



# Energy Efficiency in the Seventh Northwest Power Plan



# The Seventh Power Plan

- *Approved in February, the Plan includes conservation targets that would provide electricity resources to meet nearly all of the regional load growth over the next 20 years*
- *Speakers:*
  - *Mr. Tom Eckman - How EE became a resource in the Northwest*
  - *Mr. Charles Grist – 7<sup>th</sup> Plan process and results*
  - *Ms. Tina Jayaweera – Res. & Ag Sector Potential*
  - *Mr. Kevin Smit – Com., Ind., & Dist. System Potential*
  - *Mr. Charles Grist – Taking action*



# A Short History of Power Planning in the Northwest

OR

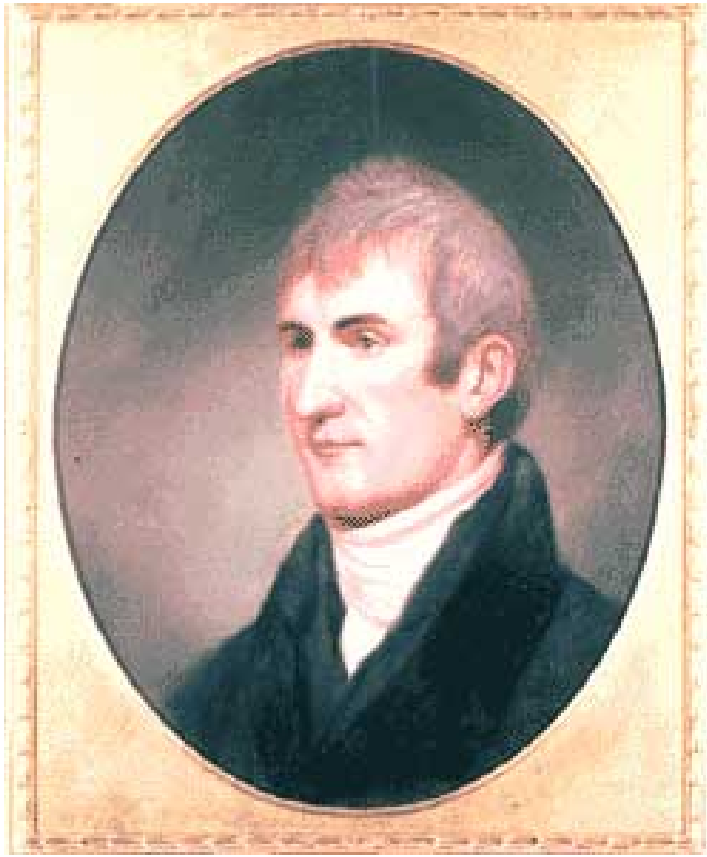
# Why You All Have Jobs!

**Presented by:**

Tom Eckman

Northwest Power & Conservation Council

# What Happened After Lewis and Clark Left?

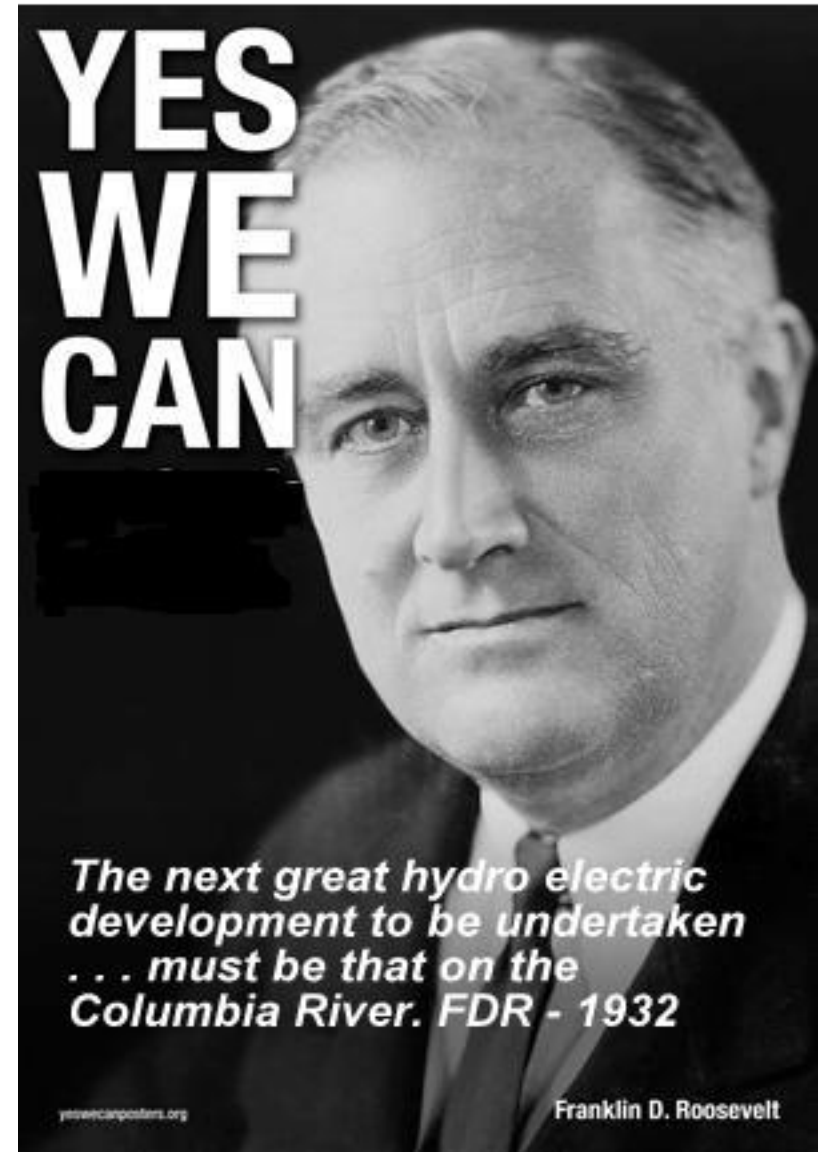


# The First Three “Eras” of Power Planning in the PNW

- “New Deal” Mysticism (1930-1950)
  - Politicians plan using “chicken entrails and crystal balls” legislate what’s needed and when
- Engineering Determinism (1950-1970)
  - Engineers, using graph paper and rulers, schedule the next power plants
- Economic Determinism (1970 to April 27, 1983)
  - Economist, using price elasticity, slow the engineer’s construction schedules

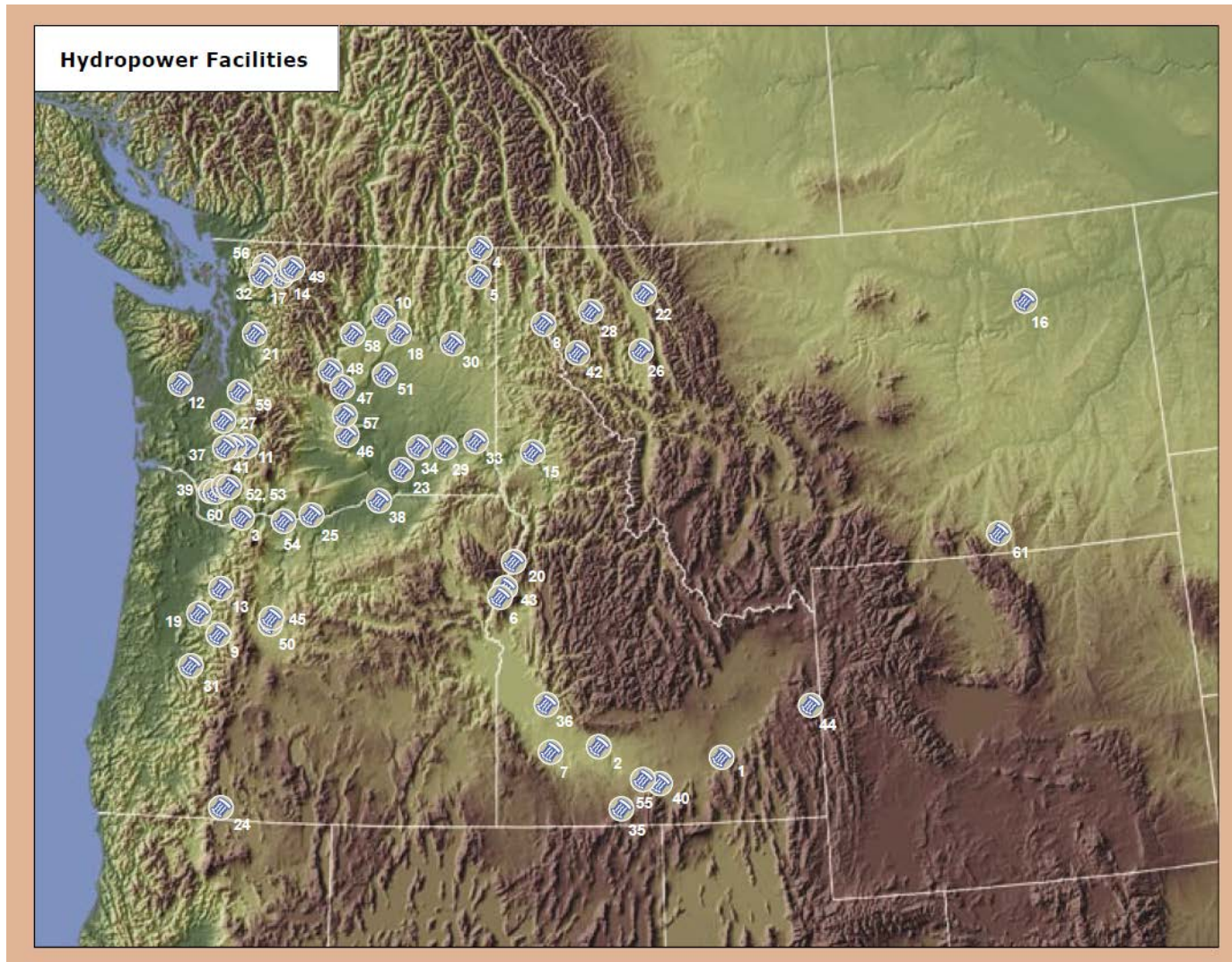
# The “New Deal”

- Federal Government authorized the development hydroelectric projects on the Columbia and Snake Rivers
- Bonneville Power Administration established to market federal power to the region’s public and private utilities

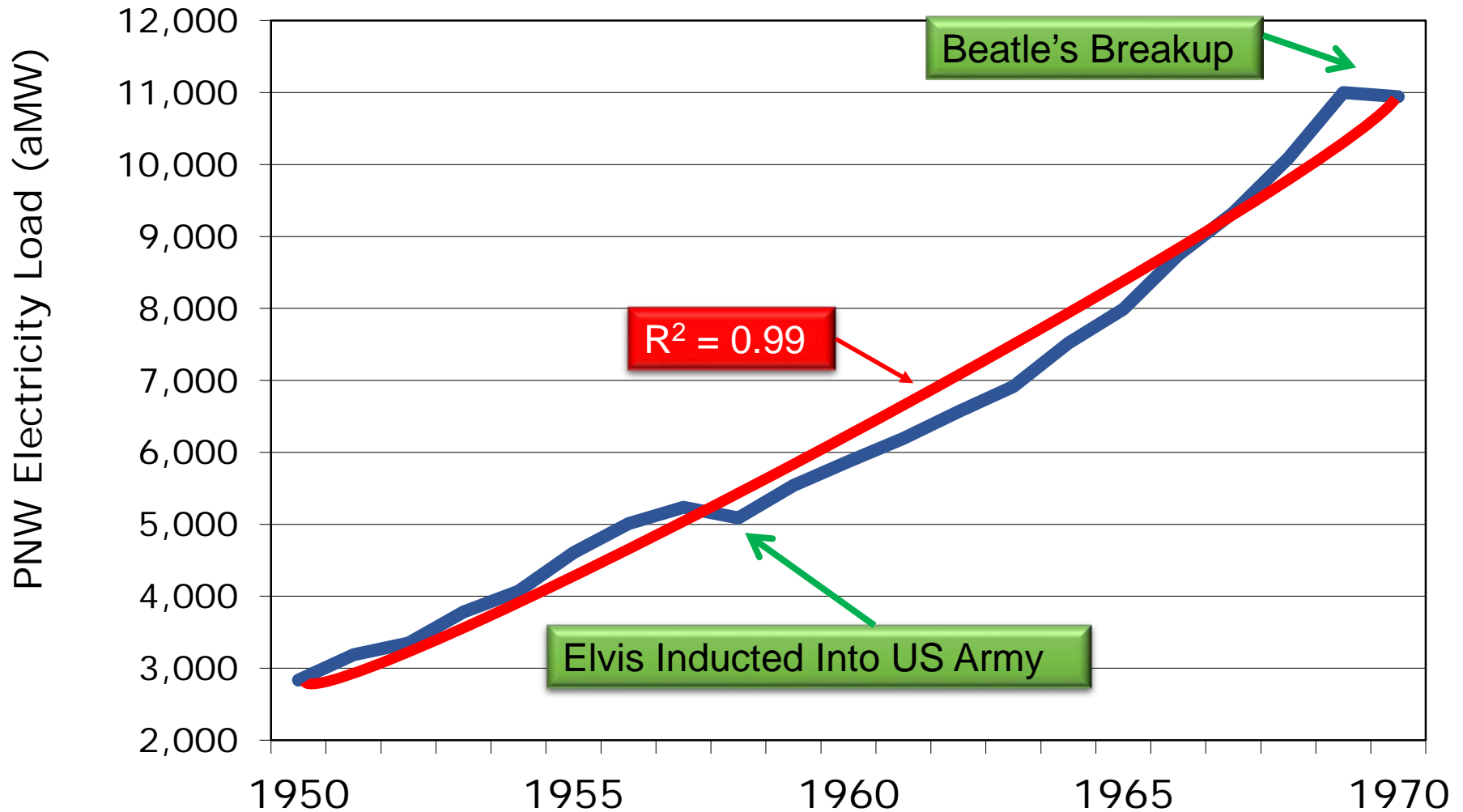




# The “New Deal’s” Legacy

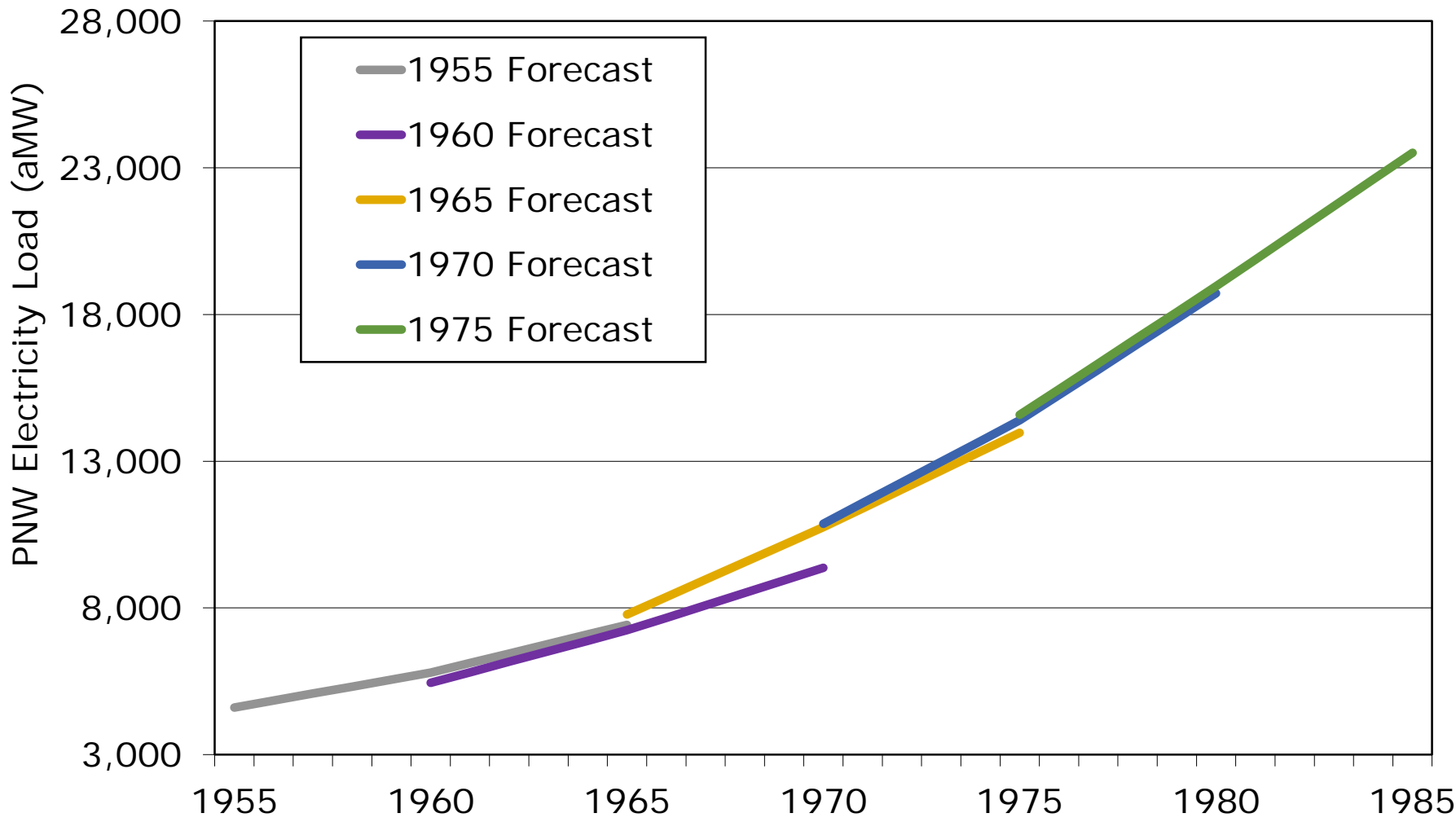


# Regional Electricity Demand Growth Averaged 7% Annually from 1950 - 1979

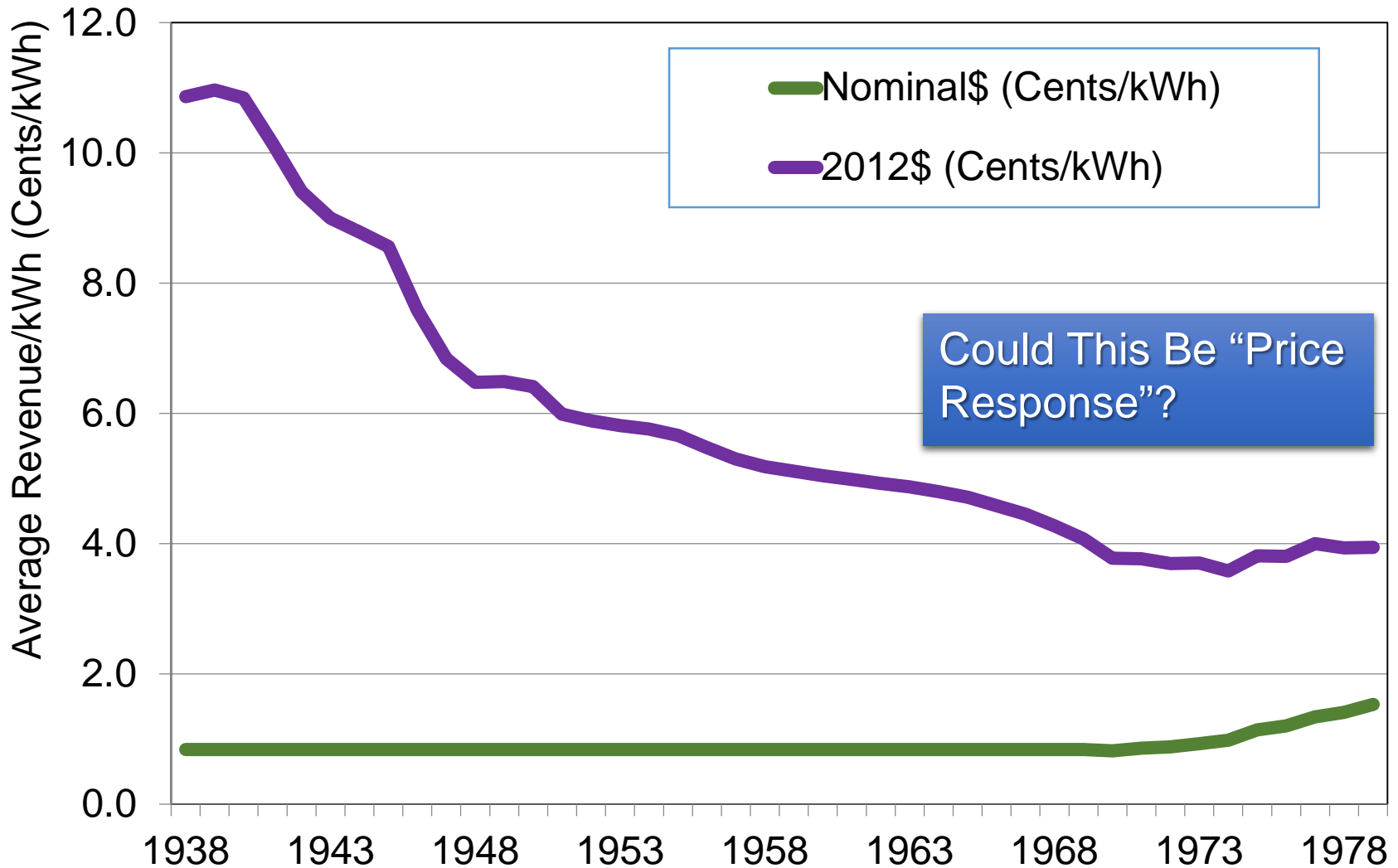




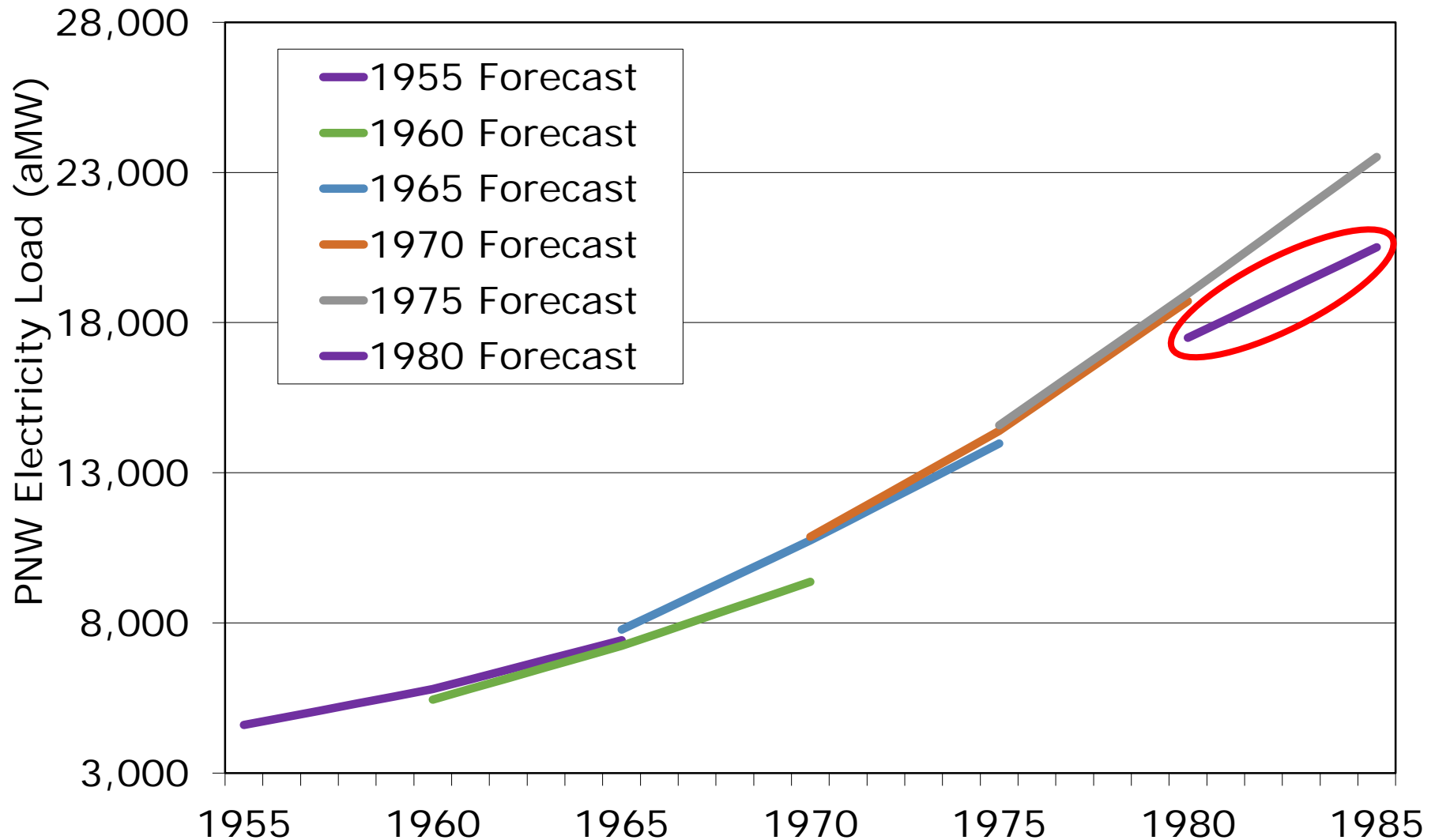
# Engineers, Observing This Data, Forecast Continued “Trend Line” Growth



# Economists, Observed That Retail Electric Rates, After Declining (in real terms) Since 1938 Were Increasing



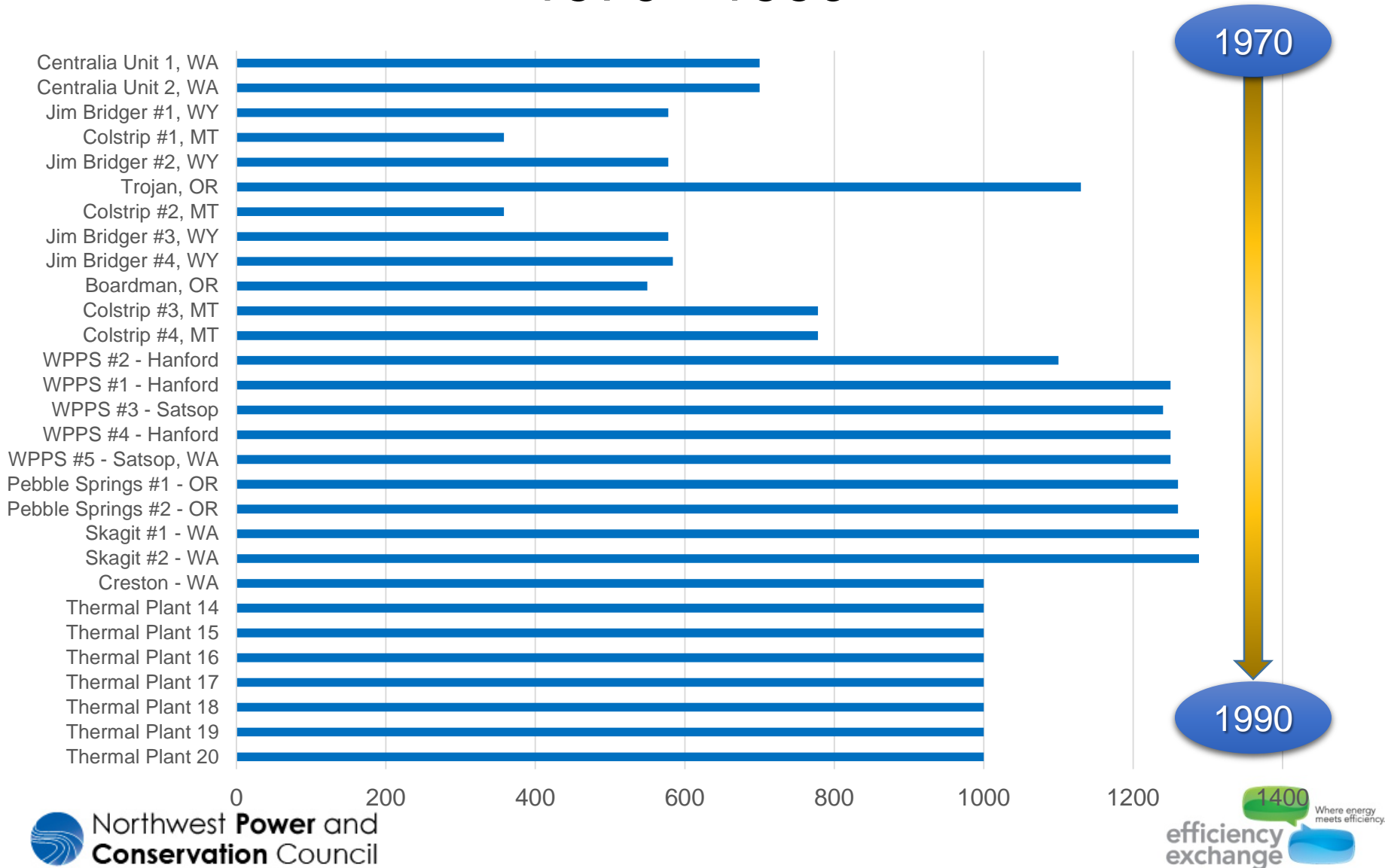
# Economist Recognized “Price Response” and Significantly Lowered Forecast



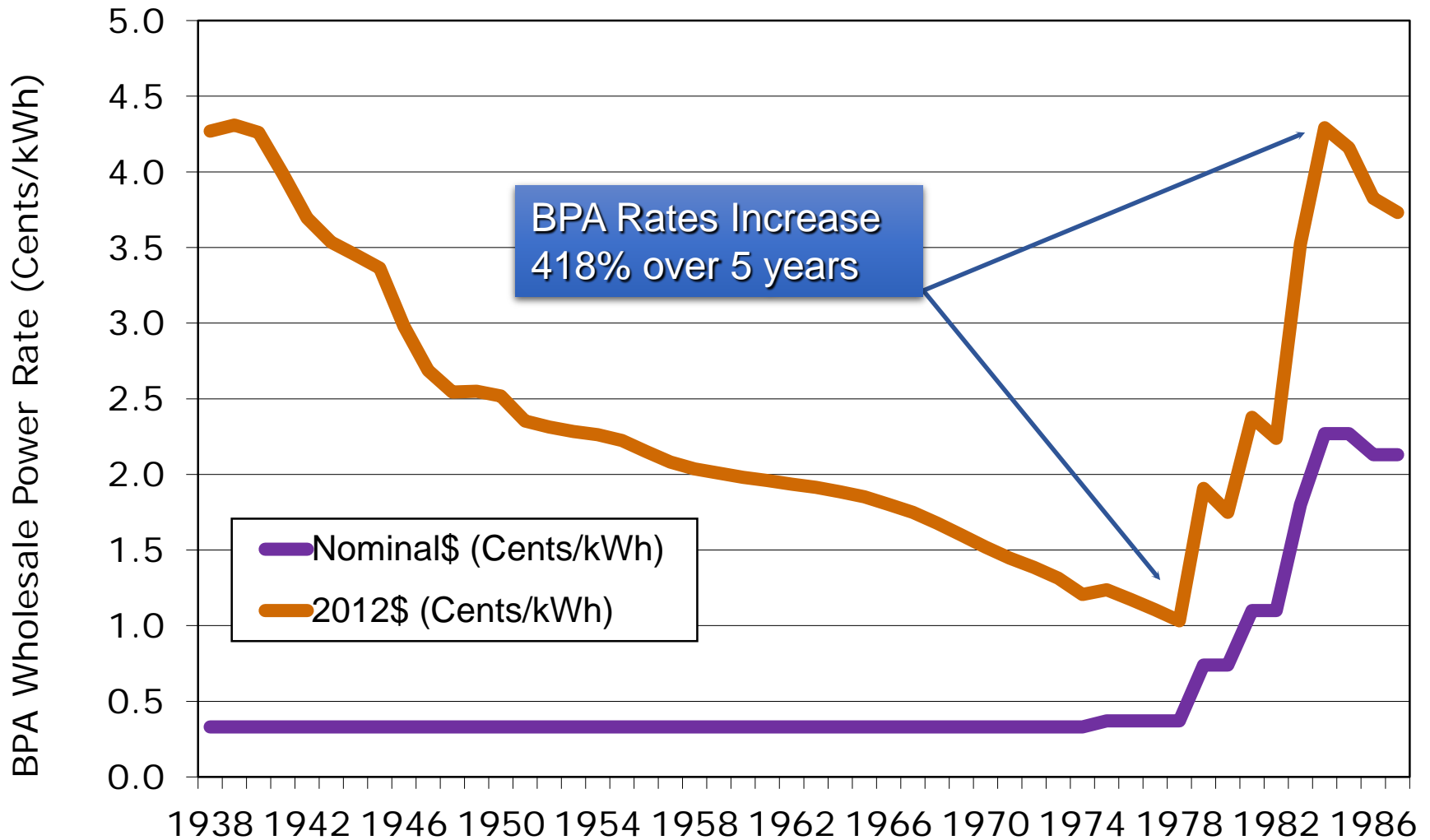
# Actions Taken in Response to “Engineering and Economic Determinist’s” Forecasts

- Hydro -Thermal Power Program (HTPP) Created
  - Utilities planned and/or started construction on 28 power plants to be completed over a 20-year period.
  - Environmental groups sued Bonneville over plans to turn the Columbia into “Wave World”
- Native American tribes sued the state and federal government over loss of salmon

# Hydro-Thermal Power Program Plants 1970 - 1990

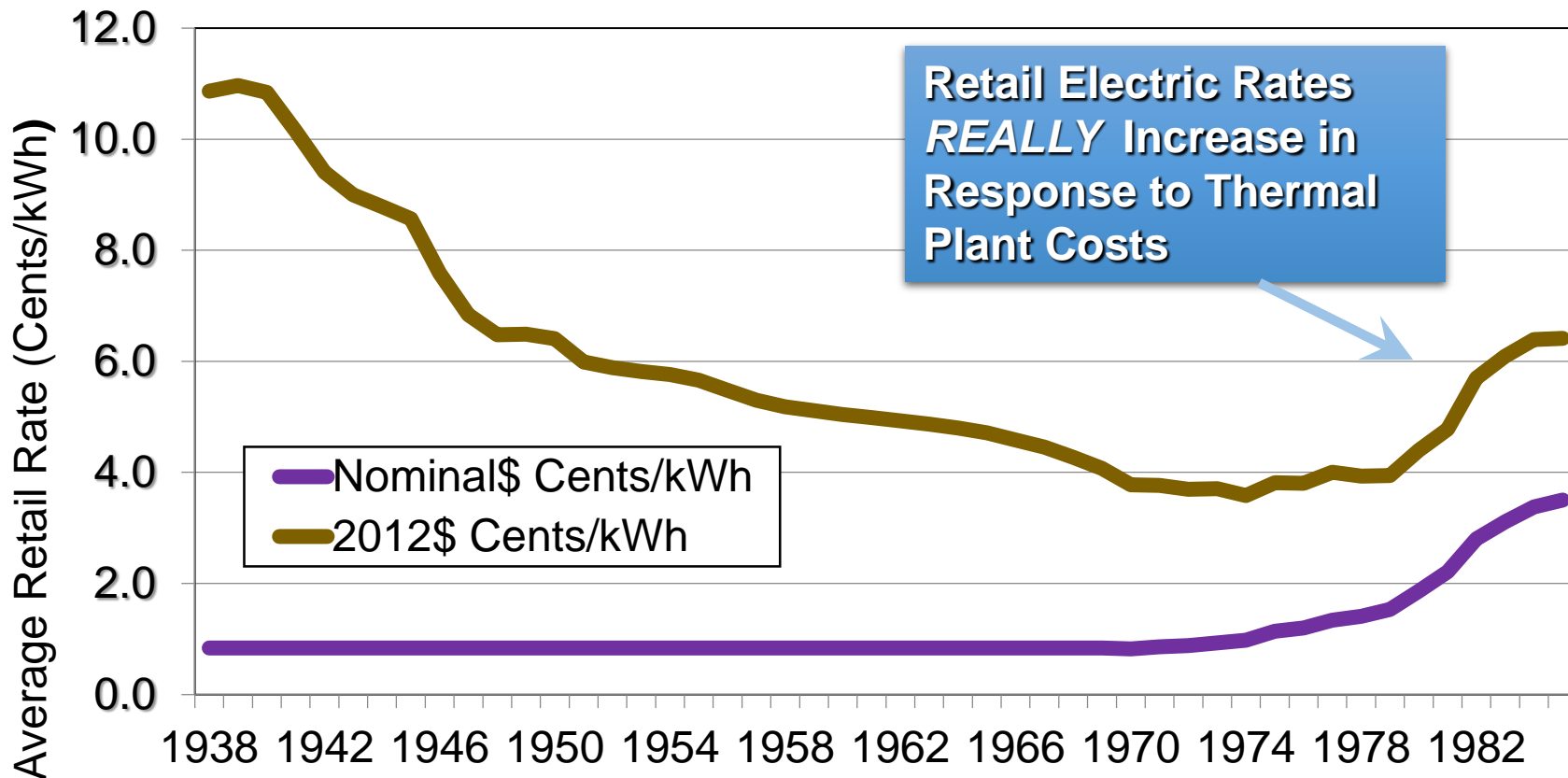


# The First Assault on the Hydro Legacy: Thermal Plant Cost Dramatically Increase Wholesale Rates

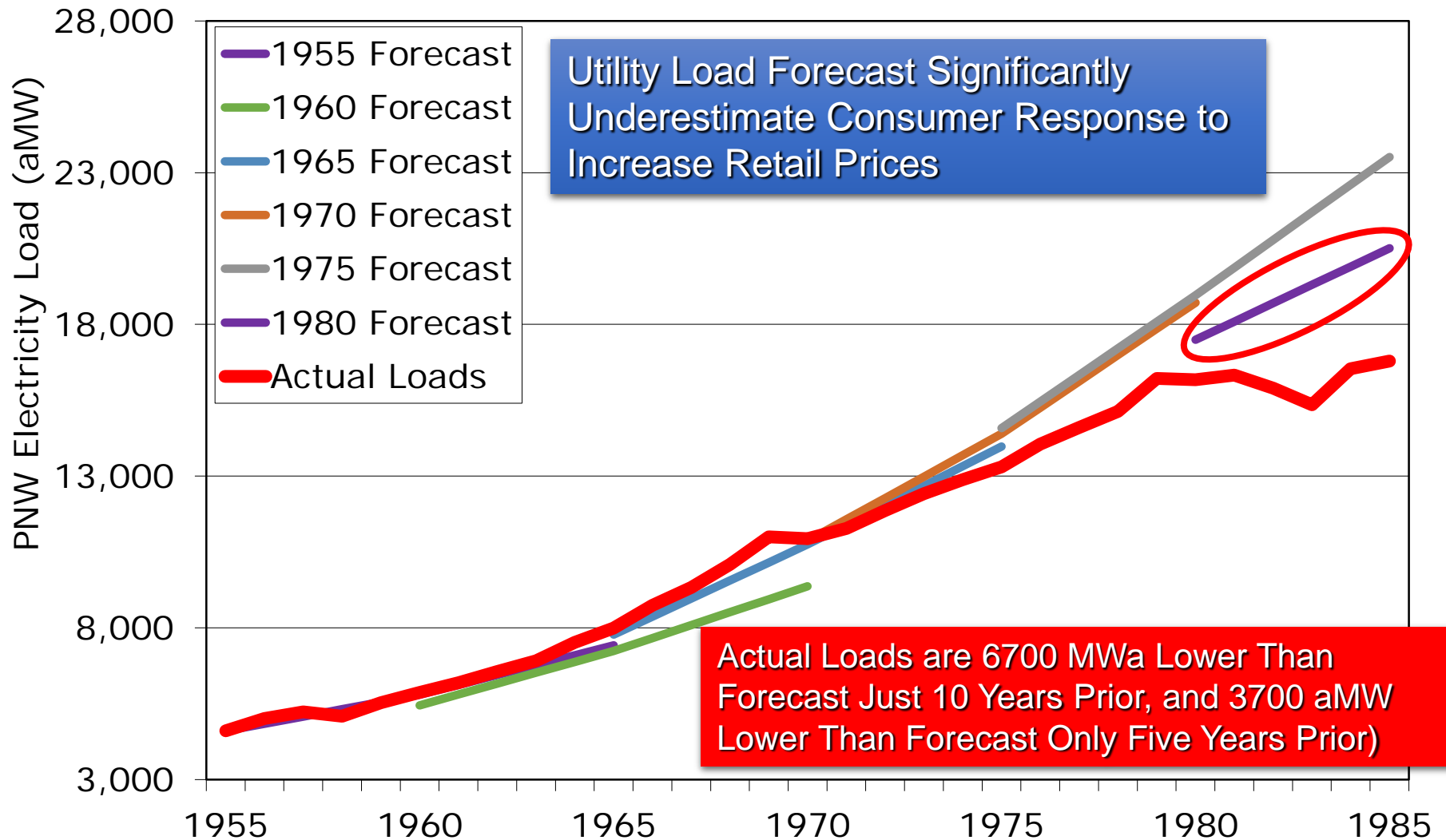




# PNW Retail Electric Rates 1938 - 1985



# Utility Forecasts Dramatically Underestimated Consumer Response to “Price Effects”



# Regional Response to the Assault on the PNW's Hydro Legacy



- Terminate construction on 9 nuclear and differ construction of 9 coal plants at a cost to the region's consumers of more than \$7 billion.
- Motivate the region's politicians, utilities, larger industries and public interest groups to accept the "deals" embodied in the Northwest Power Planning and Conservation Act of 1980

# Major Elements of the Northwest Power and Conservation Act of 1980

- Authorized States to form Council
- Directed Council to develop 20-year load forecast and resource plan (“The Plan”)
- Bonneville is given authority to acquire resources consistent with the Council’s Plan
- Plan is to provide for the development of the least cost mix of resources
- Conservation is defined as resource equivalent to generation and given a 10% cost advantage
- Mandated public involvement in planning process.

# The Evolution of Energy Policy

President Carter  
Awarded Nobel Peace  
Prize



April 18, 1977 –

Conservation means a cold dark house

President Carter announces we are engaged in the  
“Moral Equivalent Of War” (MEOW)

December 5, 1980 -

Conservation declared a resource equivalent  
to generation

President Carter signs Northwest Power  
and Conservation Act

# Contact

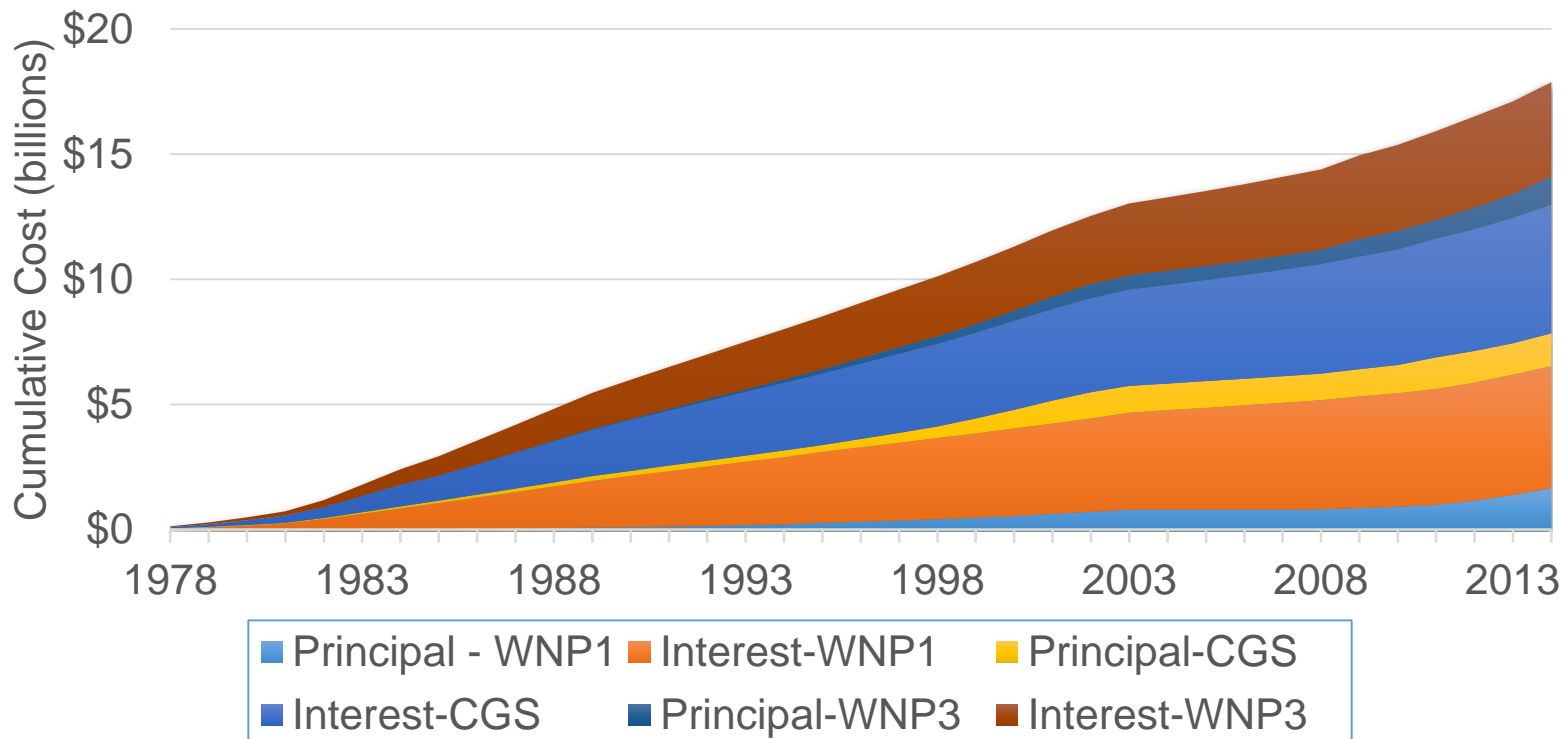
For more information, contact:

Tom Eckman  
Director, Power Division  
Northwest Power & Conservation Council  
TEckman@nwcouncil.org  
503-222-5161

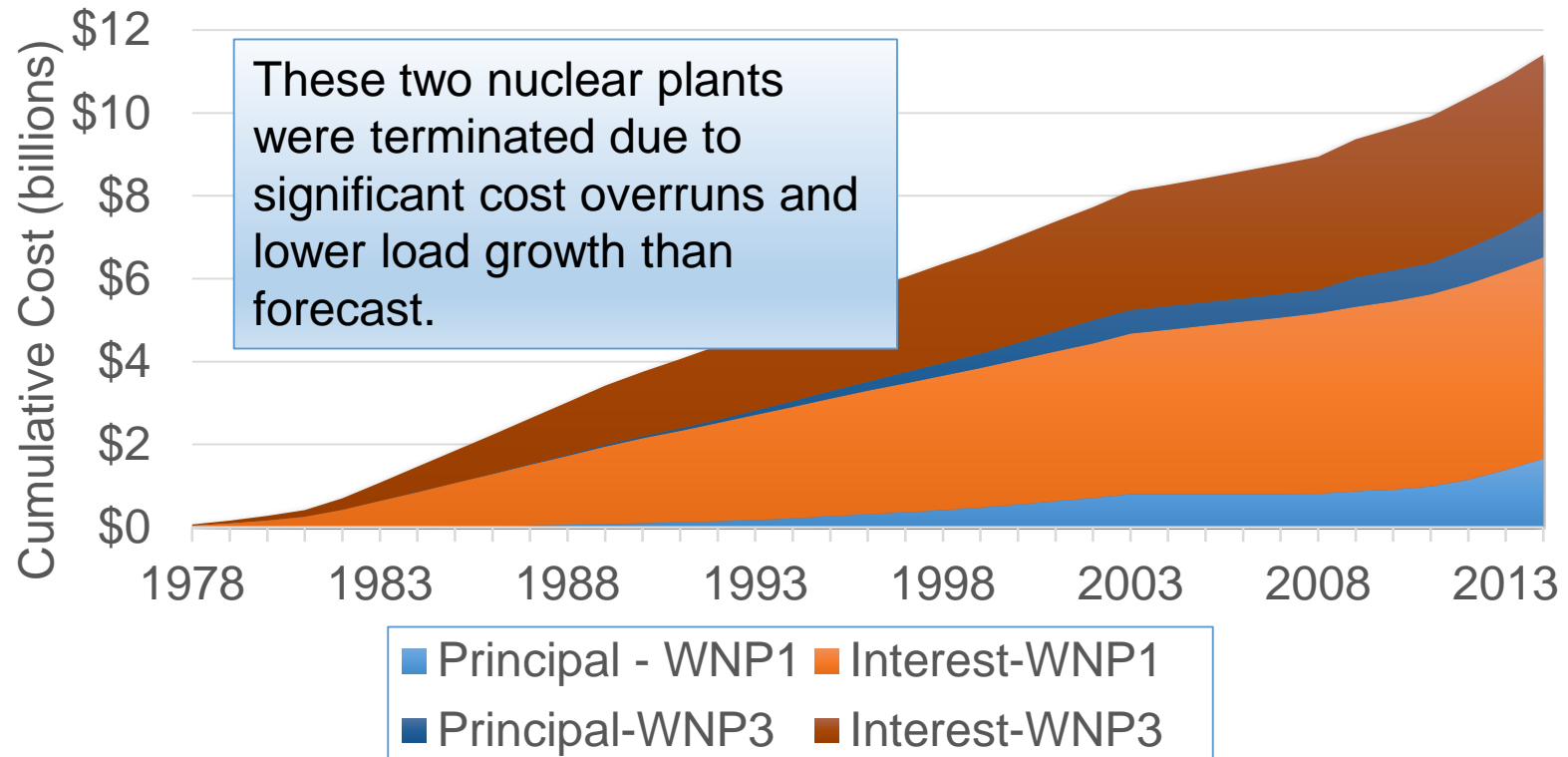
Offer Expires June 30, 2016  
So Act Soon!



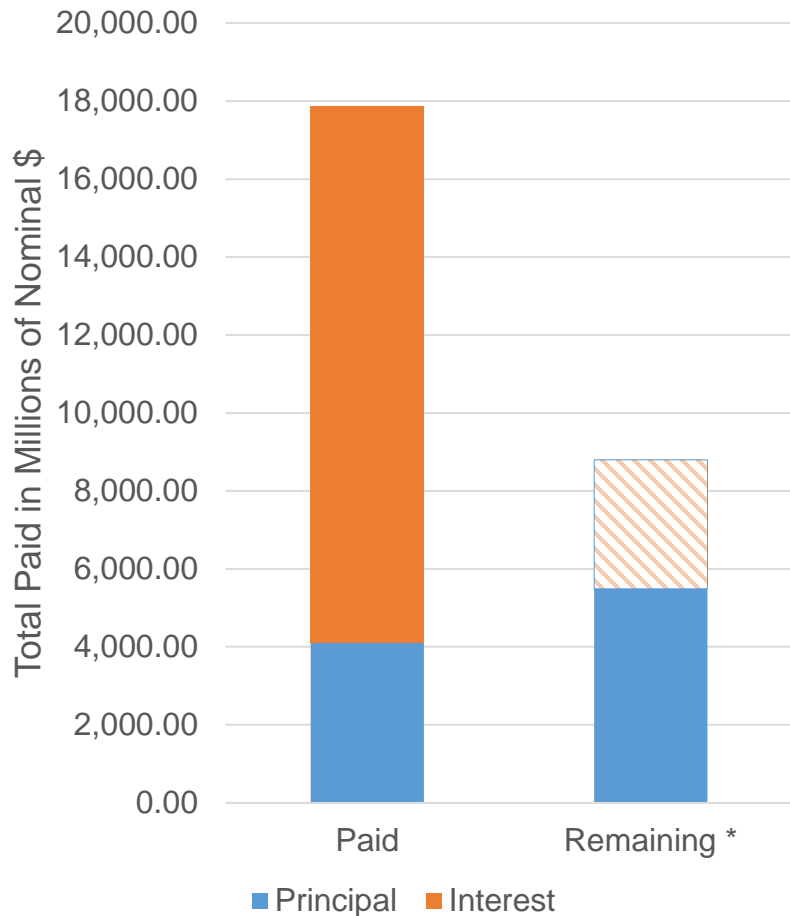
# Bonneville Debt Repayment from 1978 through 2014 for WNP 1 - 3



# Bonneville Debt Repayment from 1978 through 2014 for WNP 1 and 3



# Net Debt Impacts of CGS and Projects 1 & 3



## Nominal Impacts

	Principal	Interest
Paid	4,101	13,773
Remaining *	5,489	3,305

## Inflation Adjusted Impacts

	Millions of 2012 \$
Principal Paid	4,544
Interest Paid	18,658
Total Paid	23,203

\* - Remaining principal and remaining interest estimate based on BPA's 2015 report to Congress



# Seventh Power Plan: Key Findings and Resource Strategy

**Presented by:**  
Charlie Grist  
Northwest Power & Conservation Council



# The Council's Power Plan

- Goal: An Adequate, Efficient, Economical, Reliable Power Supply
  - Least-Cost Resource Strategy with Acceptable Risk
  - Regional Action Plan to Implement Strategy
- How is the Plan Used?
  - Guides BPA Resource Decisions
  - Independent reference for all of the region's utilities, regulatory commissions and policy-makers

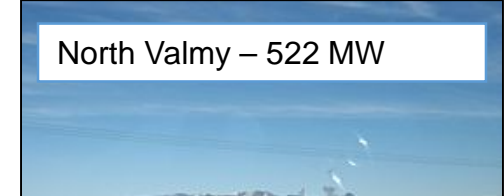
# The Seventh Power Plan – Major Issues



Centralia 1 & 2 – 1340 MW



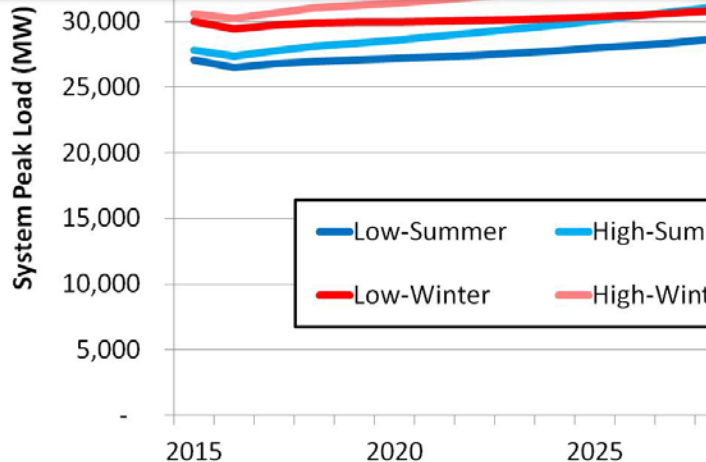
Boardman – 550 MW



North Valmy – 522 MW

**POWER PLANTS ARE THE SINGLE LARGEST SOURCE OF CARBON POLLUTION**

## Impact of announced coal-plant development



CARBON DIOXIDE (CO<sub>2</sub>) 82%

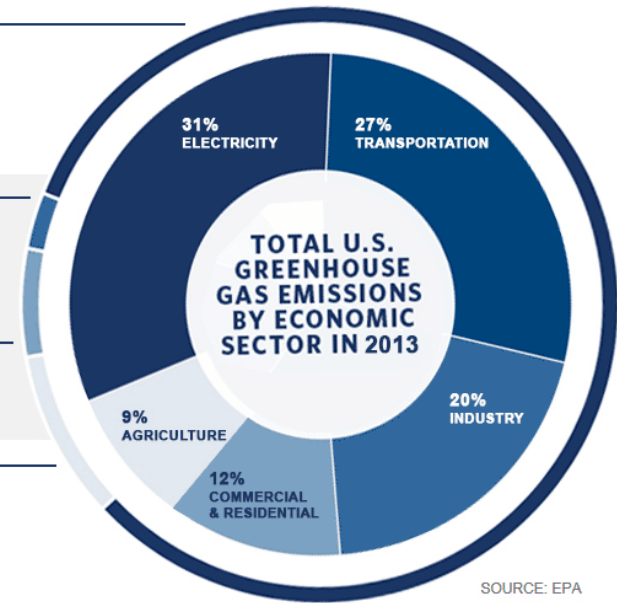


FLUORINATED GASES 3%



METHANE (CH<sub>4</sub>) 10%

NITROUS OXIDE (N<sub>2</sub>O) 5%



Implications of and options for addressing EPA's Clean Power Plan

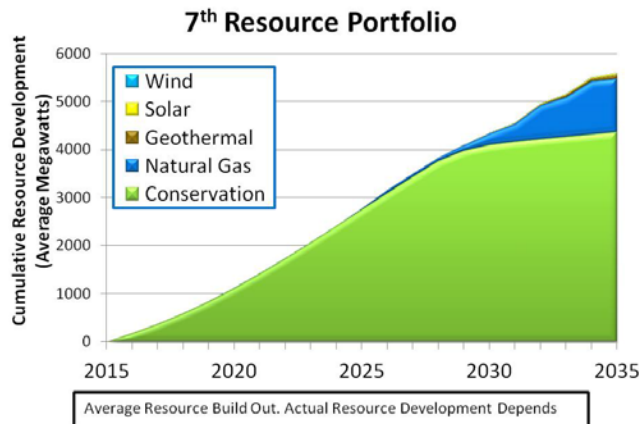
How to best meet regional need for capacity (i.e., peaking) resources



# The Answers to These Issues Requires Planning for Uncertainty

*Resource Strategies* – actions and policies over which the decision maker has control that will affect the outcome of decisions

*Futures* – circumstances over which the decision maker has no control that will affect the outcome of decisions



- Load Uncertainty
- Resource Uncertainty
  - Output
  - Cost
  - Construction Lead Times
- Wholesale Electricity Market Price Uncertainty

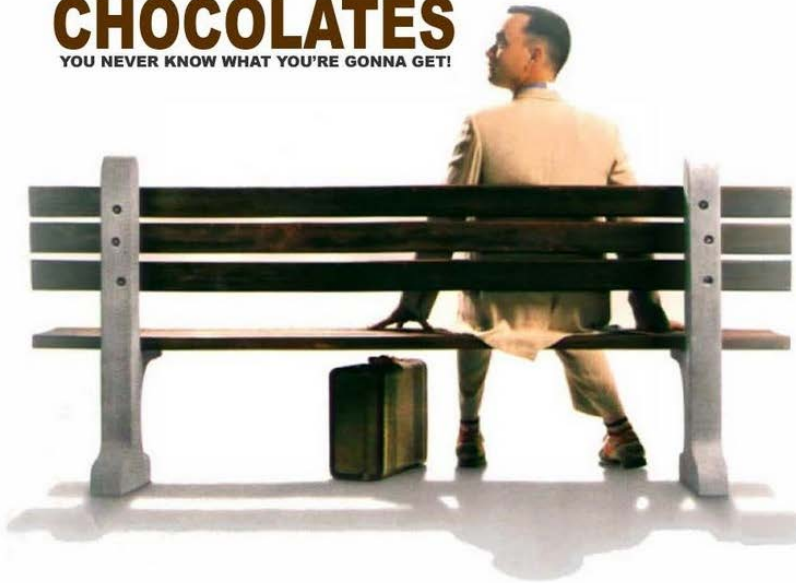


*Scenarios* – Combinations of *Resource Strategies* and *Futures* used to “stress test” how well what we control performs in a world we don’t control

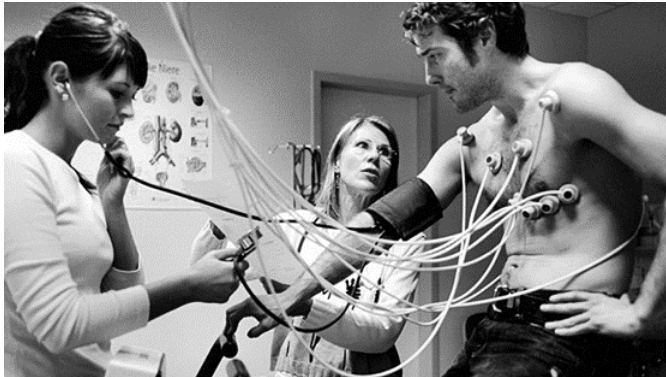
# Council Follows the “Gump” Resource Strategy Testing Model

Method: Stress testing resource strategies under uncertain futures

**LIFE IS LIKE A BOX OF  
CHOCOLATES**  
YOU NEVER KNOW WHAT YOU'RE GONNA GET!

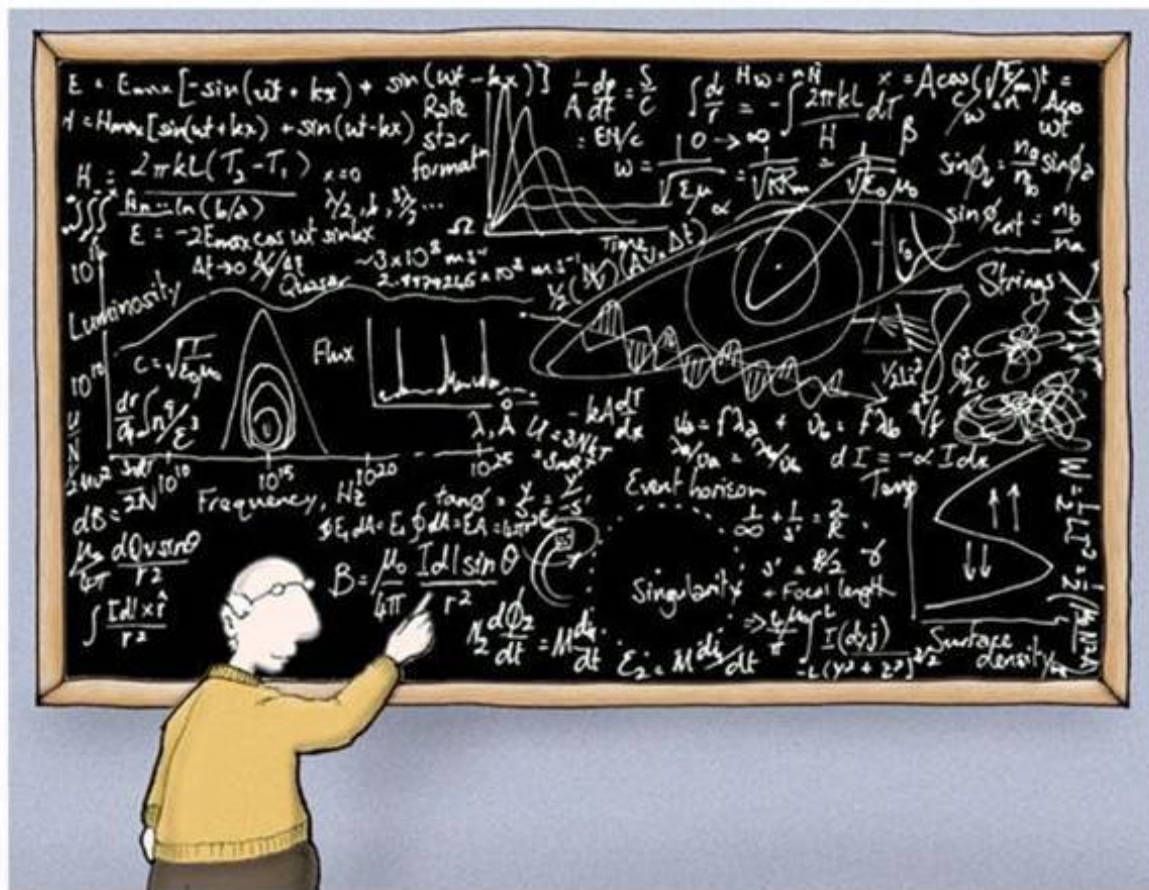


# Council Tested Over Two Dozen Different Scenarios

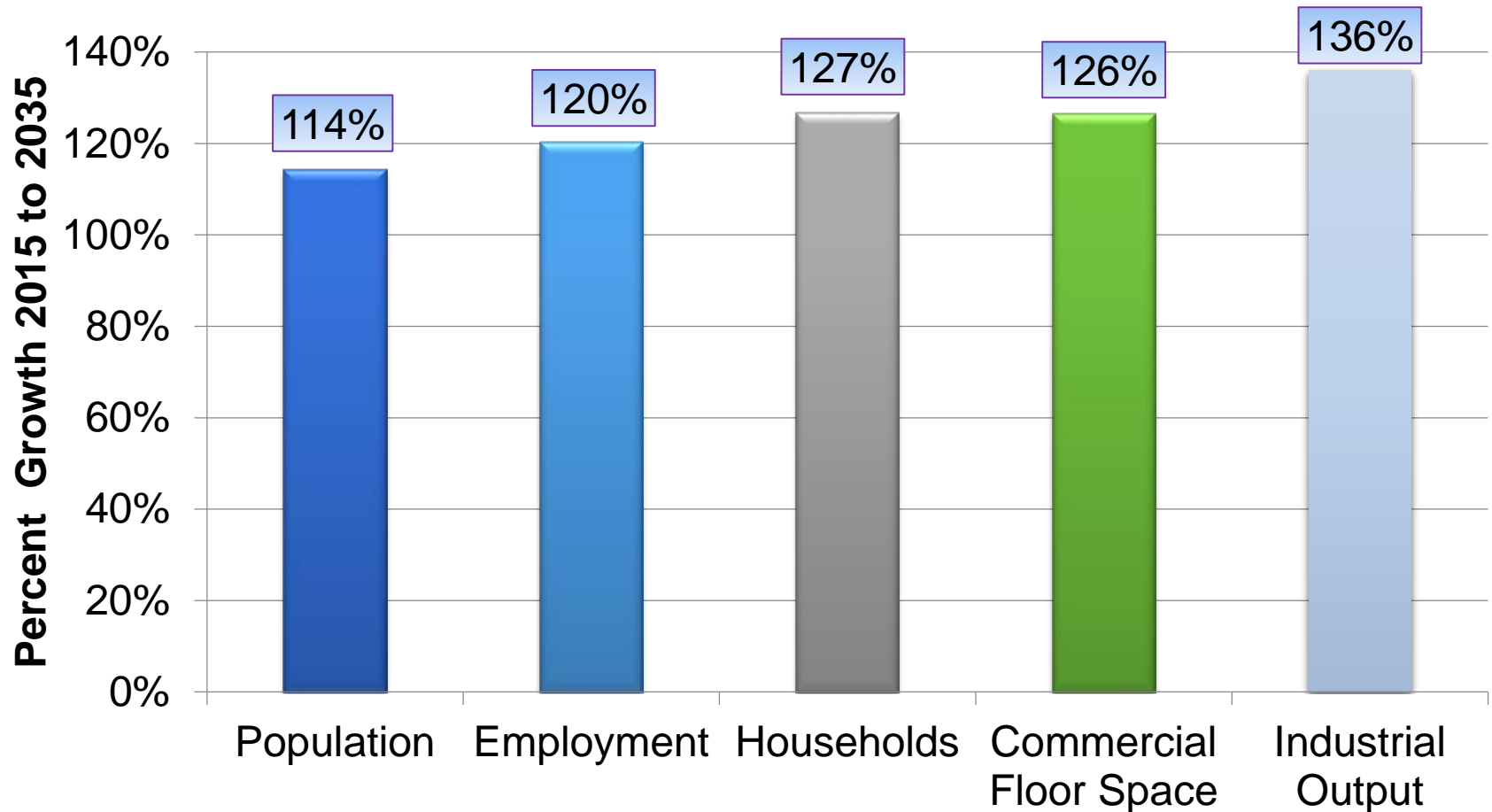


- Existing Policy
- Social Cost of Carbon
- Retire Coal
- Retire Coal and Inefficient Gas
- Retire Coal & Impose Social Cost of Carbon
- Retire Coal & Impose Social Cost of Carbon & No New Gas
- Regional RPS @ 35%
- No Demand Response
- Increase Market Reliance
- Lower Conservation

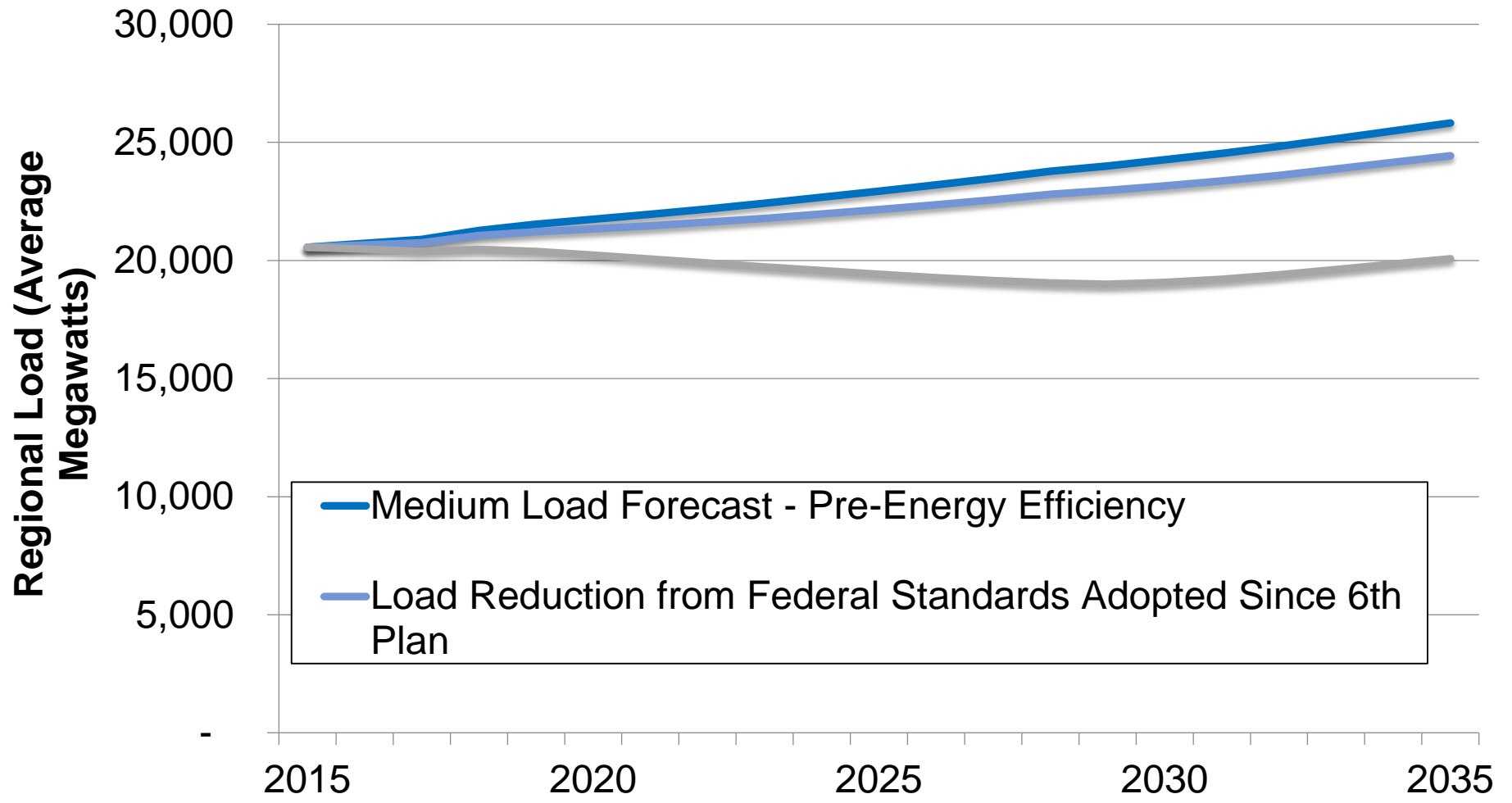
# A Brief Look at the Analysis & Findings



# Regional Population and Economic Forecast

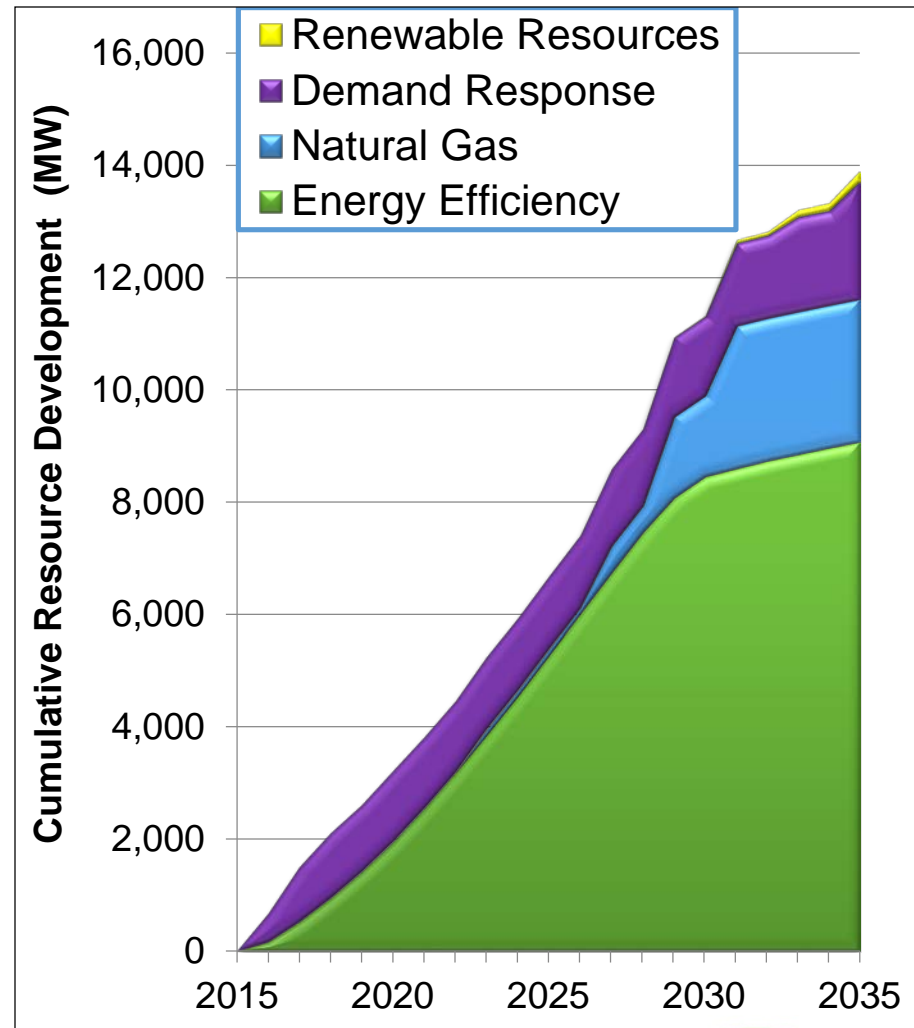
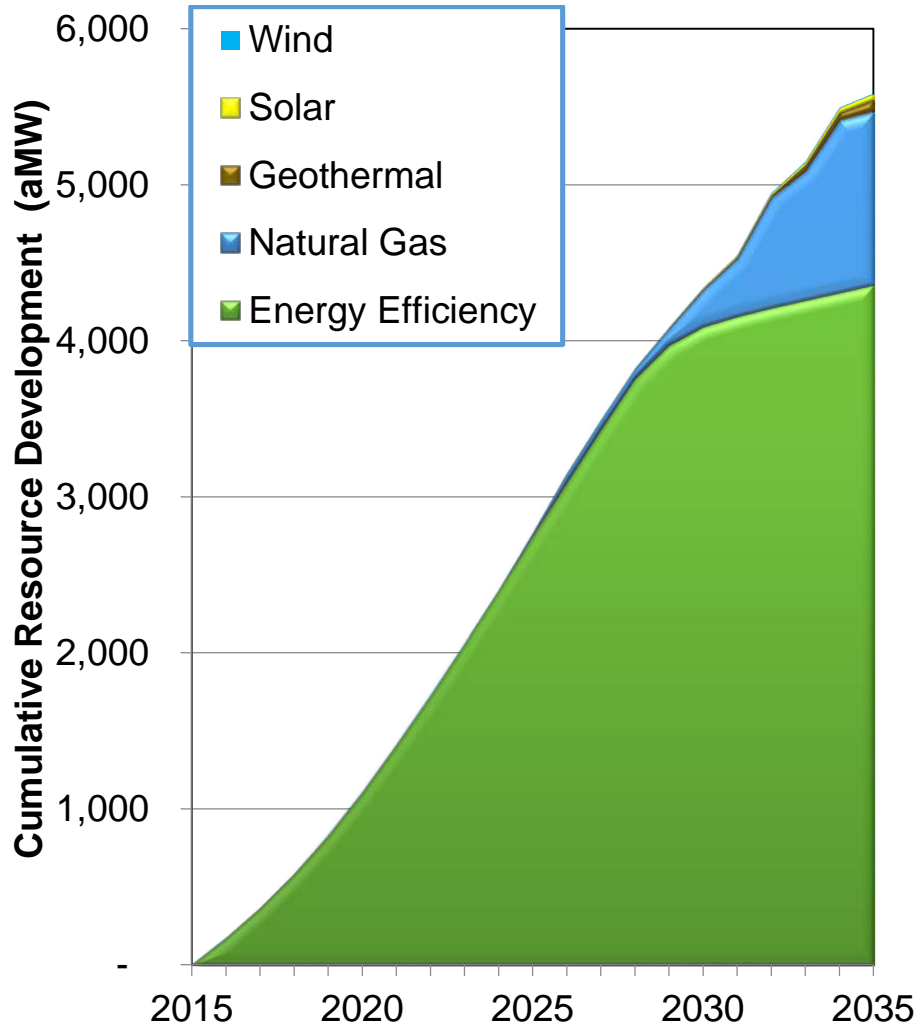


# Forecast Load Growth Over The Next Two Decades (Average Over 800 Futures)

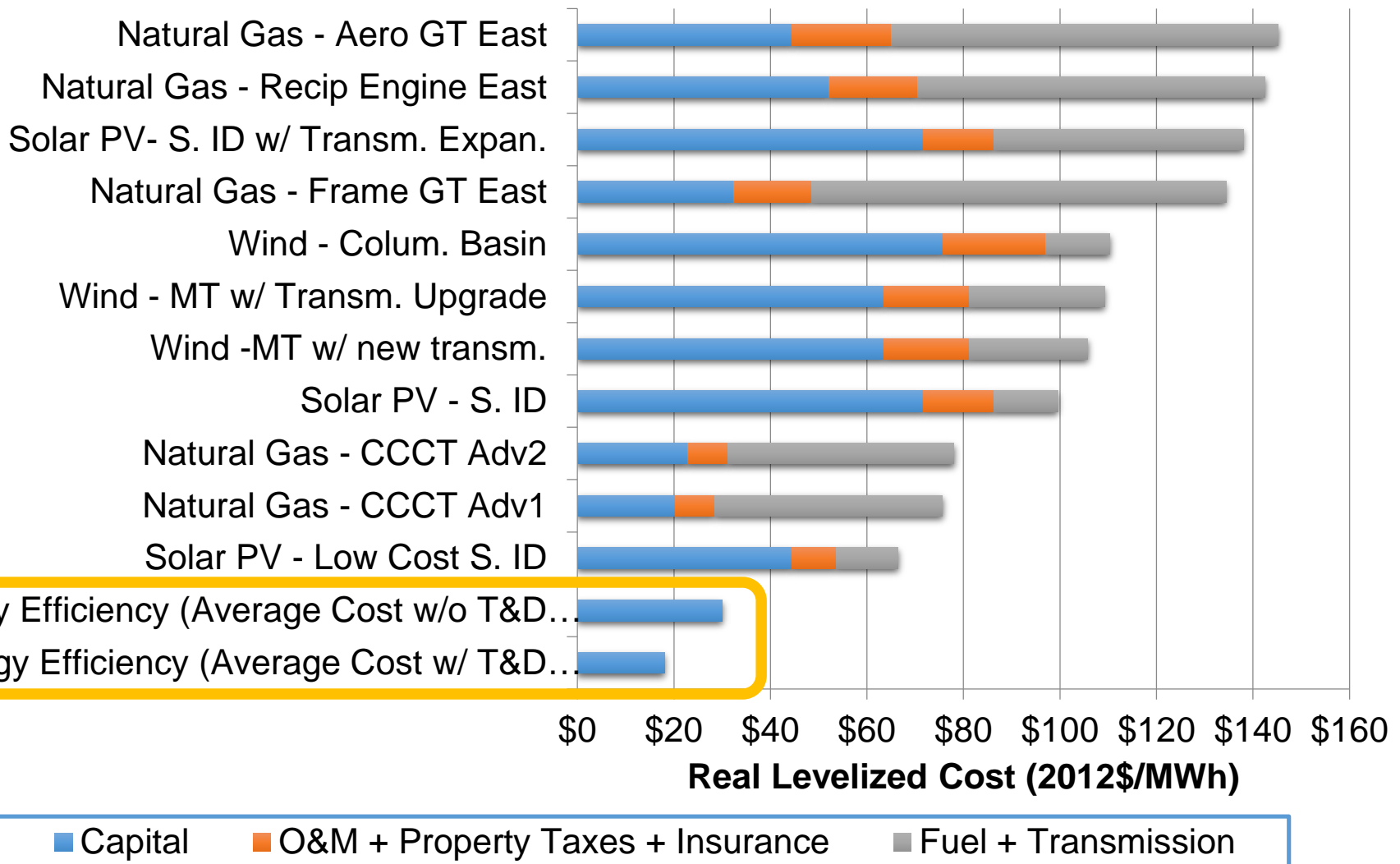




# Seventh Power Plan Least Cost Resource Strategies for Meeting Forecast Energy and Capacity Needs

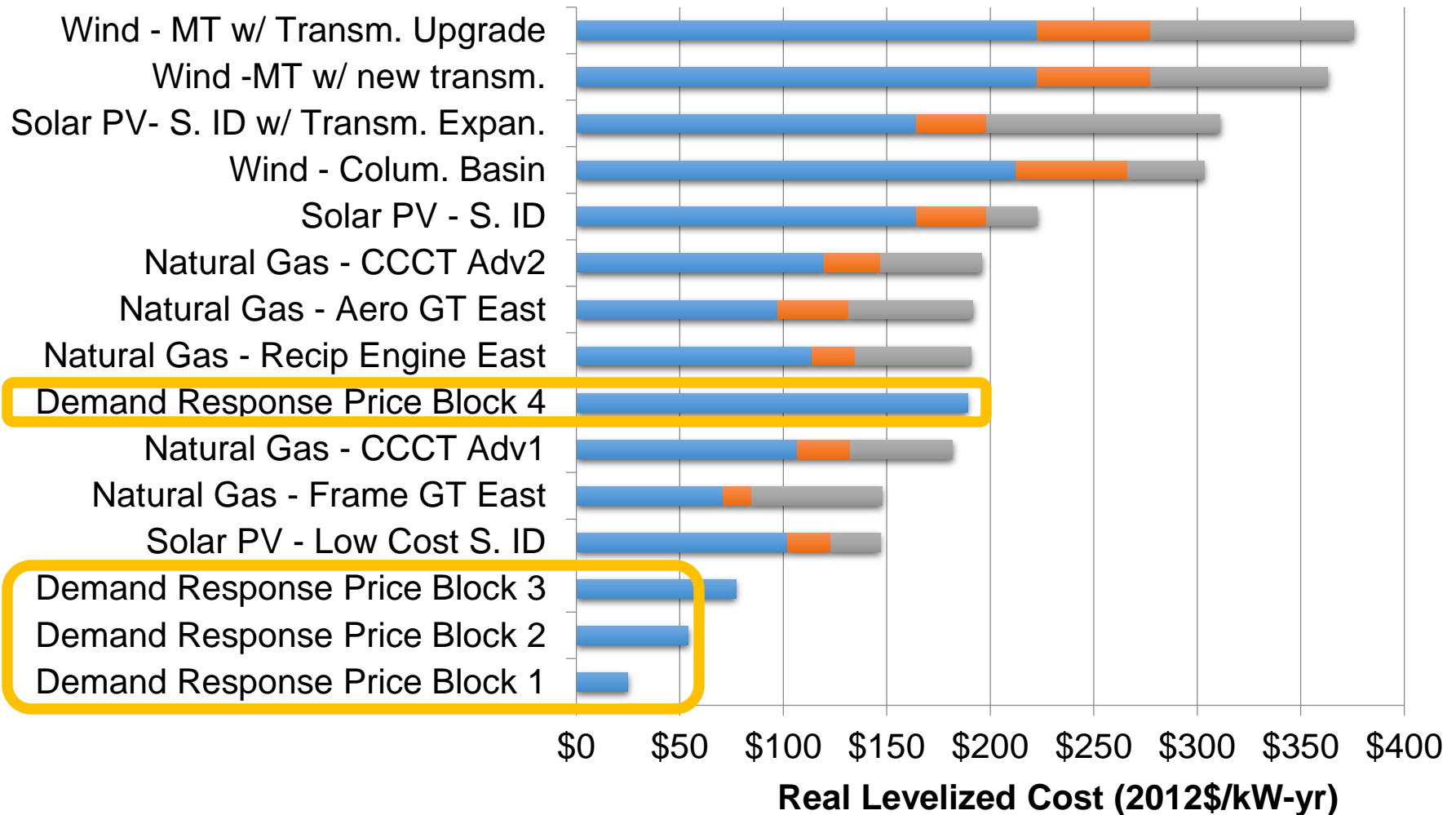


# All Resource Cost – Energy





# All Resource Cost – Peak Capacity



# Conservation Can Provide Capacity Benefits



Depending on WHEN a measure saves energy

Key Finding:

The Seventh Power Plan Relies  
on *Energy Efficiency* and  
*Demand Response* Resources  
To Meet Load Growth

Because they cost  
less!



# Residential & Agriculture in the Seventh Plan

**Presented by:**  
Tina Jayaweera  
Northwest Power & Conservation Council

# 7P EE by Sector

Cost-Effective Energy Efficiency Potential (aMW)			
Sector	2021	2026	2035
Agriculture	63	93	121
Residential	585	1172	1802
Commercial	543	1224	1732
Industrial	284	485	571
Utility	28	77	187
<b>Grand Total</b>	<b>1,503</b>	<b>3,050</b>	<b>4,414</b>

**Note: the Council does not set sector-specific goals or targets**

# RESIDENTIAL



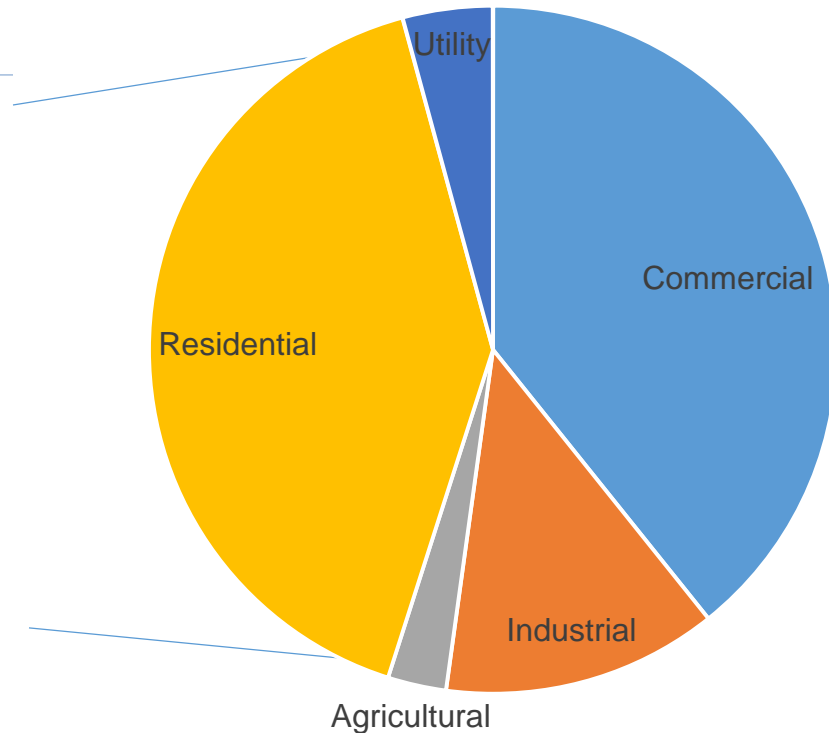
# Res Measure List

End Use	Measure Bundle(s)	End Use	Measure Bundle(s)
<b>Dryer</b>	Heat pump clothes dryer	<b>Lighting</b>	LED lighting
			LED lighting - pre 2020
<b>Electronics</b>	Monitor		Linear fluorescent lighting
	Desktop	Refrigerator	
	Laptop	Freezer	
	Advanced power strips	Aerator	
<b>HVAC</b>	Controls, Commissioning, & Sizing	<b>Water Heating</b>	Clothes Washer
	Duct Sealing		Dishwasher
	Ductless heat pump		Wastewater heat recovery
	DHP with ducted system		Heat pump water heater
	Ground-source heat pump		Showerheads
	Heat recovery ventilation		Solar water heater
	Weatherization(Insulation + Windows)	<b>Whole Bldg/Meter Level</b>	Behavior/Controls
	Air-source heat pump conversion		Electric vehicle supply equipment
	ASHP upgrades	<b>Food Preparation</b>	Microwave
	Variable-capacity heat pump		Electric oven
	WIFI enabled thermostats		

# Distribution of Cost-Effective Potential (20-yr aMW)

**Residential End-Use Category**                      **1,802**  
**(aMW in 2035)**

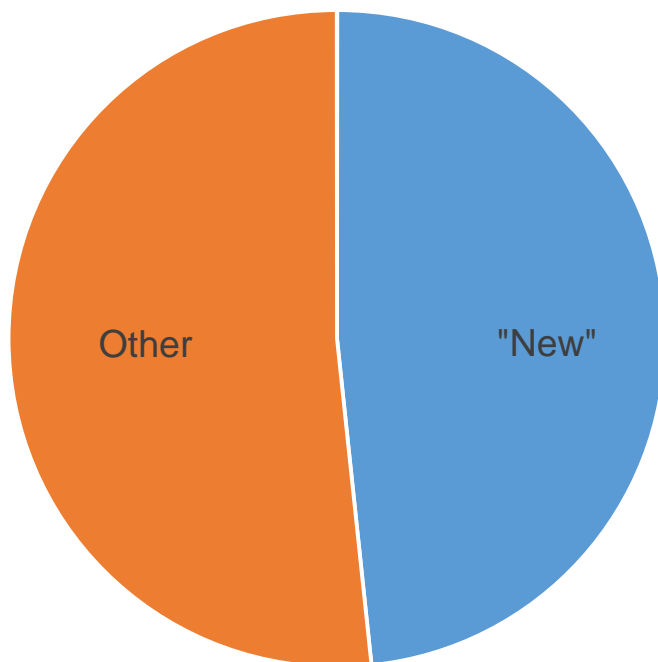
Electronics	221
Food Preparation	6
HVAC	608
Lighting	437
Water Heating	484
Whole Bldg	45



**Note: Council does not set sector or end-use specific goals**



# What's New from 6P?



## Total Cost-effective Potential Savings from "New" Res Measures (aMW)

Measure Bundle	2021	2026	2035
Advanced Power Strips	29	117	185
Aerator	5.4	21	34
Behavior	17	38	45
DHP in Ducted	28	76	158
Lighting	166	351	437
WiFi enabled tstats	4.5	9.9	12
<b>All New Measures</b>	<b>249</b>	<b>613</b>	<b>871</b>

# AGRICULTURAL

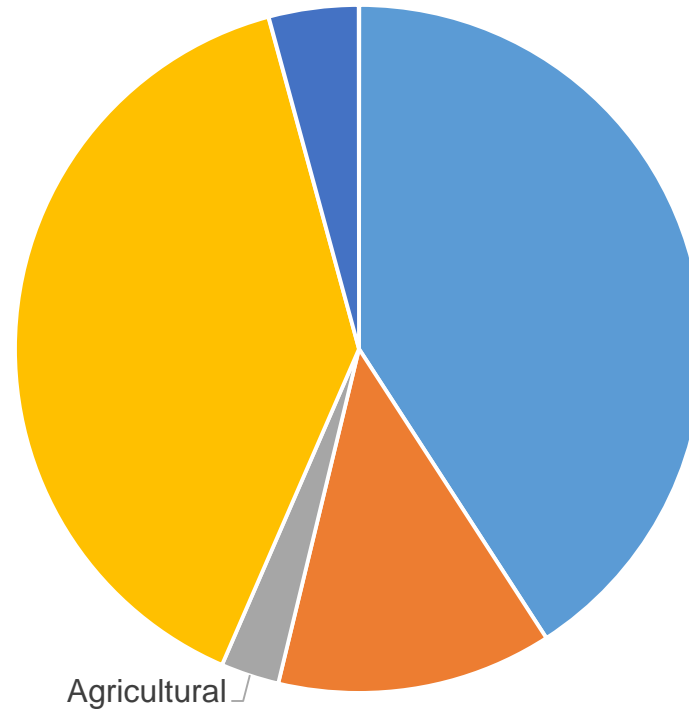


# Ag Measure List

End Use	Measure Bundle(s)
<b>Lighting</b>	Dairy lighting
	Outdoor barn lighting
<b>Dairy</b>	Vacuum pump
	Plate milk pre-cooler
	Heat recovery ventilation
<b>Irrigation Water Efficiency</b>	Scientific Irrigation Scheduling
	Low-energy spray application
<b>Irrigation hardware</b>	Green motor rewind
	Replace/rebuild nozzles/gaskets/pipes
	Convert high/med pressure to low pressure

# Distribution of Cost-Effective Potential (20-yr aMW)

<b>Agricultural End-Use Category</b>	<b>121 (aMW in 2035)</b>
Irrigation Hardware	71
Irrigation Water Management	41
Lighting	8
Dairy	1



Note: Council does not set sector or end-use specific goals

# What's New from 6P?

- LED lighting
- Low-Energy Spray Application - LESA
  - ~19 aMW of cost-effective 20-year potential
  - Low pressure (<10 psi)
  - Low elevation (below crop foliage)



# Top Takeaways for Res & Ag

1. Lighting is still big
2. Controls are the future
3. Standards are important
4. Recognize market dynamics
5. Keep an eye on long term



# Contact

For more information, contact:

Tina Jayaweera

Senior Analyst

Northwest Power & Conservation Council

[tjayaweera@nwcouncil.org](mailto:tjayaweera@nwcouncil.org)

503-222-5161



# Energy Efficiency in the Seventh Power Plan: Commercial and Industrial Sector

**Presented by:**  
Kevin Smit, Senior Analyst  
Northwest Power and Conservation Council





# 7P EE by Sector

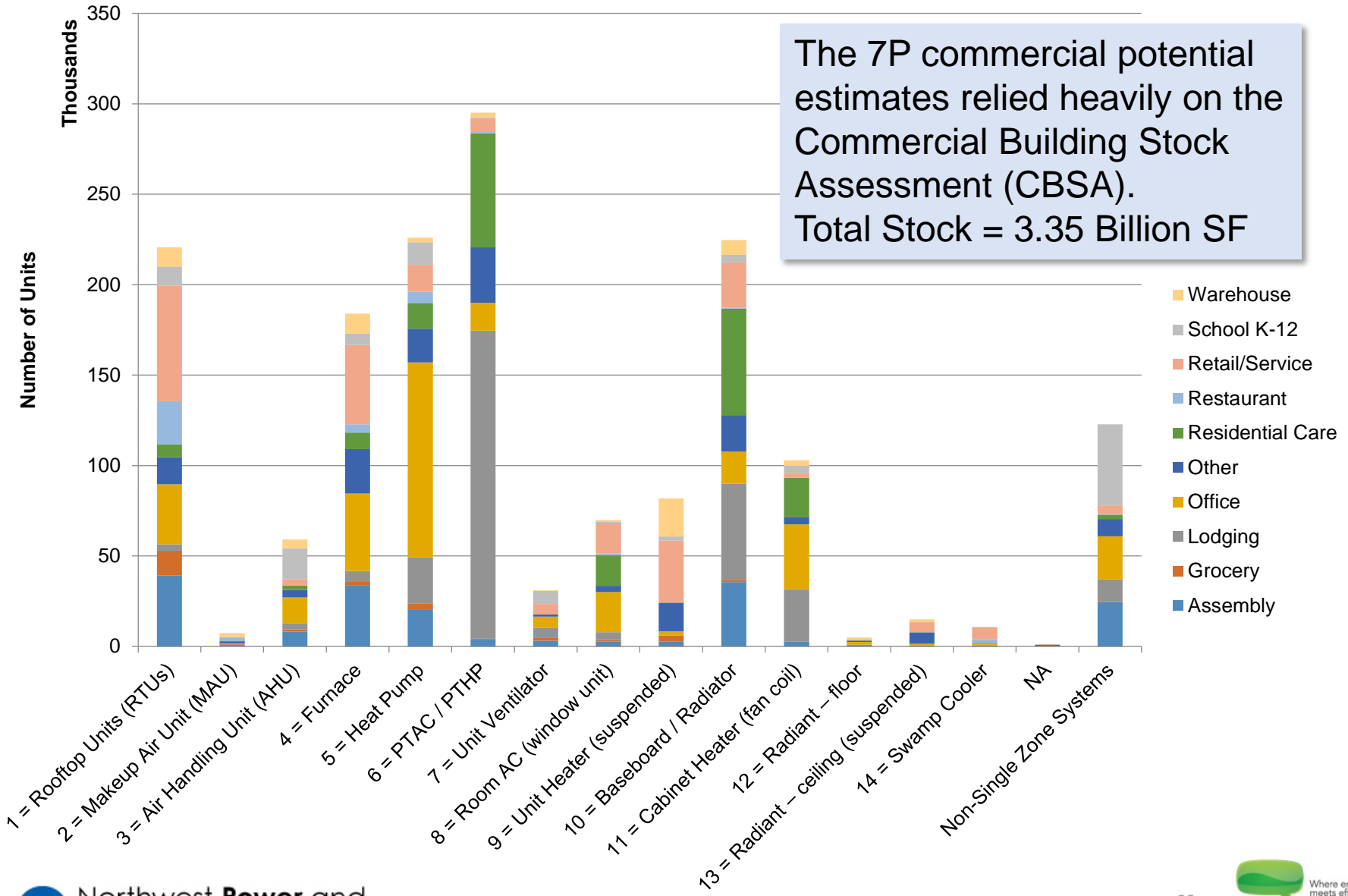
Cost-Effective Energy Efficiency Potential (aMW)			
Sector	2021	2026	2035
Agriculture	63	93	121
Residential	585	1172	1802
Commercial	543	1224	1732
Industrial	284	485	571
Utility	28	77	187
<b>Grand Total</b>	<b>1,503</b>	<b>3,050</b>	<b>4,414</b>

**Note: the Council does not set sector-specific goals or targets**



# Seventh Power Plan: Commercial Sector EE Potential

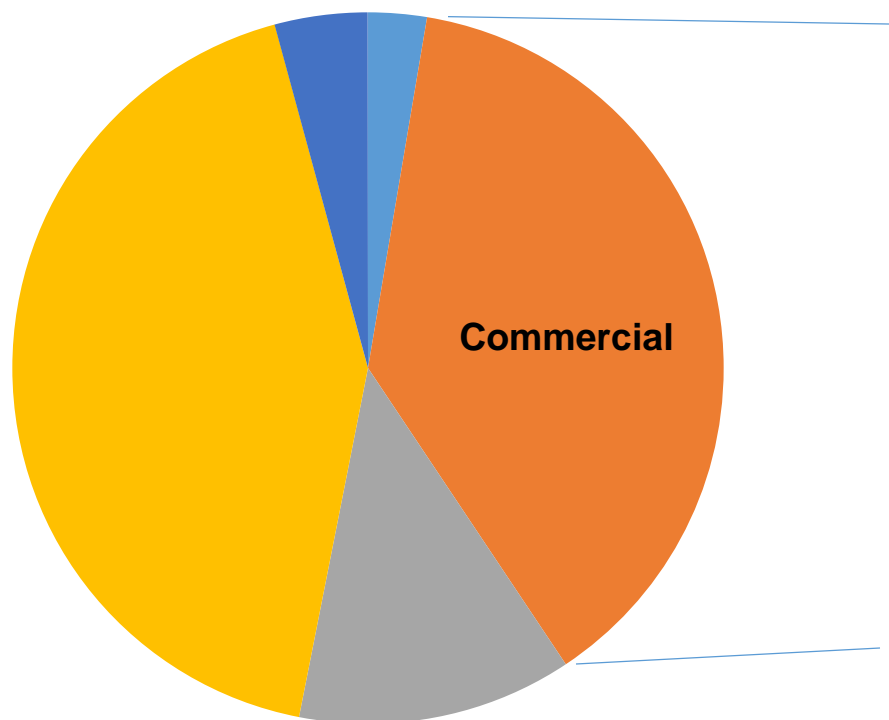
# Example CBSA: Single Zone HVAC Equipment Units



# Commercial Measure List

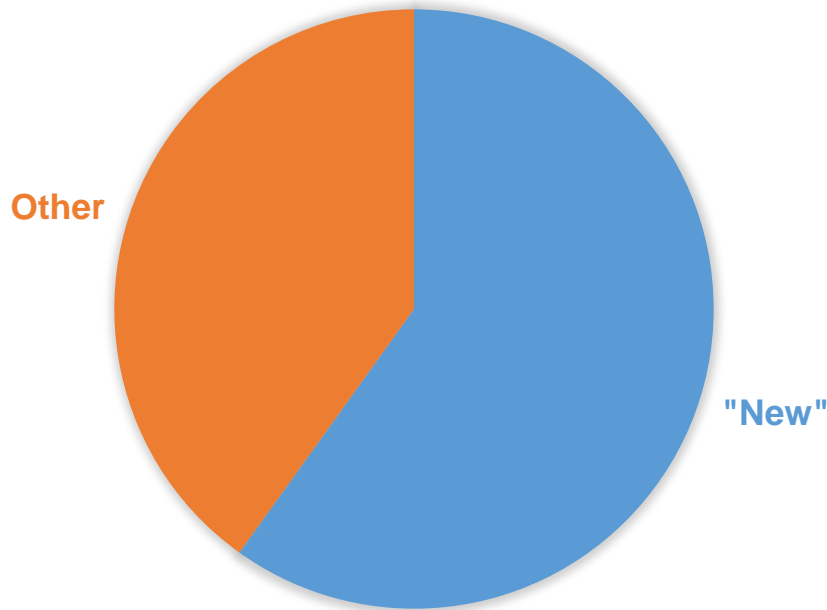
End-Use	Measure Bundle	End-Use	Measure Bundle
<b>Compressed Air</b>	Compressed Air	<b>Lighting</b>	Bi-Level Stairwell Lighting
<b>Electronics</b>	Data Centers		Exterior Building Lighting
	Desktop		LEC Exit Sign
<b>Food Preparation</b>	Laptop		Lighting Controls Interior
	Monitor	Low Power LF Lamps	
<b>HVAC</b>	Smart Plug Power Strips	Lighting Power Density	
	Cooking Equipment	Parking Garage Lighting	
	Pre-Rinse Spray Valve	Street and Roadway Lighting	
	Advanced Rooftop Controller	<b>Motors/Drives</b>	ECM-Variable Air Volume
	Commercial Energy Management		Motors Rewind
	DCV Parking Garage	<b>Process Loads</b>	Municipal Sewage Treatment
	DCV Restaurant Hood		Municipal Water Supply
	DCV Buildings	<b>Refrigeration</b>	Grocery Refrigeration Bundle
	Ductless Heat Pumps		Water Cooler Controls
	Economizer	<b>Water Heating</b>	Water Heater Tanks
	Premium Fume Hood		Showerheads
	Secondary Glazing Systems		Clothes Washer
Variable Speed Chiller			
Variable Refrigerant Flow			
Web-Enabled Programmable Thermostats (WEPT)			

# Results: Cost-effective 20-year Potential



Commercial End-Use Category	aMW in 2035
Compressed Air	17
Electronics	392
Food Preparation	64
HVAC	407
Lighting	692
Motors/Drives	35
Process Loads	47
Refrigeration	69
Water Heating	10
<b>Total</b>	<b>1732</b>

# What's New?



- Some emerging tech, some just new to 7P
- Research and development needed
- Three main categories: controls, electronics, HVAC

## Savings from "New" Measures (aMW)

Measure Bundle	2021	2026	2035
Advanced Rooftop Controller	22	83	117
Bi-Level Stairwell Lighting	1	4	9
Compressed Air	5	9	17
Embedded Data Centers	55	230	261
Ductless Heat Pump	12	43	60
Light Emitting Capacitor Exit Sign	4	9	19
Lighting Controls Interior	2	6	13
Low Power LF Lamps	14	39	39
Interior Lighting	112	216	399
Motors Rewind	2	4	5
Parking lot Lighting	6	8	8
Secondary Glazing Systems	1	5	10
Smart Plug Power Strips	30	42	47
Street and Roadway Lighting	30	57	61
Variable Refrigerant Flow	5	25	78
Water Cooler Controls	2	10	12
Web-Enabled Thermostat	3	7	7
Water Heater Tanks	0	1	2



# Seventh Power Plan: Industrial Sector EE Potential

# Key Measure & Practices

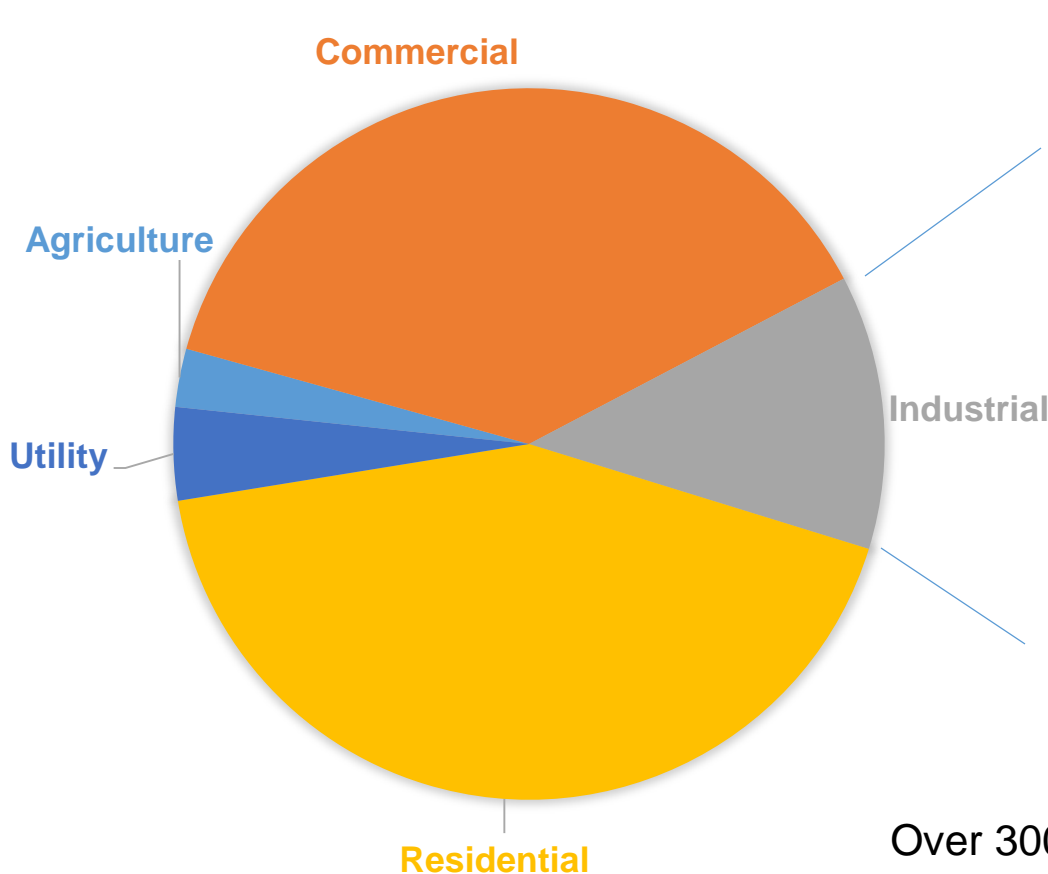
- Air Compressor Demand Reduction
- Air Compressor Equipment
- Air Compressor Management
- HighBay Lighting
- Lighting Controls
- Motors: Efficient Rewind VSD Controls
- Motor Management Program
- Fan Efficient Centrifugal
- Food: Fans and Blowers
- Other: Fans and Blowers
- Fan ASD Control
- Premium Pump
- Pump ASD Control
- Food: Cooling and Storage
- Food: Refrigeration 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 Dist Retrofit & Tuneup



# Industrial Segments

<b>Industrial Segment</b>	<b>Forecasted Load (MWh 2035)</b>
Mechanical Pulp	4,261,225
Kraft Pulp	2,596,442
Paper	5,267,664
Foundries	673,247
Frozen Food	1,243,766
Other Food	3,189,467
Wood - Lumber	620,280
Wood - Panel	718,938
Wood - Other	1,525,349
Sugar	582,684
Hi Tech - Chip Fabrication	999,801
Hi Tech - Silicon	347,399
Metal Fabrication	668,274
Transportation Equipment	1,697,223
Refinery	1,143,256
Cold Storage	1,129,112
Fruit Storage	3,380,049
Chemical	4,496,577
Miscellaneous Manufacturing	4,717,786
<b>Total</b>	<b>39,258,539</b>

# Cost-effective Industrial Potential (20-yr aMW)



Industrial End-Use Category	aMW in 2035
Low Temp Refer	21
Med Temp Refer	60
Compressed Air	18
Drying and Curing	2
Fans and Blowers	63
Heating	4
HVAC	10
Lighting	45
Material Handling	51
Other Motors/EM	214
Pumps	82
<b>Total</b>	<b>571</b>

Over 300 of the 571 aMW could be considered “energy management”

# How Much “Energy Management”?

<b>Energy Management</b>	<b>Total</b>	<b>311 (aMW)</b>
Air Compressor Optimization		6
Clean Room: Chiller Optimize		1
Cold Storage Tuneup		2
Energy Project Management		86
Fan Energy Management		8
Fan System Optimization		24
Food: Refrigeration Storage Tune-up		7
Fruit Storage Tuneup		11
Groc Dist Tuneup		1
Integrated Plant Energy Management		77
Plant Energy Management		40
Pump Energy Management		12
Pump System Optimization		34

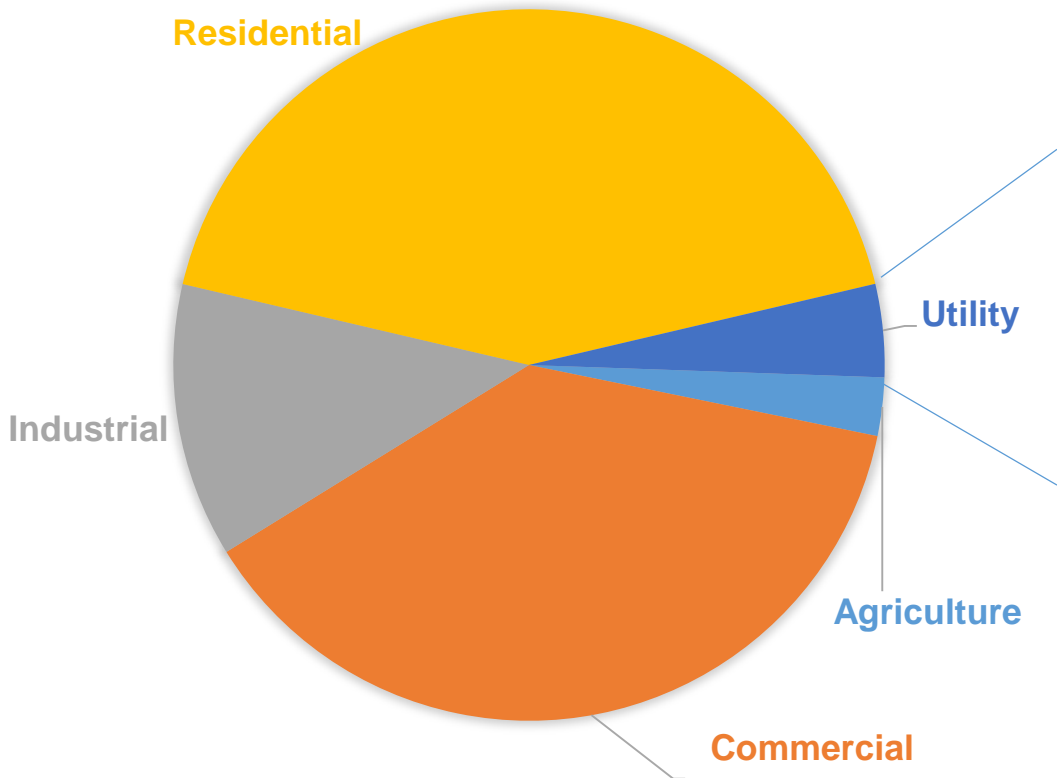


# Seventh Power Plan: Distribution System EE Potential

# 7<sup>th</sup> Plan Distribution Efficiency

- Reduces losses on the distribution system with out a reduction in service
- Total potential = 187 aMW
- Includes the same measures as the Sixth Plan, e.g.,
  - CVR
  - Reconductoring
  - VAR management
  - Phase load balancing
  - Feeder load balancing
  - Voltage regulators
  - EOL and LDC voltage control

# Cost-effective Industrial Potential (20-yr aMW)



Distribution Efficiency Category	aMW in 2035
Reduce system voltage	83
Minor system improvements (e.g., phase load balancing)	50
Major system improvements (e.g., reconductoring)	55
<b>Total</b>	<b>187</b>

# Top Takeaways for Commercial, Industrial and Distribution System

1. Lighting is still big
2. Controls are the future
3. Energy management is still big, and difficult
4. Data centers and electronics
5. Don't forget about the distribution system



# Contact

For more information, contact:

Kevin Smit

Senior Analyst

Northwest Power and Conservation Council

[ksmit@nwcouncil.org](mailto:ksmit@nwcouncil.org)

503.222.5161



# Seventh Power Plan: Taking Action

# 7P Action Items

- 71 Action Items: Who, What, When, Why
- 26 Action Items Directly EE
  - Ten Bonneville-Specific Actions
  - Nine items for NEEA – some new
  - Items for RTF
  - Model Conservation Standards
  - Revised cost-effectiveness methodology
  - Research, tracking, regulation
  - Non-Energy Impacts
  - Focus areas like Hard-To-Reach Markets
  - Promoting the value proposition for EE

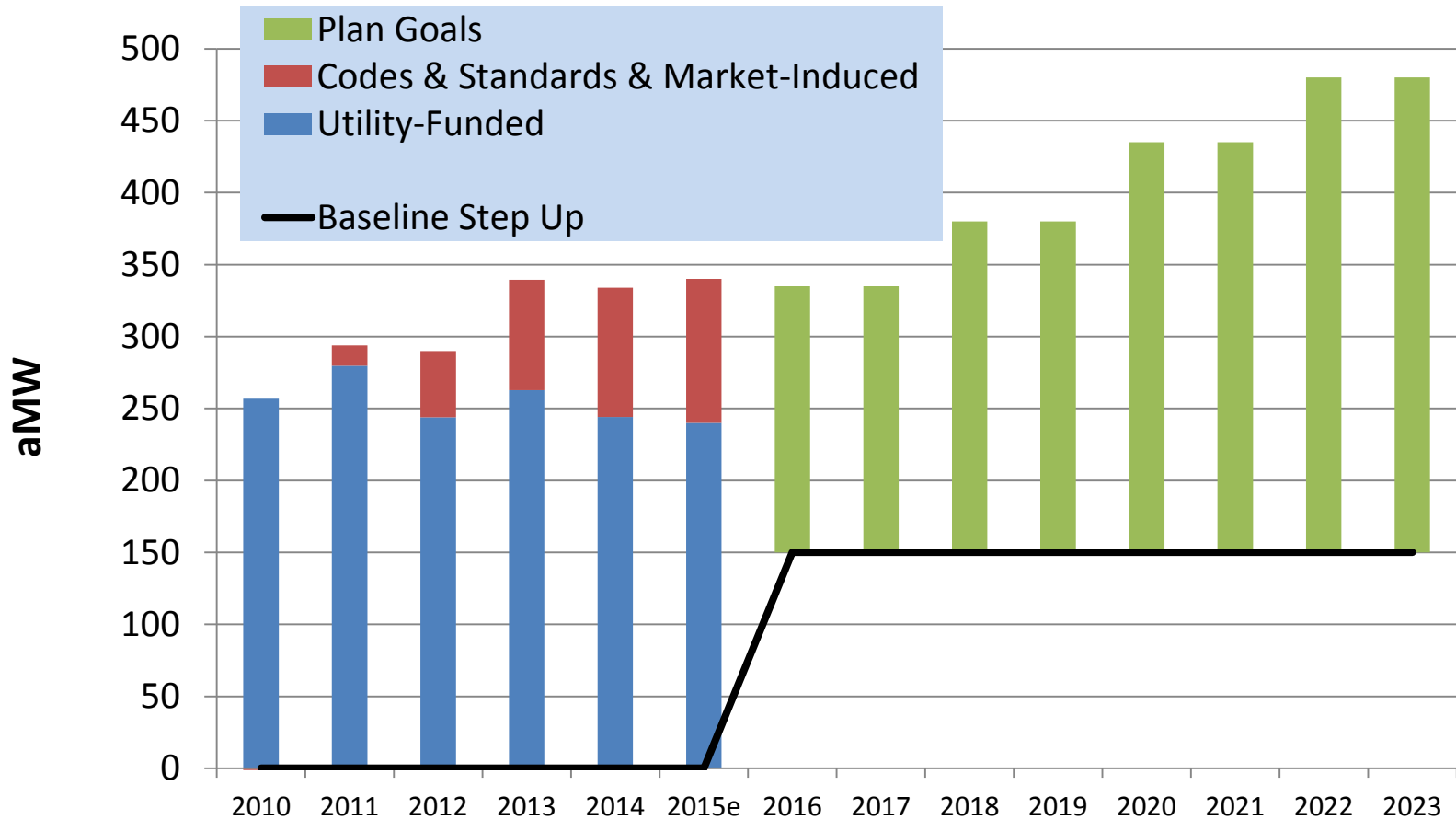


# What Does This Mean for EE Programs & Evaluators & Engineers ?

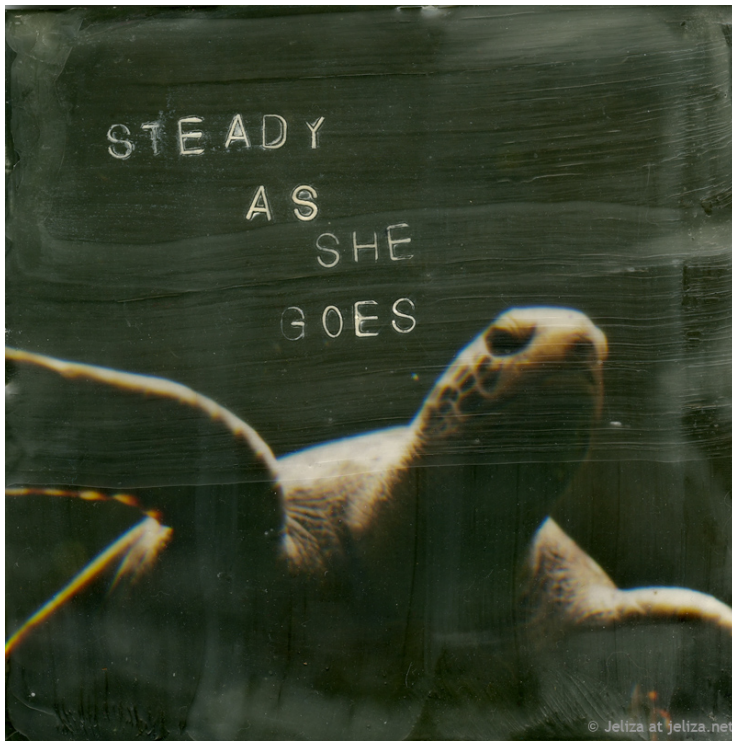
- Steady as she goes
- Lots of low-cost potential & challenges to acquire it
- Spot market price is NOT the avoided cost for least-cost
- Expand thinking beyond annual average savings
- Integration with DR programs
- Baselines changing – programs adjust
- Be smart & strategic about programs
- Importance of EE research & performance



# 7P: New Goals & New Baselines



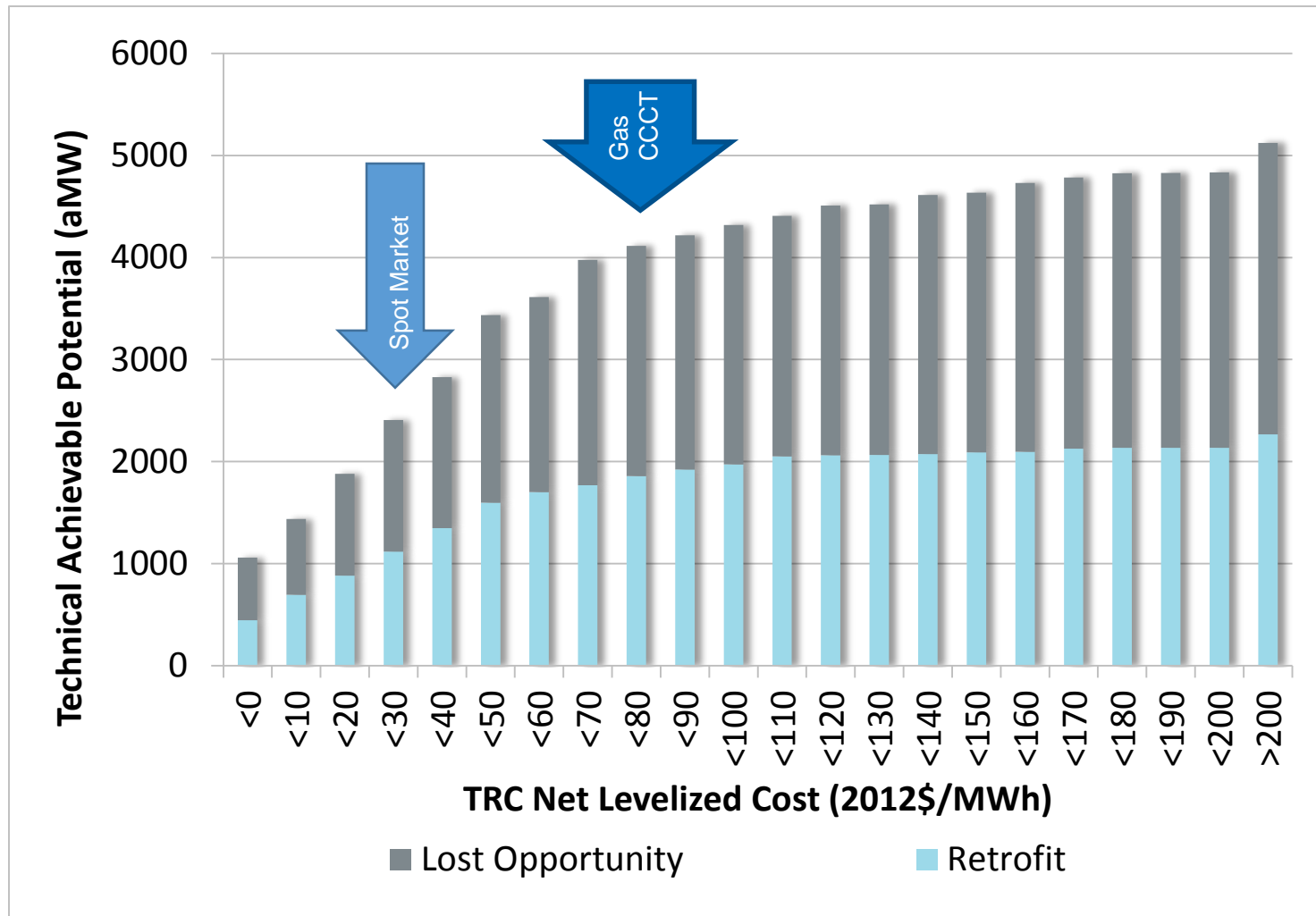
# But What If We Don't Need Energy or Capacity Today?



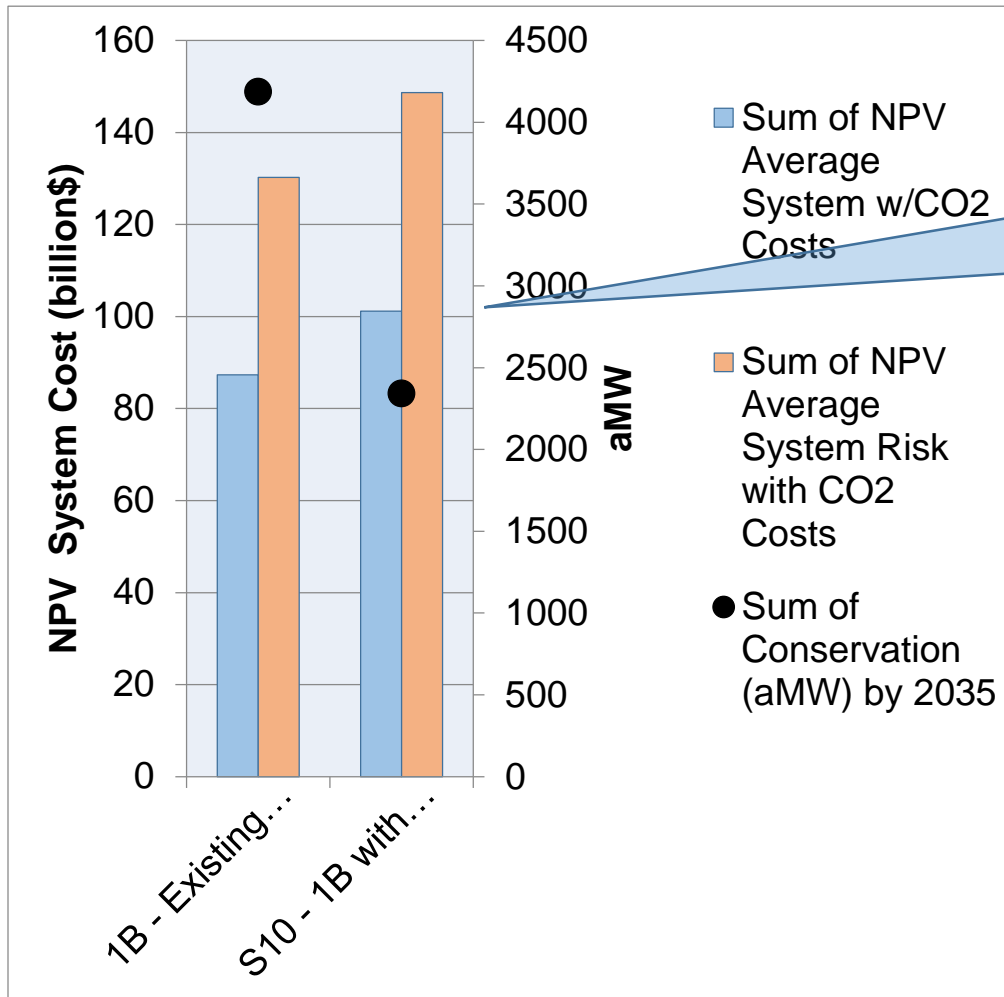
## Plan Findings

- Underlying load growth
- Loss of existing generation
- A steady EE build - Offsetting long-term net growth is least-cost and low-risk
- Incremental sustained progress at low cost accumulates high value

# Lots of EE Between Spot Market Price & Cost of New Generation



# Spot Market Price Is Not The Least-Cost Avoided Cost For EE



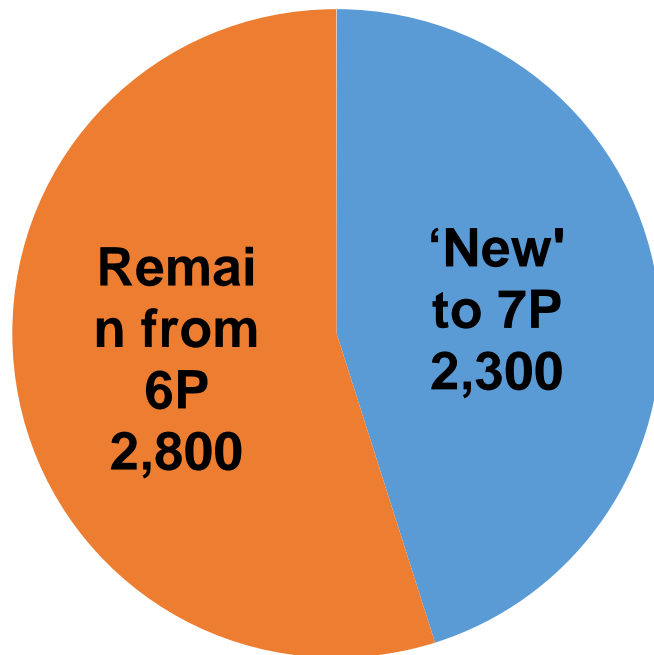
System costs and risk both increase by about 15 percent if spot market price is used as avoided cost

## Plan Findings

- Building about twice the EE than would be built with spot market as avoided cost
- And reduces long-term system cost & risk & revenue requirements

# And There Are New Measures

## Total Savings Potential (aMW Year 2035)



- About 30 new measures
- Nearly half of potential
- Key new technology
  - SSL & Controls ~50%
  - HVAC ~25%
  - Electronics ~15%
  - Plug loads
  - Behavioral
  - New applications of old



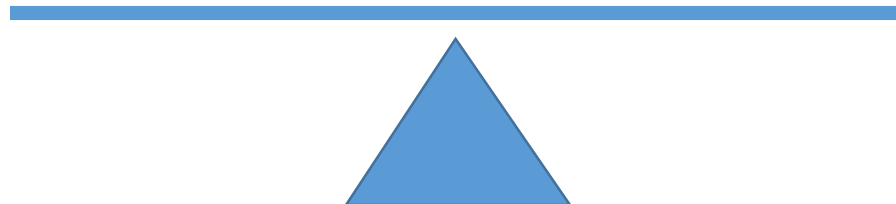
# Incorporate Value of Deferred Generation Capacity in B/C

- Energy
- Deferred Capacity
- Avoided Annual O&M
- Avoided Other fuel
- Non-Electric Benefit
- Avoided Periodic Replacement
- Risk Avoidance

- Capital
- Program Admin
- Annual O&M
- Other fuel
- Non-Electric Cost
- Periodic Replacement

***Benefits***

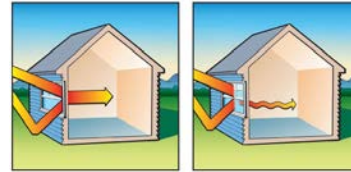
***Costs***



# What Does Revised Cost-Effectiveness Mean?



- Will credit more value to measures that provide peak capacity reduction



- And less to those that don't



# Some EE & DR Overlap



- Efficiency Device?
- A Demand Response Device?
- Who's Storage Is It?
- A Noisy Thing in the Closet?



Regional  
Technical  
Forum

## RTF Issues

- Updated Cost-Effectiveness & Avoided Costs
- Current Practice Baseline
- Tee-Up Research Needed for Savings Estimates
- Research & Guidelines for Non-Energy Impacts
- Facilitating Research Agenda
- Reviewing Big Mo
- Hourly Profiles of Savings Important

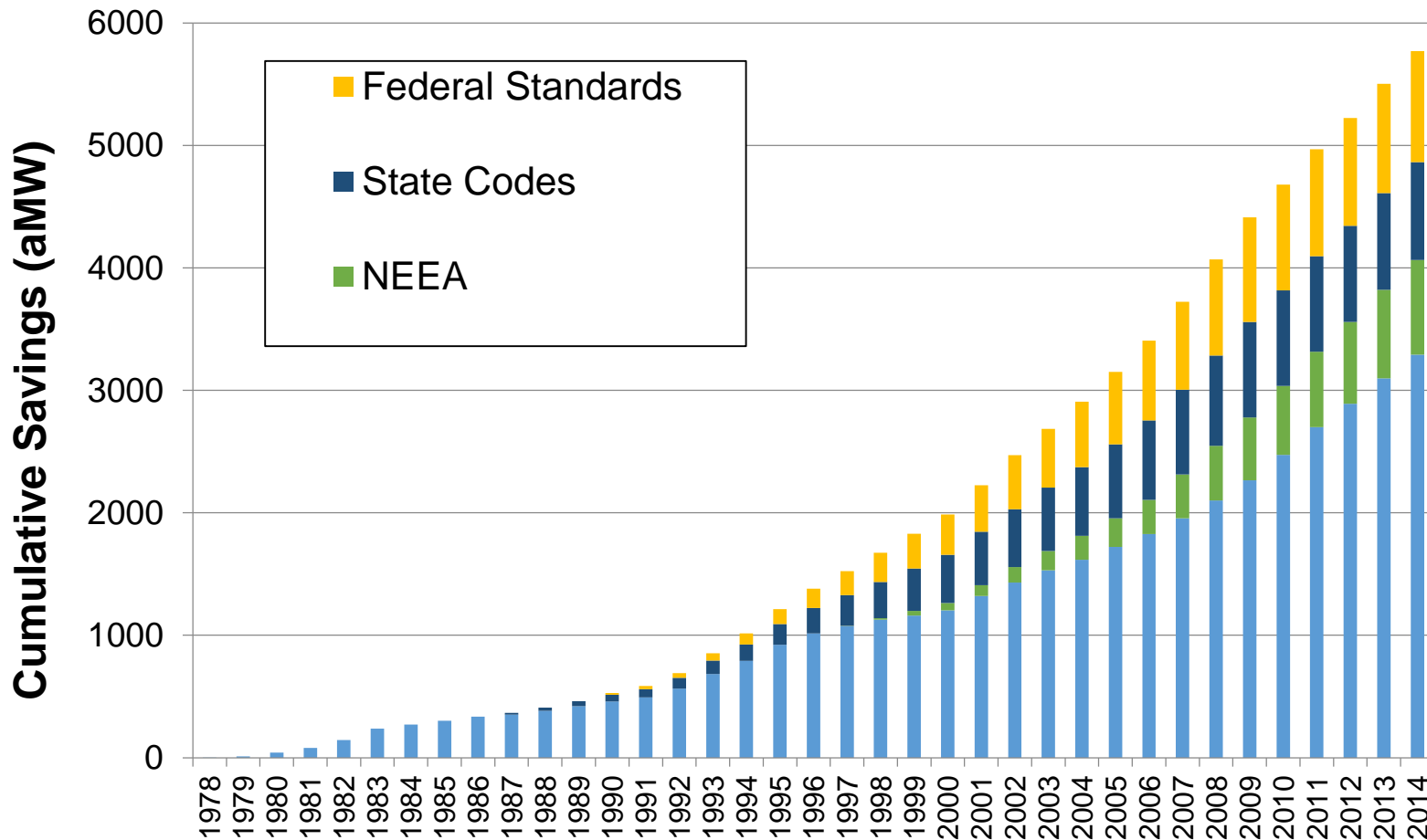
# Summary

- Not Done Yet on EE
- Steady As She Goes
- Be Smart About It
  - A dynamic & evolving ecosystem
  - Strategic, focused, flexible, opportunistic
  - Monitor uptake outside of programs
  - Leverage the easy stuff
  - Build strategies for the difficult



# Wrap Up & Stoke

# Since 1978 Utility Funded Programs and Codes and Standards have Produced Nearly 5800 aMW of Savings

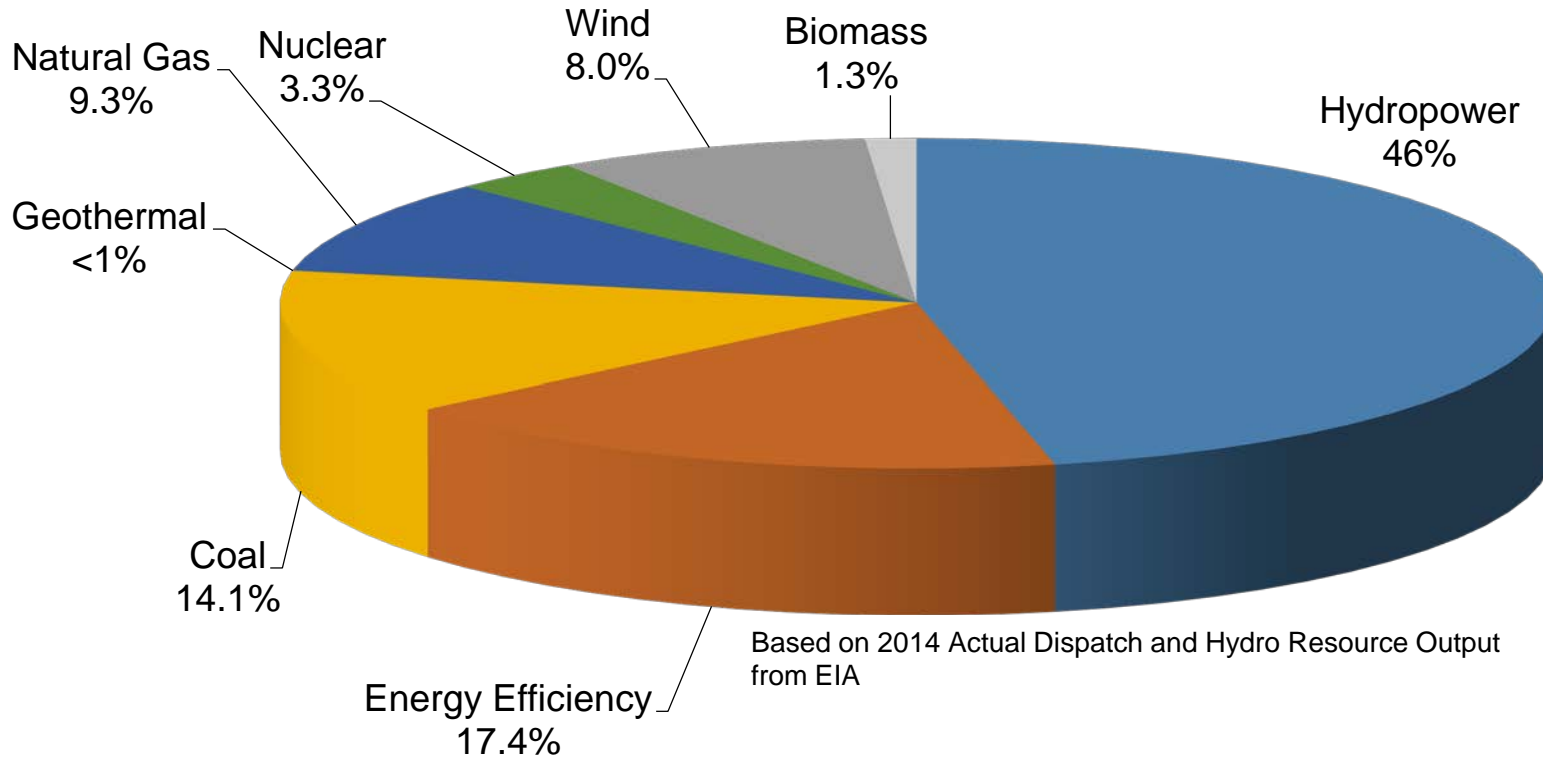


# What's the Value of 5800 aMW?

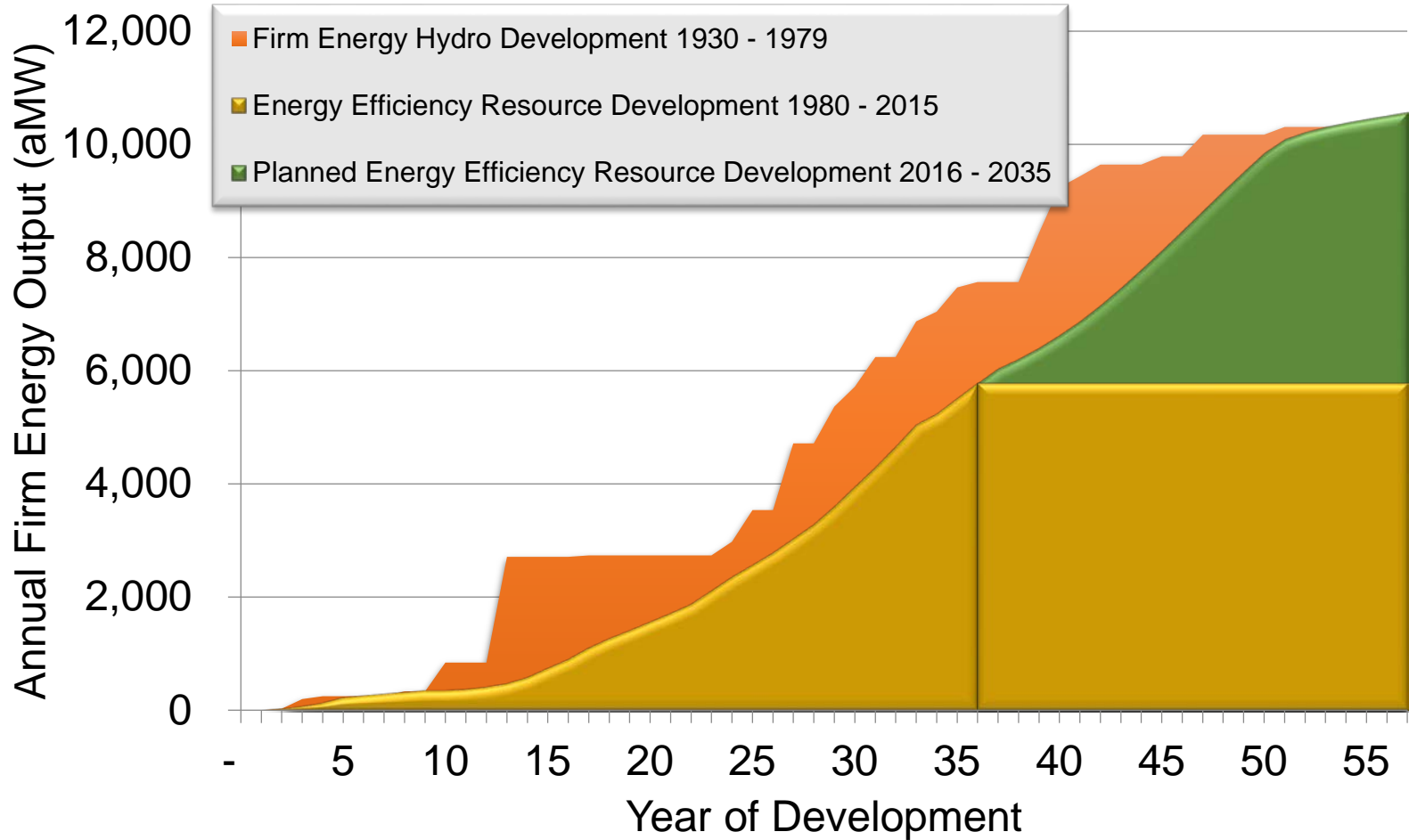
- It represents enough energy savings to save the region's electricity consumers nearly \$3.7 billion in 2014
- It lowered carbon emissions in the Pacific Northwest by an estimated 22.2 million MTE



# Energy Efficiency Was The Region's Second Largest Resource in 2014



# 50 Years to Develop the PNW Hydro-System Energy Efficiency Can Extend That Legacy



**I don't always write power plans.  
But when I do, I prefer *EFFICIENCY***



**Stay *EFFICIENT*, my friends!**

# Contact

For more information, contact:

Charles Grist

Conservation Resources Manager

Northwest Power & Conservation Council

[cgrist@nwcouncil.org](mailto:cgrist@nwcouncil.org)

503-222-5161

End