Integrating DSM into Integrated Resource Plans

Susan E. Stratton, Executive Director, NEEA

Presented to: Indiana Utility Regulatory Commission

September 1, 2015

(with major credit to the NWPCC for its published materials on IRP)

Northwest Energy Efficiency Alliance

neea

Avista
Bonneville Power Administration
Cascade Natural Gas Corporation — A Subsidiary of MDU Resources Group, Inc.
P.U.D. Chelan County
Clark Public Utilities
Cowlitz PUD
Energy Trust of Oregon
Grant PUD
Idaho Power — An IDACORP Company
NorthWestern Energy
NW Natural
Pacific Power
PGE
Puget Sound Energy
Seattle City Light
Snohomish County PUD — Public Utility District No. 1
Tacoma Power — Tacoma Public Utilities

About NEEA

NEEA Funders

- $37 Million/year (Electric and natural gas)
- Bonneville Power Administration, on behalf of more than 140 utilities
- Energy Trust of Oregon
- Public and investor-owned utilities

Regional EE Investment

- $375 million of utility funding
- 10% directed to NEEA for MT programs including codes and standards.
- MT results in 20% of total regional savings

EE Goal setting

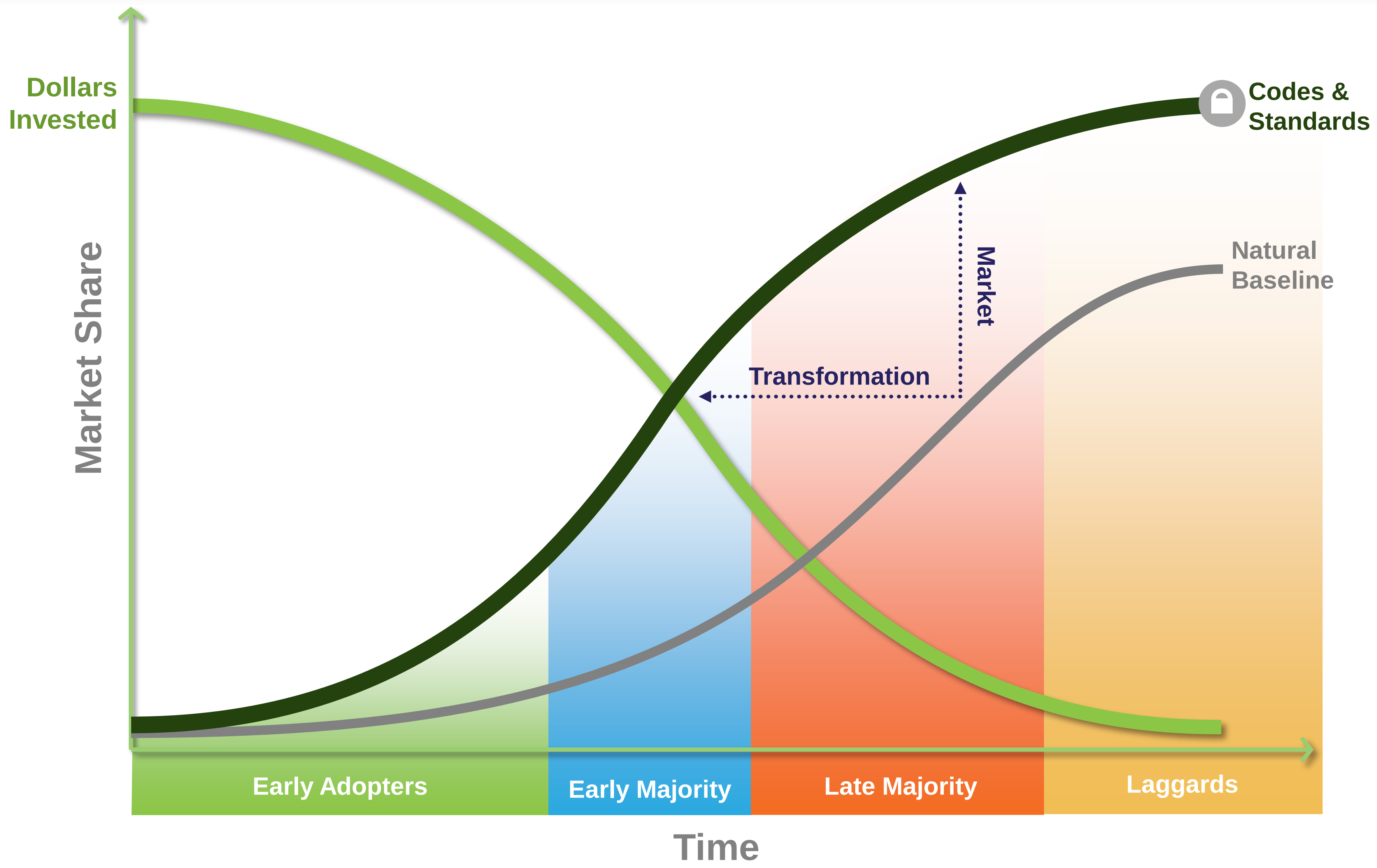
- NWPCC determines baseline and conducts regional IRP every 5 years
- Current plan: 85% of growth met with EE
- Targets exceeded every year since 2005
- Utilities may adjust targets depending on regulatory requirements

What is Market Transformation?

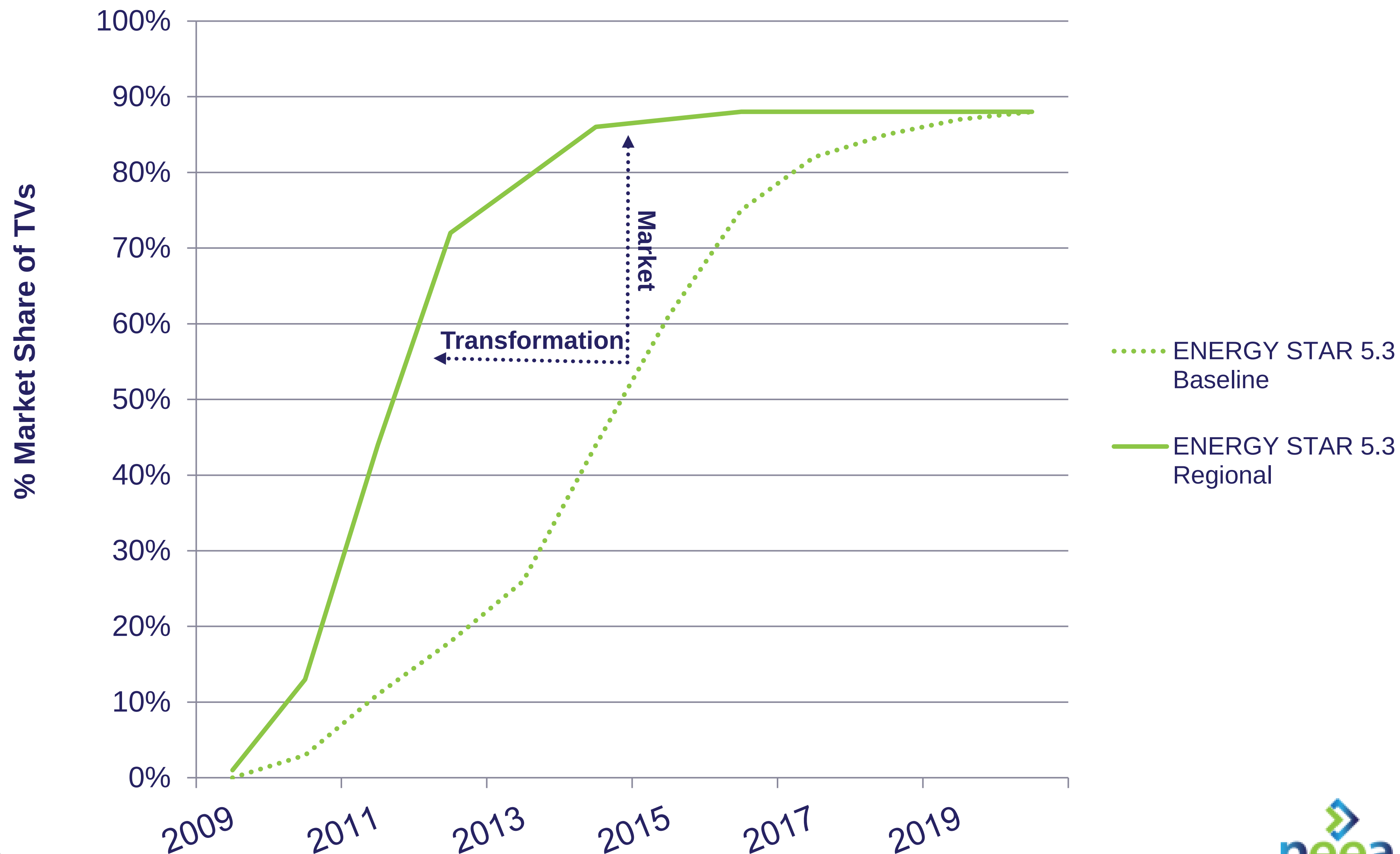
NEEA’s Definition:

“The strategic process of intervening in a market to create lasting change.”

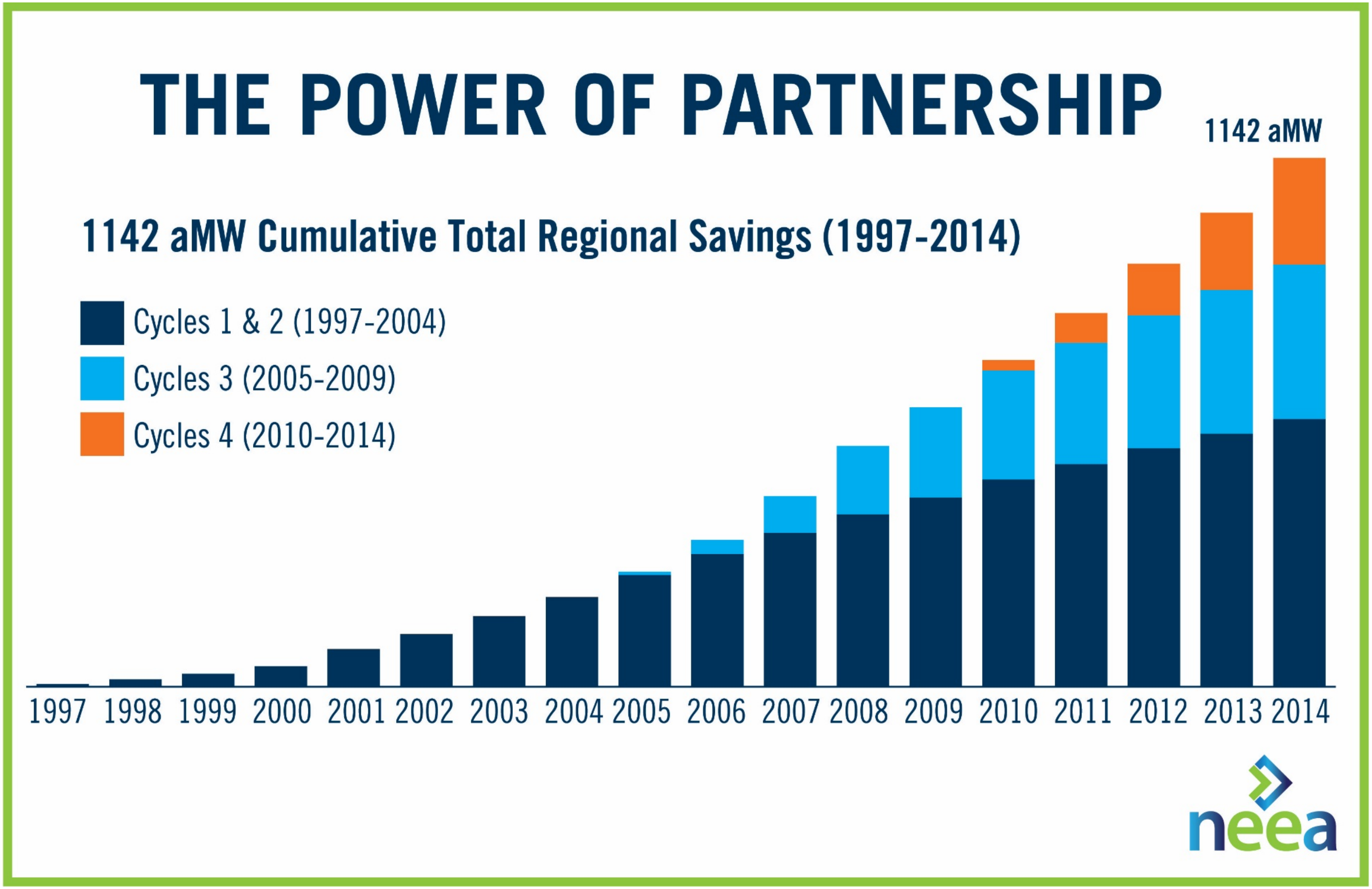
Market Adoption Curve



TVs Market Transformation



NEEA Cumulative Savings



Legislative Support for IRP

a utility…**shall submit to the commission an integrated resource plan that assesses a variety of demand side management and supply side resources to meet future customer electricity service needs in a cost effective and reliable manner.**

neea

What is IRP?

"integrated resource planning“ means a utility's assessment of a variety of **demand-side** and **supply-side** resources to cost-effectively meet customer electricity service needs. The IRP may also include:

(1) A public participation procedure.

(2) An analysis of the uncertainty and risk posed by different resources and external factors.

Why is EE often overlooked in IRP

Barriers:

1. It’s just rounding error
2. You can’t dispatch it
3. Can’t depend on it
4. Don’t have data on baseline use
5. Don’t have data on load shape of measure
6. Desire to sell more electricity
7. It’s complex
8. It’s easier to take a little off the forecast

neea

NWPCC (Council)

Integrating energy and the environment in the Columbia River Basin

- Longest running IRP Process in US
- Published six regional plans since 1983
- All Plans have called for significant reliance on energy efficiency
- No regulatory authority over utilities or state PUCs

Council's plans serve as a reference against which utility specific IRPs are reviewed

Columbia River Basin

Another View of the Columbia River

NW accomplishments through IRP

Since 1980, over half of the NW region's growth in demand for electricity has been met with energy efficiency. (~100% since 2010)

► Over 5,600 average megawatts saved—enough to power the state of Oregon and western Montana

► Ratepayers spend about $3.5 billion less per year for electricity

► Lower annual carbon dioxide emissions—20.8 million tons less in 2012

► The region has exceeded annual efficiency targets every year since 2005

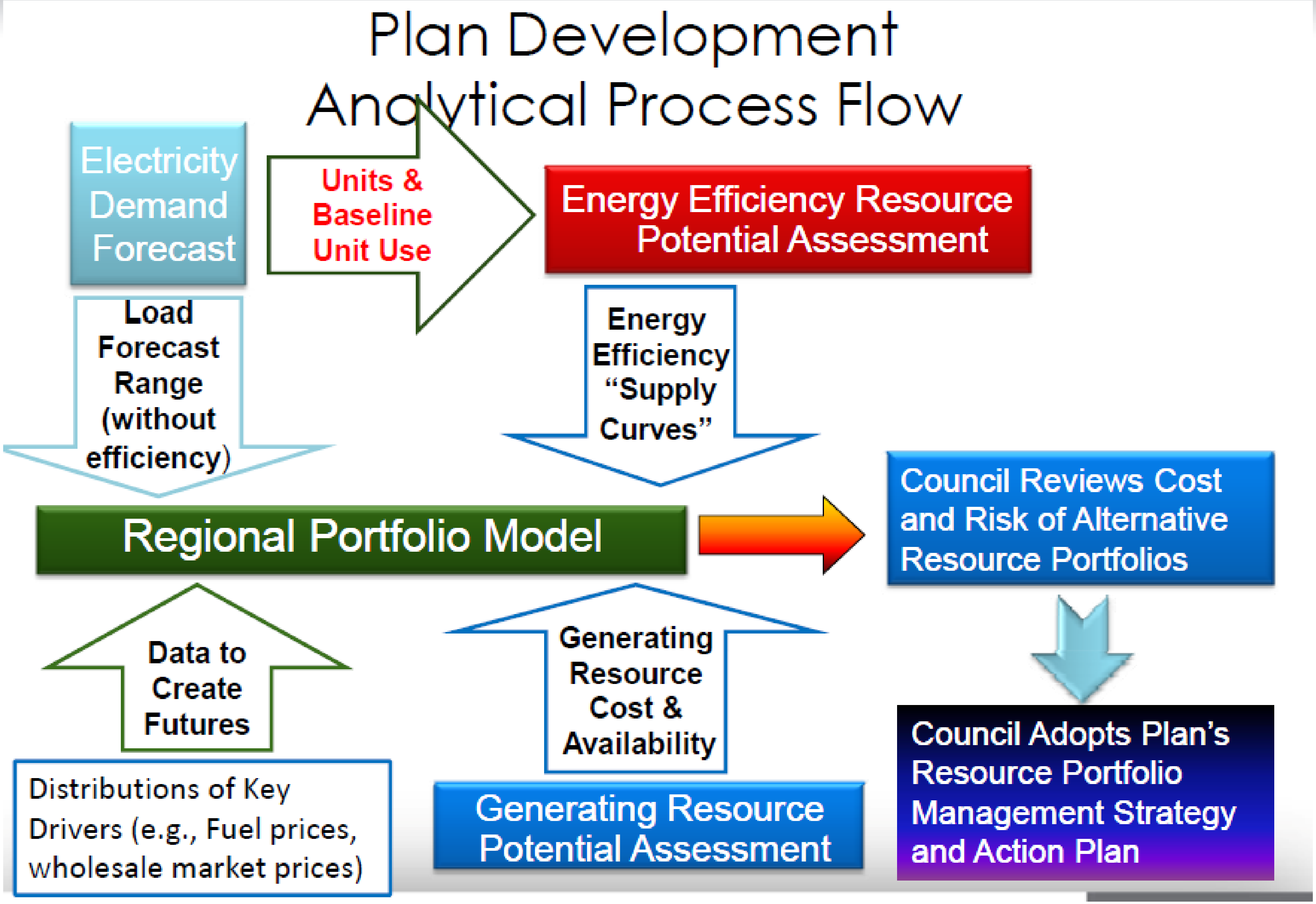
IRP elements

- A *demand forecast* of at least twenty years
- A forecast of *power* (energy and capacity) resources required to meet forecast demand by resource type
- An *energy conservation "program,"* including *model conservation standards*;
- Regional *reliability and reserve requirements*,
- A *methodology* for determining quantifiable environmental costs and benefits

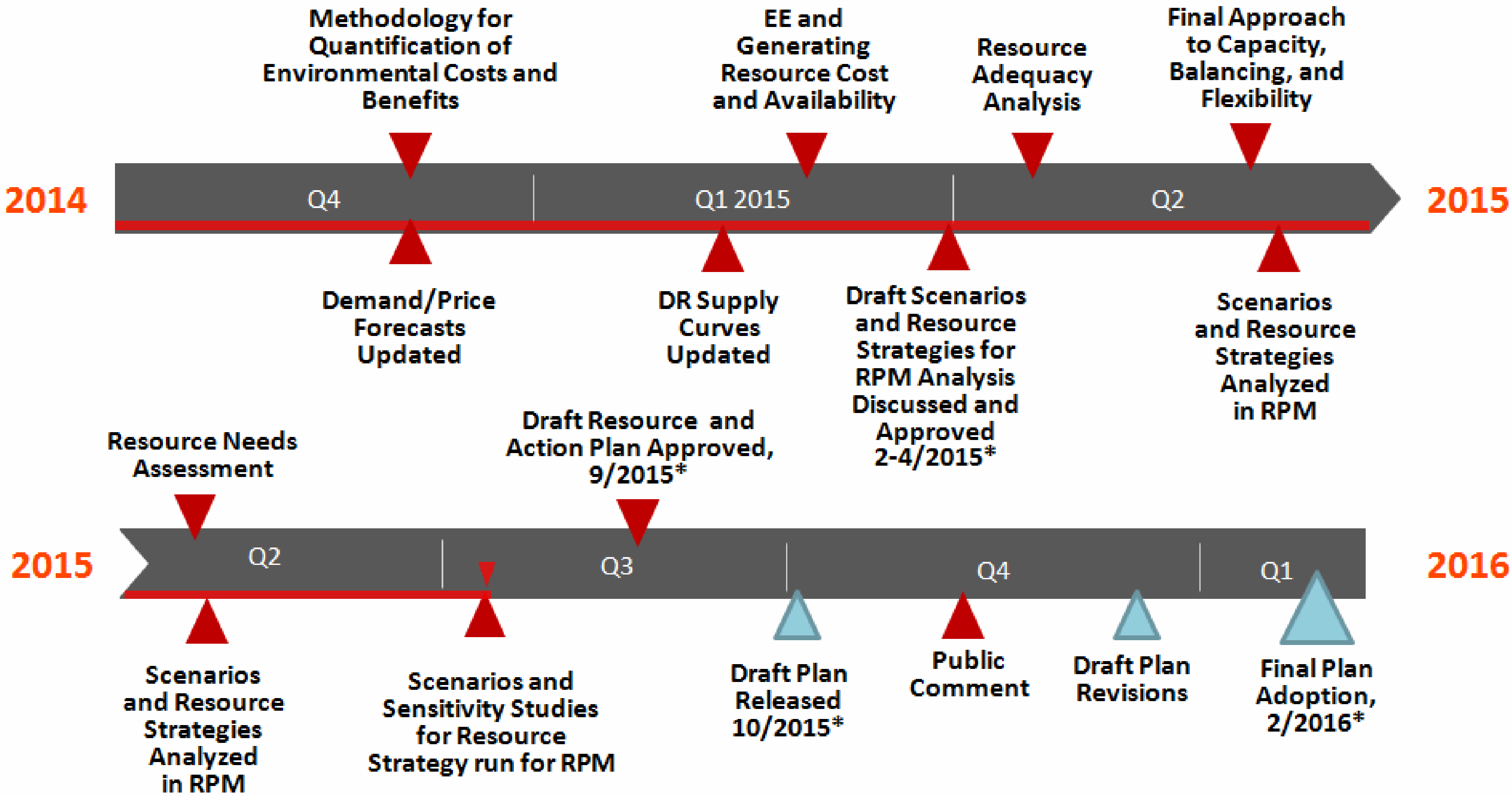
Example of analytical tools used in NW

Energy 2020	Energy 2020 is an open source model developed by Systematic Solutions, Inc. This model has been customized for and by the Council. Used to forecast the hourly demand for electricity, potential applications for efficiency resources, ensure consistency between the demand forecasts and efficiency assessment.
Fuel Price Forecasting Model	Council developed model. Used to convert assumptions about fuel commodity prices to regional wholesale prices at various locations, and to convert to estimate retail fuel prices for input to demand forecasts and resource costs estimates
AURORA$^{xmp®}$ Electricity Market Model	Proprietary model from EPIS, Inc. Production cost model used to forecast hourly wholesale electricity market prices at various pricing points in the western U.S. (WECC area). Can also be used to forecast hourly and total system NOx, SOx, and CO_2 emissions.
GENESYS **(GENeration Evaluation SYStem)**	Council developed model that performs hourly chronological simulation of the Northwest's resources using many different assumptions for uncertain variables, including 1) river flows (which affect the amount of water for hydroelectric generation), 2) temperature (which affects demand for electricity), 3) forced outage conditions for generating resources and 4) wind generation.
Regional Portfolio Model (RPM)	Council developed model used to identify low-cost and low-risk resource strategies given uncertain future conditions and policies. It determines cost-effectiveness of alternative generating and efficiency resources. Time resolution is quarterly, with capacity assessments done for peak hour within period.

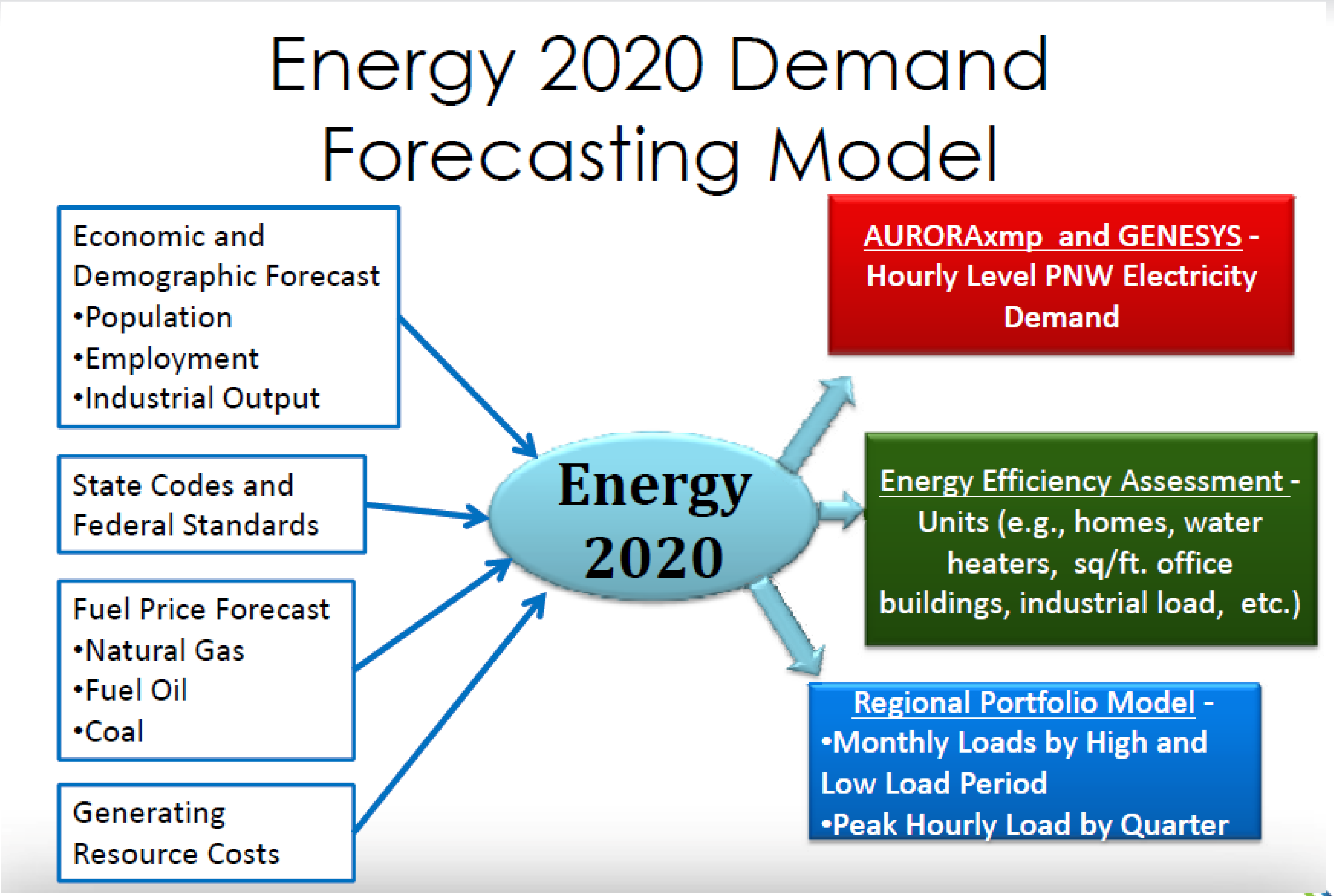
IRP-High Level View



Major Seventh Plan Development Milestones



Forecasting Demand



Guidelines for Incorporating EE

Consistency of load forecast and energy efficiency assessment

- Baseline use/efficiency assumptions are equivalent

Efficiency improvements are treated as resource options that compete against generating resources in supply expansion model

- Load forecast assumes “frozen efficiency” (i.e., no price responsive improvements occur)
- Load forecast is not decremented with assumed EE

Achievable potential is based on all savings from all mechanisms (i.e. gross savings)

Achievable potential assumes EE is a resource and can be acquired “at cost”

neea

Incorporating EE: Potential

1 - Estimate *Technical Potential* on a per application basis (i.e. savings/unit)
2 – Estimate *Economic Potential* on a per application basis (i.e., levelized cost/unit)
3 - Estimate number of applicable units (account for physical limits, retirements, new construction, etc.)
4 – Estimate *Technical Potential* for *all* applicable units
5 – Estimate *Achievable* Potential for *all* realistically achievable units

Achievable EE Potential?

Achievable Potential **=**

Number Units * Savings per Unit * Achievable Market Penetration

Examples:
- Number Homes
- Floor Area of Office Buildings
- Number of TVs
- Acres Irrigated
- Pounds of Paper

Use per Unit at Current Efficiency – Use per at Improved Efficiency) = Savings (kWh/yr)

Current Efficiency is adjusted for adopted codes & standards and stock turnover (Frozen Efficiency)

Fraction of units realistically achievable over time

Incorporating EE: Bottom-up Review

- 400 measures considered for buildings, appliances, and processes for residential, commercial, industrial, and agriculture sectors. Measures for the utility distribution system are included as well.

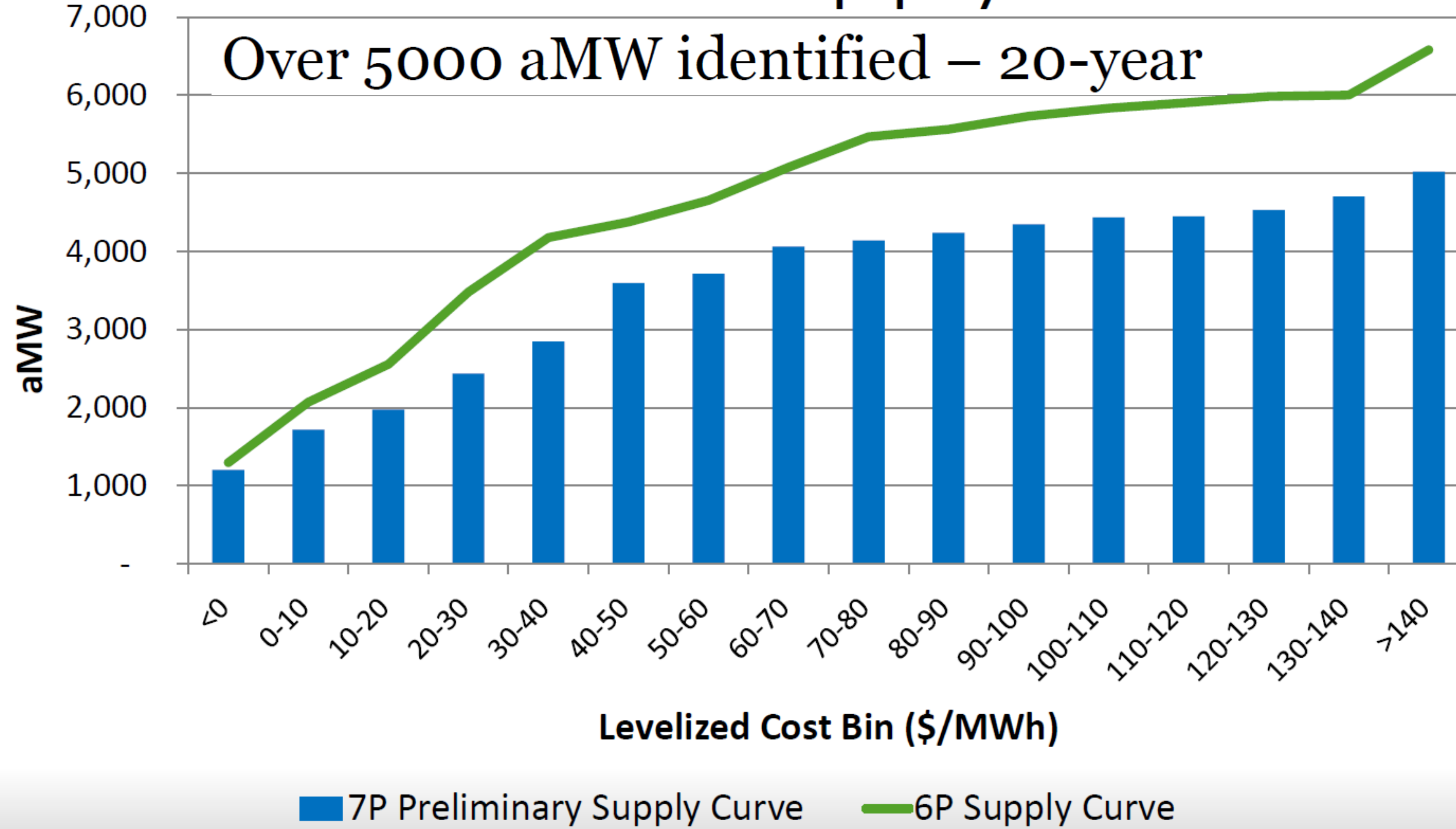
- 1,400 different permutations of savings opportunities were evaluated incorporating:
  - climate zone,
  - heating system and building type and vintage, etc,

Incorporating EE: New technologies

- Solid state lighting
- Variable refrigerant flow HVAC systems
- HP clothes dryer
- Advanced power strips

neea

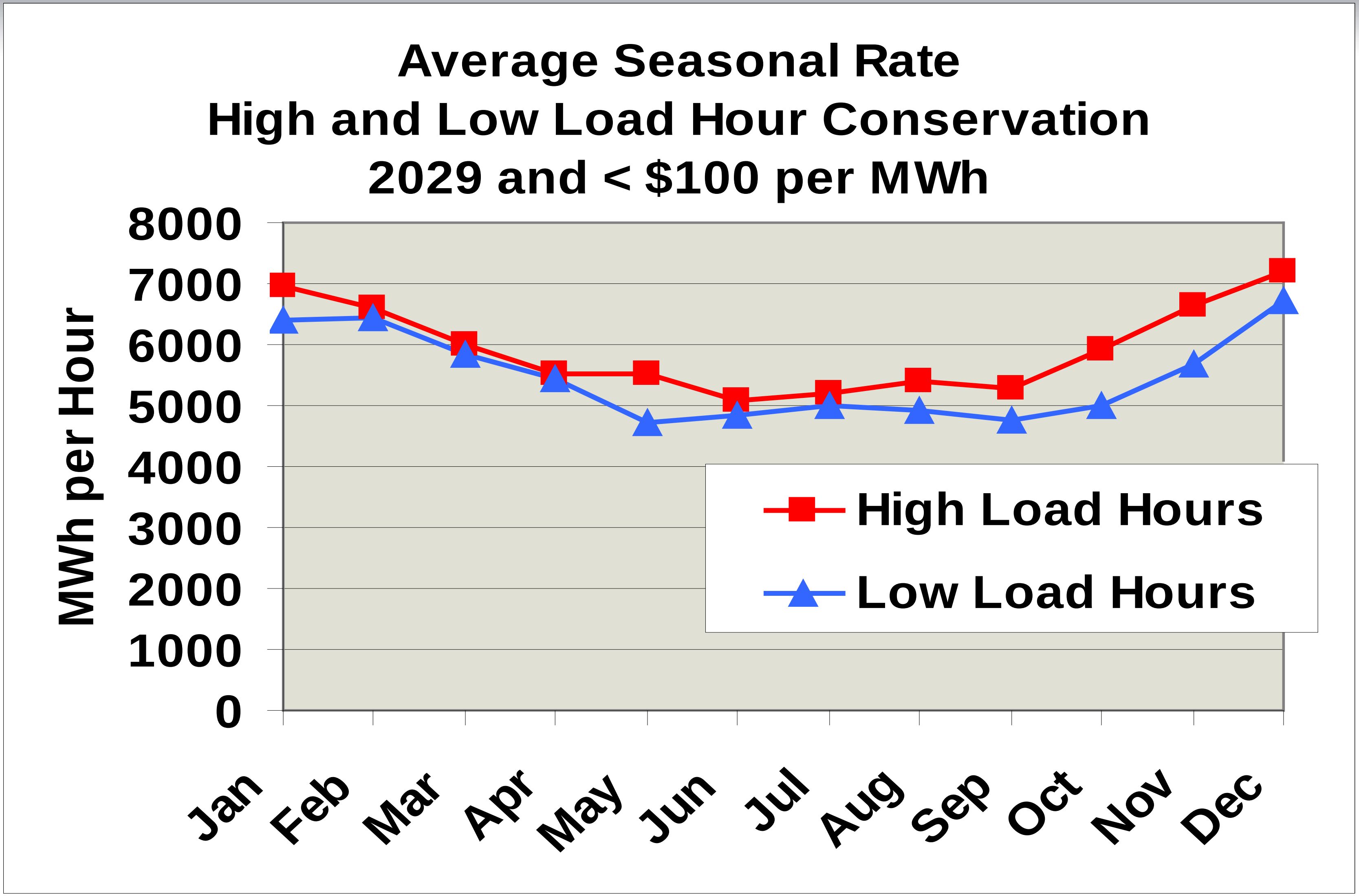
Sixth and Seventh Plan Conservation Supply Curves



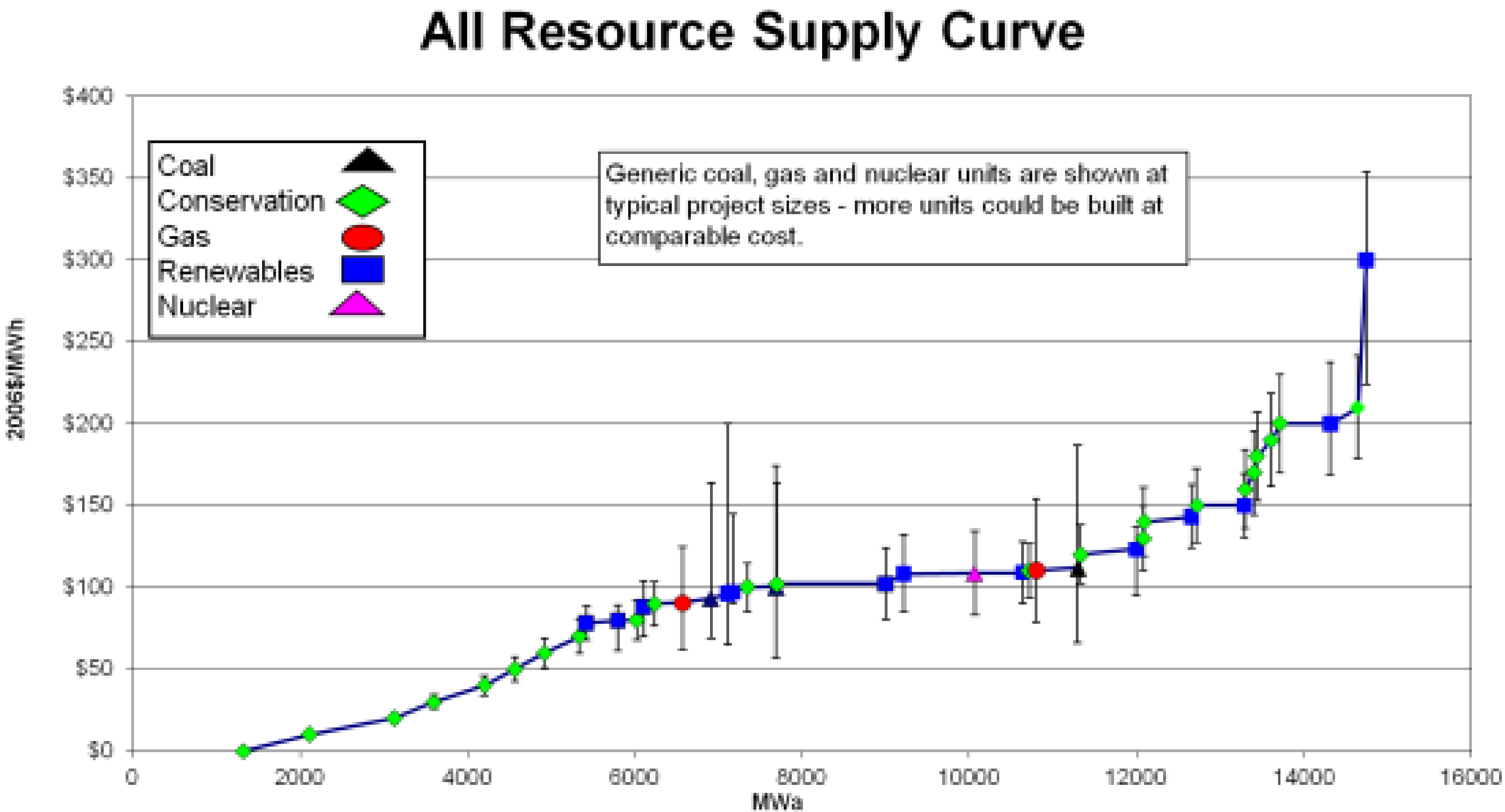
Understanding the Shape of EE

As the region faces increasing needs for peaking capacity and system flexibility, identifying how energy-efficiency programs affect the system is becoming more important. Data on the hourly, daily, and seasonal patterns of electricity use are over 20 years old. Appliance saturations, improved equipment efficiency, and changing behavior may have significantly altered these patterns. Improved end-use research is needed to understand how these profound changes in electricity use are influencing capacity and flexibility requirements.

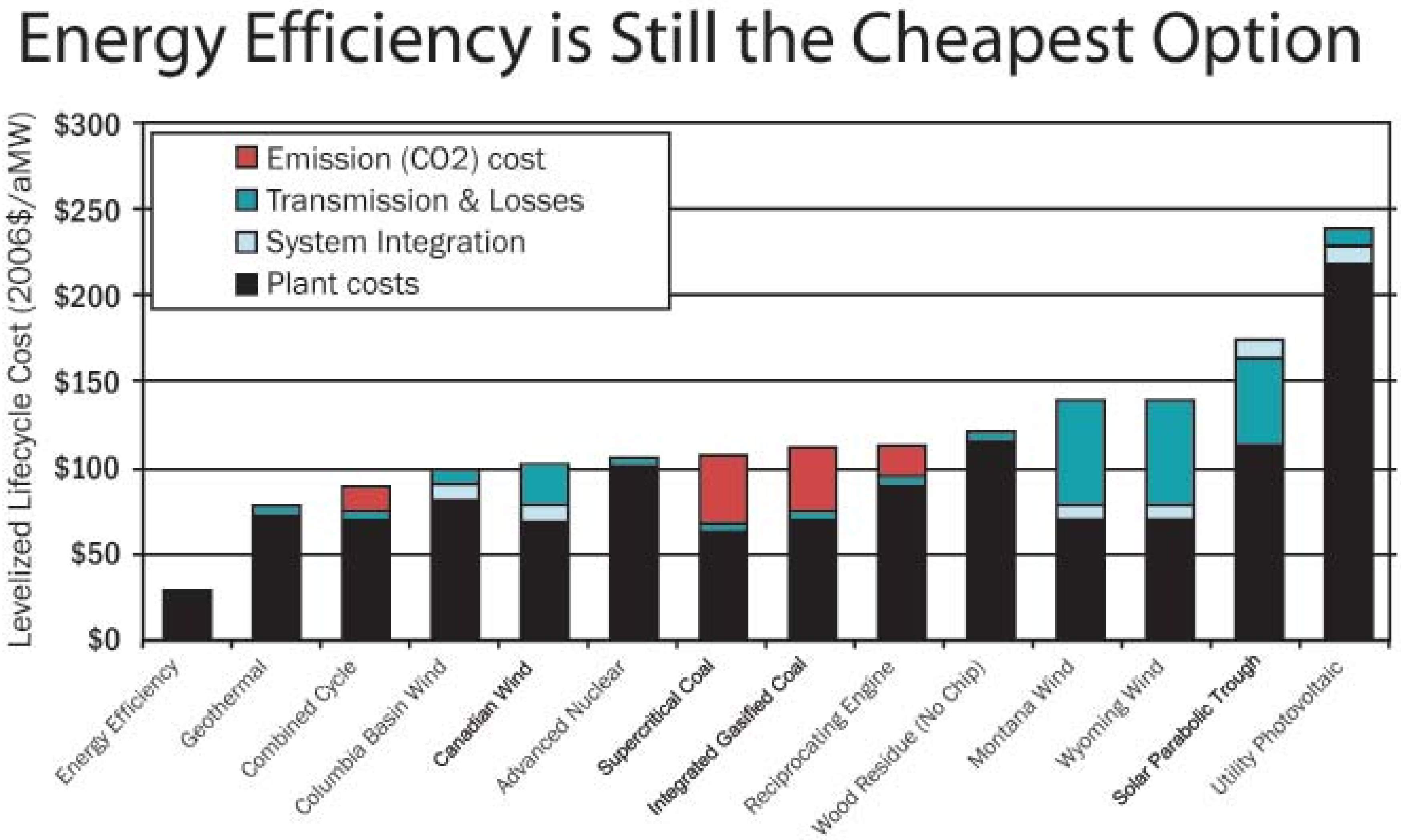
What is the “shape” of conservation



Supply Curves: All Resources



Resource stack



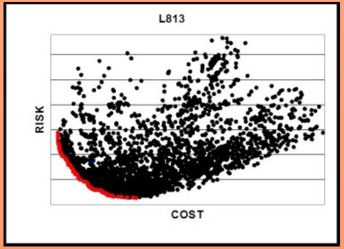
Incorporating EE: integration with Supply

Conservation Inputs

Retrofit
- One Supply Curve
- Max Annual Pace Limit
- No Use No Lose Rule
- Shape of Savings

Lost-Opportunity
- Twenty Supply Curves
- One Each Year
- Use It or Lose It Rule
- Shape of Savings

RPM



Tests alternative development strategies for conservation, generation, and market purchases using range of market price and risk adders

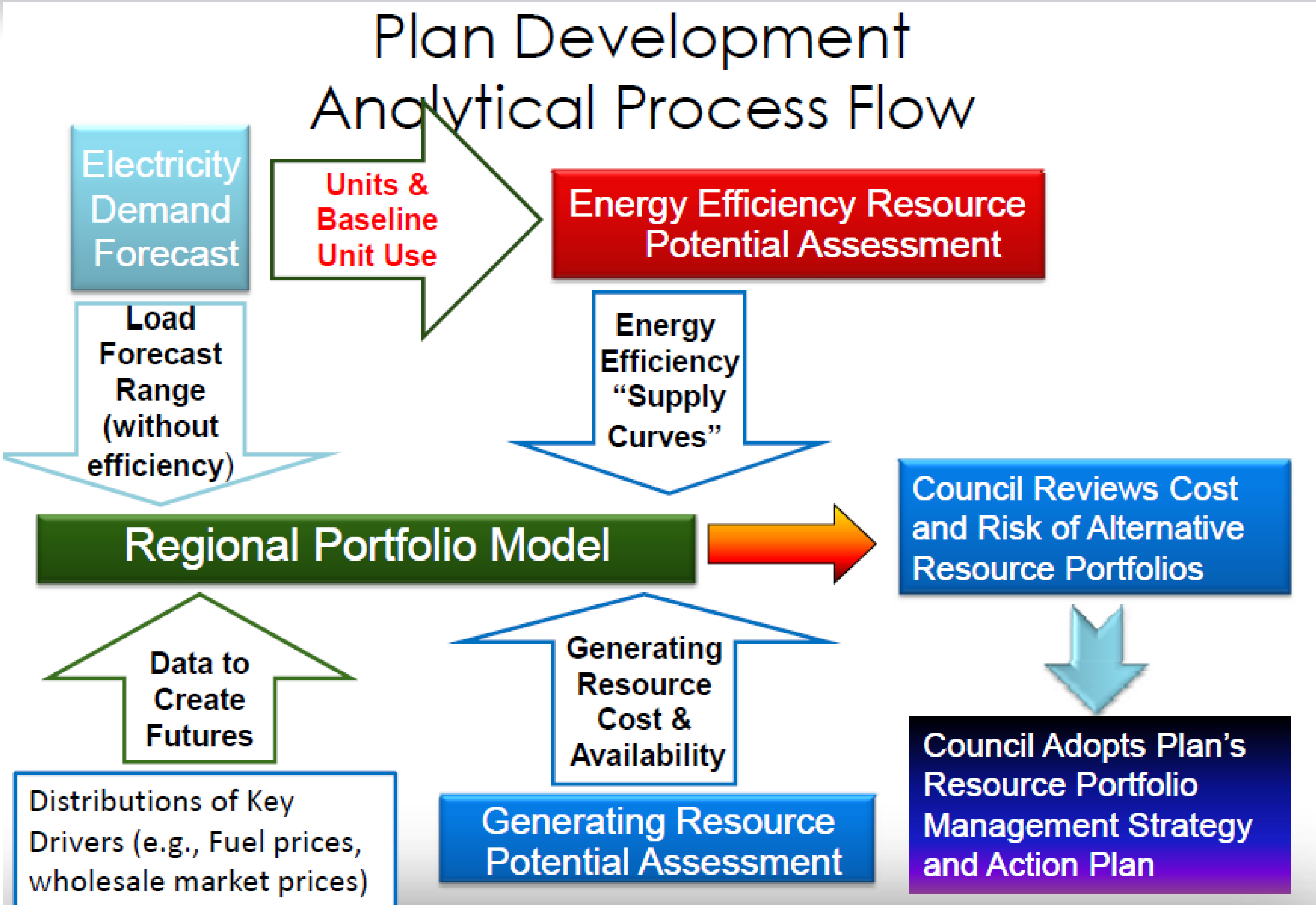
Conservation Strategy

- Retrofit Build Schedule
- LO Build Schedule
- Market Price Adder
- Risk Adder

Adders produces cost-effectiveness metric for program development

Cost-Effectiveness based on Short-Term Market Price plus Adders

IRP-High Level View



Planning for Uncertainty

Plans – 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

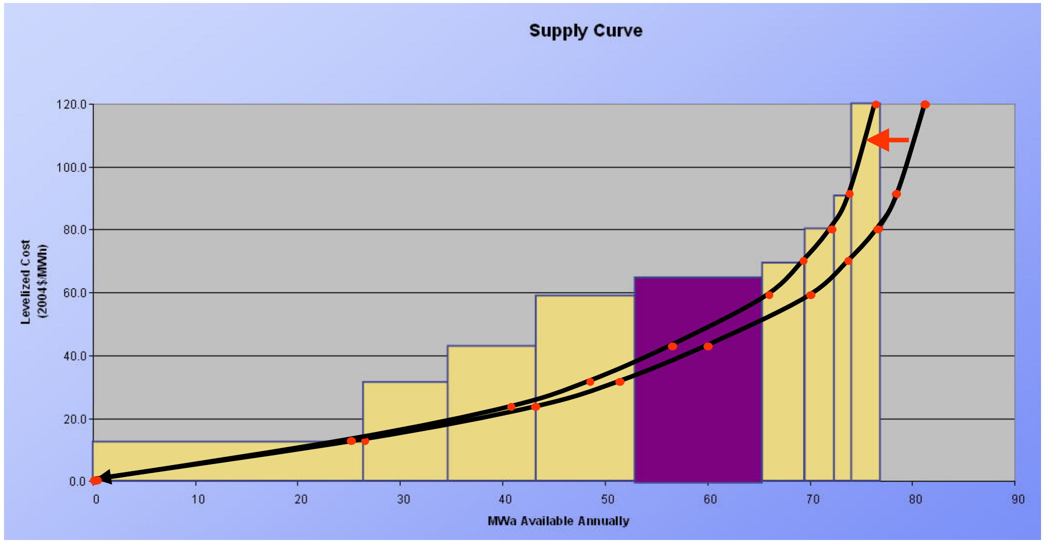
Scenarios – Combinations of Plans and Futures used to "stress test" how well what we control performs in a world we don't control

What if EE costs more than estimates?

- Tested Conservation Uncertainty
  - Assumed Conservation Savings Cost 30% More (or equivalently saved 30% less) than base case

Findings:

•Conservation market adders were unchanged
•Average acquisition of conservation over the 20-year study period was unchanged
•Additional wind generation was optioned



EE outcomes robust under all scenarios

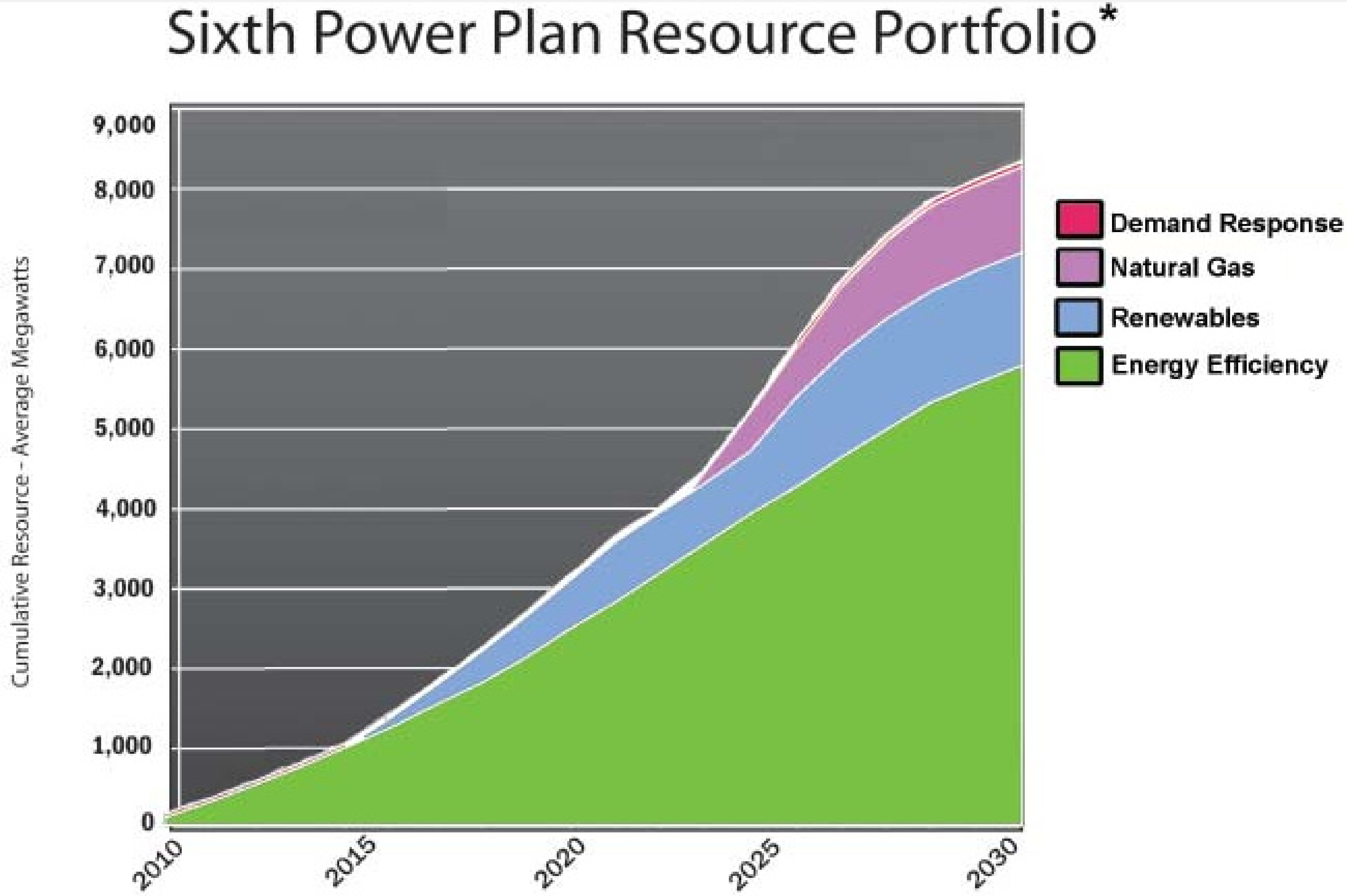
neea

Sensitivity Analysis: Efficiency

Energy Efficiency

- All least cost resource strategies rely heavily on conservation to meet *both* winter capacity and energy needs
- Under 90 percent of the futures energy efficiency meets all load growth through 2030 and under 60 - 70 percent of the futures all load growth through 2035.
- Under all scenarios and sensitivity studies an average of between 1300 and 1430 aMW are developed by 2021
- Why
  - Significant amounts are available below projected future market prices (e.g., 1200 aMW by 2021 and 3500 aMW by 2035 <$30/MWh
  - It produces 2.0 MW/MWh saved during winter
  - It has a shorter lead-time and comes in more "modular" sizes than generation
  - It does not have fuel price risk
  - It does not have carbon price risk
  - Its development is essential to attaining carbon emissions reductions, but the quantity developed under least cost resources strategies does not significantly increase when carbon risk is considered

Example: 6th Plan Selected Portfolio



Preliminary Overall Findings: 7th Plan

- Least Cost Resource Strategies Consistently Rely on Conservation and Demand Response to Meet Future Energy and Capacity Needs
- Demand Response or Increased Reliance on External Markets are Competitive Options for Providing Winter Capacity
- Replacement of announced coal plant retirements can generally be achieved with only modest new development of natural gas generation
- Compliance with EPA CO2 emissions limits *at the regional level*, is attainable through resource strategies that do not depart significantly from those that are not constrained by those regulations.

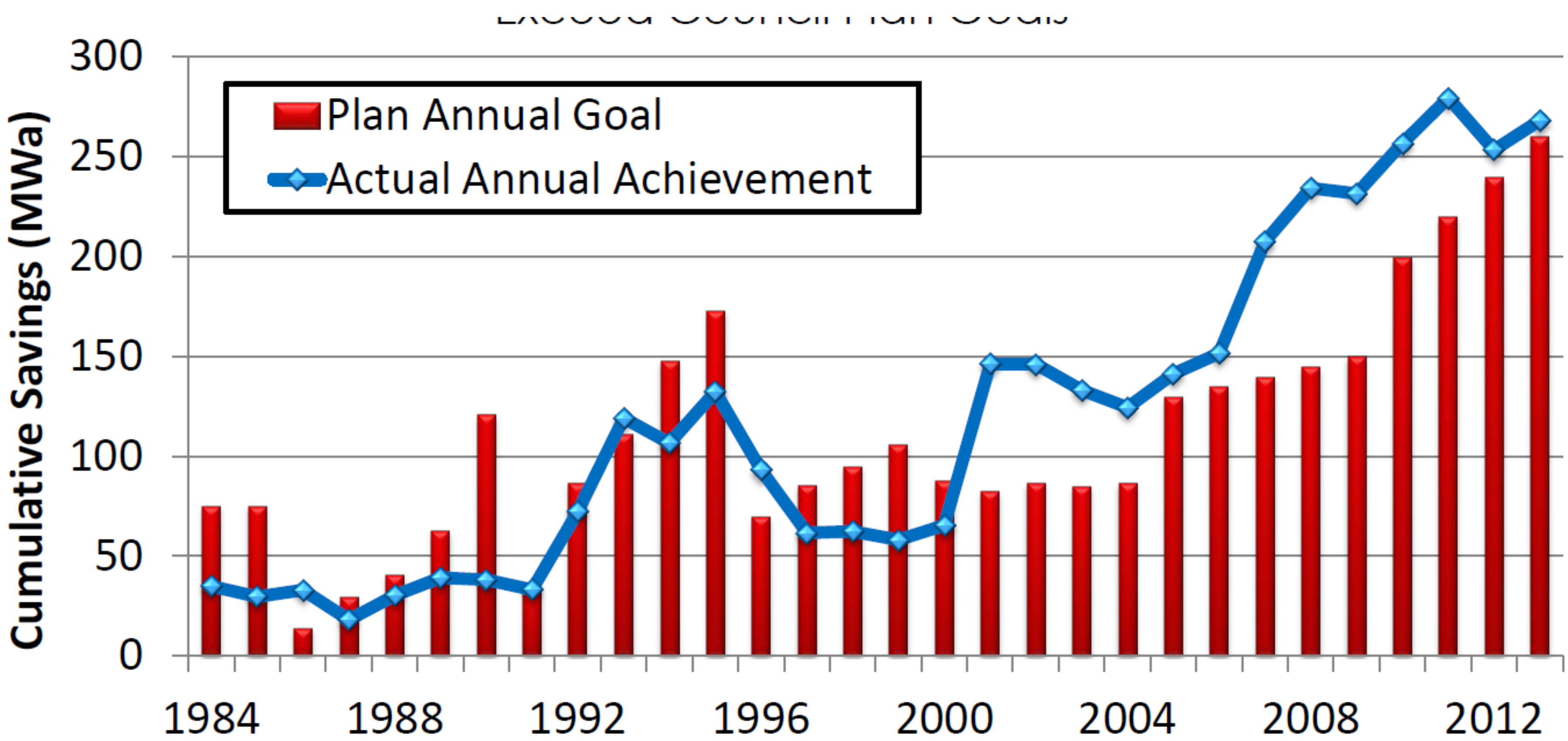
Preliminary EE results for 7th Plan

Energy efficiency plays a critical role in meeting both energy and winter capacity needs.

- Under all scenarios, 1,300-1,430 aMW developed by 2021.
- EE costs less than other resources, even under low electricity and gas prices.
- EE can be "built" relatively quickly, and in the amounts needed, without fuel price and carbon risks

"Efficiency acquisition isn't driven by the need for new energy," said Tom Eckman, power division director, "but because it's less expensive than operating existing resources and the surplus energy can be sold and exported outside the region at a profit."

Efficiency Goals in the PNW since 1984



Sectors Represented in EE Goals

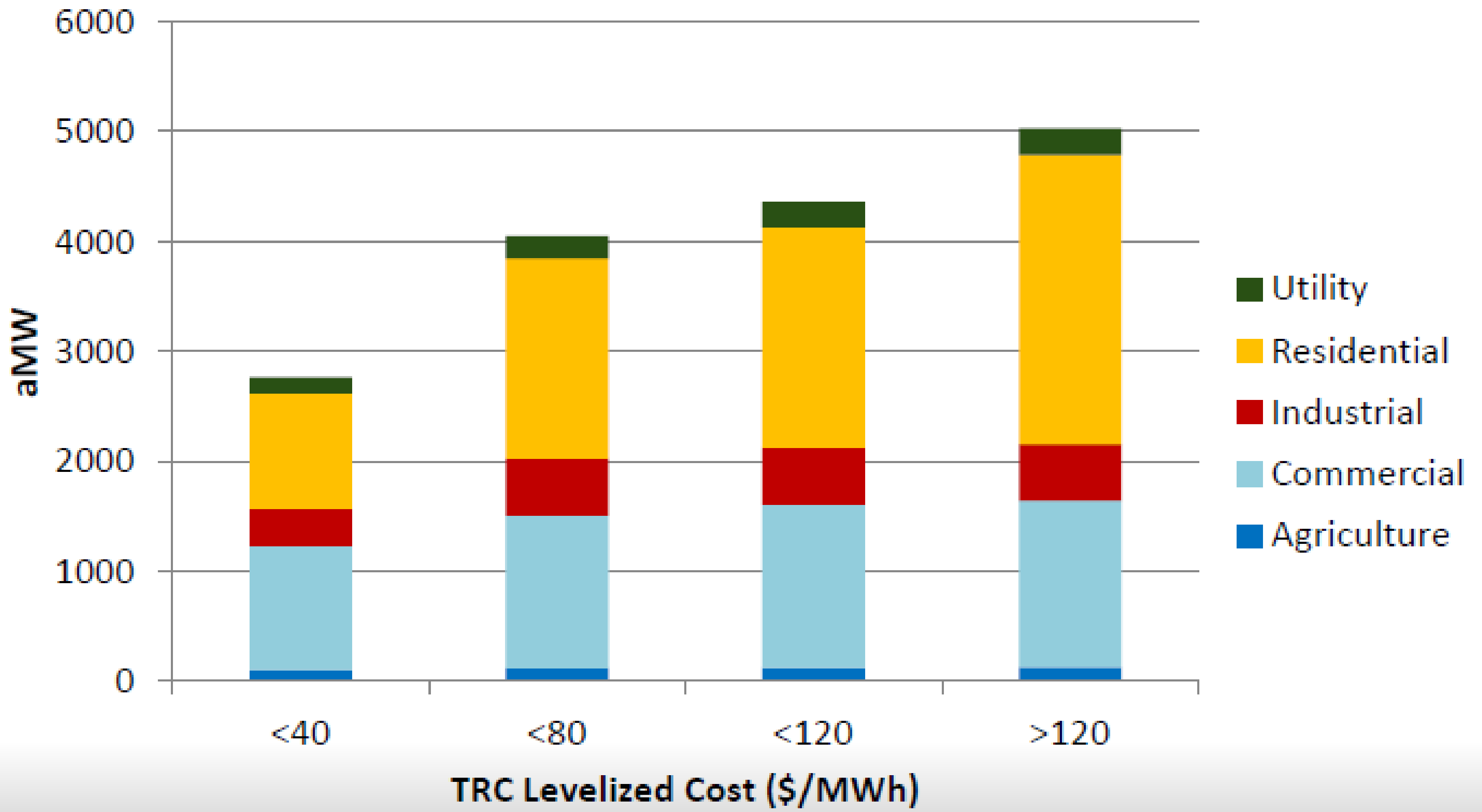
Note that NW potential assessments included all sectors

- Residential
- Commercial
- Industrial
- Agriculture

Even if a sector is not represented in current utility programs, it is well worth the effort to understand the potential value of the EE resource.

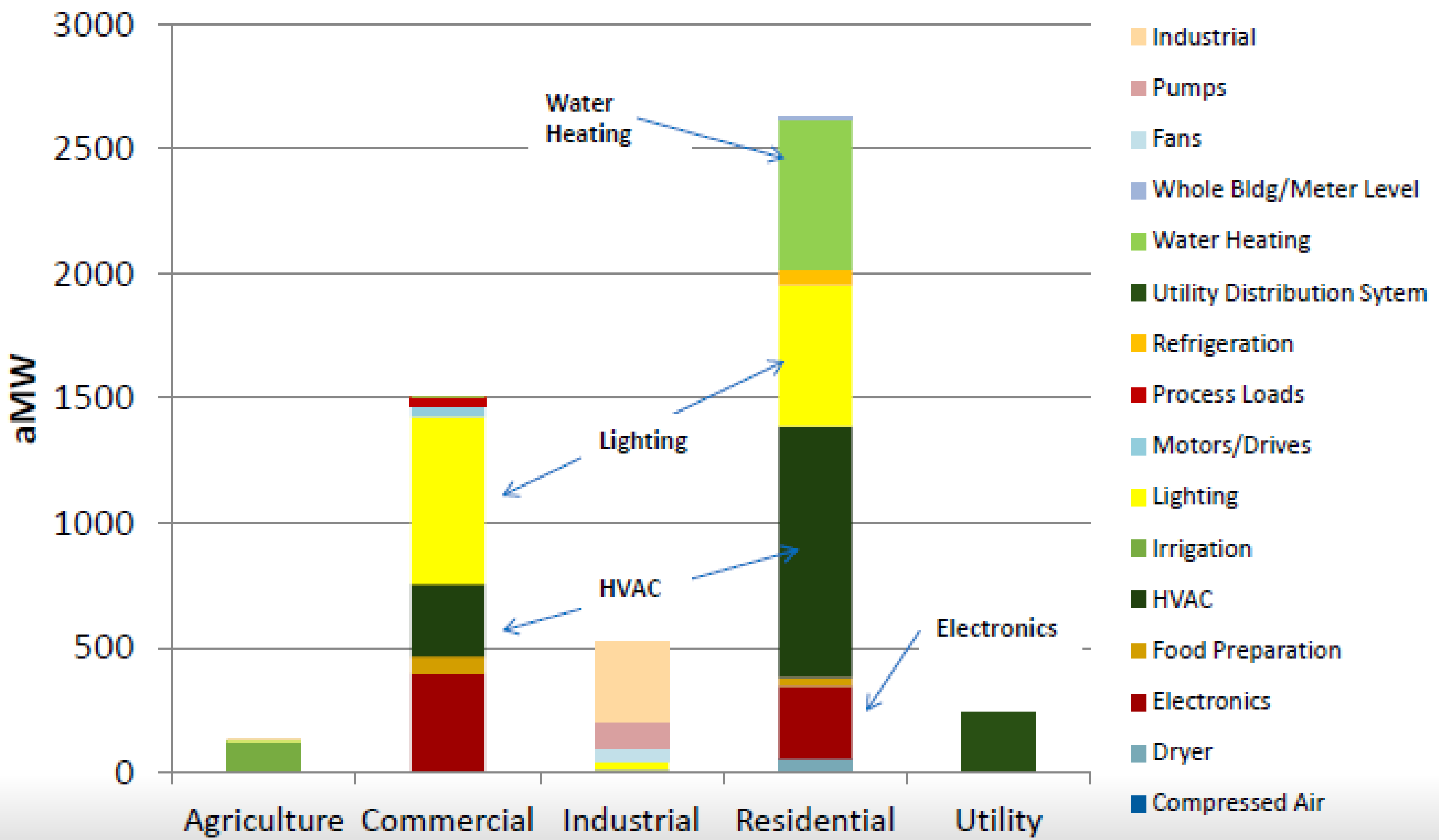
Max Achievable Conservation by Sector at Various Price Bins

(Cumulative)



Max Achievable Potential by Sector and End Use

(All Cost Bins)



NW Industrial EE Example: Food Processors

NWFPA Energy Goal:

- To accelerate the implementation of energy efficiency strategies to reduce member-wide energy intensity (energy use per unit of output) by 25% in 10 years and through innovation, new technologies and new resources to achieve a total reduction of 50% in 20 years.

Strategic Energy Management* in NW

2015: ACEEE awards JR Simplot’s Don Sturtevant (at right) and NEEA represented by Geoff Wickes (2nd from left) as champions of energy efficiency in industry.

**aka “Continuous Energy Improvement”*

Wrap up

IRP is complex, data intensive process
It’s not fast, easy, or cheap
The value of a plan well done is to:

- Uncover value in demand-side resources
- Reduce risk of over-building supply-side resources
- Take advantage of more “modular” investments represented by EE and DR
- Clarify trade-offs between risk and cost
- Understand the consequences of alternative futures.

Questions & Comments

Filling the Energy Efficiency Pipeline	Accelerating Market Adoption	Leveraging Regional Advantage

Thank You!

neea.org

Supplemental Slides on EE included

7th Power Plan EE measures by sector

- Residential
- Commercial
- Industrial
- Agriculture
- Utility System

Residential Measures

Total Achievable Potential Available by Year (aMW)

Residential	2025	2035
HVAC	**439**	**820**
ResWx	242	266
ASHP	34	122
Controls Commissioning & Sizing	14	50
DHP	40	143
DHP Ducted	66	158
Duct Sealing	30	34
GSHP	2	19
HRV	2	16
WIFI enabled tstats	9	12
Lighting	**413**	**565**
Lighting	351	503
Lighting PPA	62	62
Electronics	**229**	**302**
Advanced Power Strips	191	260
Computer	31	34
Monitor	7	8

Residential	2025	2035
Water Heating	**255**	**613**
Showerheads	96	121
HPWH	51	289
Behavior	34	45
Solar Water Heater	32	56
Clothes Washer	23	60
Aerator	17	33
Dishwasher	0	1
WasteWater Heat Recovery	1	8
Refrigeration	**7**	**58**
Refrigerator	6	55
Freezer	0	3
Food Preparation	**15**	**34**
Electric Oven	11	28
Microwave	4	6
Dryer	**13**	**53**
Clothes Dryer	13	53
Whole Bldg/Meter Level	**1**	**7**
EV Supply Equip	1	7
Grand Total	**1,371**	**2,453**

Commercial Measures

Total Achievable Potential Available by Year (aMW)

Commercial	2025	2035
Lighting	**429**	**682**
LPD Package	200	382
Low Power LF Lamps	38	39
Lighting Controls Interior	14	38
Exterior Building Lighting	116	143
Street and Roadway Lighting	47	60
Parking Lighting	9	9
Bi-Level Stairwell Lighting	4	11
Electronics	**263**	**392**
Data Centers	185	261
Smart Plug Power Strips	41	47
Desktop	25	56
Monitor	11	24
Laptop	1	4
HVAC	**166**	**371**
Advanced Rooftop Controller	72	119
Commercial EM	37	77
DCV Parking Garage	11	13
Demand Control Ventilation	15	29
Secondary Glazing Systems	14	40
VRF	15	88
Premium Fume Hood	1	4

Commercial	2025	2035
Refrigeration	**65**	**77**
Grocery Refrigeration Bundle	56	63
Water Cooler Controls	9	13
Food Preparation	**19**	**67**
Cooking Equipment	18	66
Pre-Rinse Spray Valve	1	1
Process Loads	**41**	**49**
Municipal Sewage Treatment	29	35
Municipal Water Supply	12	14
Motors/Drives	**16**	**39**
ECM-VAV	12	34
MotorsRewind	4	5
Compressed Air	**2**	**4**
Compressed Air	2	4
Water Heating	**4**	**5**
Showerheads	4	4
WHTanks	1	2
Grand Total	**1,004**	**1,687**

Industrial Measures

Total Achievable Potential Available by Year (aMW)

Industrial	2025	2035
Pumps	92	108
Fans	45	54
Energy Project Management	80	95
Integrated Plant Energy Management	43	86
Lighting	30	34
Plant Energy Management	40	45
Food Processing	15	17
Food Storage	13	14
Compressed Air	11	12
Material Handling	16	19
Hi-Tech	8	10
Pulp	6	13
Paper	3	6
Wood	6	7
Metals	0	1
Grand Total	**407**	**519**

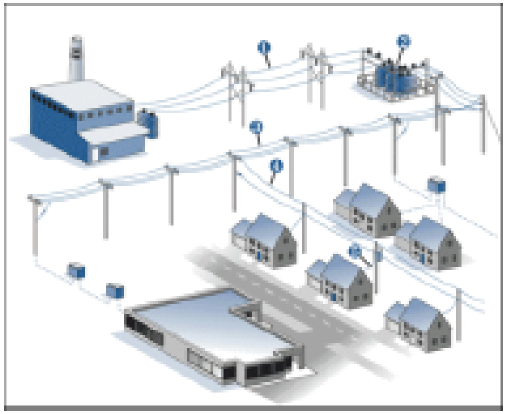
Agriculture Measures

Total Achievable Potential Available by Year (aMW)

Agriculture	2025	2035
Irrigation	**87**	**125**
Irrigation Hardware	47	54
Irrigation Pressure	9	26
Irrigation Water Mgmt	23	23
Irrigation Efficiency	7	22
Lighting	**3**	**4**
Dairy	0	0
Lighting	3	3
Motors/Drives	**3**	**3**
Dairy	0	0
Irrigation Motor	3	3
Refrigeration	**1**	**1**
Dairy	1	1
Grand Total	**93**	**133**

Utility System Measures

Total Achievable Potential Available by Year (aMW)



Utility	2025	2035
Utility Distribution System	**155**	**236**
LDC voltage control method	60	92
Light system improvements	35	53
Major system improvements	38	58
EOL voltage control method	20	30
SCL implement EOL w/ major system improvements	1	2
Grand Total	**155**	**236**