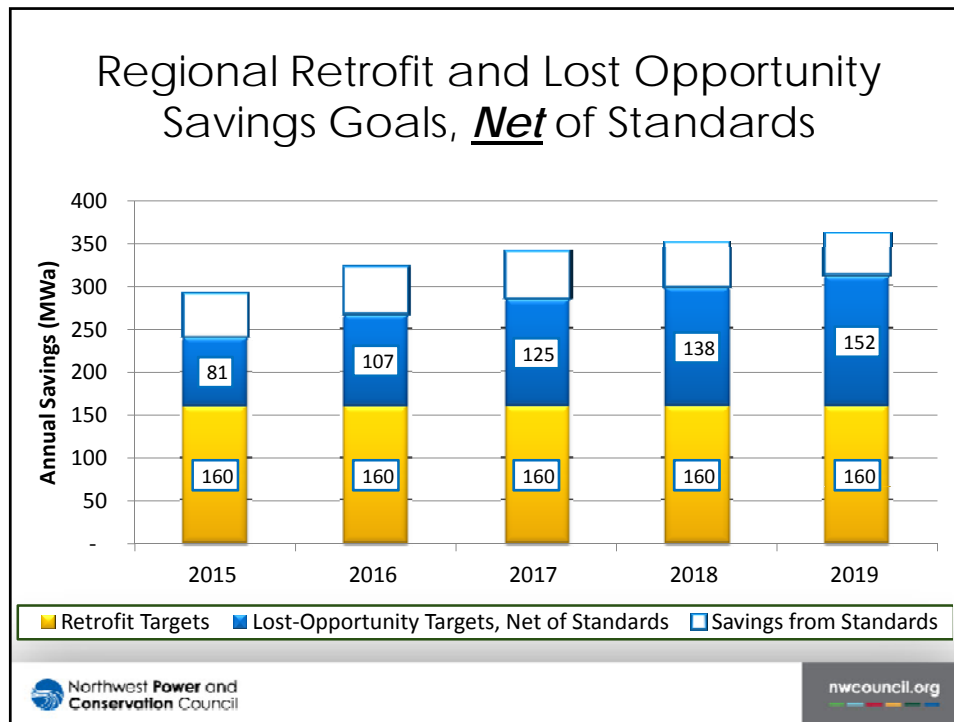


Federal Standards Are Estimated to Save Just Over **100 aMW** by 2014 and **265 aMW** between 2015-2019









Implication for the Seventh Plan

- **Compared to the Sixth Plan:**
 - Load forecast will be lower, particularly over the long term
 - Remaining conservation potential will be lower
 - But not as much lower as the load forecast, since standard impact all units, but conservation assesment assumes less than 100% program success
 - Conservation programs will need adjust their focus to measures less impacted by federal standards

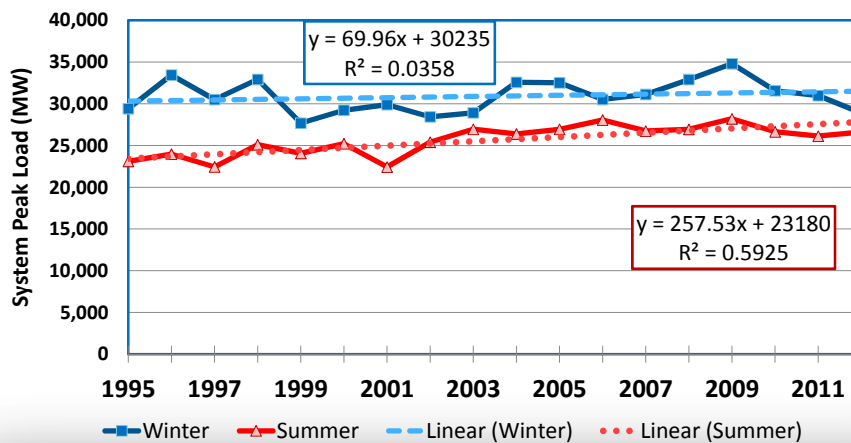
New Data on load shape of Appliances and the Capacity Impacts of Energy Efficiency

What We Know
and
What We Don't Know

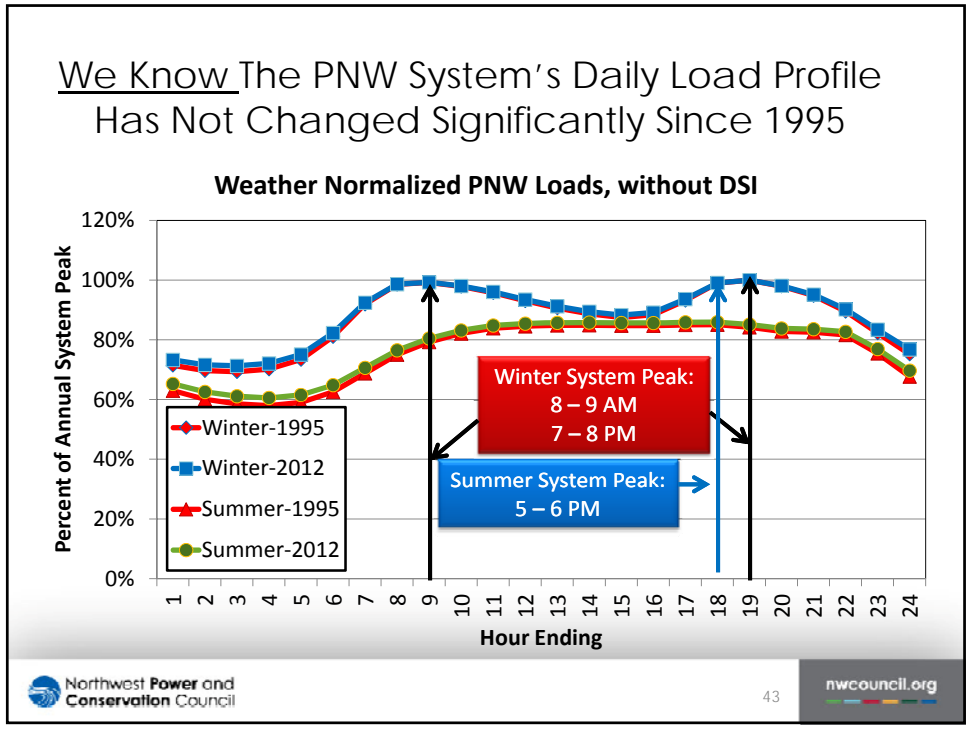
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We Know That Winter Peaks Aren't Growing, While Summer Peaks Probably Are

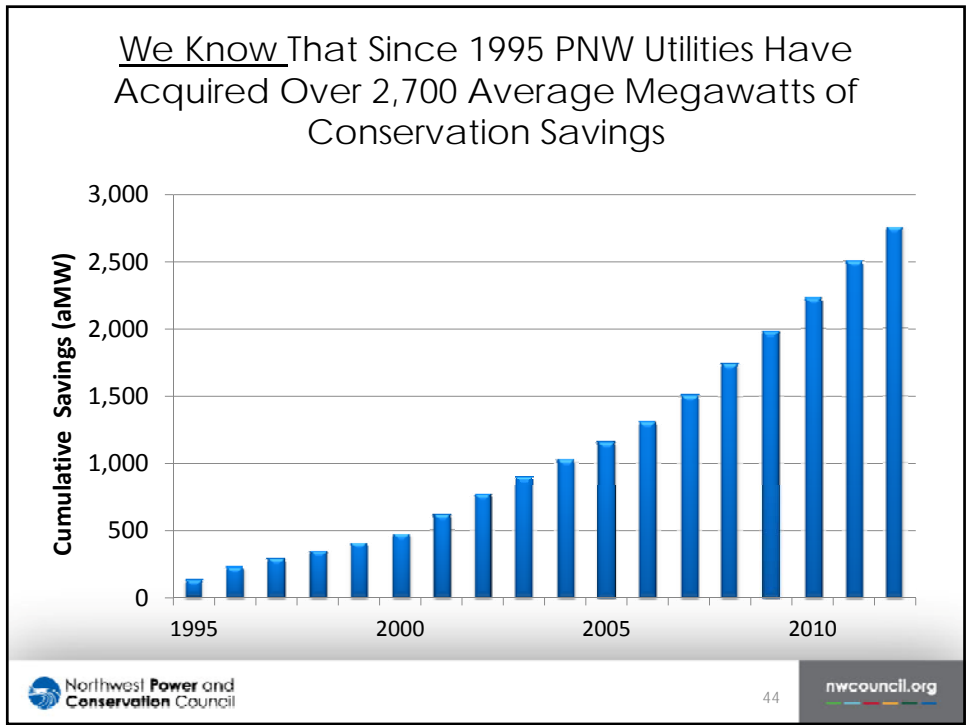
Trends in PNW Region Peak Loads 1995 - 2012



We Know The PNW System's Daily Load Profile Has Not Changed Significantly Since 1995



We Know That Since 1995 PNW Utilities Have Acquired Over 2,700 Average Megawatts of Conservation Savings

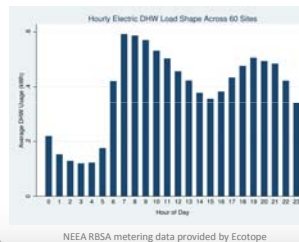
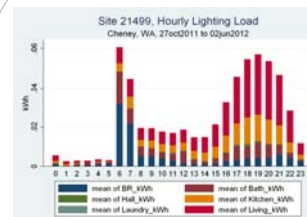
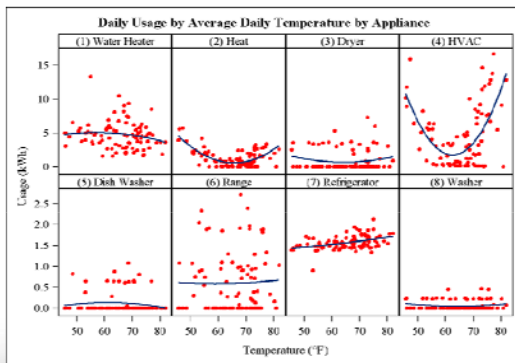


We Don't Know What Impact (If Any) These Energy Savings Have On the Region's Need for Capacity Resources

However:

- We Do Know That Improvements in Energy Efficiency also change hourly demands
 - Savings shape matches end use load profile:
 - If a device uses 20% less total energy over the course of the year, it uses 20% less each hour of the year (e.g., installation of lower wattage lighting)
 - Savings shape is the difference between the *pre-case* end-use profile and the *post-case* end-use load profile
 - If a device uses 20% less total energy over the course of the year, but the reduction in uses is not proportional across all hours (e.g., occupancy sensors for lighting turn lights off during business hours)
- We Do Know That End Use and Energy Efficiency Savings Load Profiles Are Needed to Assess Capacity Impacts

What Is End-Use Data?



We Know The Current State of End Use Load Research

- ***The Good News*** - Bonneville conducted a comprehensive End Use Load Research (EULR) project, the End-Use Load and Consumer Assessment Program (ELCAP)*
- ***The Bad News*** – This year marks the 25th anniversary of when the last ELCAP data was collected
 - There have been no comparable studies in the US or Canada since then
 - There are none planned

*The ELCAP was later designated as the Regional End-Use Metering Project (REMP)

We Know What Was Collected in ELCAP

- ELCAP began in 1983 and ended in 1991
- ELCAP's Goal – Collect a comprehensive set of customer characteristics and hourly end-use electricity consumption and weather data from residential and commercial sector consumers
- ELCAP's Product - Created hourly (8760) load profiles at the individual end use and building level along with associated customer characteristics and weather data

We Know The Concerns Raised About ELCAP and Existing EULR Data Sources*

- **They're Old**
 - The last ELCAP data was collected in 1989
- **They Don't Reflect Current Building and Equipment Stock**
 - Appliance characteristics and usage have changed (e.g., increased efficiency standards);
 - There are new emerging/growing technologies (e.g., computers, plasma TVs, Electric Vehicles, variable speed drives, demand controlled loads, LED's, etc.);
 - New appliances, lighting and equipment are "electronic" and may have differ Power Factors than existing "resistance" based appliance, lighting and equipment
- **They Don't Provide Energy Savings Load Shapes**
 - Energy Efficiency measure savings, especially controls, do not have the same shapes as their end-use load shapes (e.g., occupancy sensors are designed to turn off lights during the day when no one is present)

*Results of a RTF Regional and National Review of the Business Case for End Use Load Research

We Don't Know If These Concerns Warranted

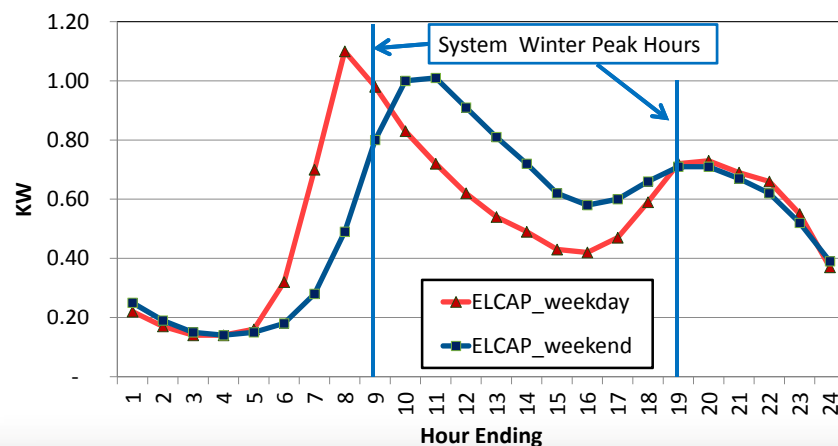
To Test This Premise Staff Compared ELCAP Data To More Recent, But Less Comprehensive Studies

- **The Northwest Energy Efficiency Alliance (NEEA) Research**
 - Residential Building Stock Assessment "Test Bed"
 - EULR study of approximately 100 single family homes
 - Preliminary (1st year) results are now available
 - Ductless Heat Pump Pilot Program
 - Detailed 5 minute interval data on approximately 100 ductless heat pumps
 - Heat Pump Water Heater Pilot Program
 - Detailed 5 minute interval data on approximately 50 heat pump water heaters
- **While not as comprehensive as ELCAP these studies do provide some insights into what's changed and what hasn't, but only in the residential sector**

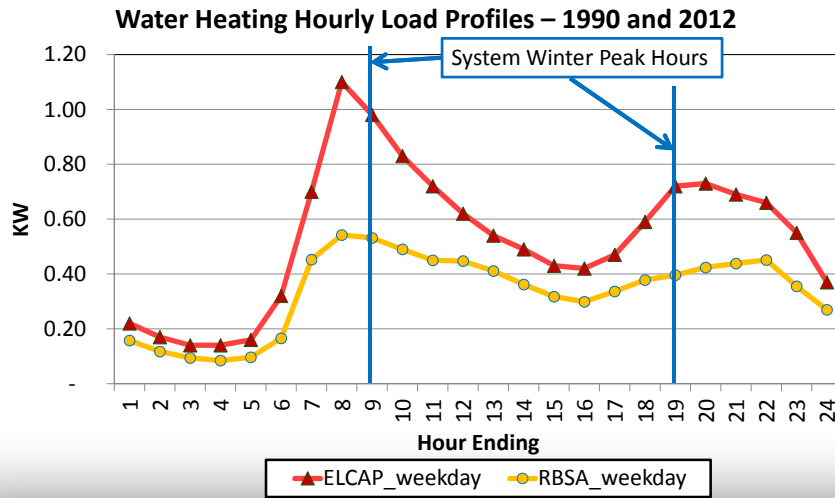
Five Tests of the ELCAP Data

- Electric water heating
 - What impact did improvements in efficiency since 1990 that reduced annual energy consumption from 4,700 kWh/yr to 3,000 kWh/yr have on winter peak demands?
- Residential Refrigerators
 - What impact did improvements in efficiency since 1990 that reduced annual energy consumption from 1,500 kWh/yr to less than 500 kWh/yr have on winter peak demands?
- Residential space heating
 - What impact will supplementing existing zonal electric heating systems (e.g. baseboard, radiant ceiling, wall heaters) with Ductless Heat Pumps have on winter and summer peak demands?
- Residential lighting
 - What impact will federal efficiency standards that are changing the mix of lighting technologies from primarily (90%) incandescent lamps to over primarily (60% - 80%) fluorescent (CFLs) /solid state (LED) lamps have on winter peak demands and power factor?
- Total System Impacts
 - Is ELCAP data “good enough”? (i.e., Is there a significant difference between using ELCAP load profiles and more recent data to estimate the impact of energy efficiency measures on system peaks?)

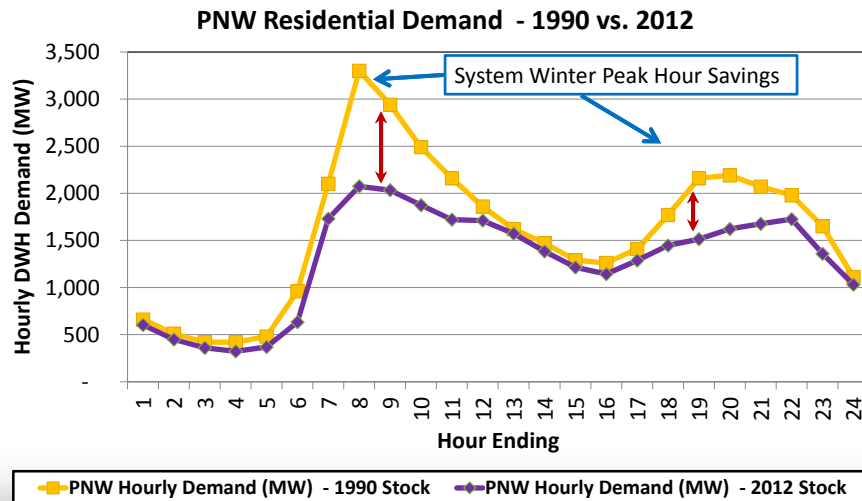
ELCAP Residential Water Heating Load Shape



We Know That Residential Water Heating Load Profiles Have Changed



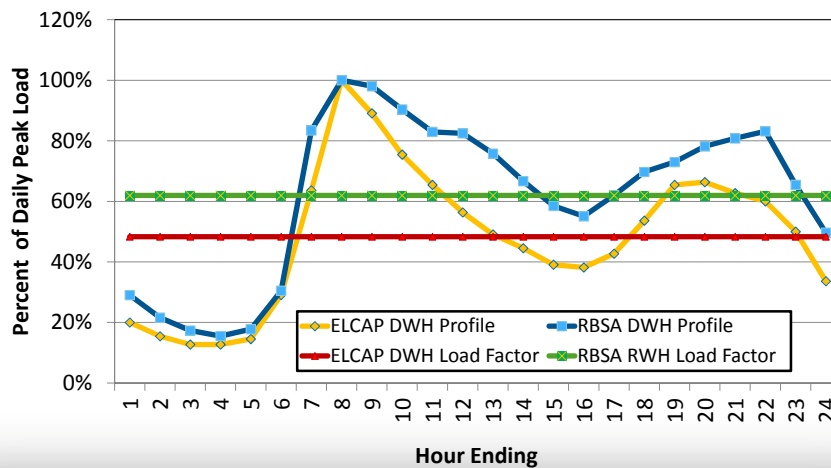
We Know That PNW Residential Water Heating Hourly Demand Has Decreased



We Know That Capacity Savings From Residential Water Heating Efficiency Improvements Between 1990 and Today Were Three Times Their Annual Energy Savings

	1990	2012
Annual Use (kWh)	4,700	3,000
Savings/Unit (kWh)		1,700
Water heater stock ≤55g	2,701,000	3,489,700
Water heater stock >55g	300,100	337,800
Water heater stock - Total	3,001,200	3,827,500
Annual Load (aMW)	1,610	1,310
PNW 2012 Savings (aMW)		300
Coincident Peak Load (MW)	2,940	2,035
Coincident Peak Savings (MW)		905

We Know That Current Water Heating Load Factors Now Higher

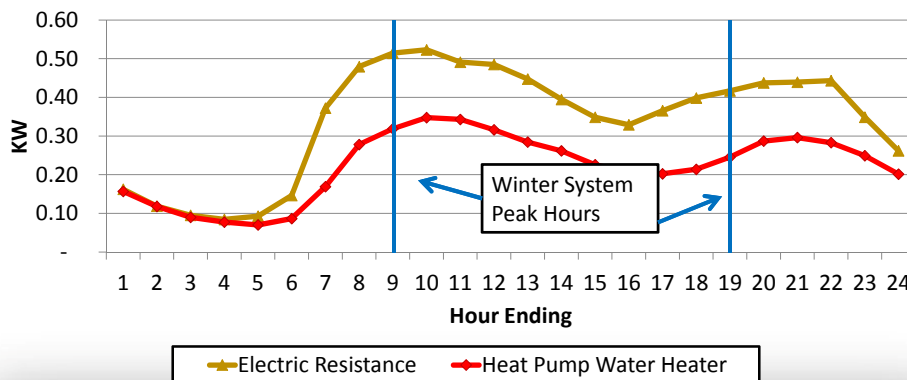


We Now Know That Using Old (ELCAP) Load Profiles Understate the Capacity Impact of Changes in Water Heater Efficiency

	1990	2012 – ELCAP Load Shape	2012 – RBSA Load Shape
Annual Use (kWh)	4,700	3,000	3,000
Savings/Unit (kWh)		1,700	1,700
Water heater stock ≤55g	2,701,000	3,489,700	3,489,700
Water heater stock >55g	300,100	337,800	337,800
Water heater stock - Total	3,001,200	3,827,500	3,827,500
Annual Load (aMW)	1,610	1,311	1,311
PNW 2012 Savings (aMW)		300	300
Coincident Peak Load (MW)	2,940	2,370	2,035
Coincident Peak Savings (MW)		570	905

We Know That Federal Standards Will Decrease Water Heating Energy Use Further Altering This End Use's Load Shape

Electric Resistance vs. Heat Pump Water Heater Hourly Load Profiles

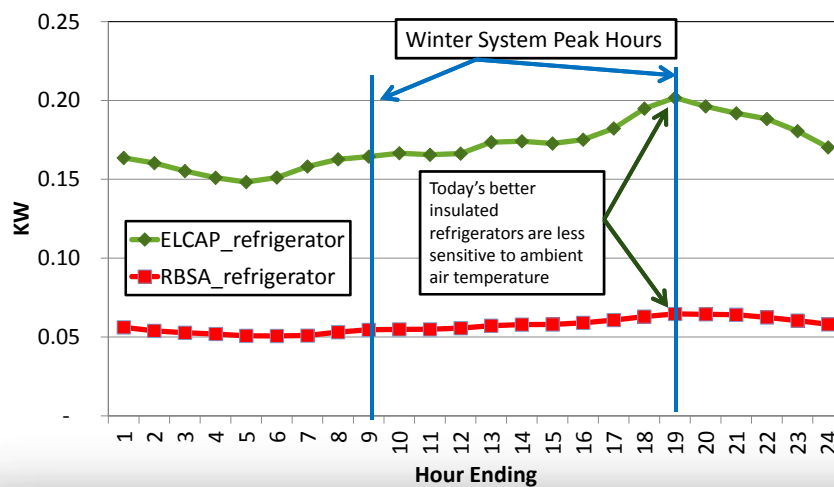


Capacity Impact of Changes in Water Heater Efficiency Due to New Federal Standards

	2012 ER	2012 HPWH
Annual Use (kWh)	3,000	2,000
Savings/Unit (kWh)		1,000
Water heater stock >55g	337,815	337,815
Annual Load (aMW)	115	75
PNW 2012 Savings (aMW)		40
Coincident Peak Load (MW)	175	110
Coincident Peak Savings (MW)		65

We Know That Without More Recent End Use Load Research We Would Not Be Able to Estimate the Capacity Impacts of Heat Pump Water Heaters.

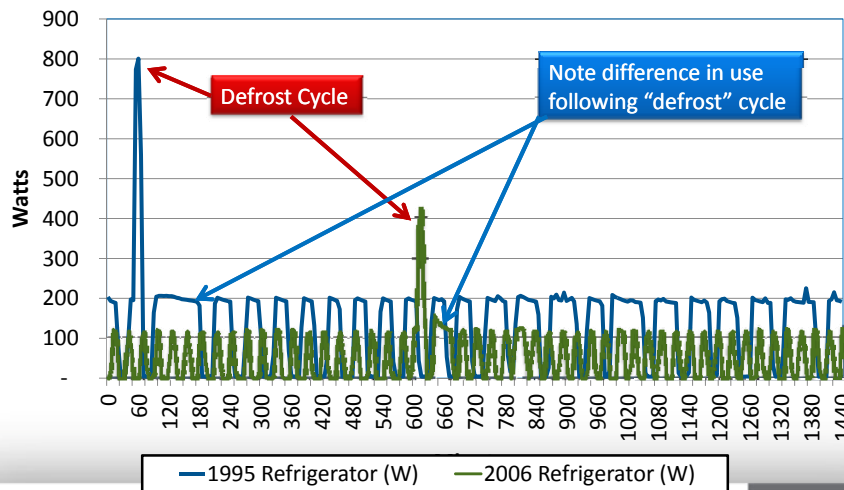
We Know That Compared to the Stock in 1990 the Current Stock of Refrigerators Uses One-Third the Energy and Requires One-Half the Capacity

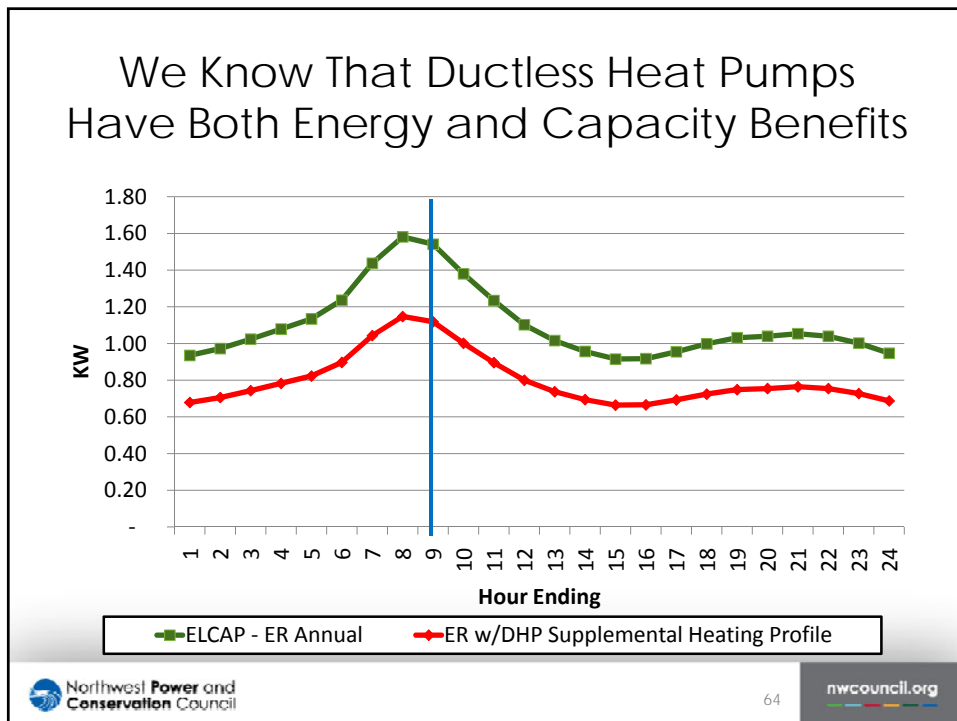
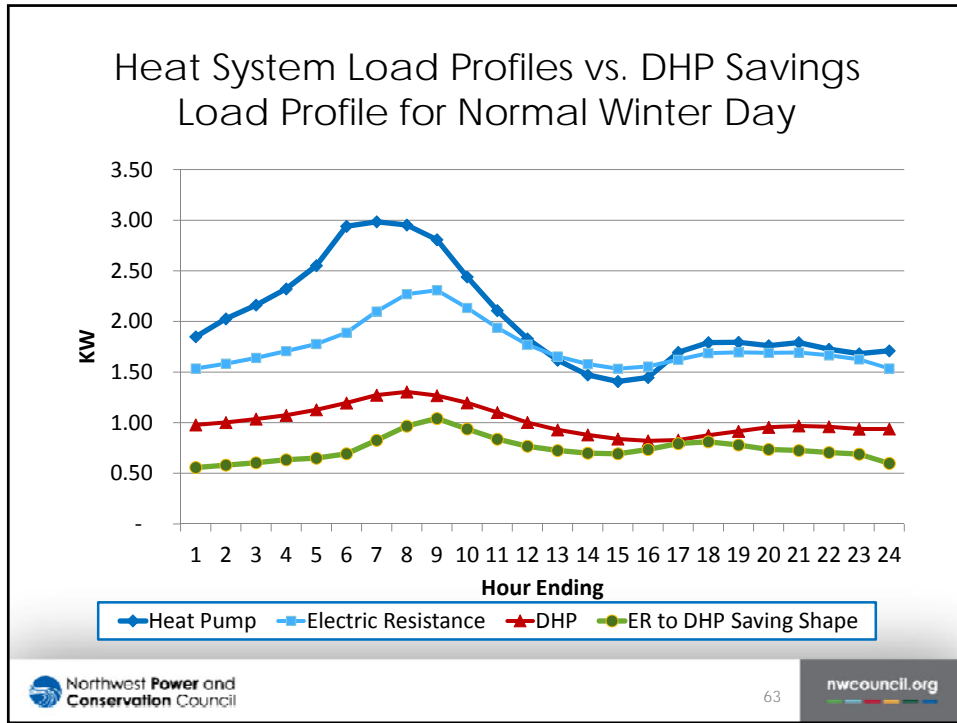


We Know That Since Refrigerator Load Profiles Have Not Changed Significantly ELCAP Data Is Still A Reasonable Representation of Capacity Impacts

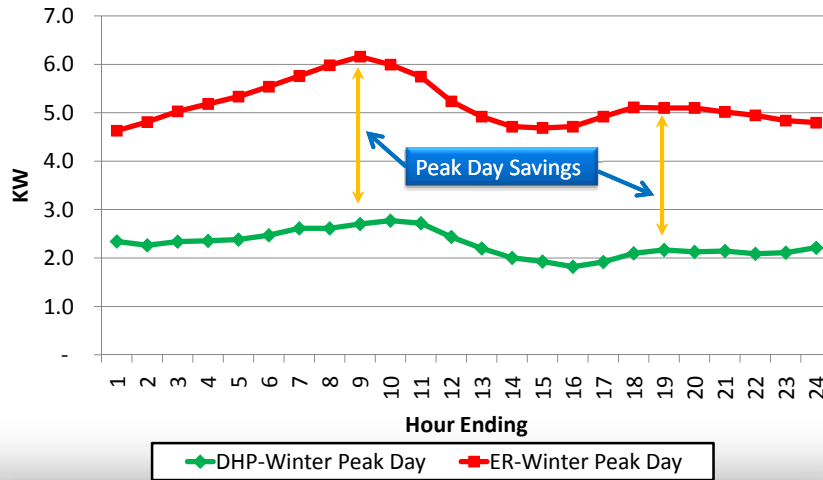
	1990	2012 – ELCAP Load Shape	2012 – RBSA Load Shape
Annual Use (kWh)	1,500	500	500
Savings/Unit (kWh)		1,000	1,000
Water heater stock - Total	4,635,880	7,148,900	7,148,900
Annual Load (aMW)	795	410	410
PNW 2012 Savings (aMW)		385	385
Coincident Peak Load (MW)	760	390	390
Coincident Peak Savings (MW)		370	370

On the Other Hand, There Are Subtle “Within Hour” Differences That Might Matter for Demand Response

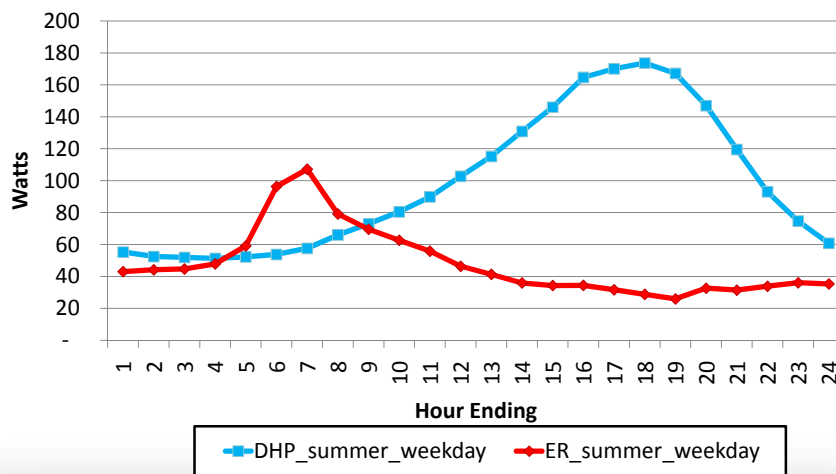




We Know That Ductless Heat Pumps Capacity Benefits Even On Extreme Winter Peak Days



We Know That Ductless Heat Pump Provide Air Conditioning – So Summer Peak Loads Will Increase



Potential System Impacts from Ductless Heat Pumps

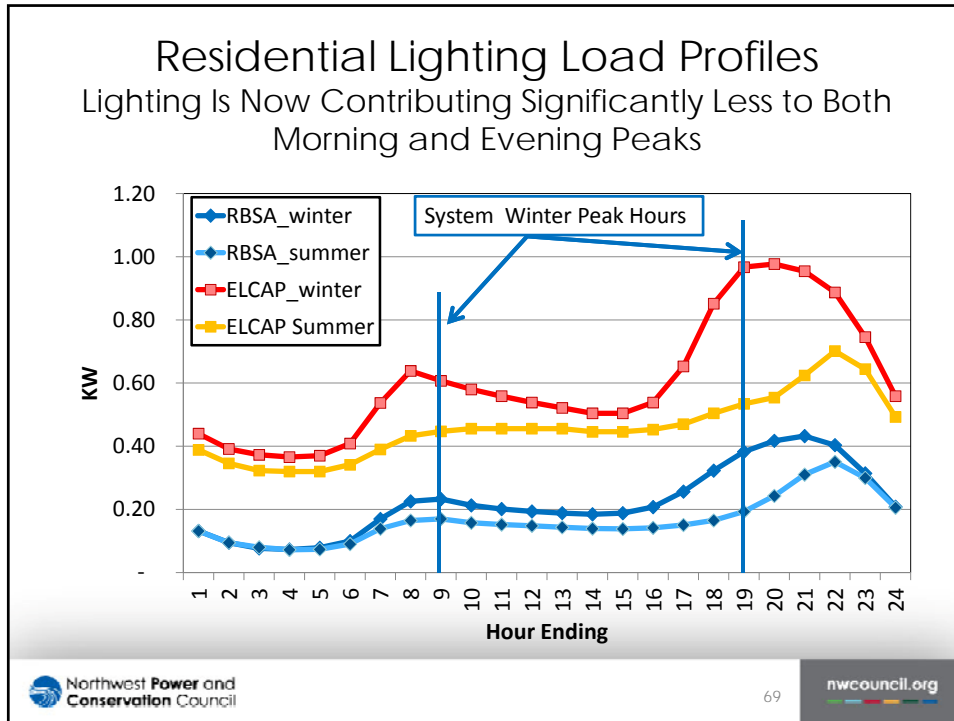
	Electric Zonal Heat	Electric Zonal w/DHP Supplement	Electric Zonal Extreme Peak	Electric Zonal w/DHP Supplement
Annual Use (kWh)	9,680	6,360	6.2 (KW)	2.7 (KW)
Savings/Unit (kWh)		3,320		3.46 (KW)
Existing Baseboard Heated Stock	542,600	542,600	542,600	542,600
Annual Load (aMW)	600	395	N/A	N/A
Potential Savings (aMW)		205		N/A
Winter Coincident Peak Load (MW)	1,725	485	3,345	1,465
Winter Coincident Peak Savings (MW)		1,245		1,880
Summer Coincident Peak Load (MW)	45	115		
Summer Coincident Peak Savings (MW)		(70)		

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Lighting Energy Use

Scenario	LPD (W/ft ²)	Annual Energy (kWh/yr)
ELCAP	3.54	4500
Current Survey (RBSA)	1.40	1845
Full EISA Compliance w/ EISA targets	1.18	1555
Full EISA Compliance w/ CFLs	0.85	1120

- Four scenarios
 - 1990 – Lighting load as measured in ELCAP
 - 2012 – Lighting load as measured in RBSA
 - Full EISA compliance with EISA targets assume all currently non-complying, non-exempt lamps are replaced with their minimum compliance equivalents
 - Full EISA compliance with CFLs assumes all non-complying, non-example lamps replaced with CFL equivalents
- Annual energy use is for 2,006ft² house with 1.8 hours per day of on-time (Source: RBSA sample house size and lighting on-time metering)



Historical and Forecast System Impacts from Residential Lighting Efficiency Improvements

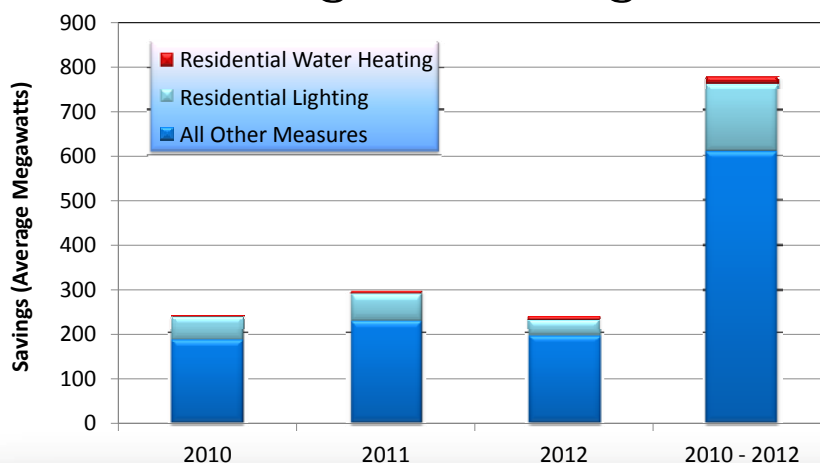
	Lighting Loads (ELCAP) - 1990 Stock & Efficiency	Lighting Loads (ELCAP load shape, 2012 stock & efficiency)	RBSA Lighting Load Shape - 2012 Stock & Efficiency	Post-EISA 2020 Lighting Standards Loads (2012 Stock)
Annual Use (kWh)	4,500	1,770	1,770	1,080
Savings/Unit (kWh)		2,730	2,730	690
Single Family Residential Stock	4,021,700	5,798,220	5,798,220	5,798,220
Total Annual Lighting Loads (aMW)	2,065	1,170	1,170	715
PNW 2012 Savings (aMW)		895	895	455
Coincident Peak Load (MW) - Morning	2,080	1,180	1,230	750
Coincident Peak Load (MW) - Evening	2,885	1,640	1,850	1,135
Coincident Peak Load Savings (MW) - Morning		900	850	480
Coincident Peak Load Savings (MW) - Evening		1,245	1,030	725

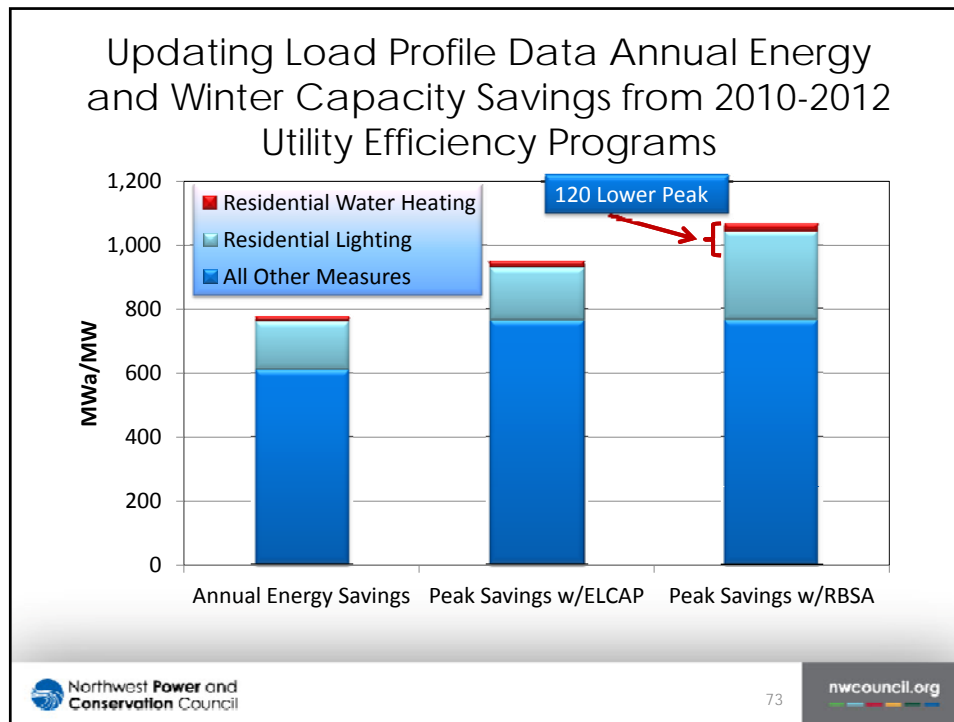
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What's All This Mean

- The region's development of energy efficiency resources also has capacity impacts
- Our knowledge of the relationship between energy and capacity savings is largely based on data collected 25 years ago
- Let's see just how much difference using updated data for just two end uses makes

2010 -2012 Utility Efficiency Program Savings

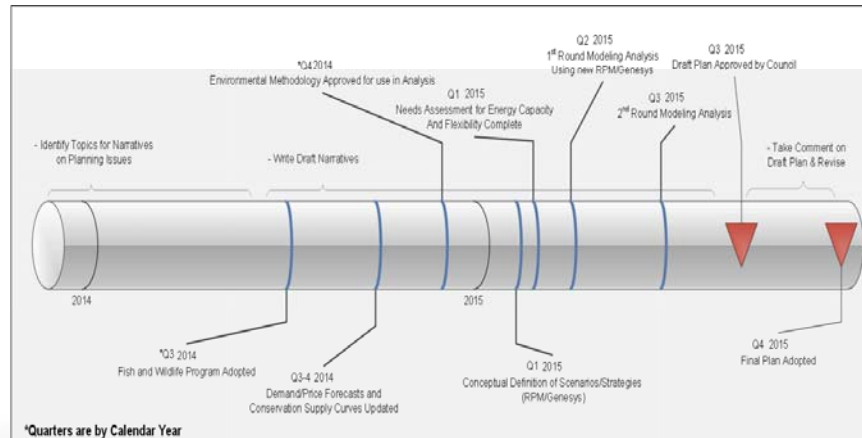




Next Steps

- Update on Seventh Plan timing
- Update on Drivers
- How the standards and load shapes will be incorporated into the long term model.
- Next DFAC meeting

Next steps in Seventh Power Plan Development



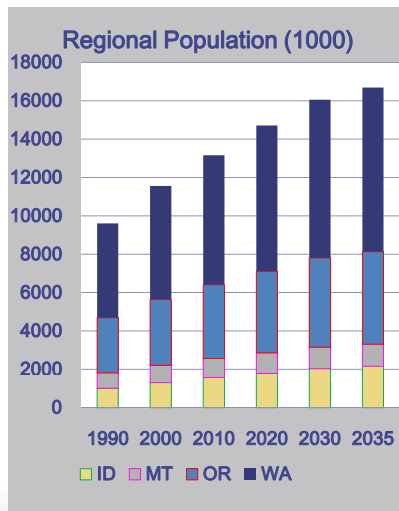
Next steps

- **Updates to Economic Drivers of the model**
 - No significant change in Population and Economic drivers are observed.
 - Range of forecast for residential, commercial, industrial sectors similar to 2013 updates.
 - Range of natural gas price projections widening.
 - Updating long-term model with 2012-2013 baseline for RBSA, CBSA, IFSA.
 - Incorporate impact of federal appliance standards in long-term demand forecasting model.
 - Incorporating roof-top solar into forecast.
 - Q3-Q4 update to long-term forecast.

Key Demographic and Economic Drivers

- Population growth
- Business drivers
 - New homes
 - Commercial floor space
 - Industrial output
- Natural Gas Prices

Regional Population



	1985-2014	2015-2035
ID	1.73%	1.30%
MT	0.77%	0.50%
WA	1.64%	0.90%
OR	1.37%	0.80%
4 States	1.50%	0.90%
USA	1.03%	0.90%

Average Annual Addition to Population (1000)	1985-2015	2015-2035
ID	21	24
MT	7	6
WA	90	66
OR	43	34
4 States	162	130

Overall regional population growth projected to slow down.

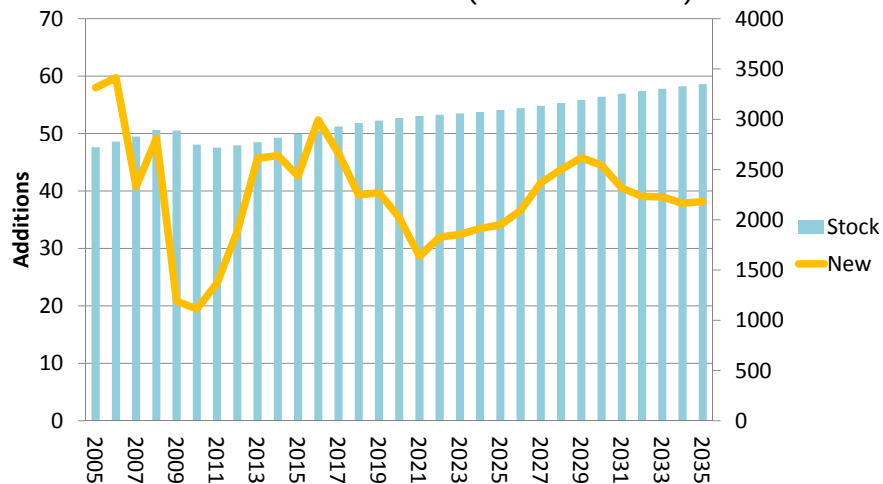
Northwest population remains about 4% of national population.

Commercial Sector*

	Annual Growth Rate		
	2005-2011	2011-2020	2020-2035
Employment	0.8%	1.4%	0.6%
Floor space Stock Req.	0.4%	1.0%	0.5%
Millions of square Feet		Cumulative	Annual Average
1985-2011 Addition		1,406	52
2015-2035 Requirement		951	40

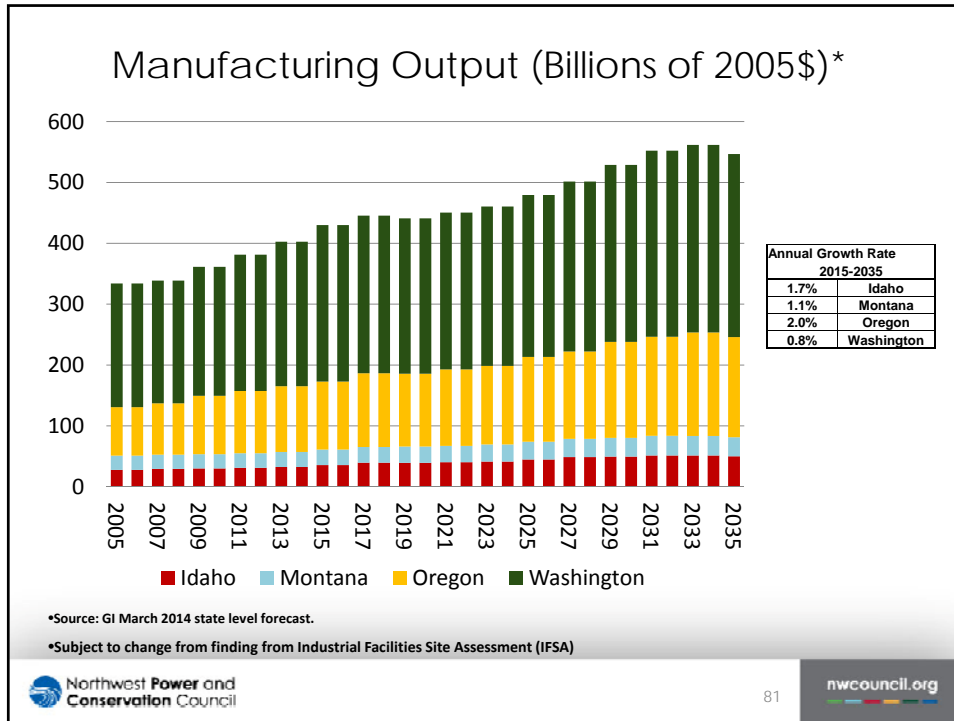
* Subject to change as Commercial Building Stock Assessment becomes available

Commercial Floor Space Requirements New and Stock (millions SQF)*



* Source: GI state level employment forecast /internal analysis.

* Subject to change as 2014 Commercial Building Stock Assessment becomes available



Proposed Natural Gas Prices 2012\$ and Nominal \$

Proposed Henry Hub Price Forecasts as of July 2014			
	\$2012/MMBTU		
	Council L	Council M	Council H
2013	3.7	3.7	3.7
2014	3.9	4.7	4.9
2015	4.0	4.6	5.1
2020	3.9	5.0	6.0
2025	3.8	5.7	7.3
2030	3.5	6.6	8.9
2035	3.2	7.4	10.8
Average 2015-2035	3.8	5.8	7.5

Proposed Henry Hub Price Forecasts as of July 2014			
	Nominal Dollars		
	Council L	Council M	Council H
2014	4.0	4.9	5.1
2015	4.2	4.8	5.3
2020	4.4	5.7	6.8
2025	4.7	7.1	9.1
2030	4.7	8.9	12.0
2035	4.7	11.0	16.0
Average 2015-2035	5.7	8.7	11.4

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How we incorporate impact of federal appliance standards in the Long-term model

- **Council's long-term forecasting tool is an enduse model.**
- **Demand is forecasted at enduse level**
 - **Marginal efficiency is set to greater of market or the standard**
- **Efficiency for transformers are modeled as improvement in distribution efficiency.**

Next DFAC Meeting

- **Most likely in October**
- **How are you incorporating these topic areas in your demand forecasting”**
 - **Rooftop PV**
 - **Data Center load growth and impact on the economy**
 - **How to incorporate information technology improvements in the demand forecast (Internet of Things, big data,...)**
 - **Electric vehicles loads**
 - **Indoor growing operation loads- Washington (I502)**
- **other key topic areas you are dealing with in your work?**

- Thank you for participating