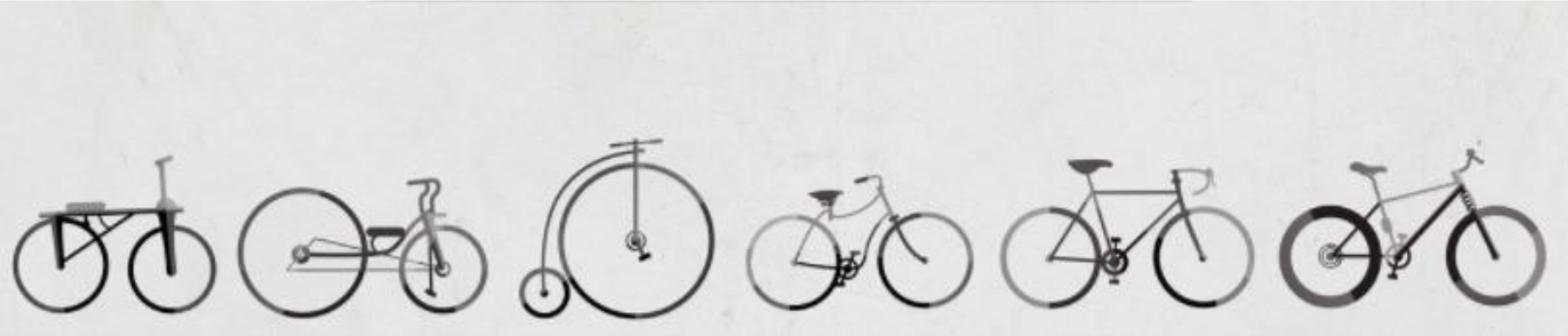
Why Keep Pushing on Efficacy?



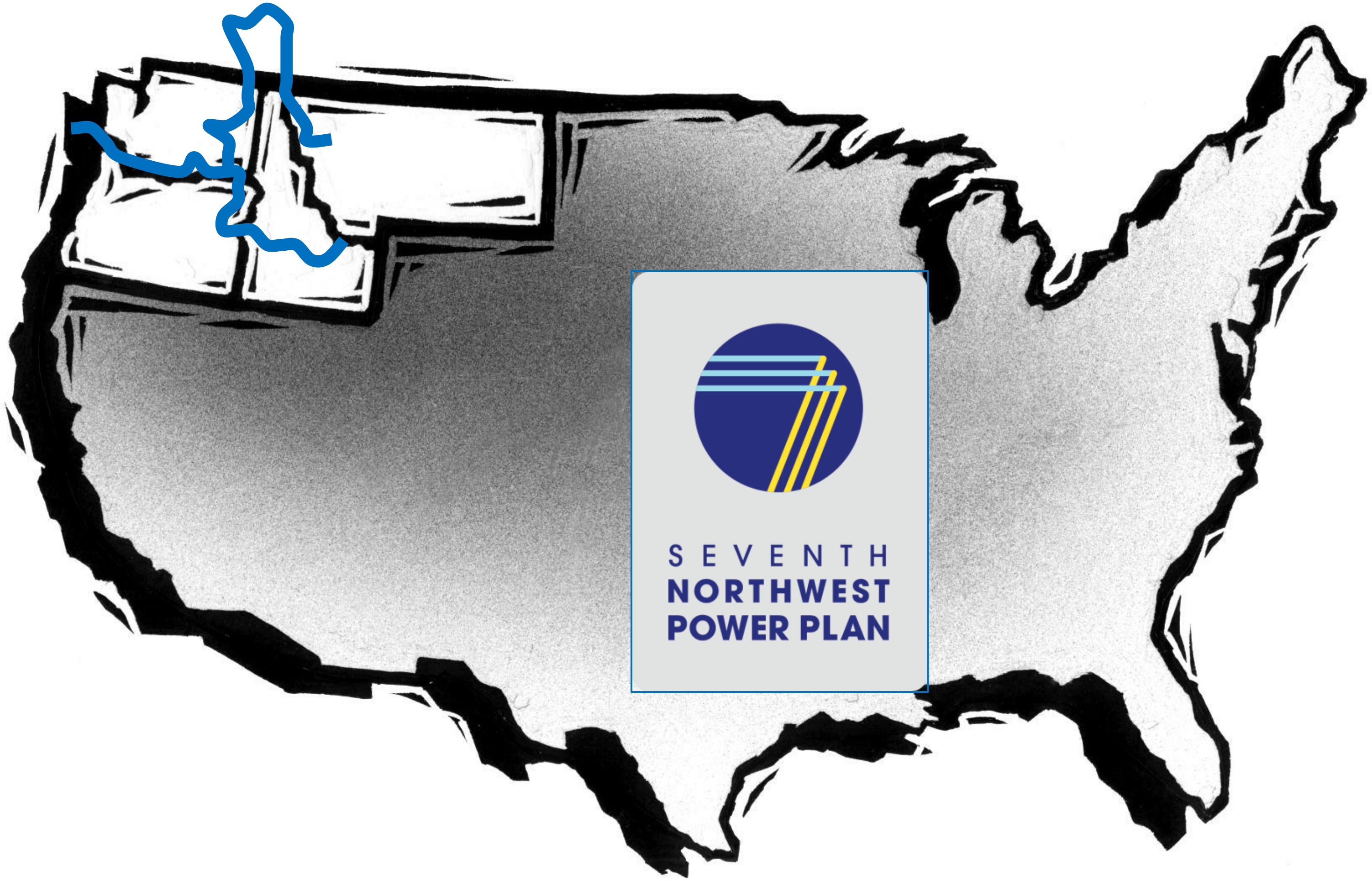
DOE 2017 SOLID-STATE LIGHTING TECHNOLOGY R&D WORKSHOP

November 8, 2017 • Portland, OR

Charlie Grist, Northwest Power & Conservation Council

Pacific Northwest Region

The 1980 Regional Power Act

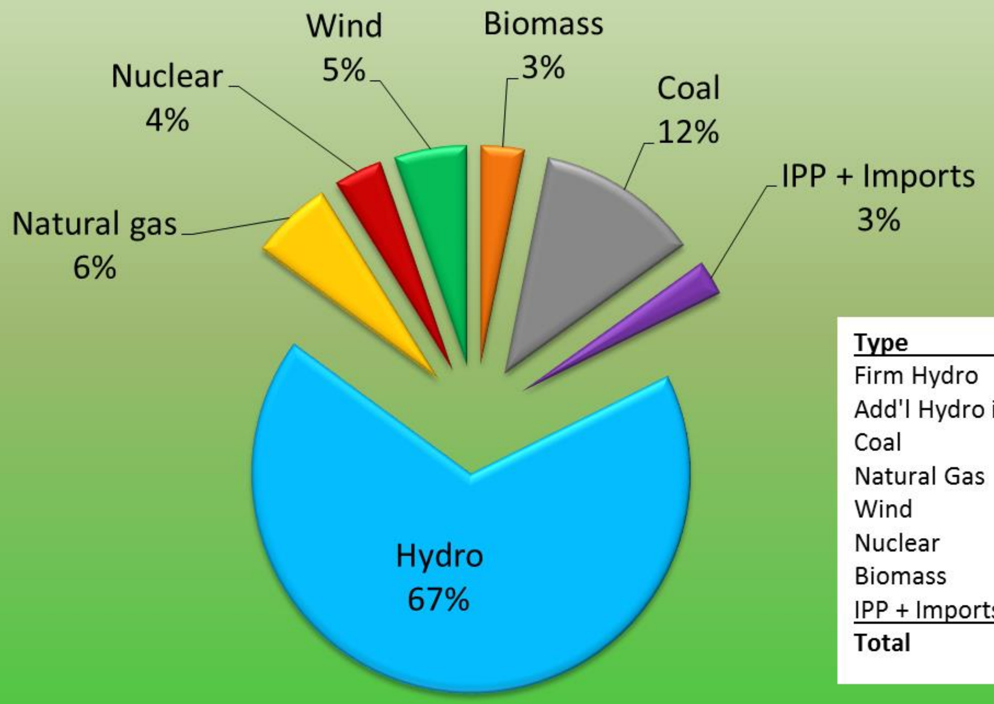


Outline: Efficacy from a Power System Perspective

1. The PNW Power System
2. The Value Propositions for Efficacy & Efficiency
3. Unique Attributes of Lighting as a Power Resource
4. Thoughts on Improving Lighting Efficacy

PNW Power System

Annual *Energy* Dispatch of *Pacific NW* Generation in 2017
(average hydro year conditions)



Type	Average MW
Firm Hydro	11,800
Add'l Hydro in Avg Yr	4,275
Coal	2,835
Natural Gas	1,436
Wind	1,260
Nuclear	849
Biomass	750
IPP + Imports*	614
Total	**23,819**

Source: Council's 2017 Adequacy Assessment.
* IPP = NW independent power producers
Imports = Short-term purchases from the SW

PNW Energy Production

(Average Hydro & Wind)

PNW Loads

- 28,000 MW Summer Peak Hot Year
- 36,000 MW Winter Peak Cold Winter
- 20,000 aMW Energy
- $13 Billion Annual Bill

Emerging Power System Trends & Issues

1. Flat to low load growth
2. Resource retirements – coal mostly
3. Surplus renewables – low market prices for electricity
4. Natural gas price forecasts continue to decline
5. System impacts of solar & wind
6. Capacity needs emerging as dominant driver expansion
7. Carbon constrained future
8. Business model for electric utilities

Utility Perspectives on Efficiency

Power System Resource

- Value of energy & capacity avoided
- Financial & regulatory risk

Customer Service

- Value of customer touch
- Community perception

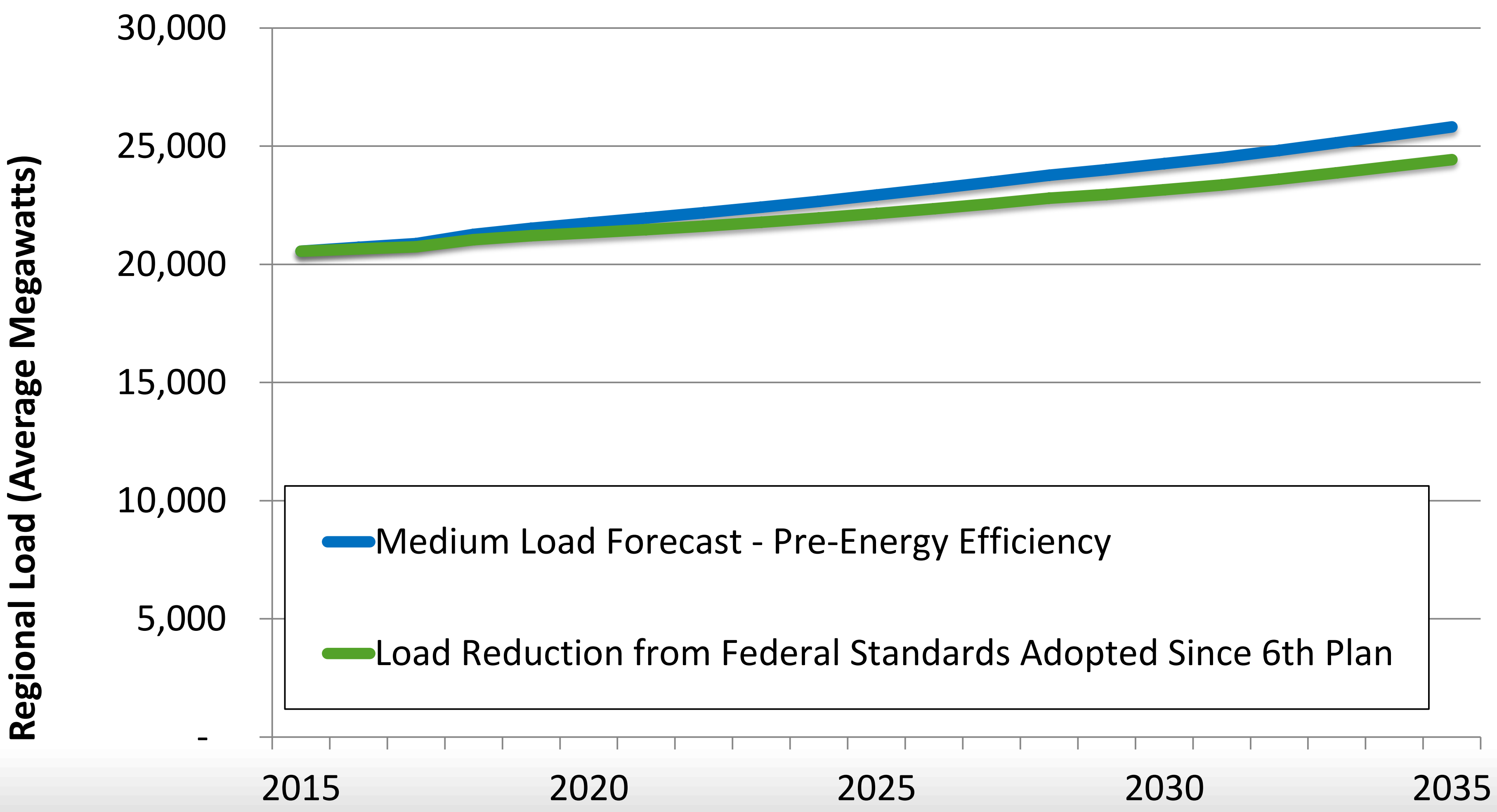
The Resource Planner's Problem

- Don't have too many resources
- Don't have too few resources
- Have "just the right amount" of resources*

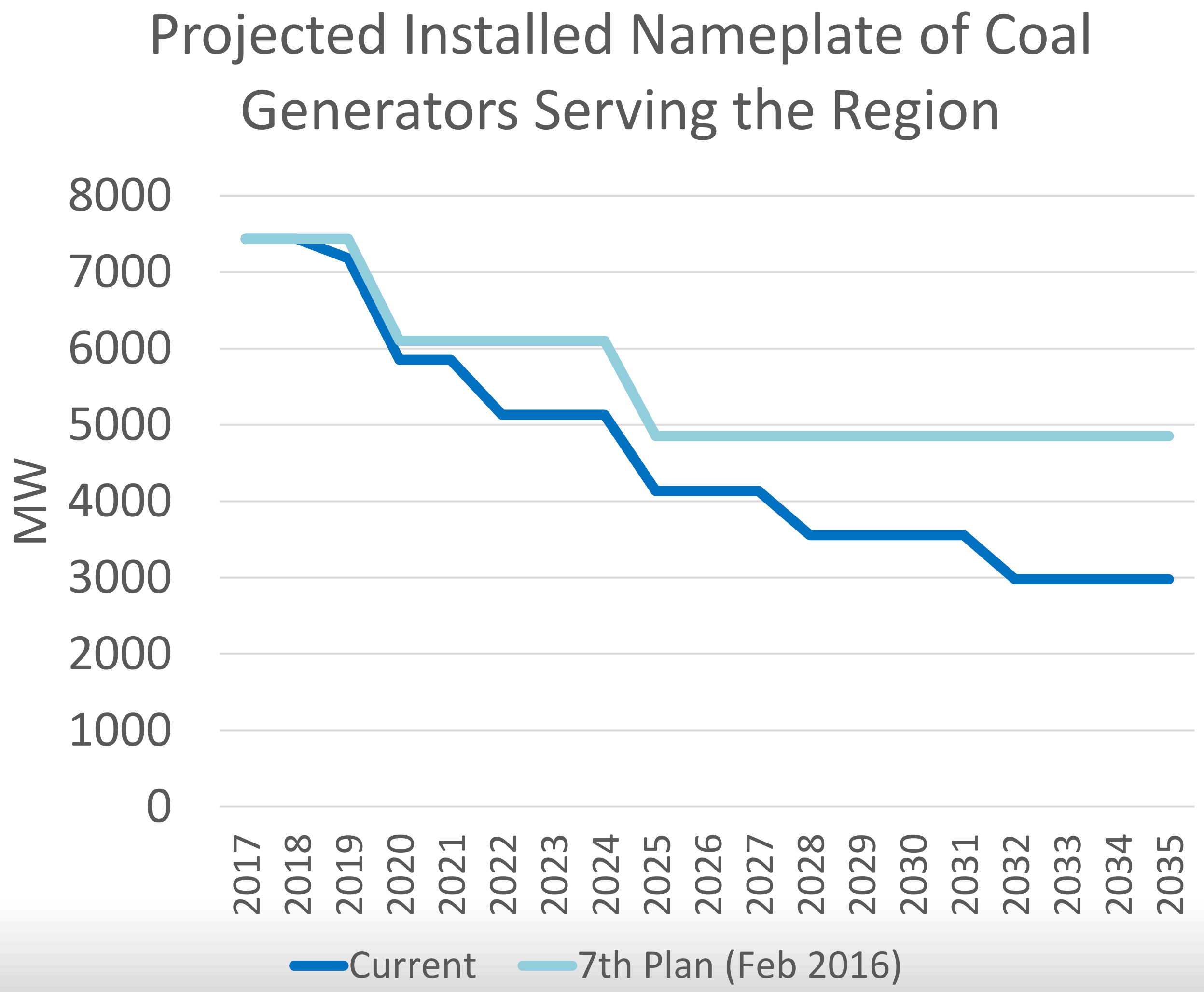
*Resources include energy, capacity, flexibility & other ancillary services needed for system reliability.

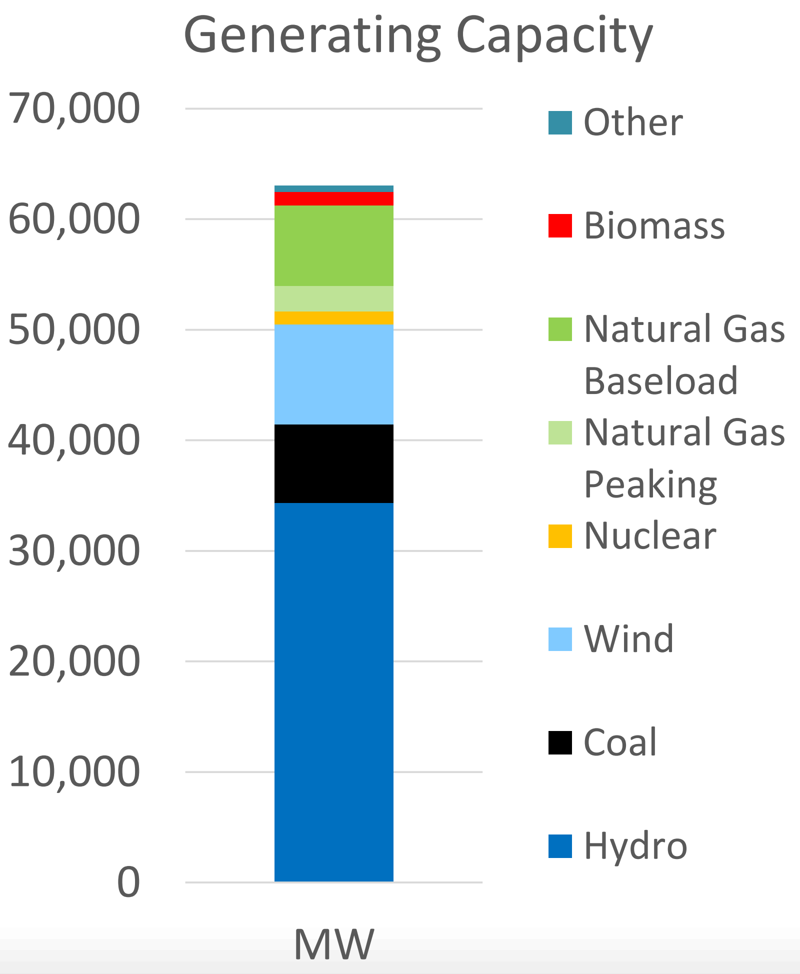
Resource <u>Cost</u> and <u>Risk Profile</u> are the big drivers

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

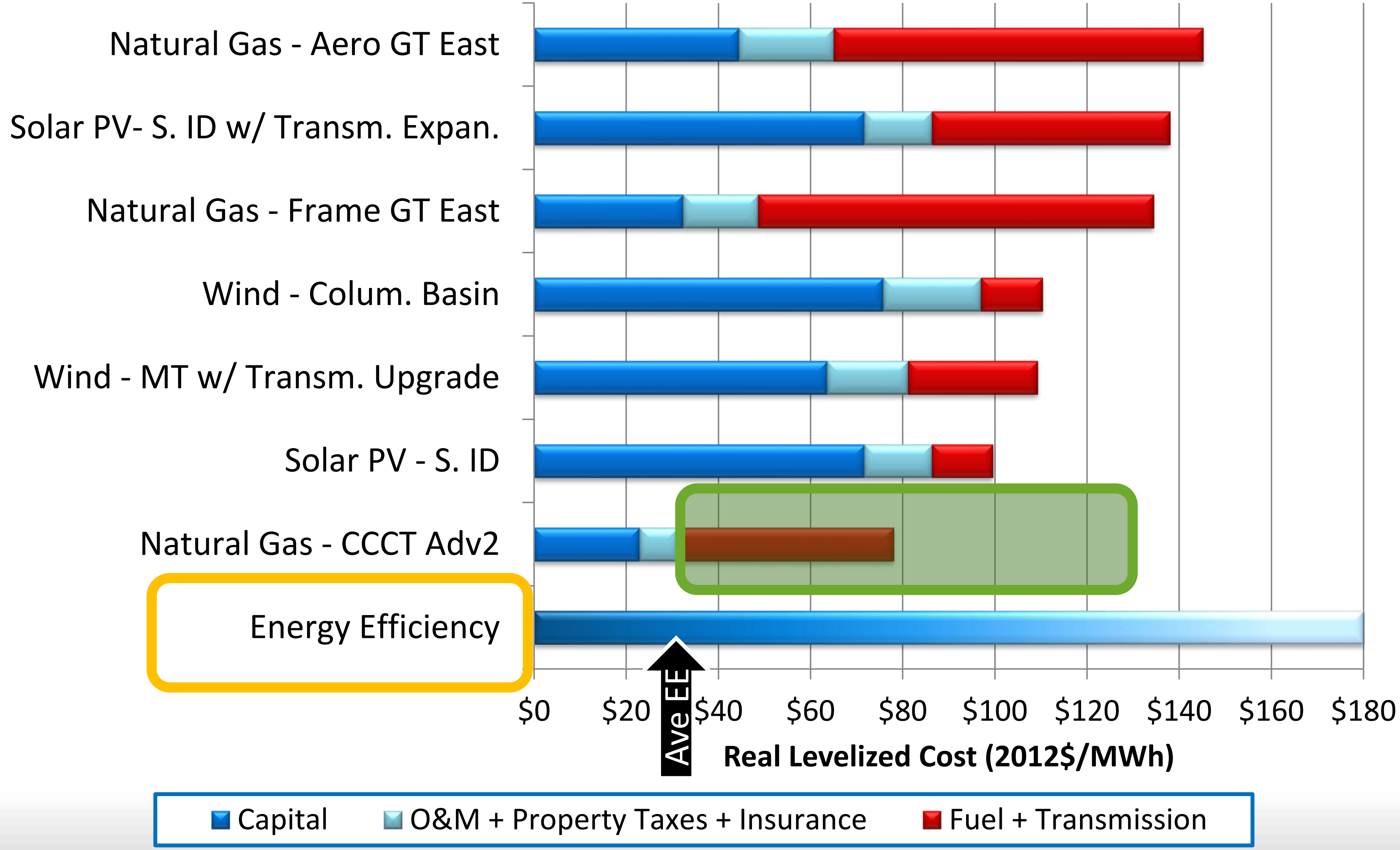


… Planned Retirements of PNW Coal





All Resource Cost – Energy



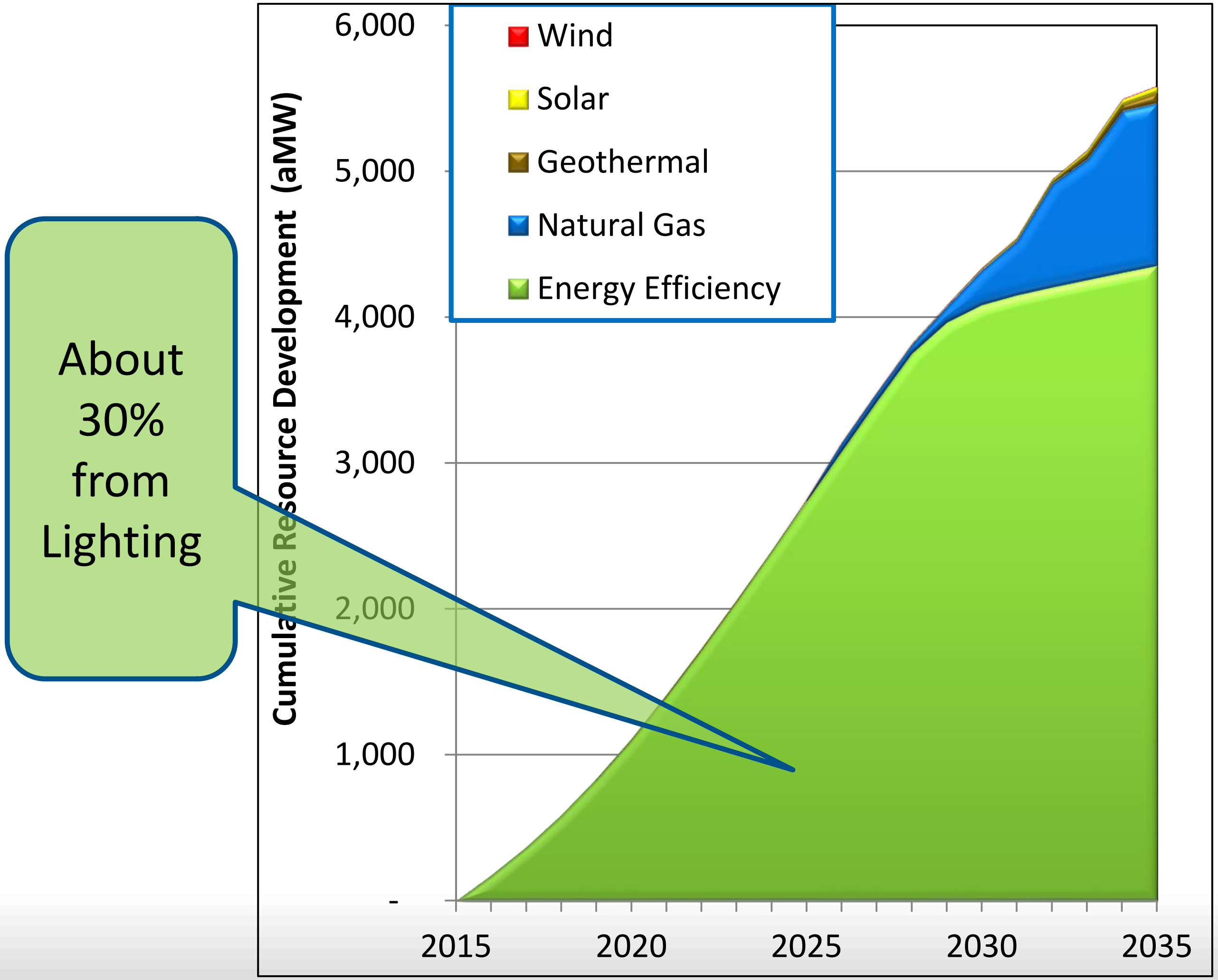
Characteristics

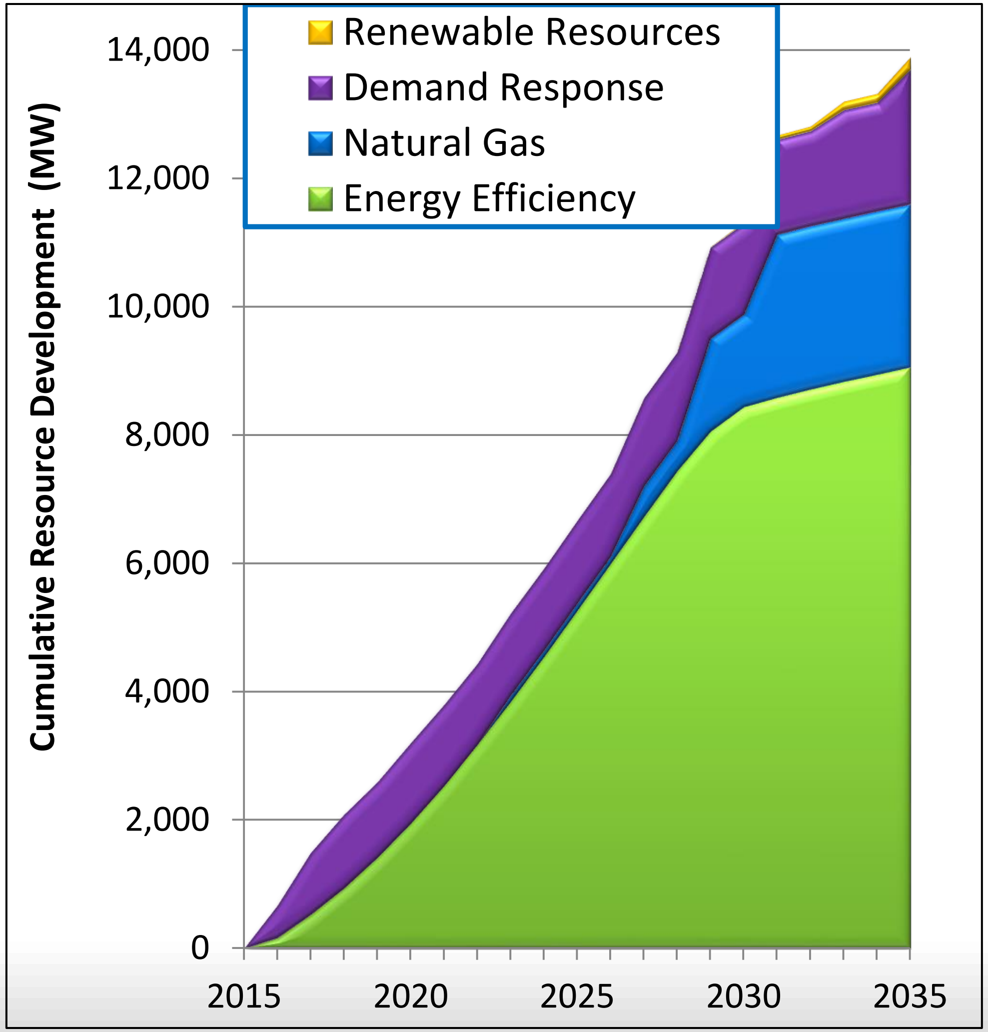
- Cost Energy
- Cost Capacity
- Flexibility

Planner Dilemma

- How Much?
- When?
- What Risk?

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





Forecast Load Growth Over The Next Two Decades
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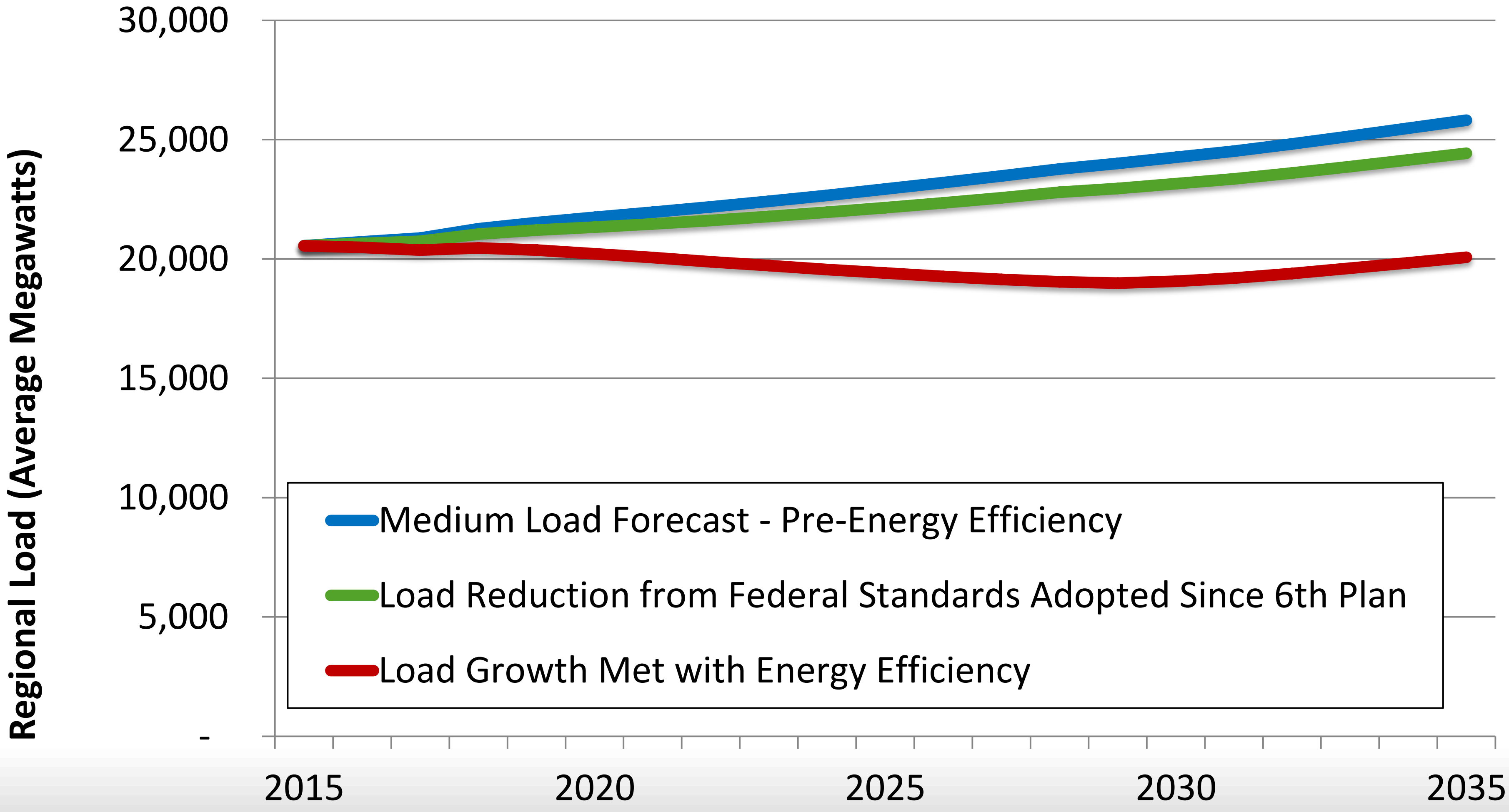
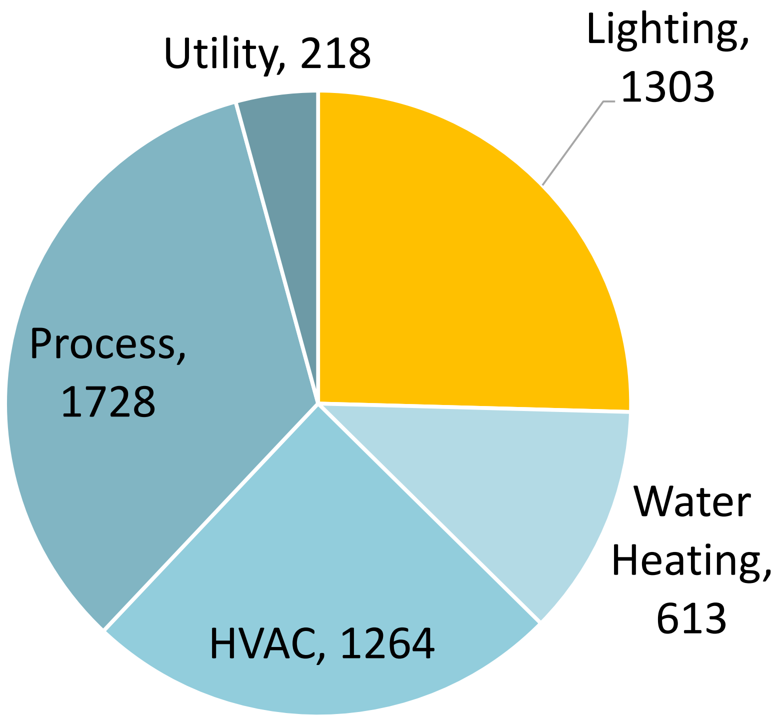


Northwest **Power** and
Conservation Council

Lighting Efficiency Potential – Existing Technology

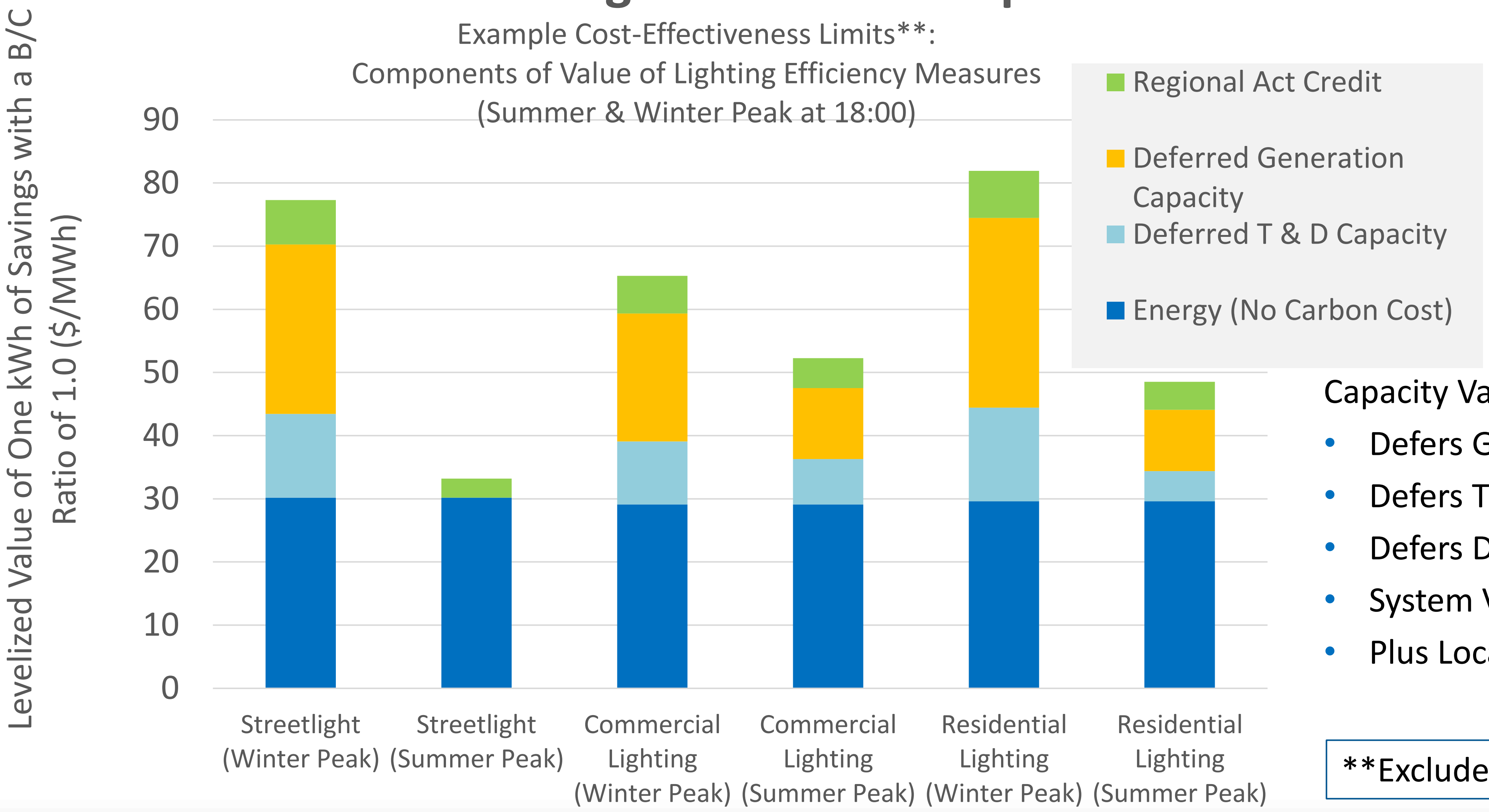
Total Potential by 2035
~5000 aMW Energy



Lighting Facts (for 2015)

- 13% of Energy Load
- 17% of Peak Demand Winter
- 12% of Peak Demand Summer

Not All Savings Are Created Equal

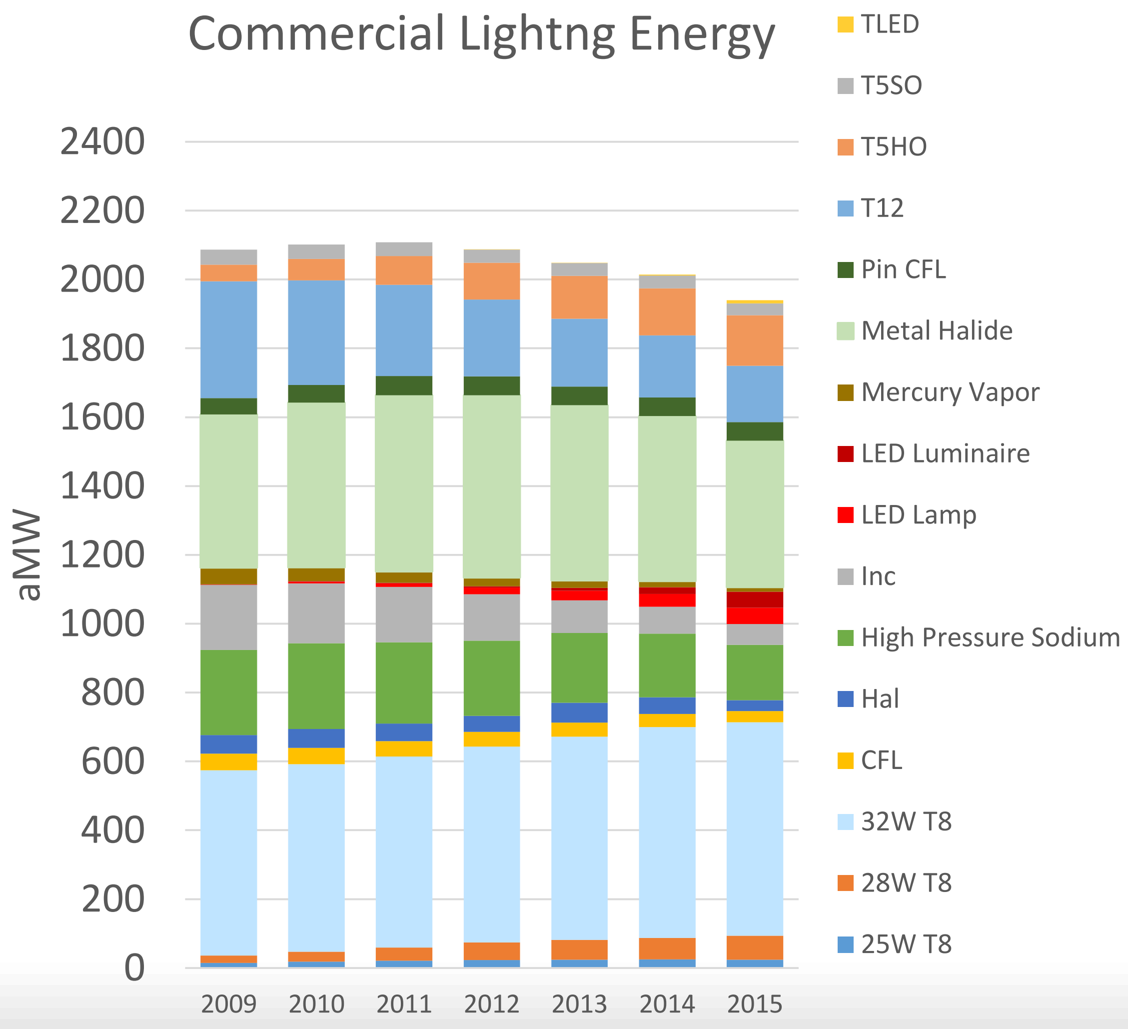


Capacity Value Matters

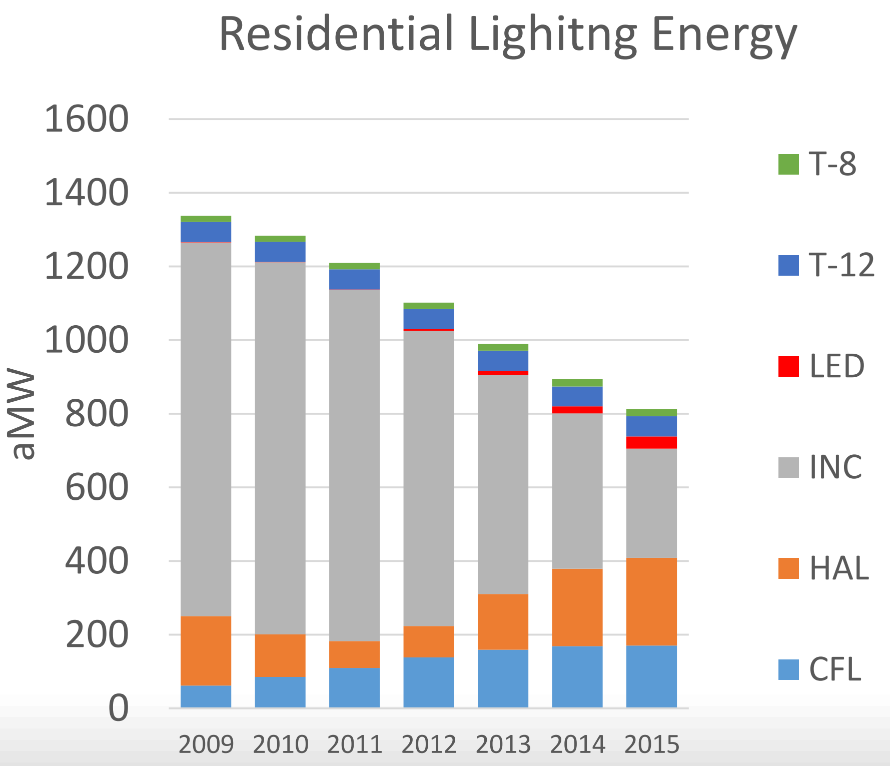
- Defers Generation
- Defers Transmission
- Defers Distribution
- System Value
- Plus Locational value

**Excluders Avoided Carbon

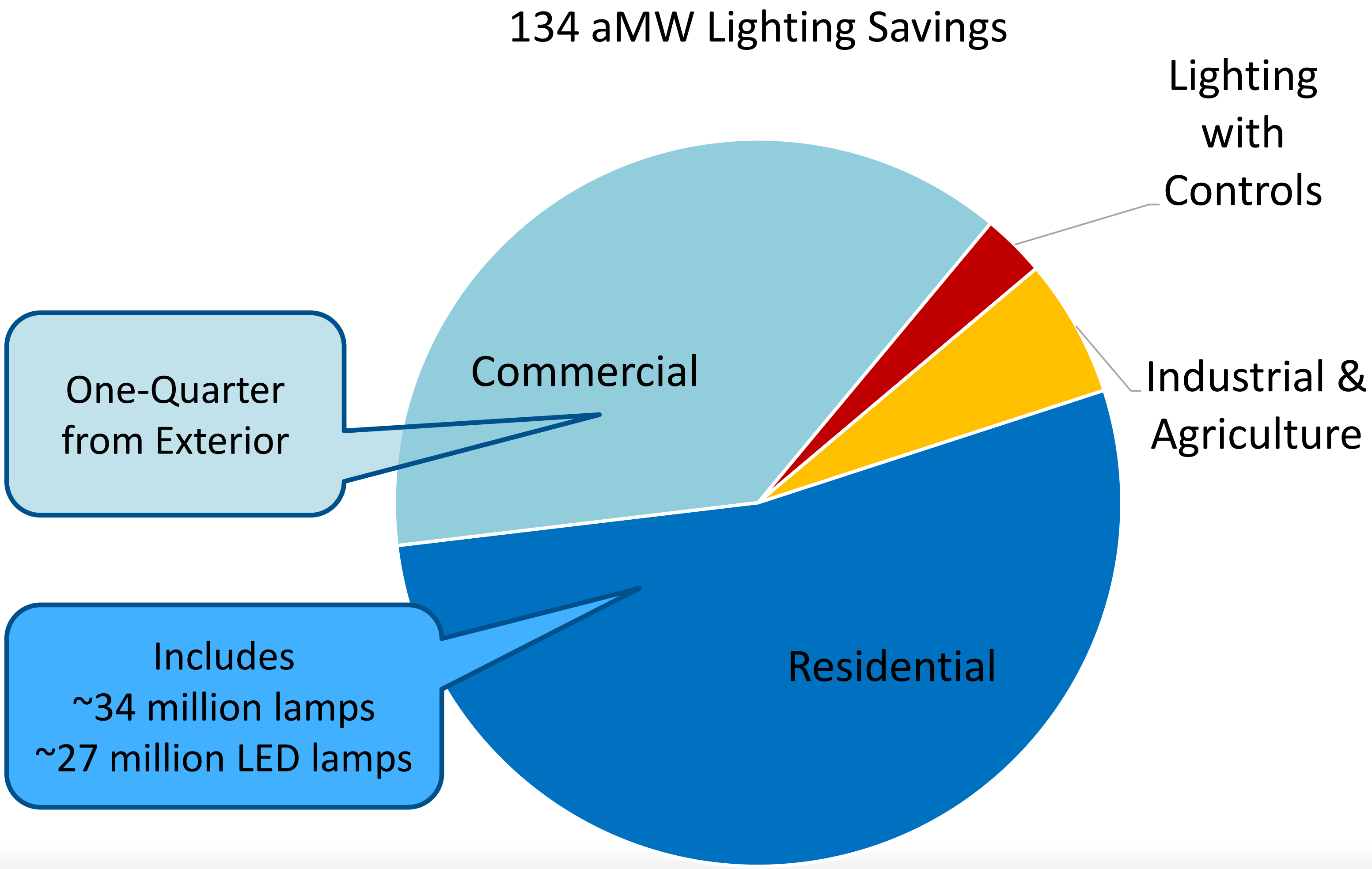
Lighting Loads Dropping



Source: PNW Lighting Market Models



2016 Lighting Savings - Half of All Savings



Faster than Anticipated

About 85% LED Residential

Over 50% LED Commercial

1 of 2 Residential Lamps are Part of Utility Programs

Small Savings from Controls

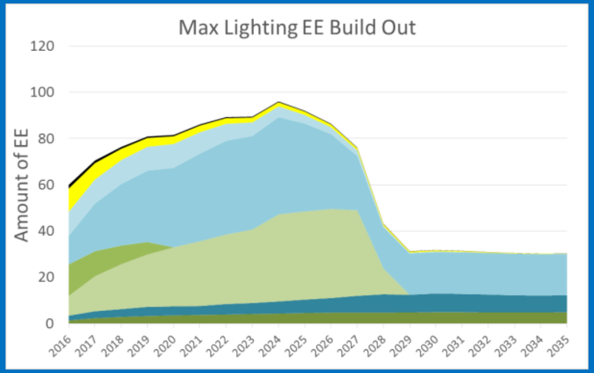
How Utilities Plan and Implement EE

Integrated Resource Plan → EE Targets → EE Budgets → EE Programs → Start Over

Integrated Resource Plan

- Loads & resources
- Assess options
- Assess risk
- Develop Least-Cost Least-Risk resource strategies
- Set EE cost-effectiveness

EE Targets

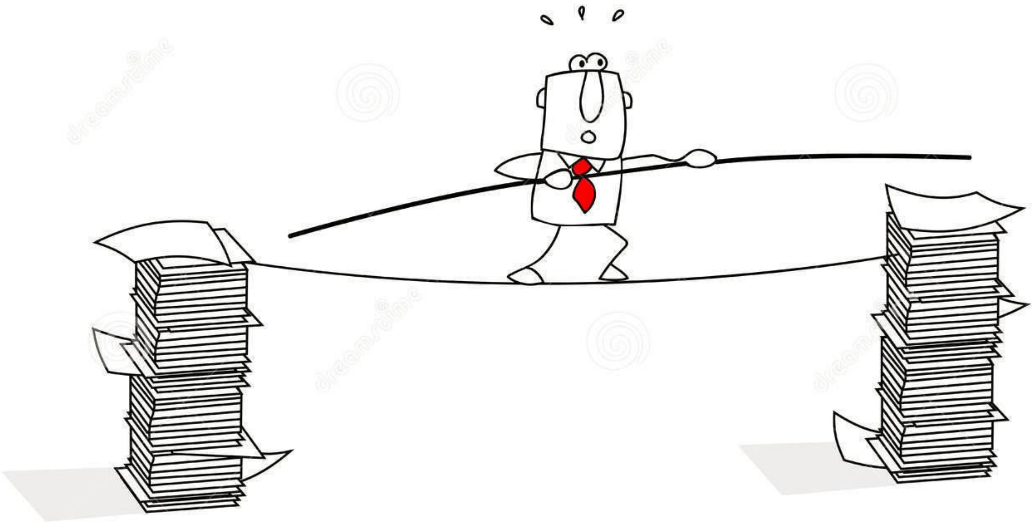


EE Programs

- Design and Operate Programs
- Set Incentive Levels
- Evaluate Progress
- Tweak as Needed

System Creates Target Tension

- Some Consequences
  - Programs favor <u>low-cost</u> and <u>easy</u>
  - Too fast ⇨ A budget a problem
  - Sub-optimal solutions from resource POV

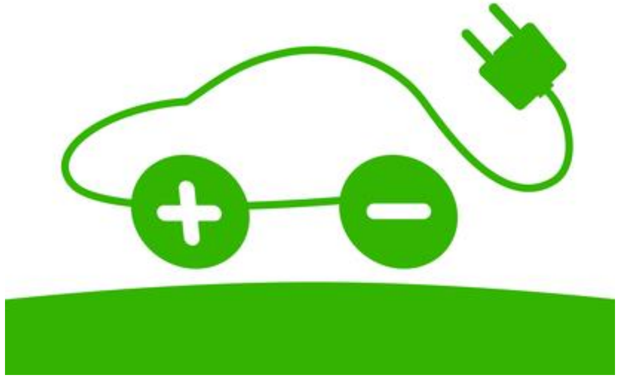


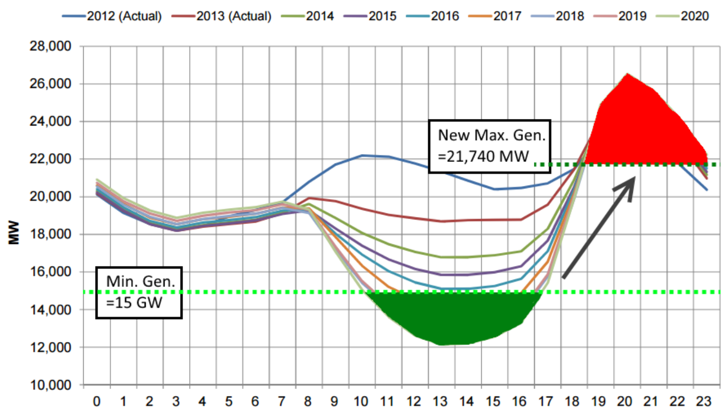
- Lighting programs deployed as gas pedal – stay on track with targets
- Long-term efficacy improvements are distant & uncertain

Utility EE Programs as Customer Service

- EE programs enhance customer & community perception
- Efficacy just part of picture: Other values rank high:
  - Appearance, ease of install, ease of use, adaptability, control, reliability
  - Bad customer experience very costly
  - For lighting programs: specifications & implementation are key

Long-Term Perspective on Pushing LED Efficacy?





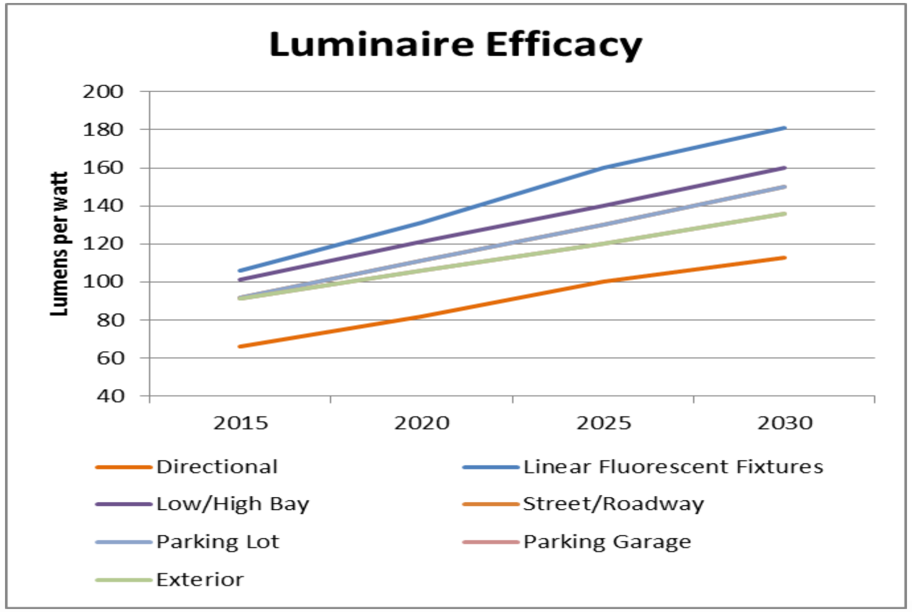
Electric Utility Industry Hot Topics:

- De-Carbonization of power system
- Plus "beneficial" electrification – including transportation
- Adapting to distributed generation like solar PV
- Smarten up the power grid

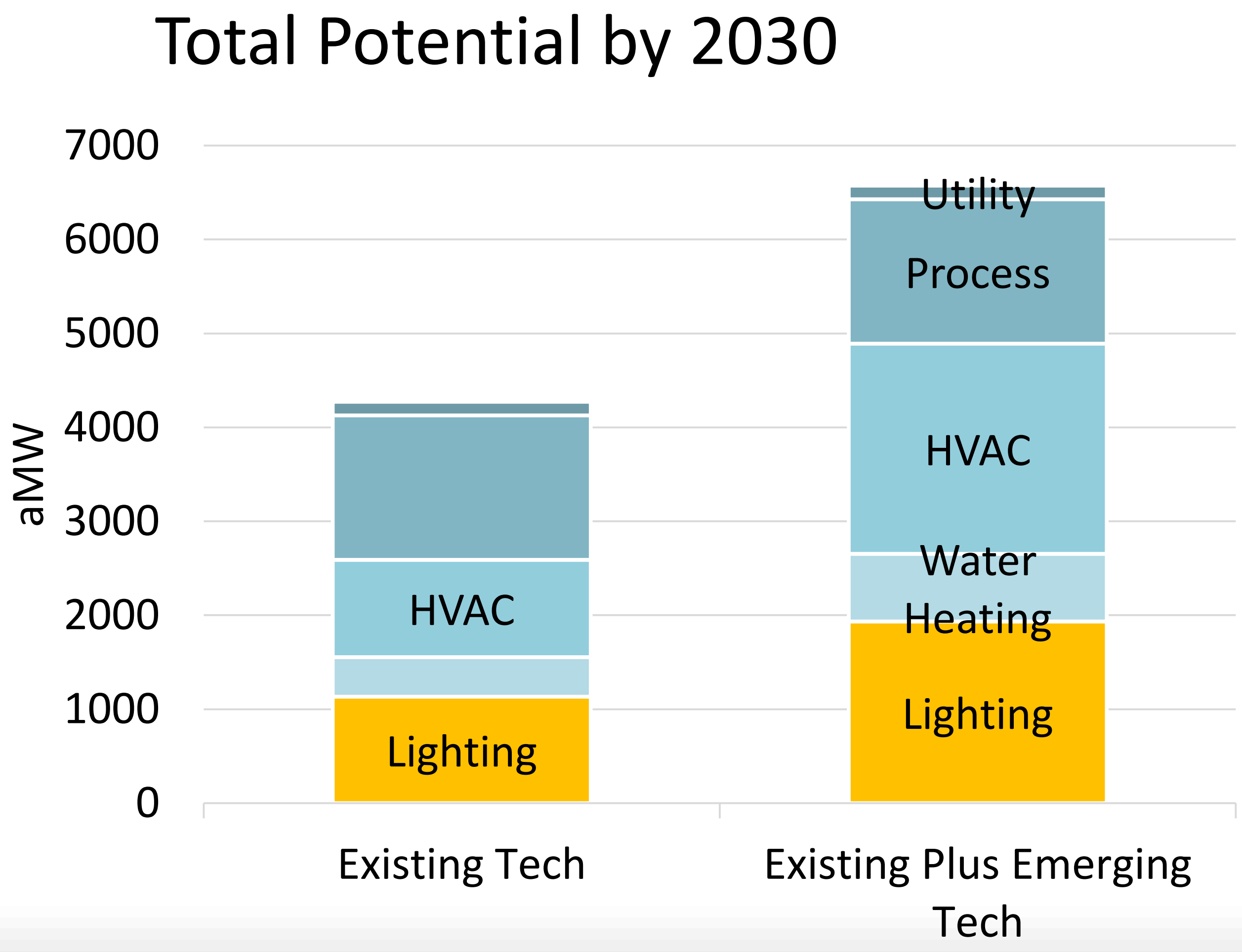
What If There's More Energy Efficiency?

Used 2014 DOE Analysis to estimate advances in SSL and other potential EE resources

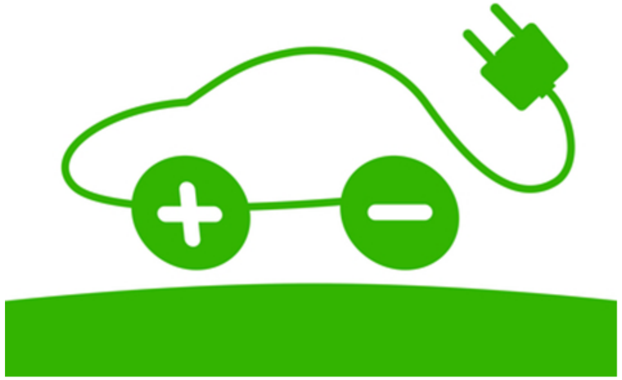
Tested Emerging EE Technology
Additional Advances in Solid-State Lighting
CO_2 Heat Pump Water Heater
CO_2 Heat Pump Space Heating
Highly Insulated Dynamic Windows - Commercial
Highly Insulated Dynamic Windows - Residential
HVAC Controls – Optimized Controls
Evaporative Cooling

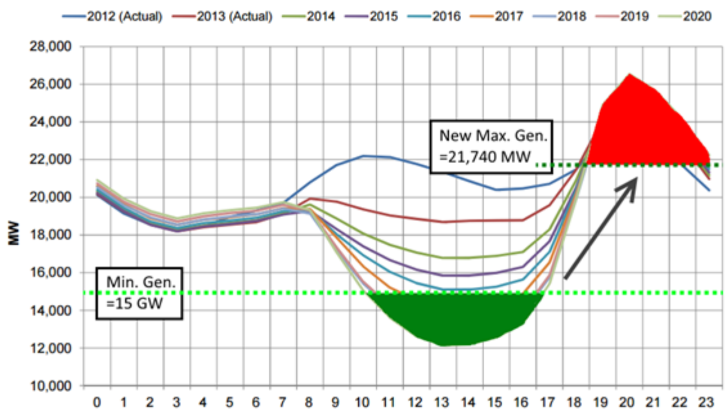


Compare Existing EE vs Emerging



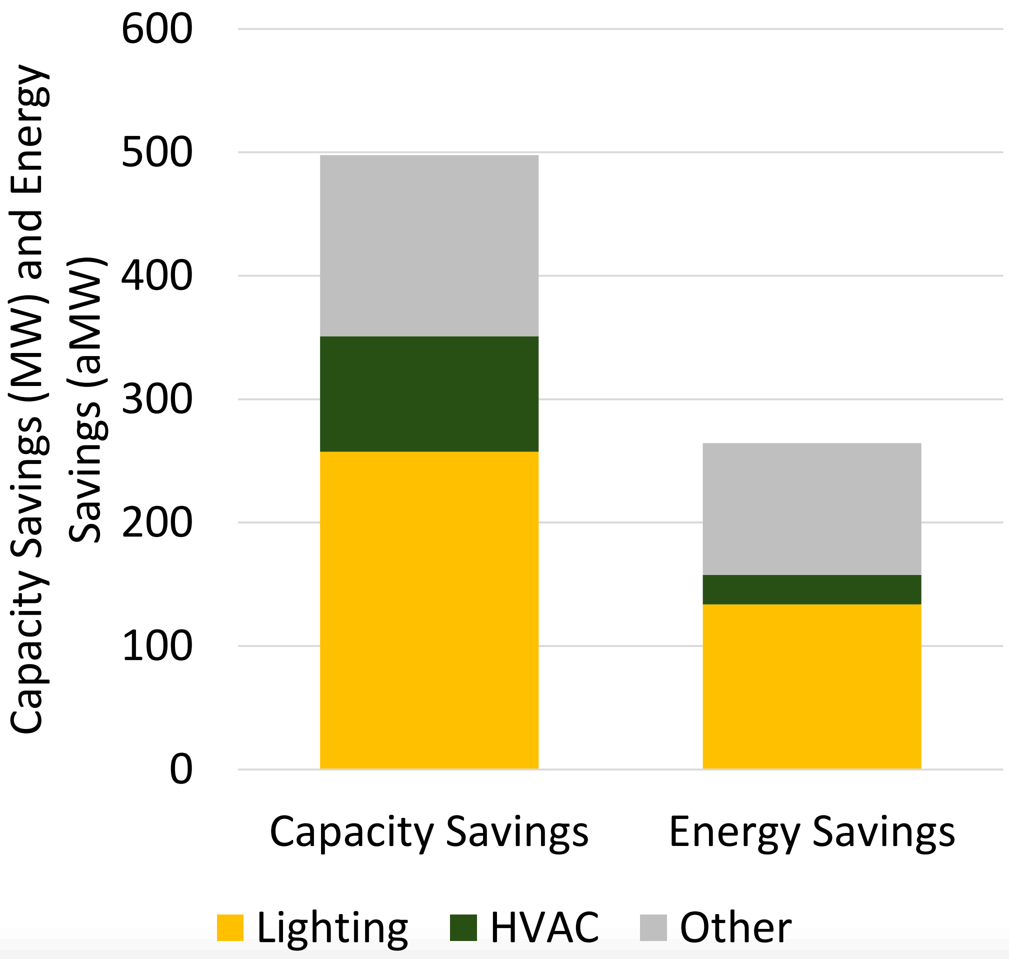
New Drivers: Capacity & Flexible Capacity





- Lighting efficacy has capacity value – lights mostly on during system peak
- Lighting controls "revolution" could add to flexible capacity needs
  - Demand Response with both up and down regulation
  - But lighting is diffuse resource for DR – many points and small kW each

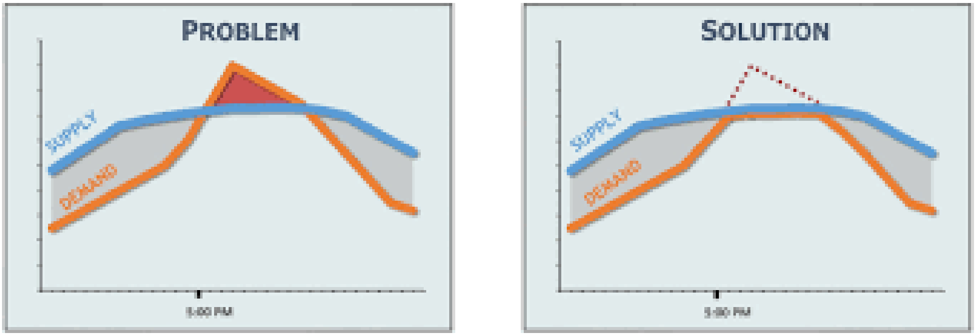
2016 Efficiency Efforts Provided Over 500 MW of Winter Capacity – Most from Lighting



- Represents approximately 1.6% reduction on last year's winter peak
- Lighting contributes significantly to capacity savings
- Deeper savings in HVAC will have a greater impact on capacity savings

Demand Response from Lighting?

Winter Capacity Analysis (2015 Loads - Normal Weather)	MW
Total System Peak Capacity	32000
Commercial Sector Peak	16000
Commercial Lighting Peak	2300
Peak After LED Conversion	1200
Fraction Customer Accepting DR	600
Fraction of Lighting Applicable	400
Fraction available at +/- 15%	60



- Com Lighting 28% of Summer Peak
- Com Lighting 15% of Winter Peak
- Diminishing DR size with efficacy
- Competition in DR
- Fast response rate?

Data

Summary:
Utility Perspectives on Pushing on Efficacy

- Least-Cost Power System
  - Near-term depends on COST of incremental saved energy & capacity
  - … and pace of efficacy change relative to stock turnover
  - Lighting improvements will compete with other EE, with DR & Storage
  - Diminishing returns on efficacy will be a challenge as efficacy improves
- Customer Touch
  - Cost, quality, non-energy characteristics
  - Pays dividends on uptake - Vibrant uptake equates to low utility cost
- Long-term
  - System capacity and de-carbonization trends favor efficacy & control

Contact

For more information:

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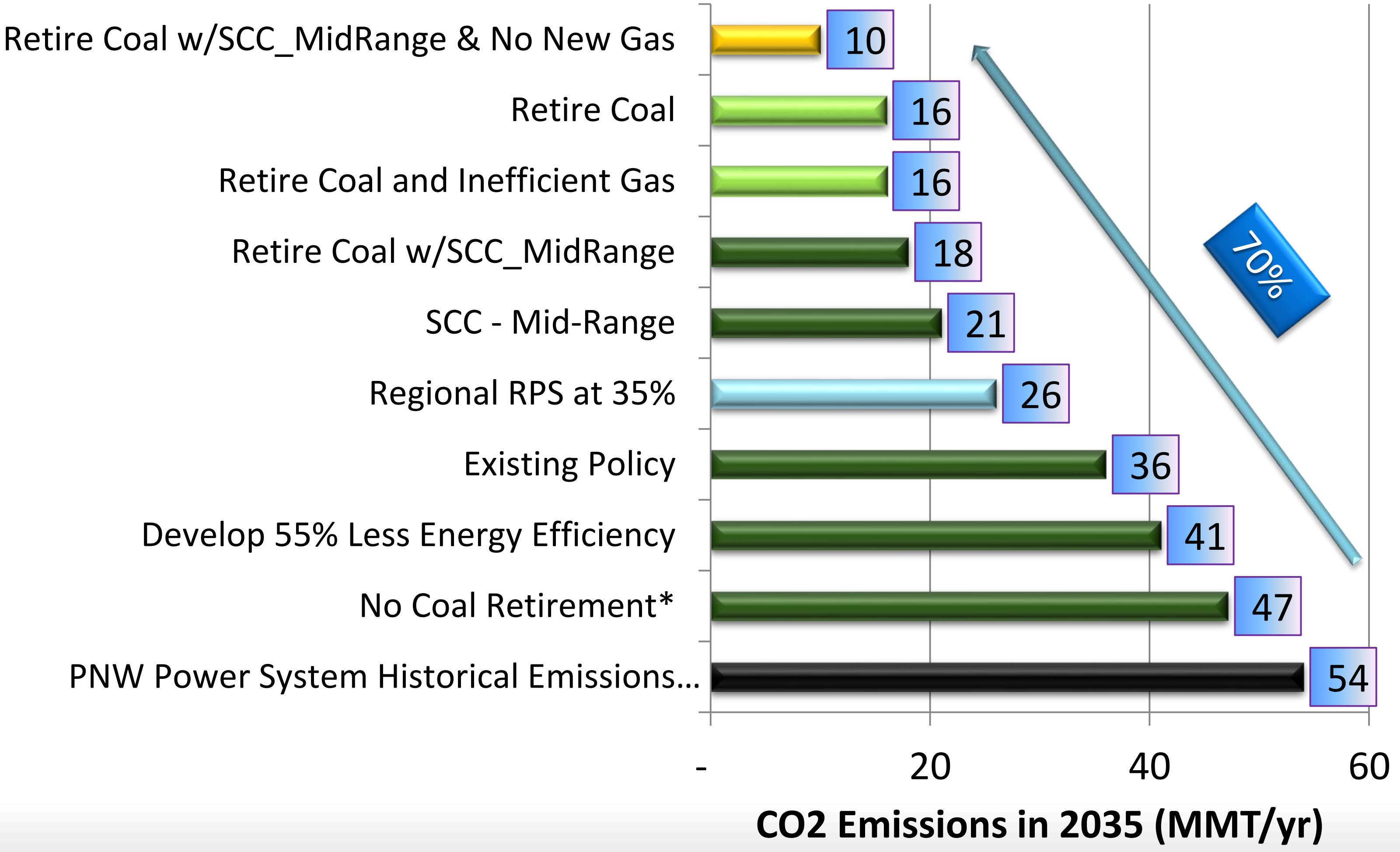
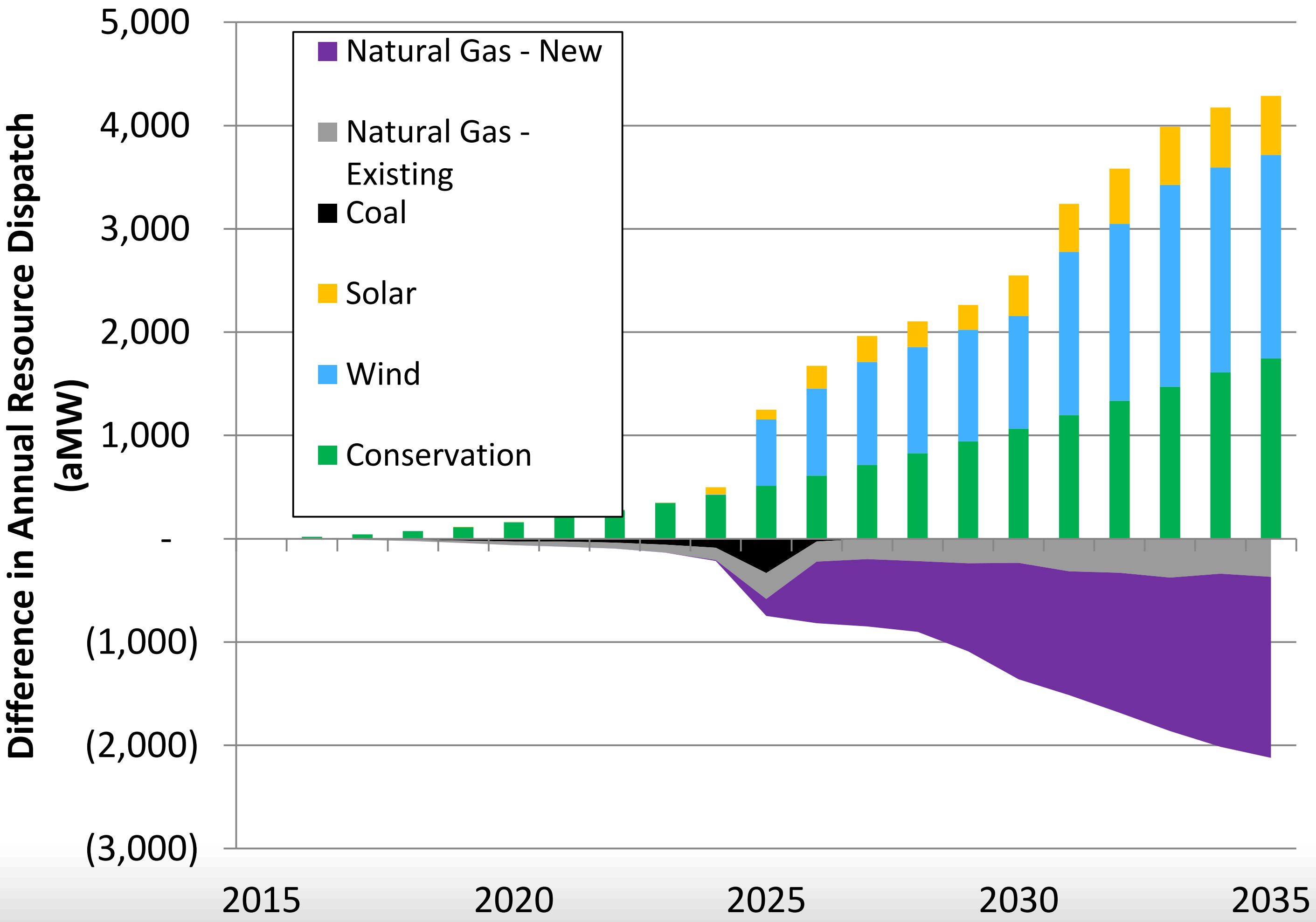
How Low Can You Go?



Annual Regional Power System CO_2 Emissions in 2035 by Scenario (Average Across 800 Futures)

*Scenario assumes Centralia, Boardman and North Valmy are not retired.

Difference in Annual Resource Dispatch: Max Carbon Reduction - Existing Technology vs **Emerging Technology**



- Reduce CO_2 10 to 6 MMT/Year

- Replace 2000 aMW Natural Gas
- Add 1750 aMW Efficiency
- Add 2500 aMW Wind & Solar

- Further reductions require zero-carbon technologies that provide both annual energy & peak capacity