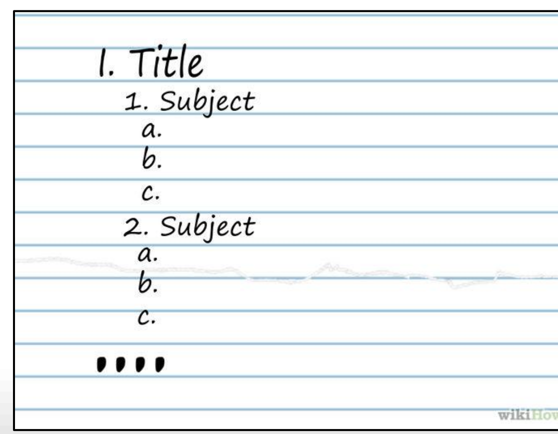
Analysis Regional Portfolio Model Results

Conservation Resources Advisory Committee September 2, 2015

Outline

- Key Resource Strategy Findings
- RPM Refresher: What it does & how we use it
- Key Findings for all resources & policies
- Key Findings for Energy Efficiency
- Principle Elements of Resource Strategy

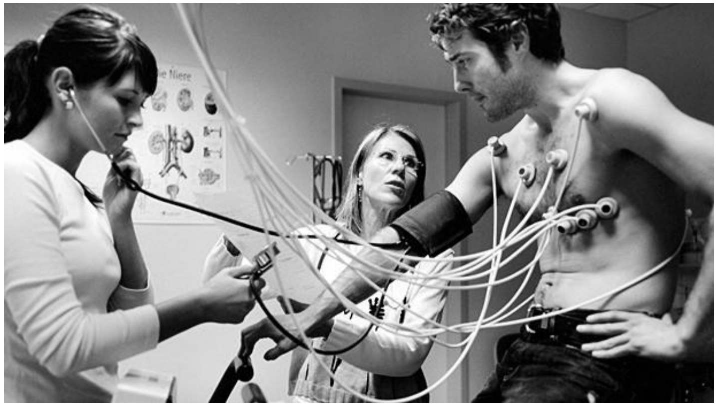


Status

- Results in this presentation are findings to date
- They form the basis of the proposed draft plan
- Currently in discussion and review with Council
- Looking for CRAC feedback

Key Resource Strategy Findings

- 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 potentially competitive options for providing winter capacity to meet regional resource adequacy requirements
- Replacement of announced coal plant retirements can generally be achieved with only modest new development of natural gas generation
- Northwest exports play a significant role in regional resource development
- Compliance with EPA CO_2 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

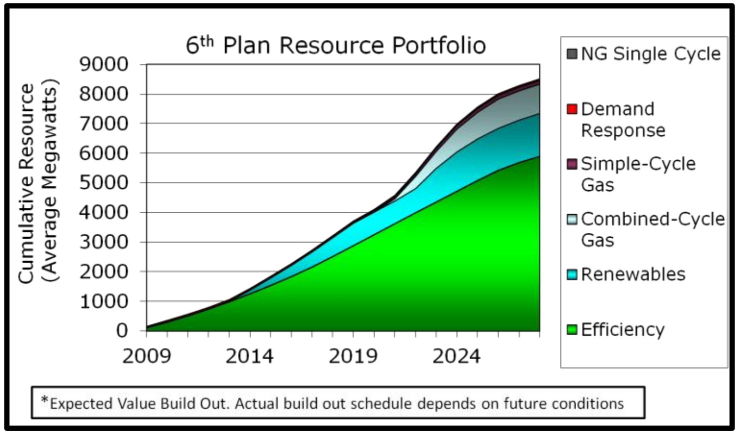


WHAT THE RPM DOES
&
HOW WE USE IT

The Council Uses Scenario Analysis to "Stress Test" Resource Strategies Against These Uncertainties

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



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

Test bed of 800 futures

=

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

Scenario Analysis Will Seek to Identify Resource Strategies That Are:

- Best suited to replace existing generating resources with known retirement dates
- Robust against the risk of a range of future
  - Load growth
  - Hydro conditions
  - Loss of existing generation resources
  - Lower "average," but occasionally volatile gas and electric market prices
  - GHG emissions controls
  - Reliance on power market imports
  - Uncertain technology change
  - "What we don't know, we don't know"

7P Scenario "Stresses"

Scenario 1A - Existing Policy, No Uncertainty
Scenario 1B - Existing Policy, No Carbon Risk
Scenario 2B - Carbon Reduction - Social Cost of Carbon
Scenario 2C - Carbon Risk
Scenario 3A - Maximum Carbon Reduction, Existing Technology
Scenario 4A - Unplanned Loss of Major Non-GHG Emitting Resource
Scenario 4B - Planned Loss of Major Non-GHG Emitting Resource
Scenario 4C - Faster Near-Term Pace of Conservation Deployment
Scenario 4D - Slower Near-Term Pace of Conservation Deployment
Scenario 5B - Increased Reliance on External Market

7P Sensitivity "Stresses"

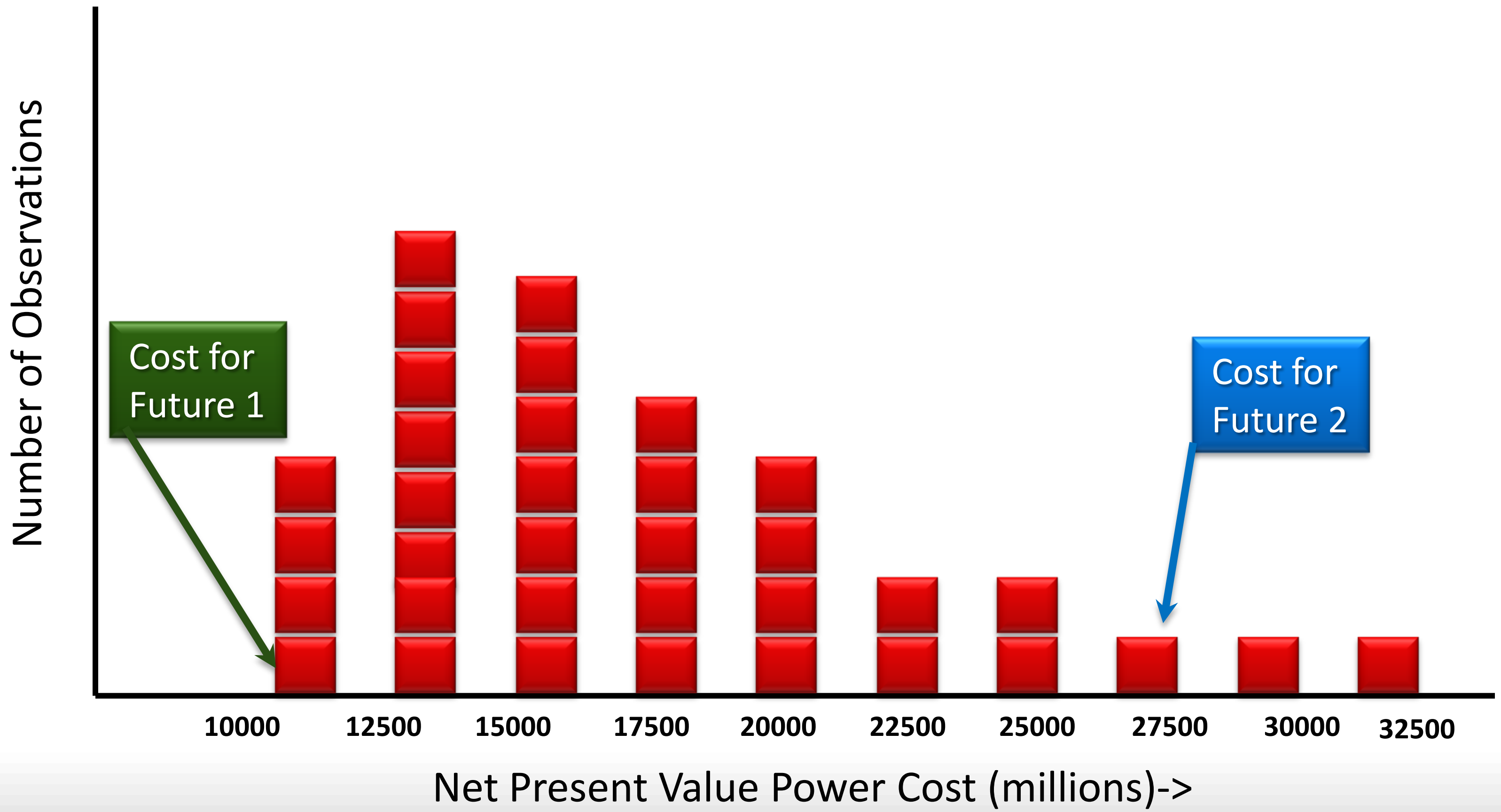
Sensitivity S1 - Scenario 1B_No Coal Retirements
Sensitivity S2 - Scenario 1B_Low Gas Prices
Sensitivity S2.1 - Scenario 2C_Low Gas Prices
Sensitivity S3 - Scenario 1B_No Demand Response
Sensitivity S3.1 - Scenario 2C_No Demand Response
Sensitivity S5 - Scenario 1B_35% RPS
Sensitivity S6 - Scenario 2B_95th Percentile SCC
Sensitivity S7 - Scenario 2B_No Conservation
Sensitivity S8 - Scenario 2B_95th Percentile SCC w/No Conservation
Sensitivity S9 - Scenario 1B_No Transmission and Distribution Cost Deferral Credit
Sensitivity S10 - Scenario 1B_No Conservation Adder

Compare Resource Strategies Across 800 Futures for All Scenarios & Sensitivities

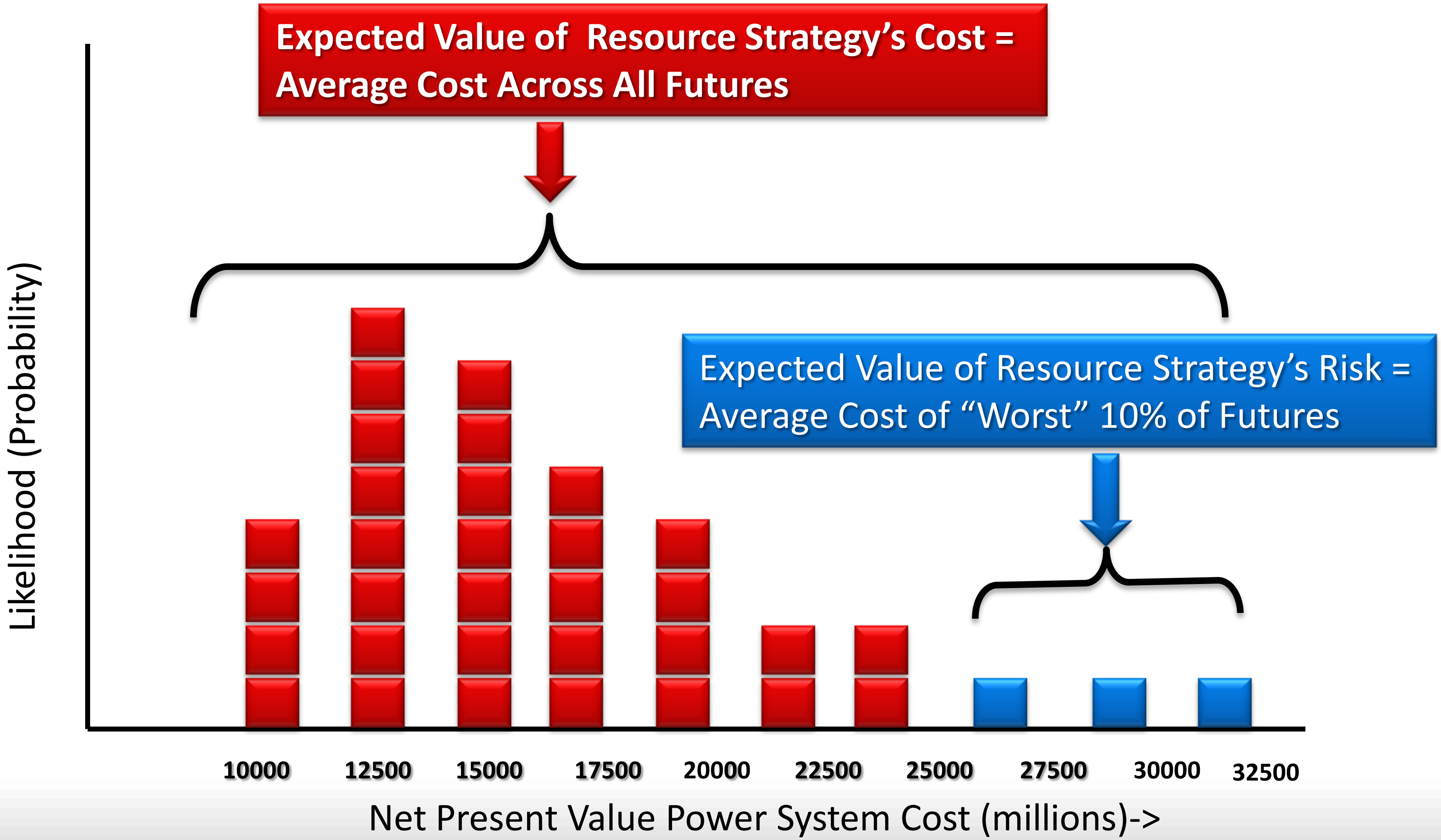
Comparison Metrics

- Distribution of Net System Cost ($)
- Distribution of Conservation development (aMW & MW)
- Distribution of RPS Resource development (aMW & MW)
- Average Thermal Resource development (aMW & MW)
- Distribution of Demand Response development (MW)
- CO_2 emissions for Total Regional Power System and Plants Affected by EPA's Proposed 111(d) Regulation (tons)

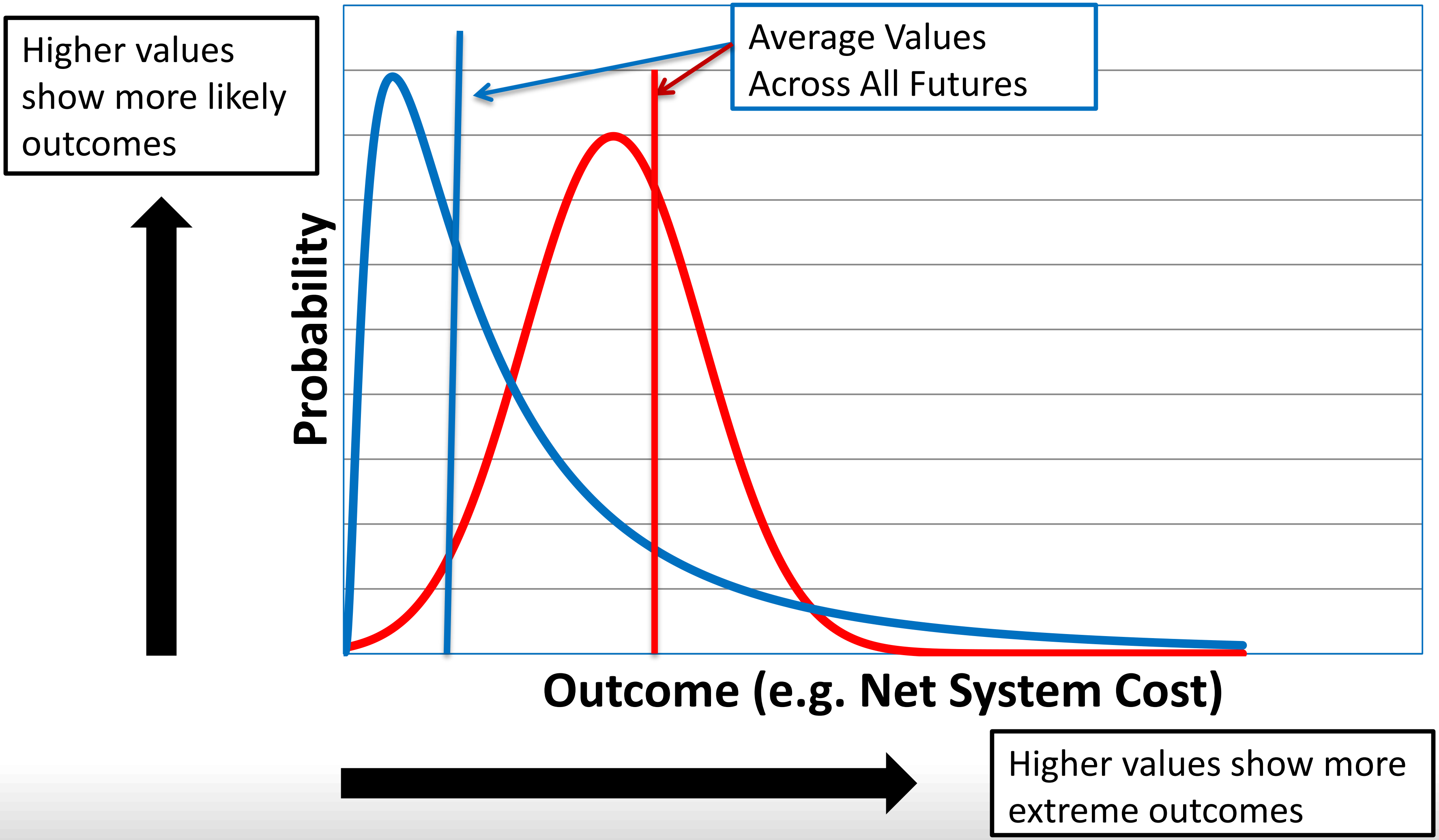
A Resource Strategy's Cost and Risk Depend on the Future



Expected Cost and Risk Metrics



Many RPM Results Are Shown As Distributions Across All Futures



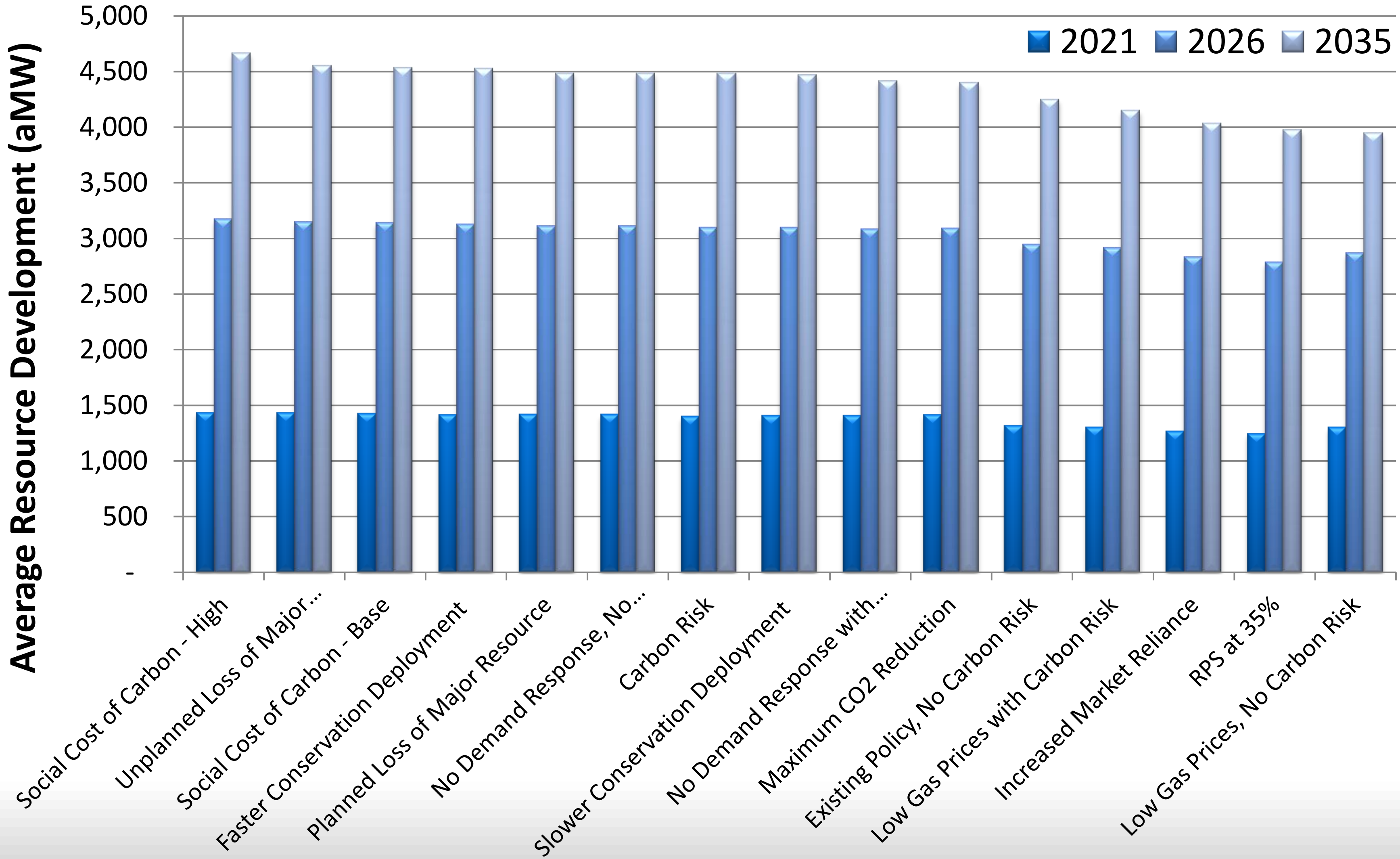
Notable RPM Revisions Since 6P

- Explicit Test for System Adequacy
  - ARM – Adequacy Reserve Margin
  - Both Energy and Capacity
  - Build trigger for energy or for capacity

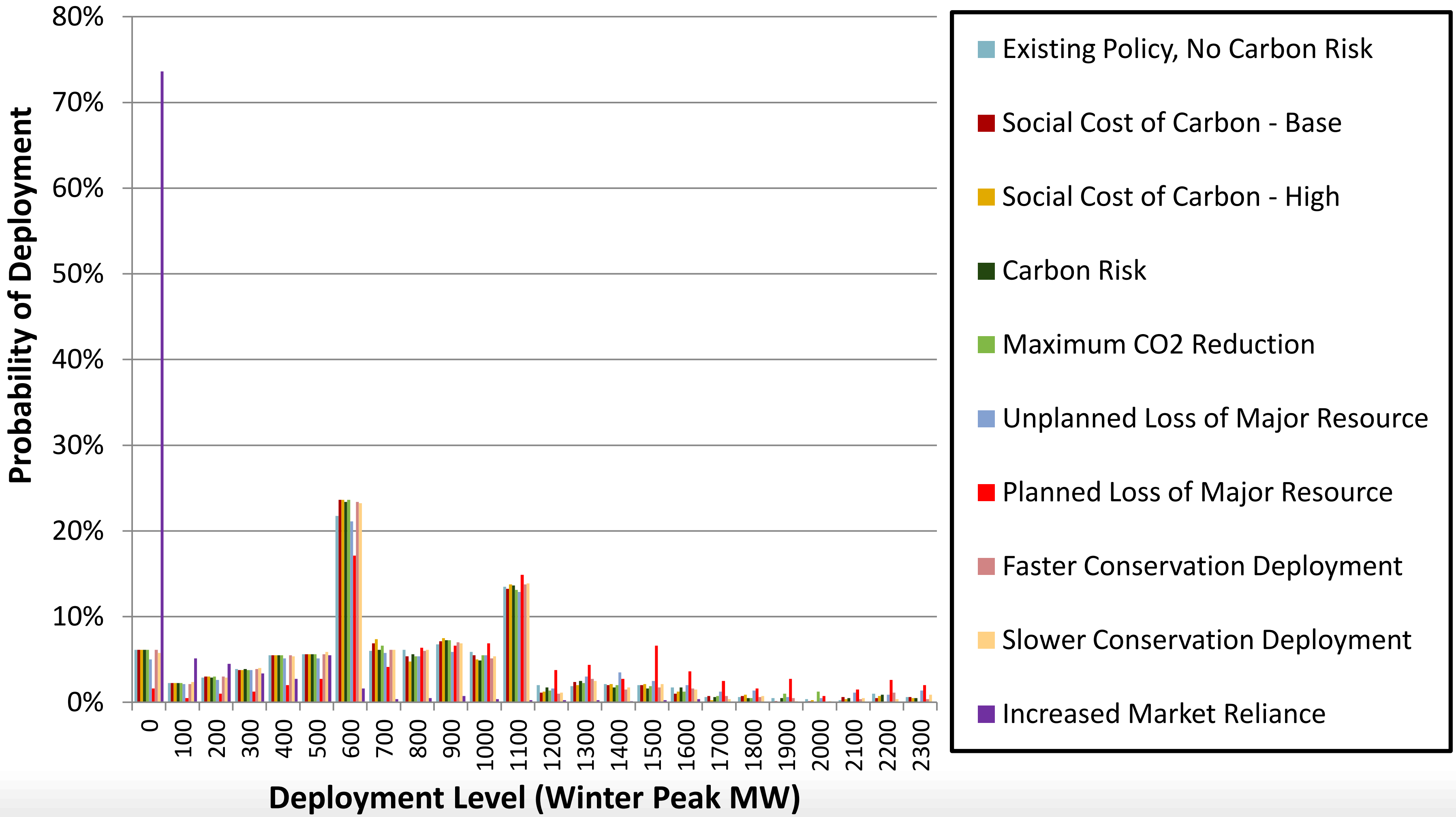
- Revised Logic for Lost-Opportunity
  - Not lost forever if frequent measure turnover

KEY FINDINGS ALL RESOURCES

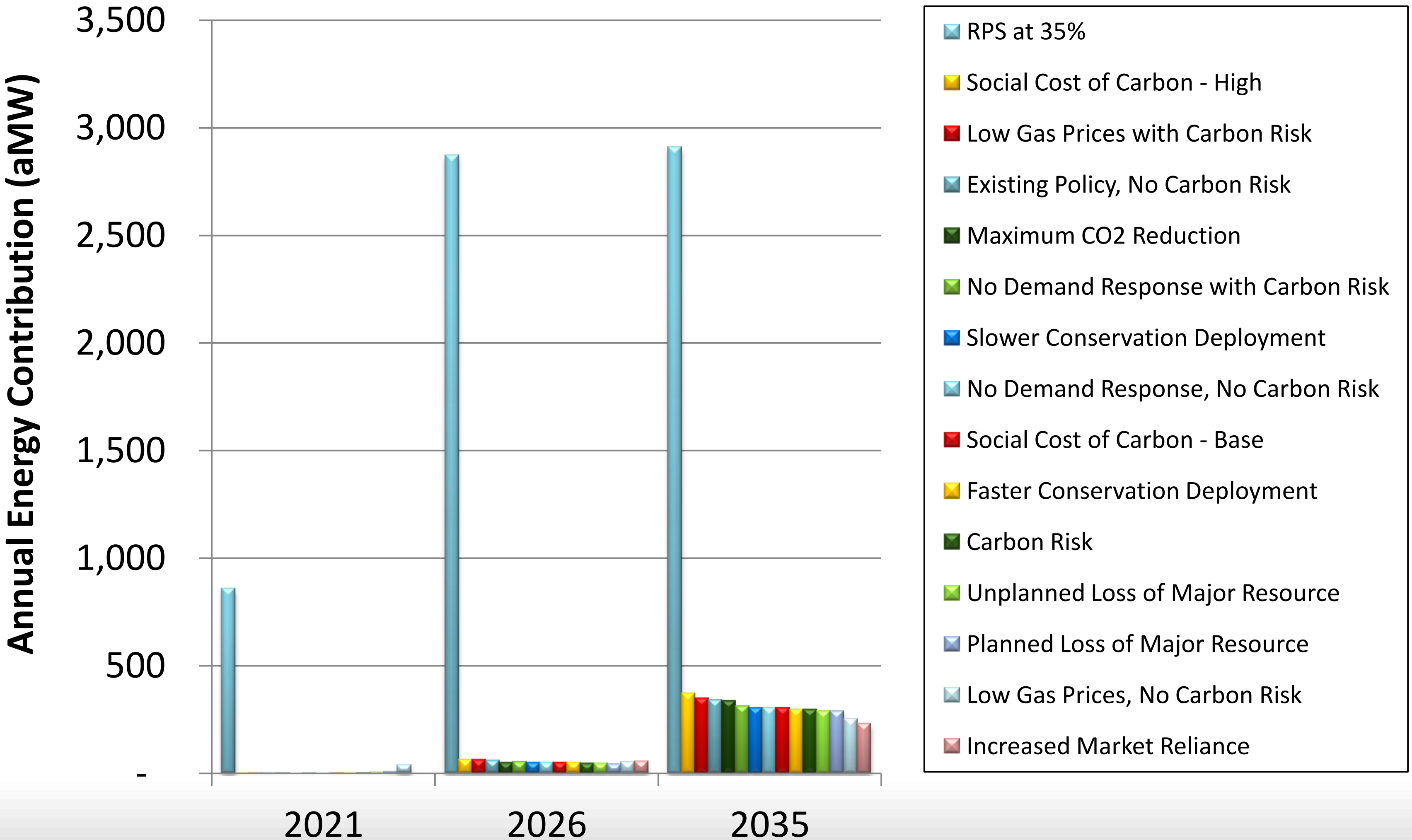
Key Finding:
Average Conservation Development Across Scenarios Varies Little Across Scenarios Except Under Sustained Low Gas Prices and Increased RPS



Key Finding:
The *Probability and Amount* of Demand Response Varies Over a Wide Range, and is Particularly Sensitivity to Extra-Regional Market Reliance Assumptions

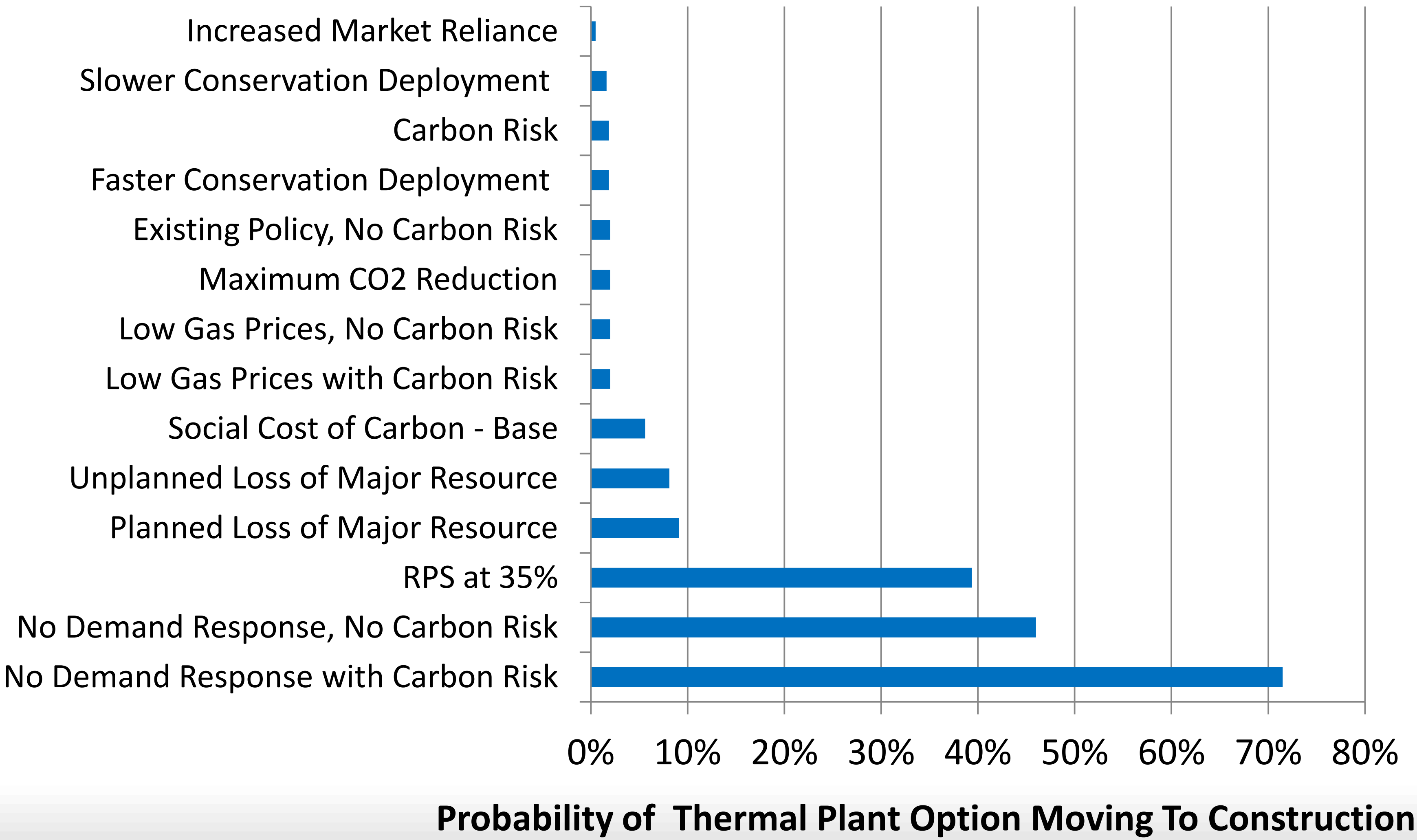


Key Finding:
Average New Renewable Resource Development *Does Not* Significantly Increase Under Carbon Emissions Reduction Policy Scenarios Except For A Policy That Sets Renewable Portfolio Standard at 35%

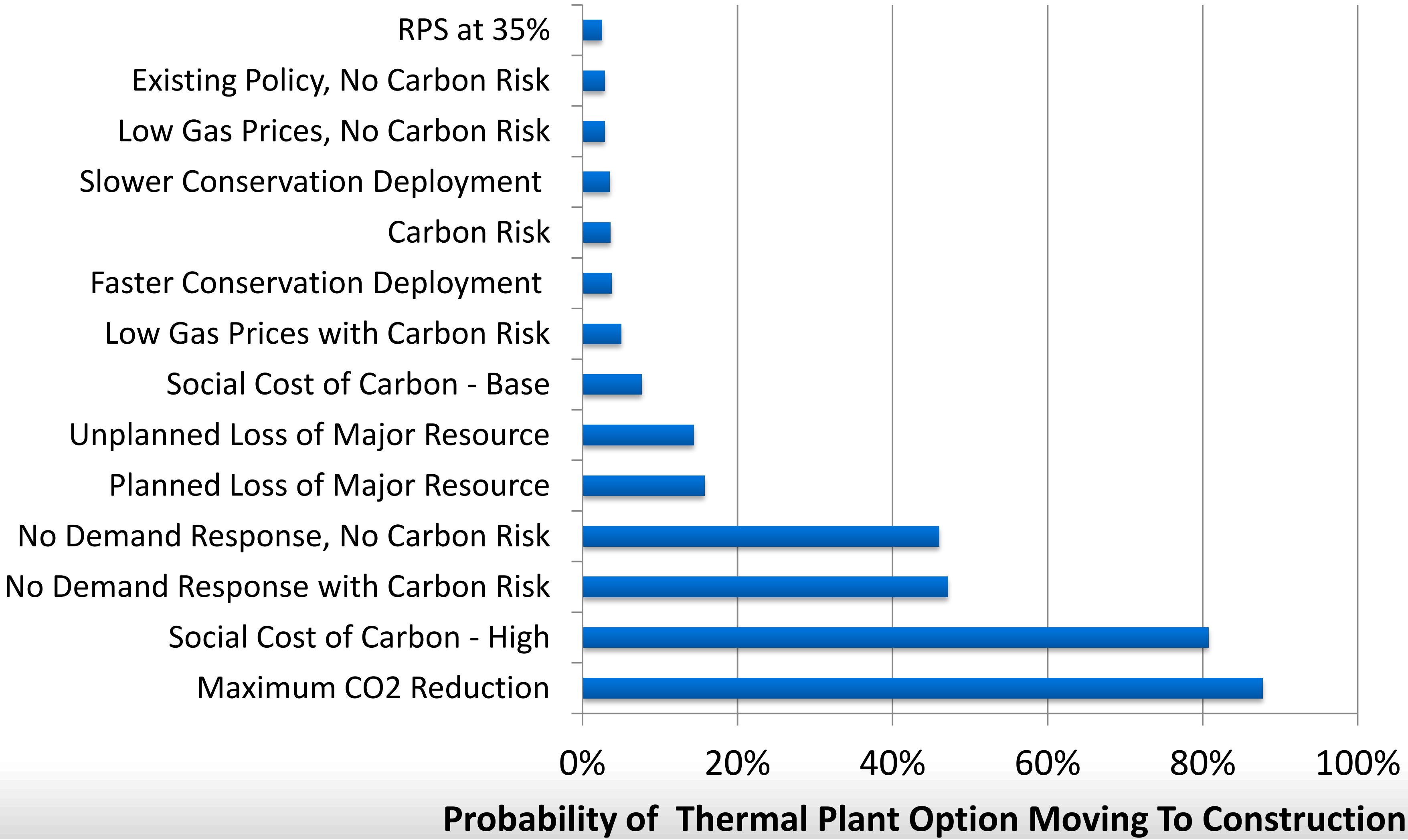


Key Finding:

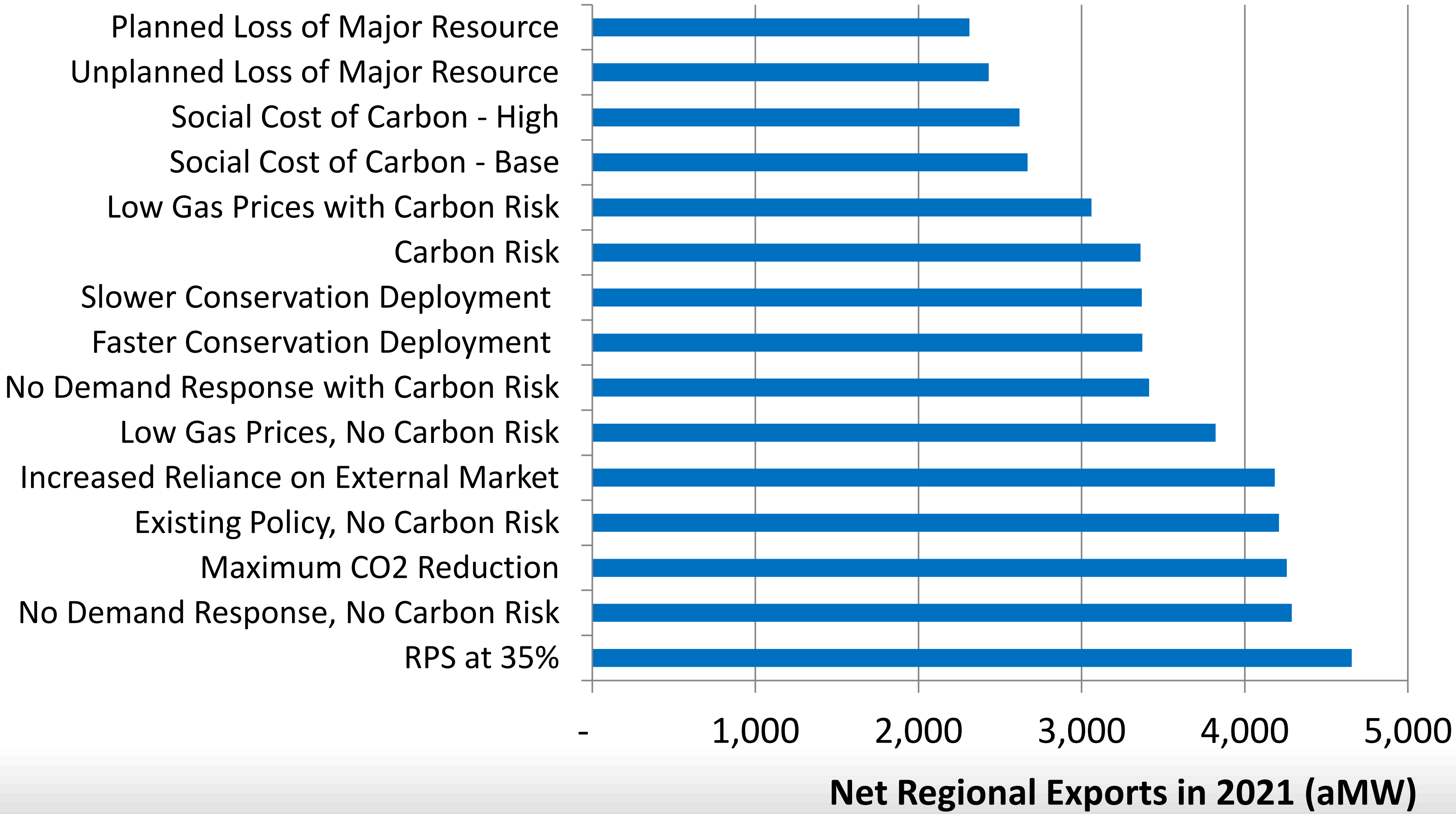
There is a Low Probability of Any Thermal Development by 2021 Except Under Scenarios That Increase RPS or Do Not Develop Demand Response



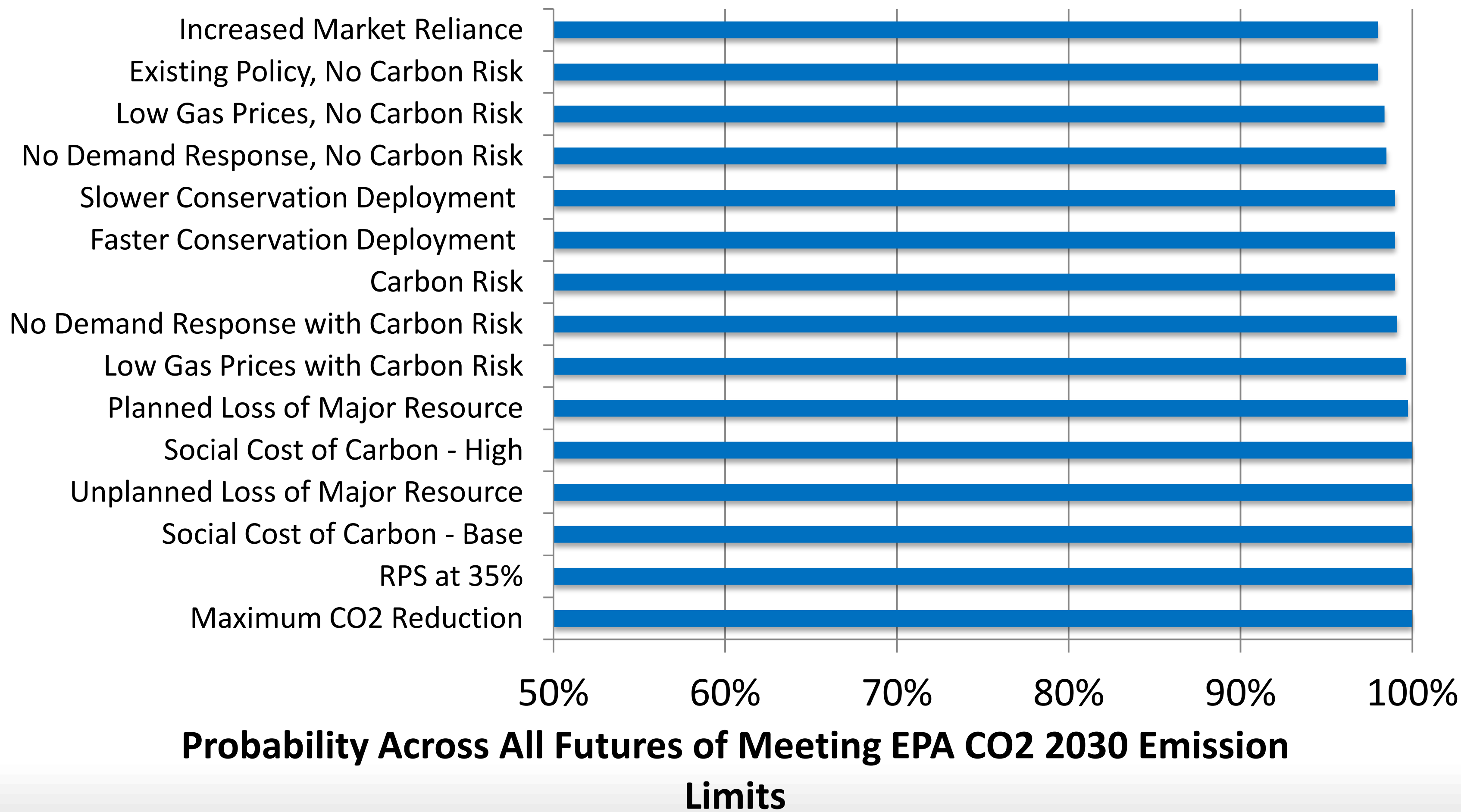
Key Finding:
The Probability of Thermal Development by 2026 Is Modest
Except In Scenarios That Assume All Coal Plant Retirements or Do Not Develop Demand Response



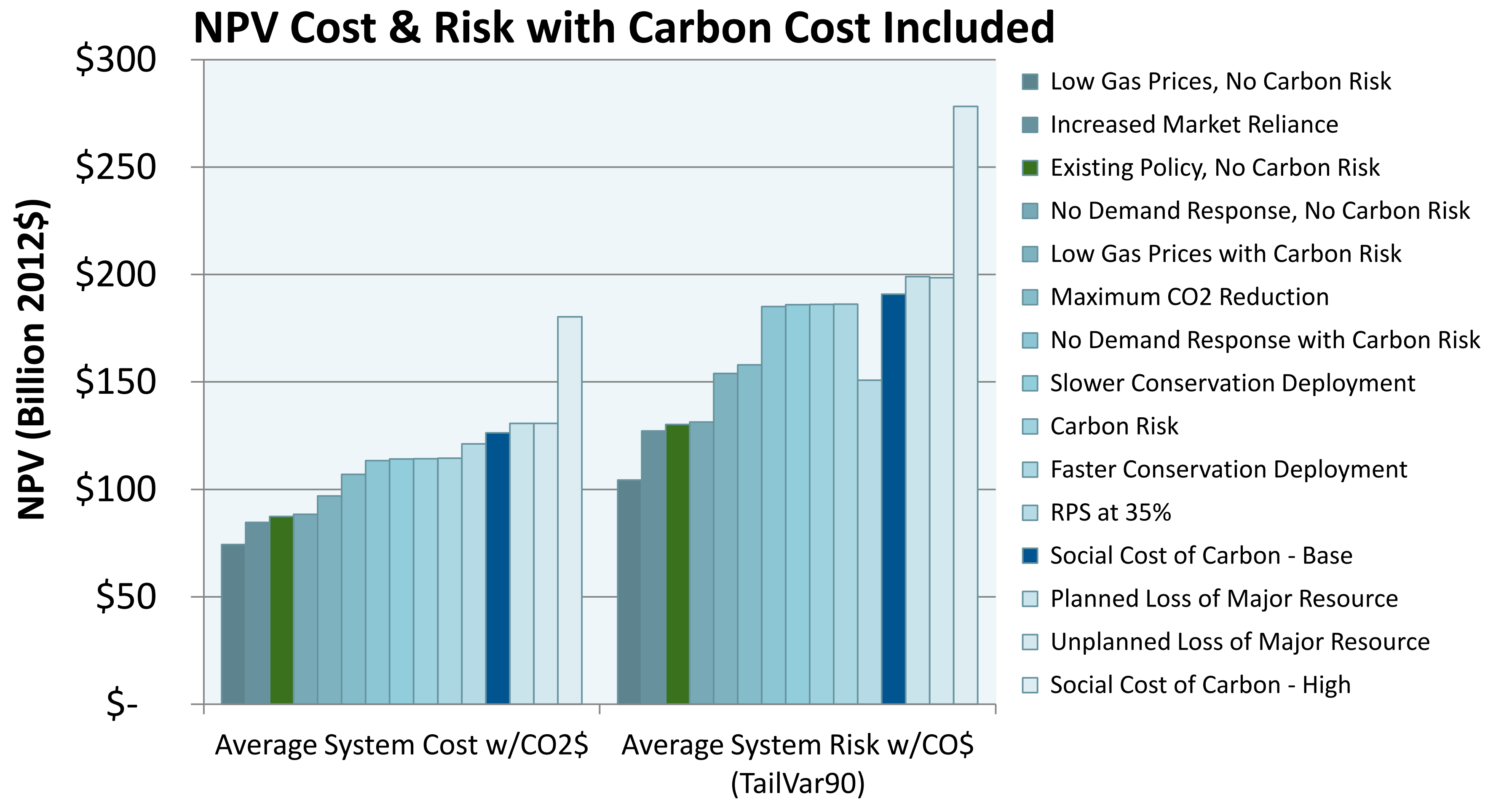
Key Finding:
Reduction of Regional Exports Generally Reduces Need for In Region Resource Development, Except with Increased RPS or When No Carbon Cost Risks Are Considered



Key Finding:
There is A Very High Probability of Meeting EPA 111(d) Emissions Limits Across All Scenarios and Future Conditions Tested



Least-Cost Strategies Have a Wide Range of Average Net Present Value System Cost



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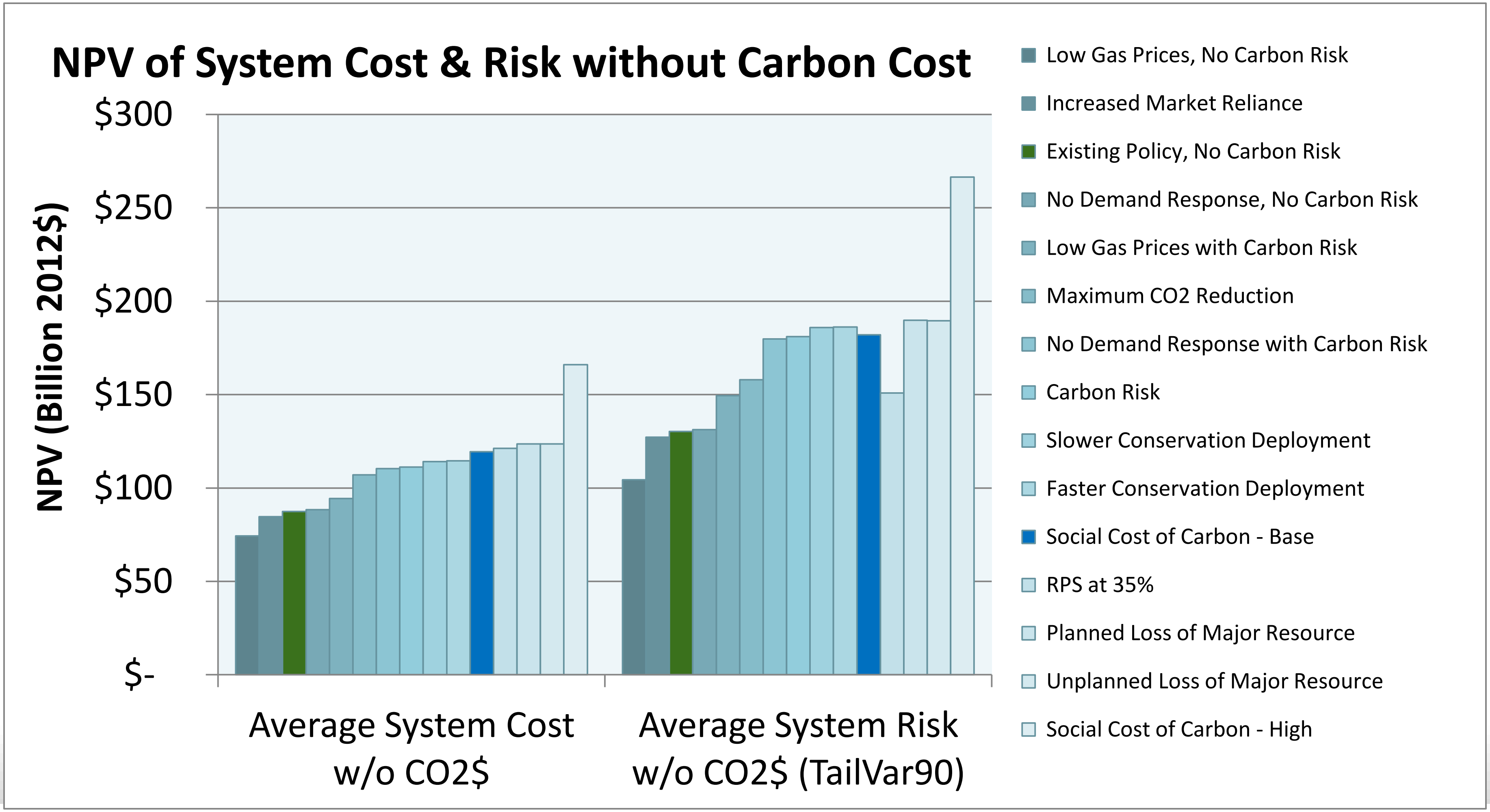
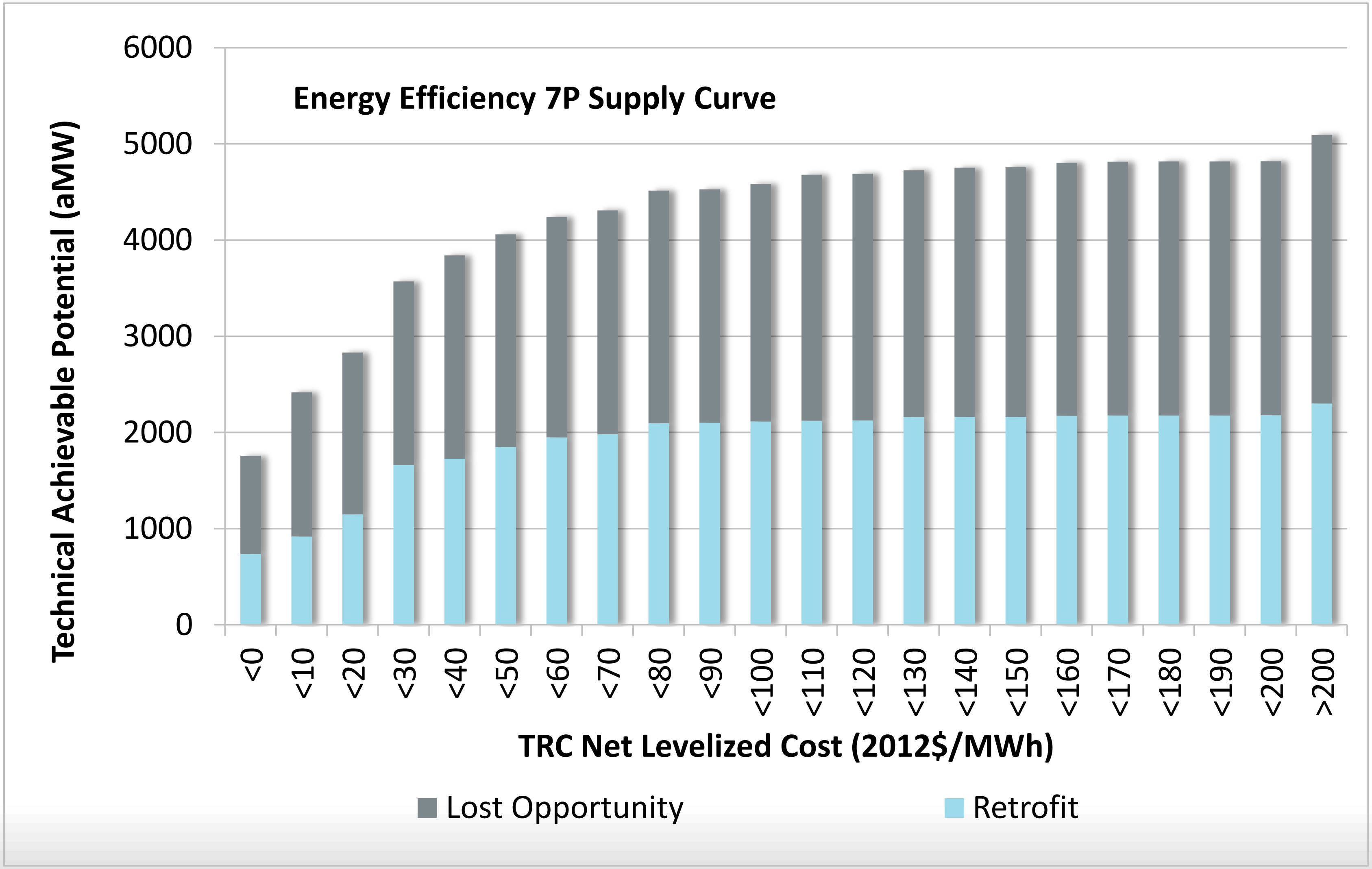
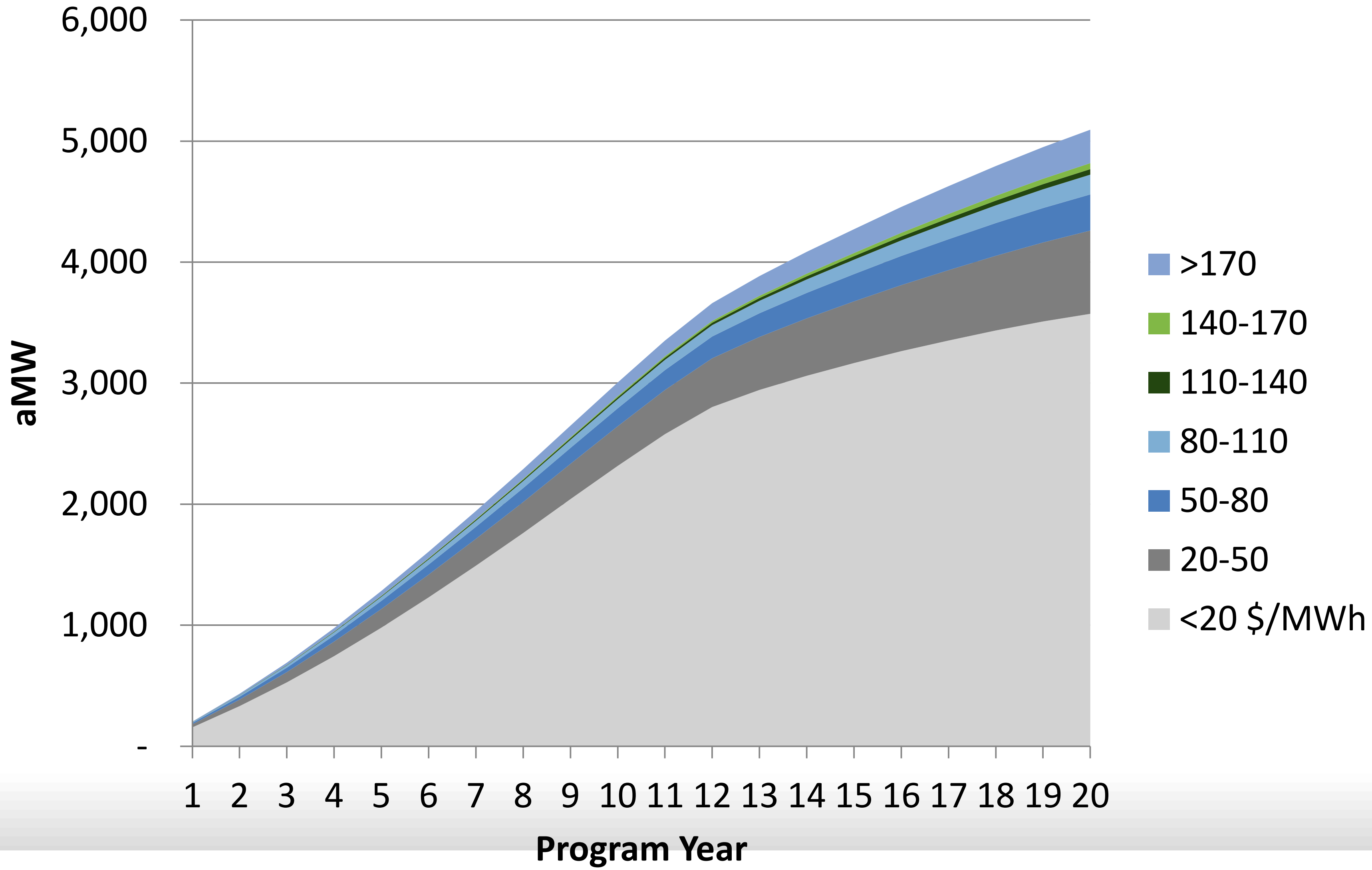


KEY FINDINGS ENERGY EFFICIENCY

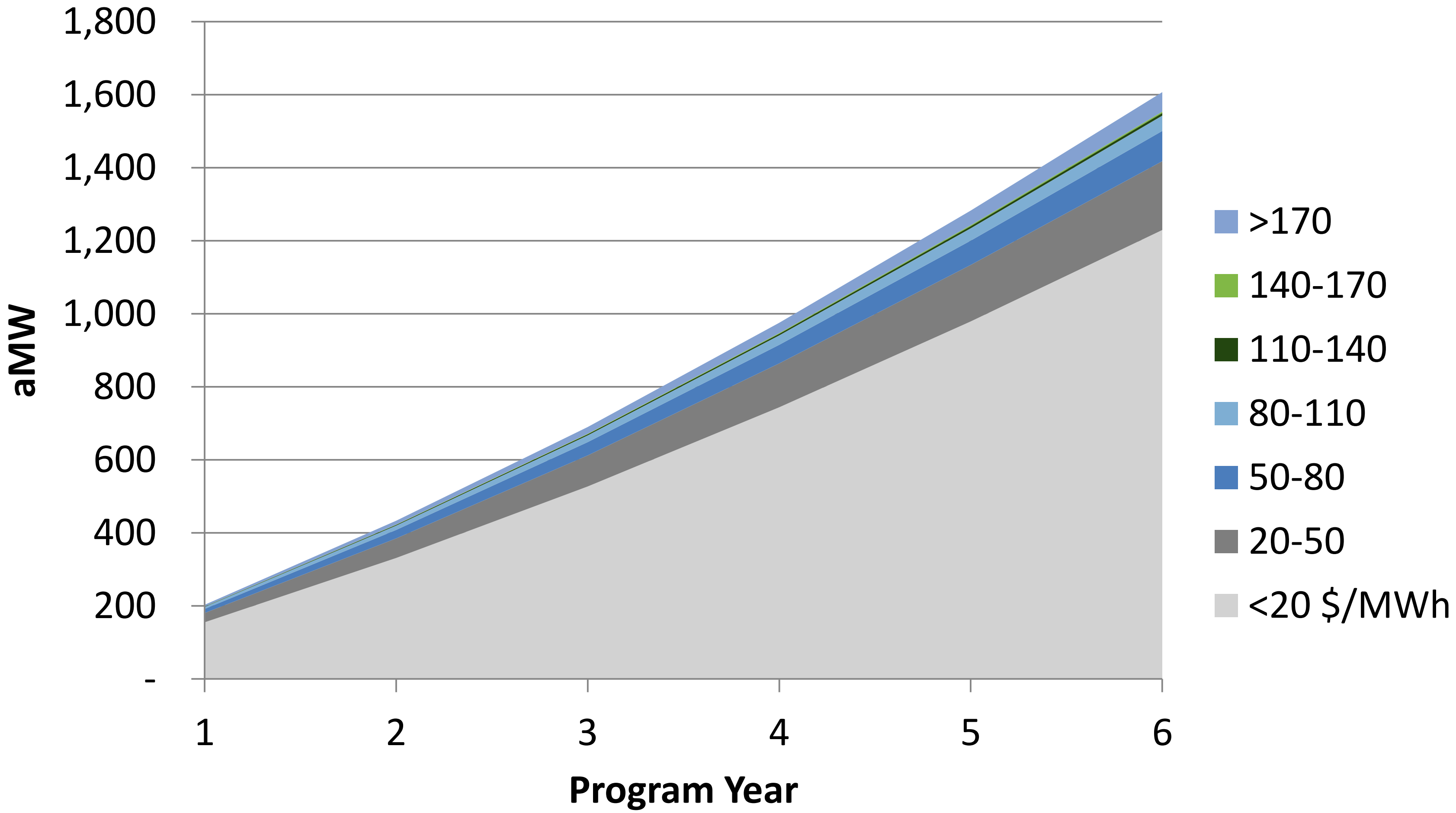
Reminder: Efficiency Inputs



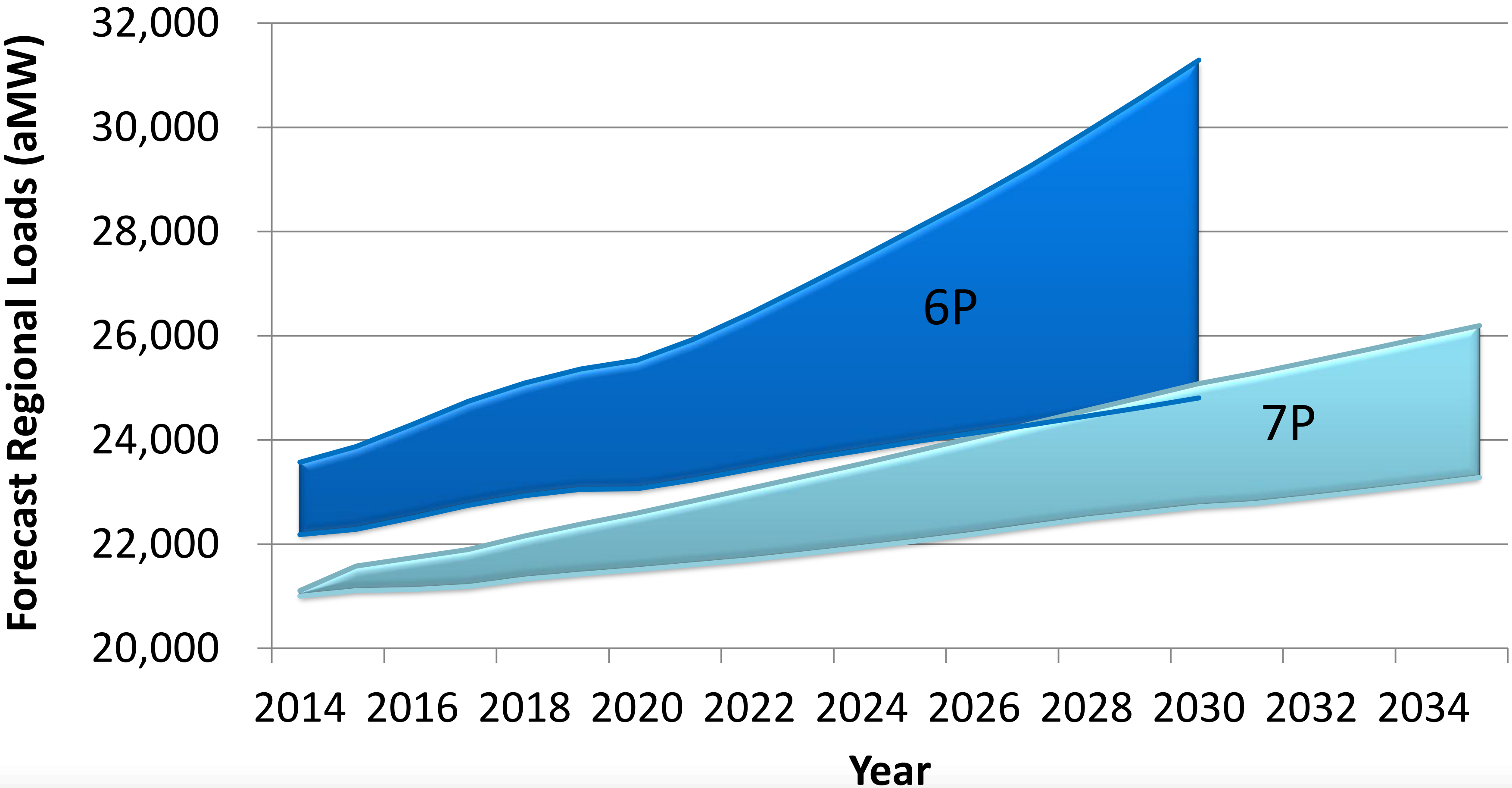
Reminder: Levelized Cost Bins



Reminder: Levelized Cost Bins



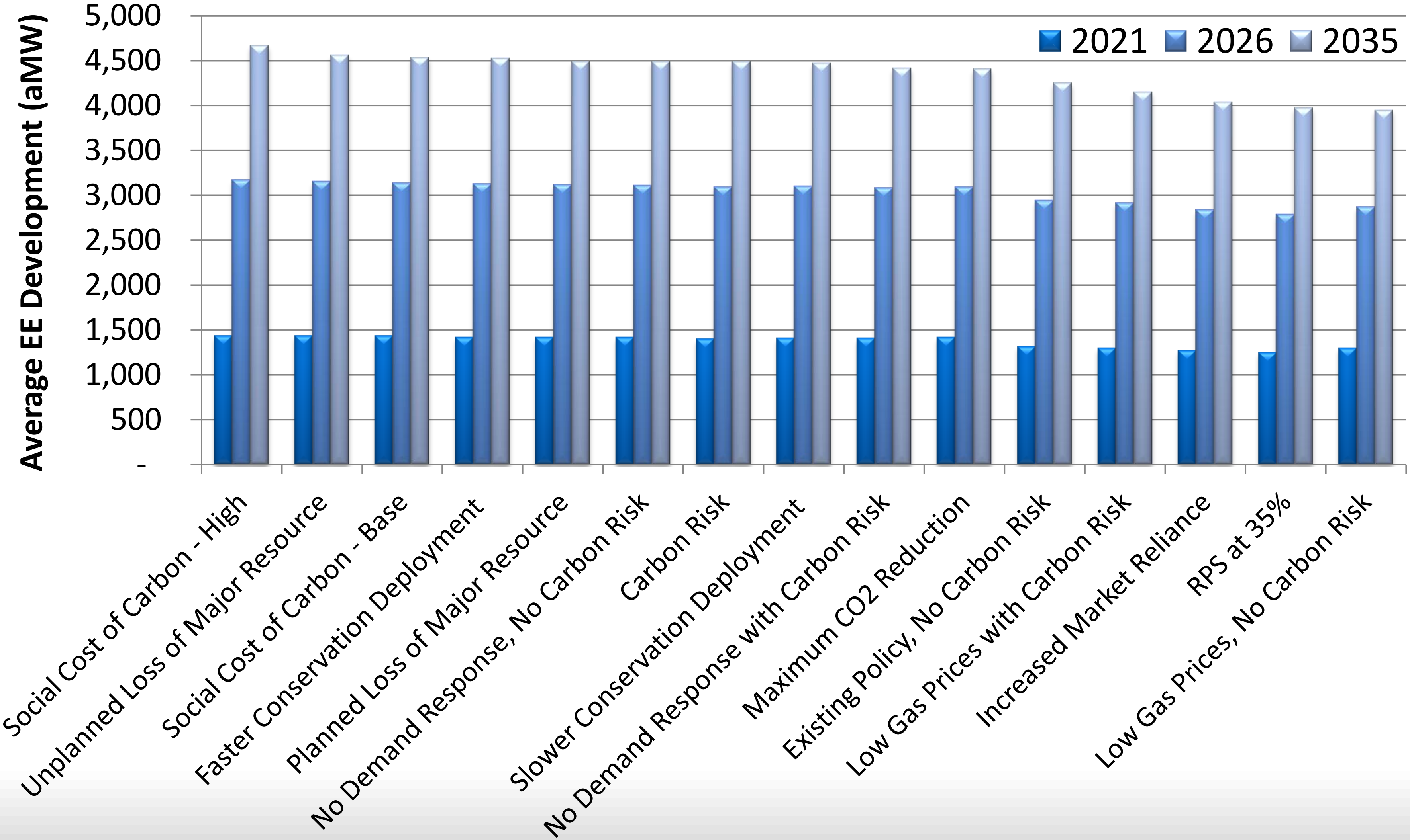
Reminder: Baseline Load Forecast is Lower & Narrower Range



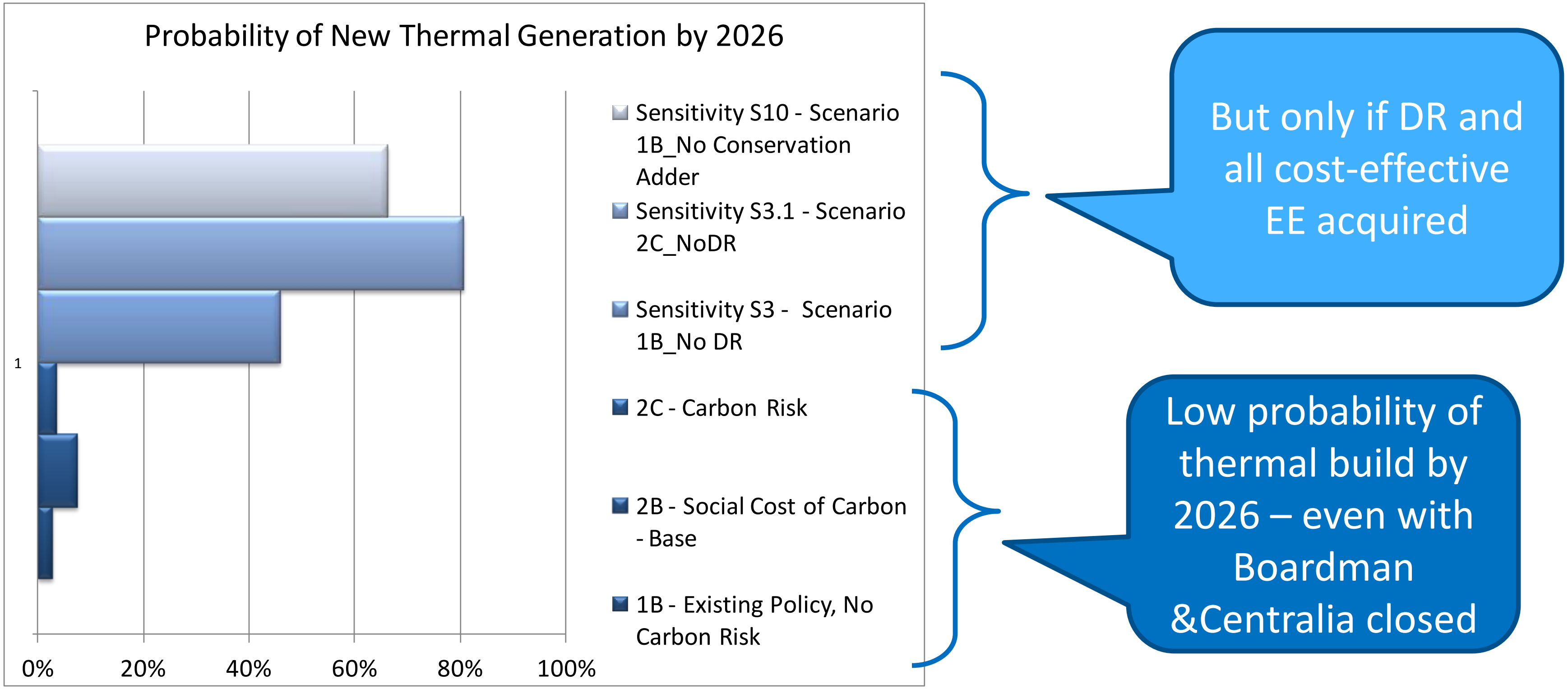
Key Findings EE

- Average conservation development varies little across scenarios
- Meet most (90%) load growth & retirement via EE & DR
- Build EE for energy if cheaper than market
  - Lots cheaper than market
- Build EE for adequacy when needed
  - Needed now in most cases
  - Adequacy need is bigger driver than ramp rates
  - Capacity value of EE is makes it a valuable resource for system adequacy
- Narrow range of development of EE within a scenario
- High system cost of buying only spot market price EE
- External Market assumptions impact EE build for adequacy
- Not much difference between Lost Opp vs Retrofit

Key Finding:
Average Conservation Development Across Scenarios Varies Little Across Scenarios Except Under Sustained Low Gas Prices and Increased RPS



Most Load Growth Met with EE & DR

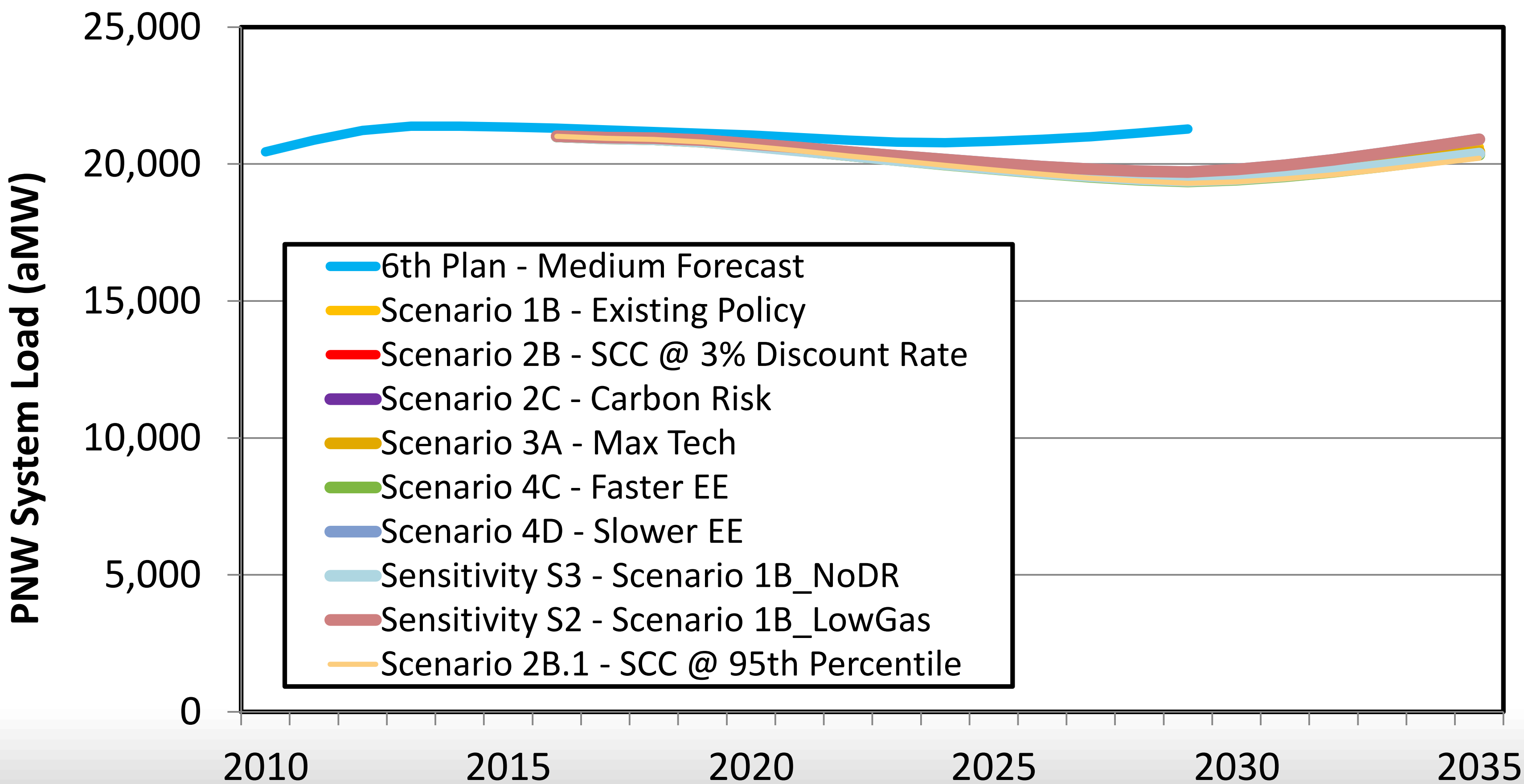


- Under 90 percent of the futures energy efficiency meets all load growth through 2030 and under 60 - 70 percent of the futures all load growth through 2035

Meet Most Load Growth with EE & DR

Net Load After Conservation Is Relatively Flat

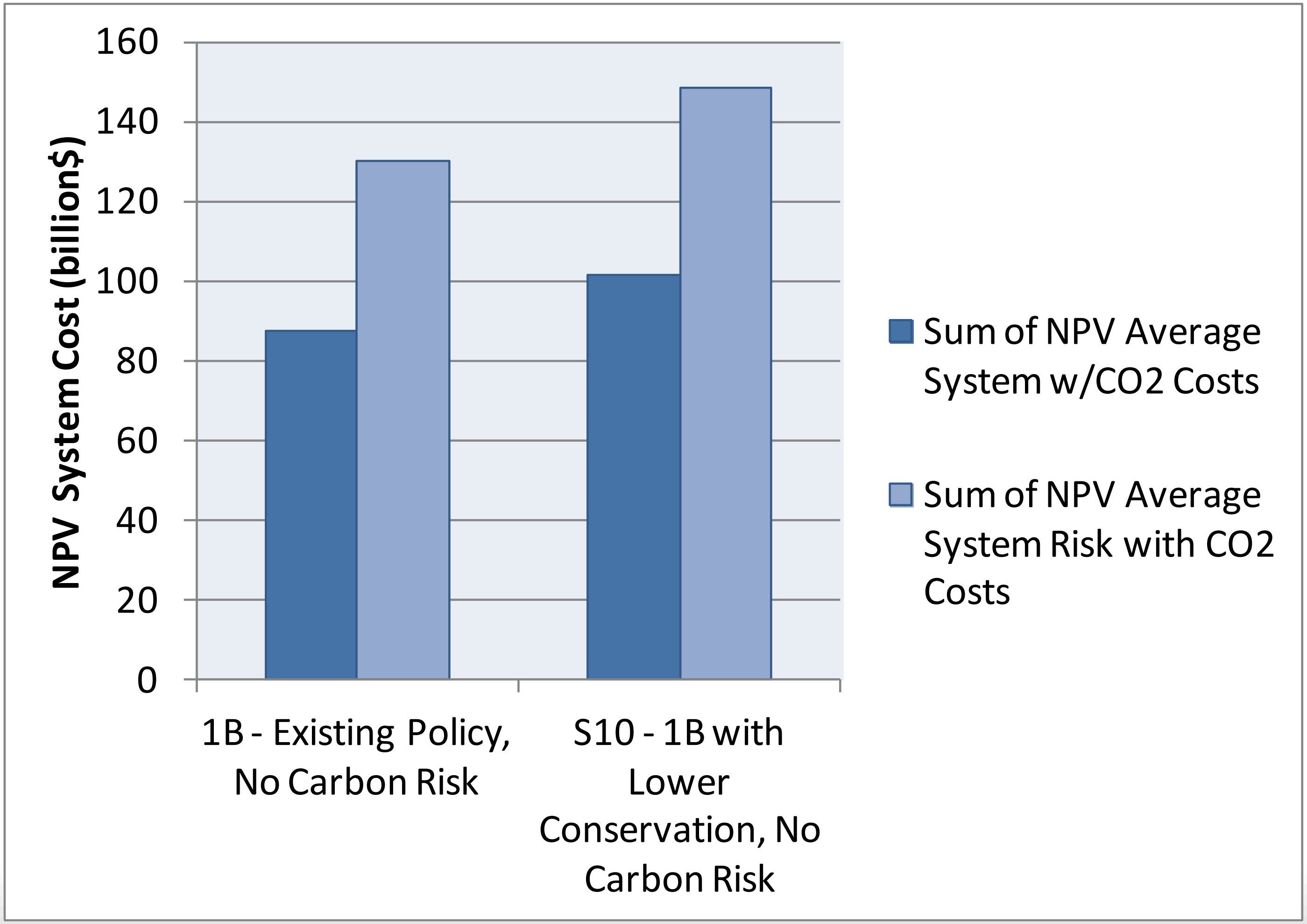
Least Cost Strategies for All Scenarios Have Similar Net Loads as 6P Loads Net of Conservation



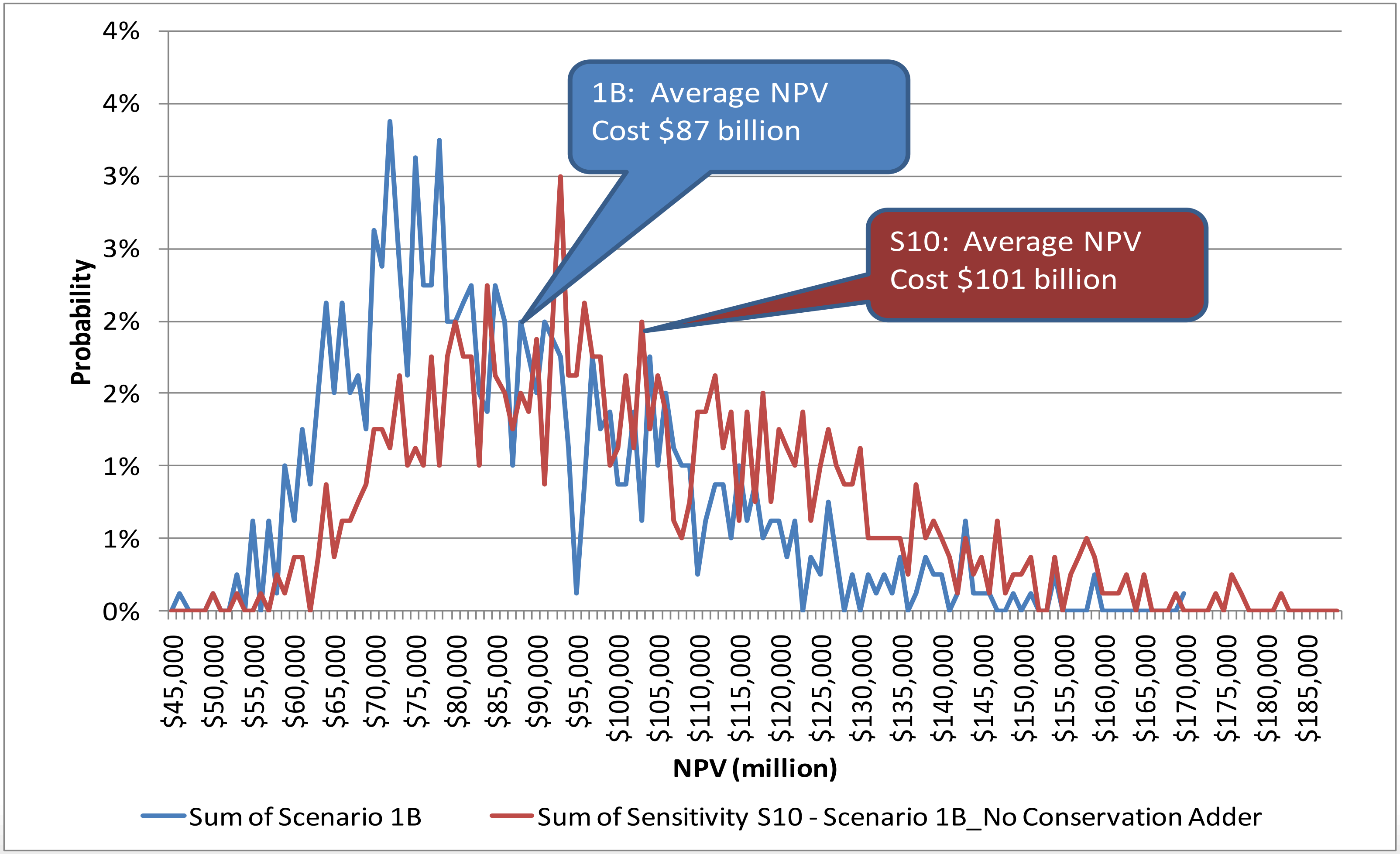
Least-Cost Plans Build EE Greater Than Spot Market Price

- Always builds EE cheaper than spot market
- Builds EE if needed for system adequacy (ARM for capacity or energy)
- Builds EE for adequacy starting 2016 in most futures
- Compare Scenario 1B and Sensitivity s10
  - S10 limits EE build to spot-market price

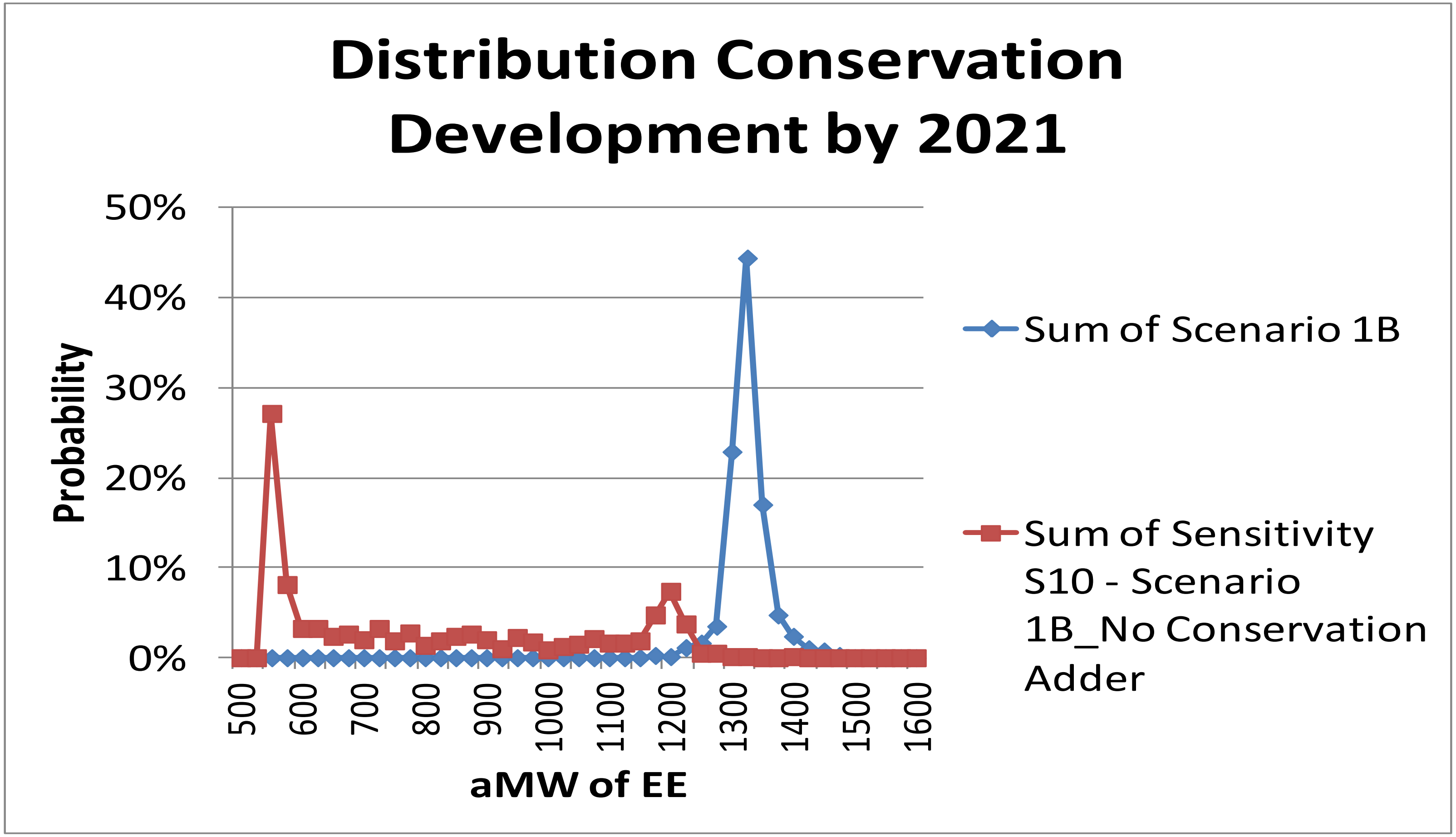
Strategies Using Spot Market Price for EE Avoided Cost Are More Expensive & Risky



But NPV System Cost Much Higher

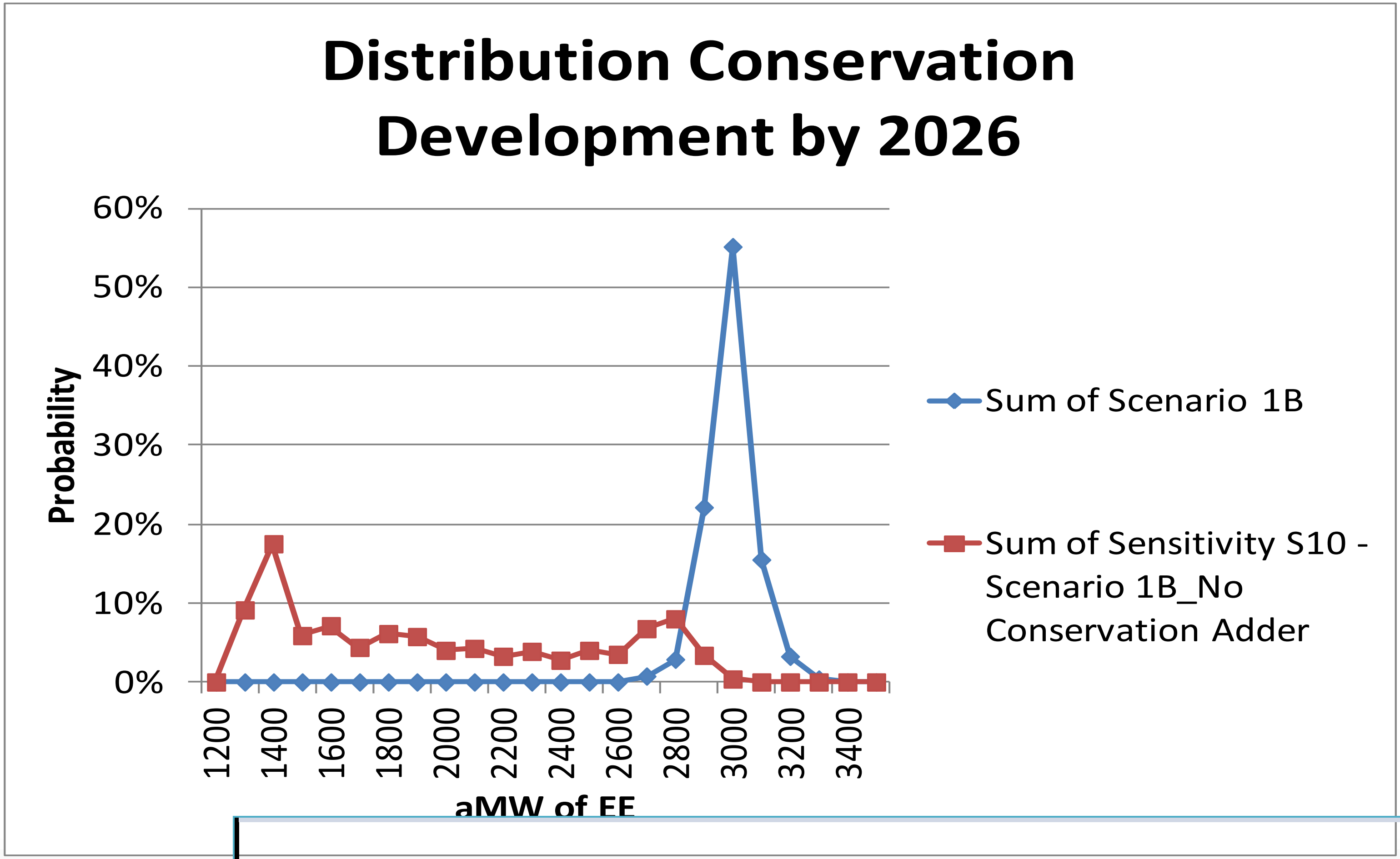


Least-Cost Strategies Build More EE Than Strategy Using Spot Market Price Avoided Cost



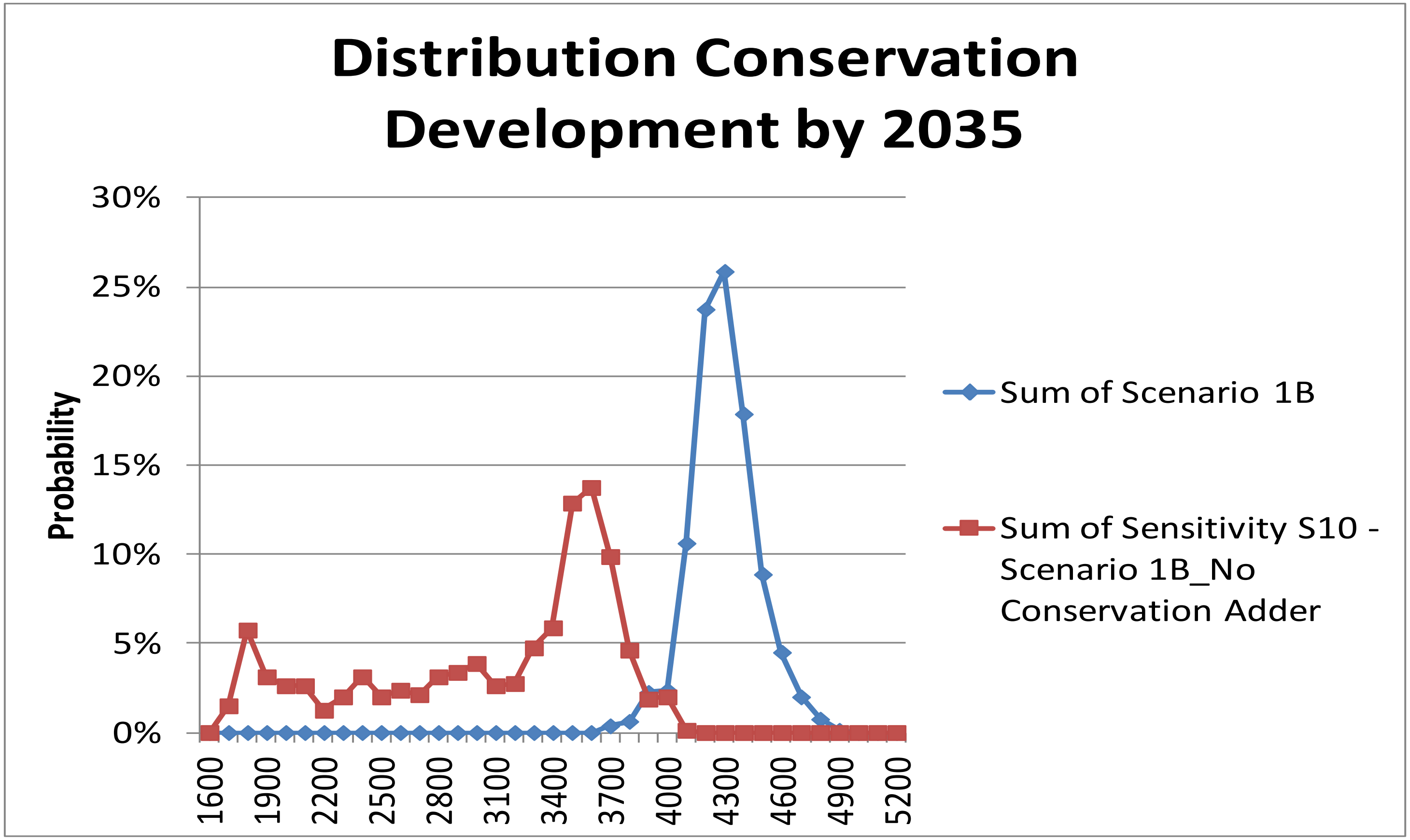
Scenario 1B: Existing Policy, No Carbon Risk

Least-Cost Strategies Build More EE Than Strategy Using Spot Market Price Avoided Cost



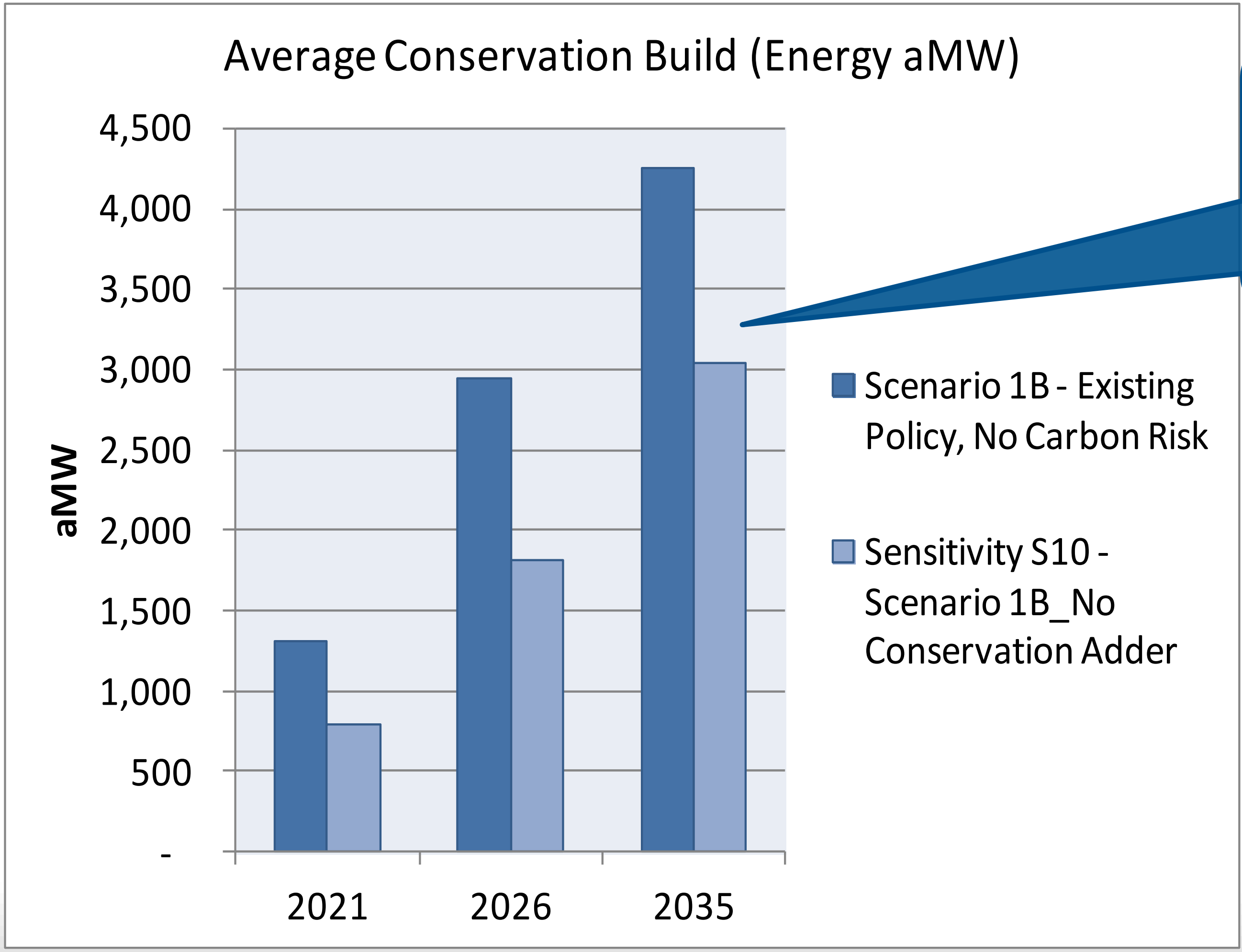
Scenario 1B: Existing Policy, No Carbon Risk

Least-Cost Strategies Build More EE Than Strategy Using Spot Market Price Avoided Cost



Scenario 1B: Existing Policy, No Carbon Risk

What About Only Building EE if Less Costly than Short Term Market Price?

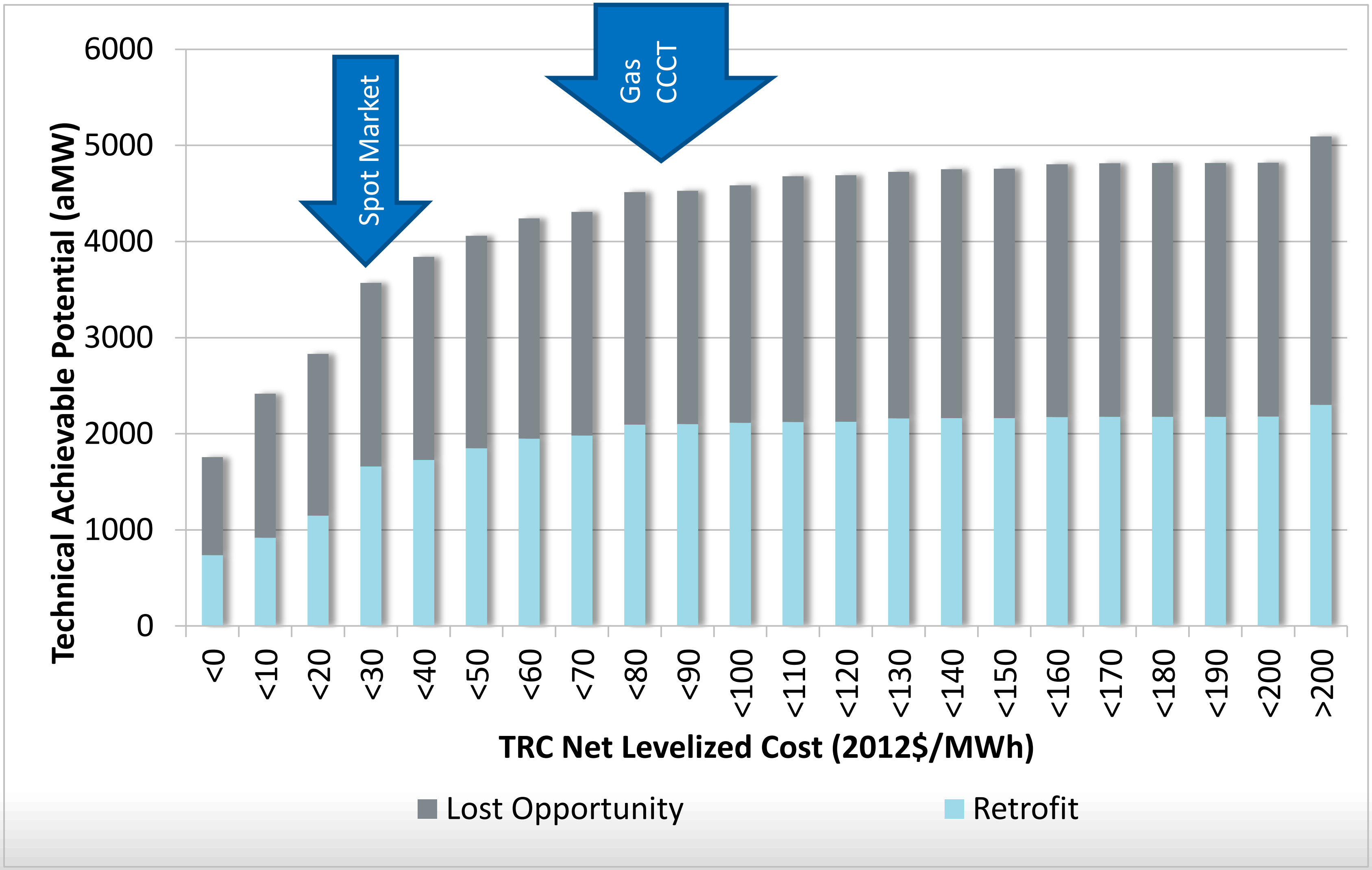


Big drop in Least-Cost EE Strategy

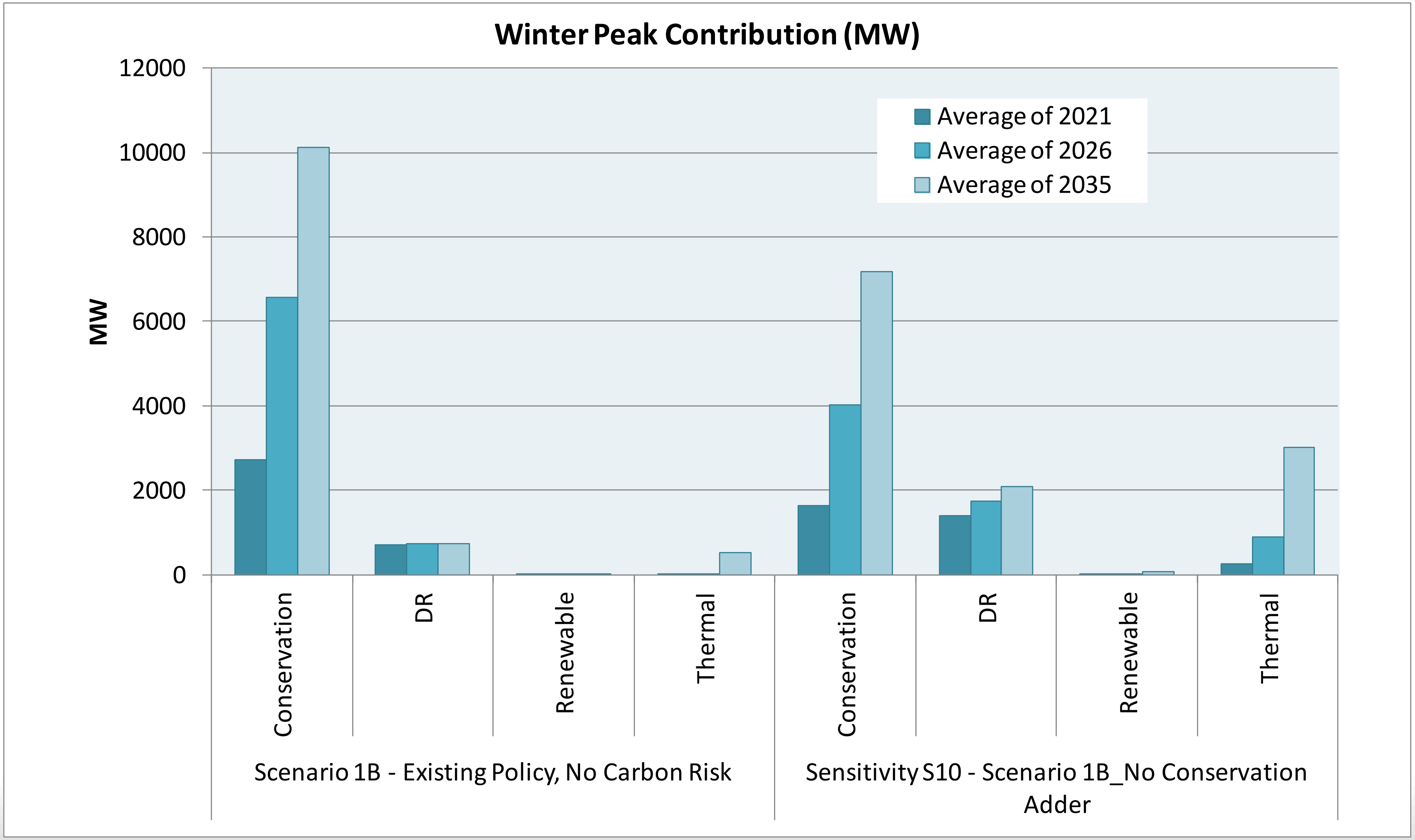
Why Build EE Over Spot Market?

- Most futures need resources for system adequacy (energy or capacity)
- EE is cheaper than other resources that can be used for system adequacy

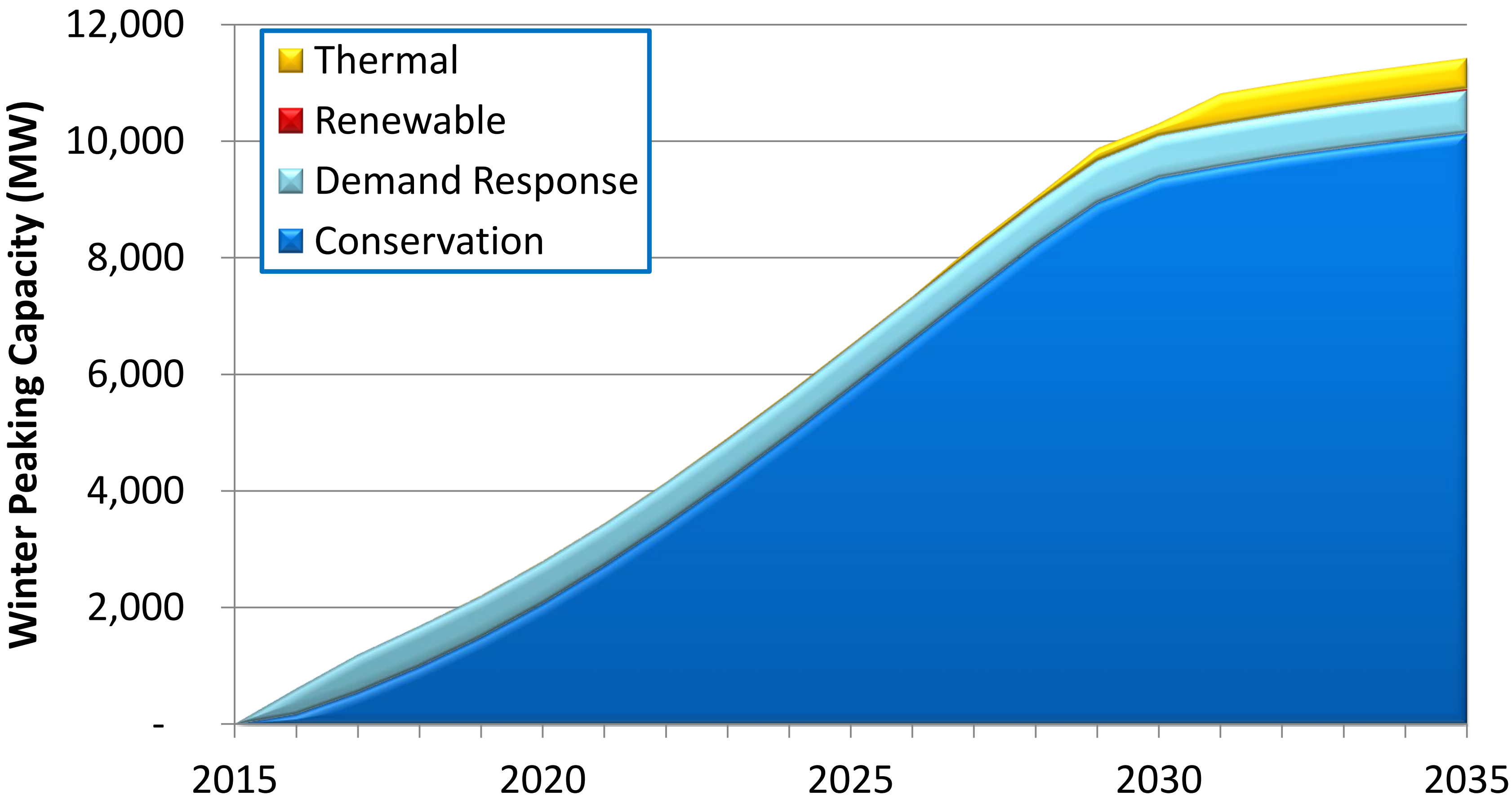
Lots of EE Between Spot Market Price & Cost of New Generation



Because More Expensive Resources Fill the Gap

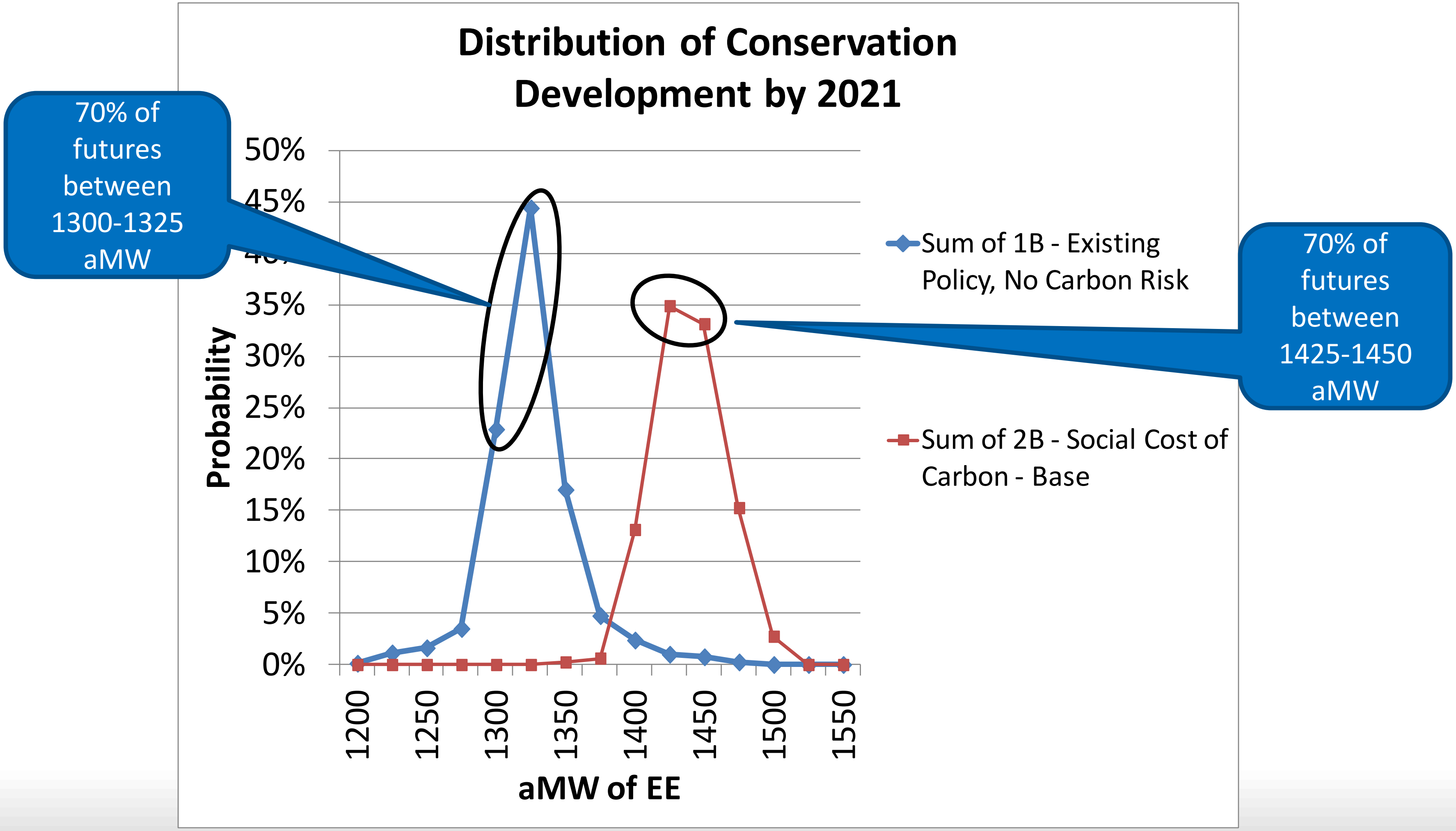


Conservation is the *Single Largest Source* of Winter Peak Development in Least Cost Resource Strategies

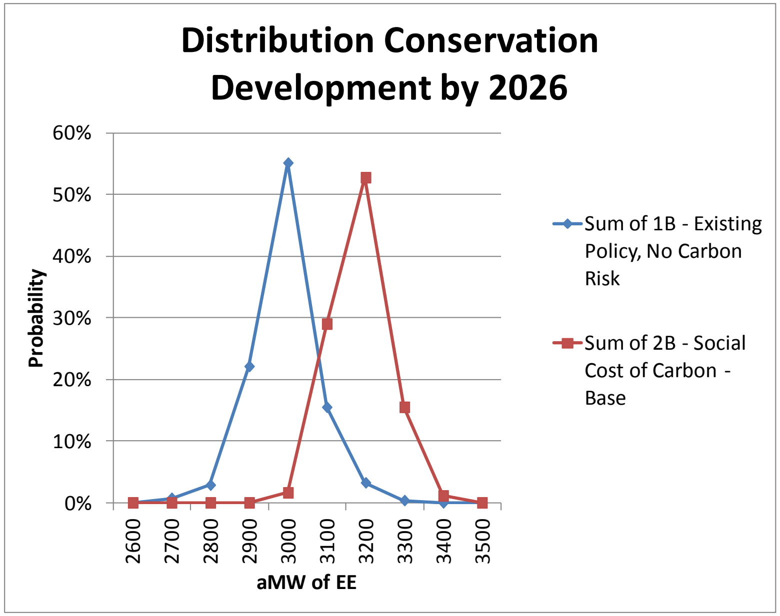


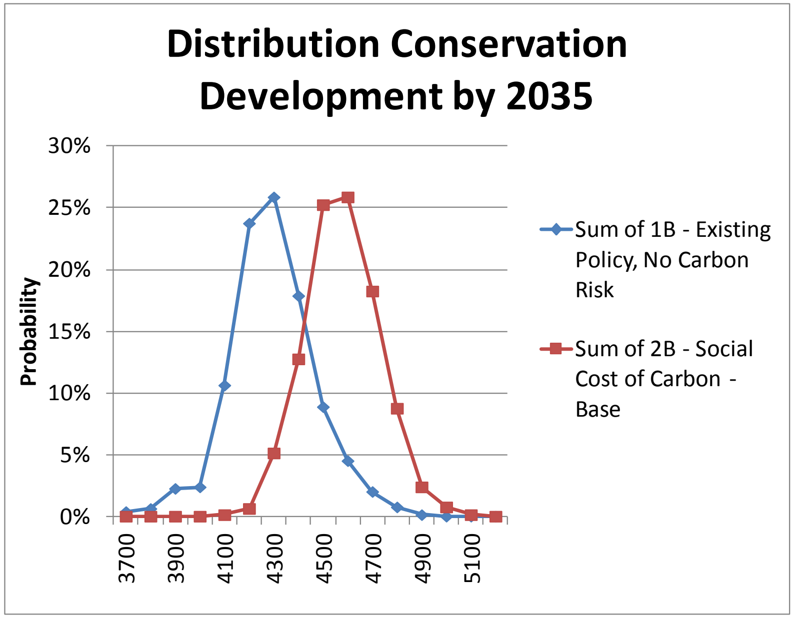
Scenario 1B: Existing Policy, No Carbon Risk

Narrow Range of EE Build For Least-Cost Strategies Across 800 Futures within a Scenario



Narrow Distribution Later Too

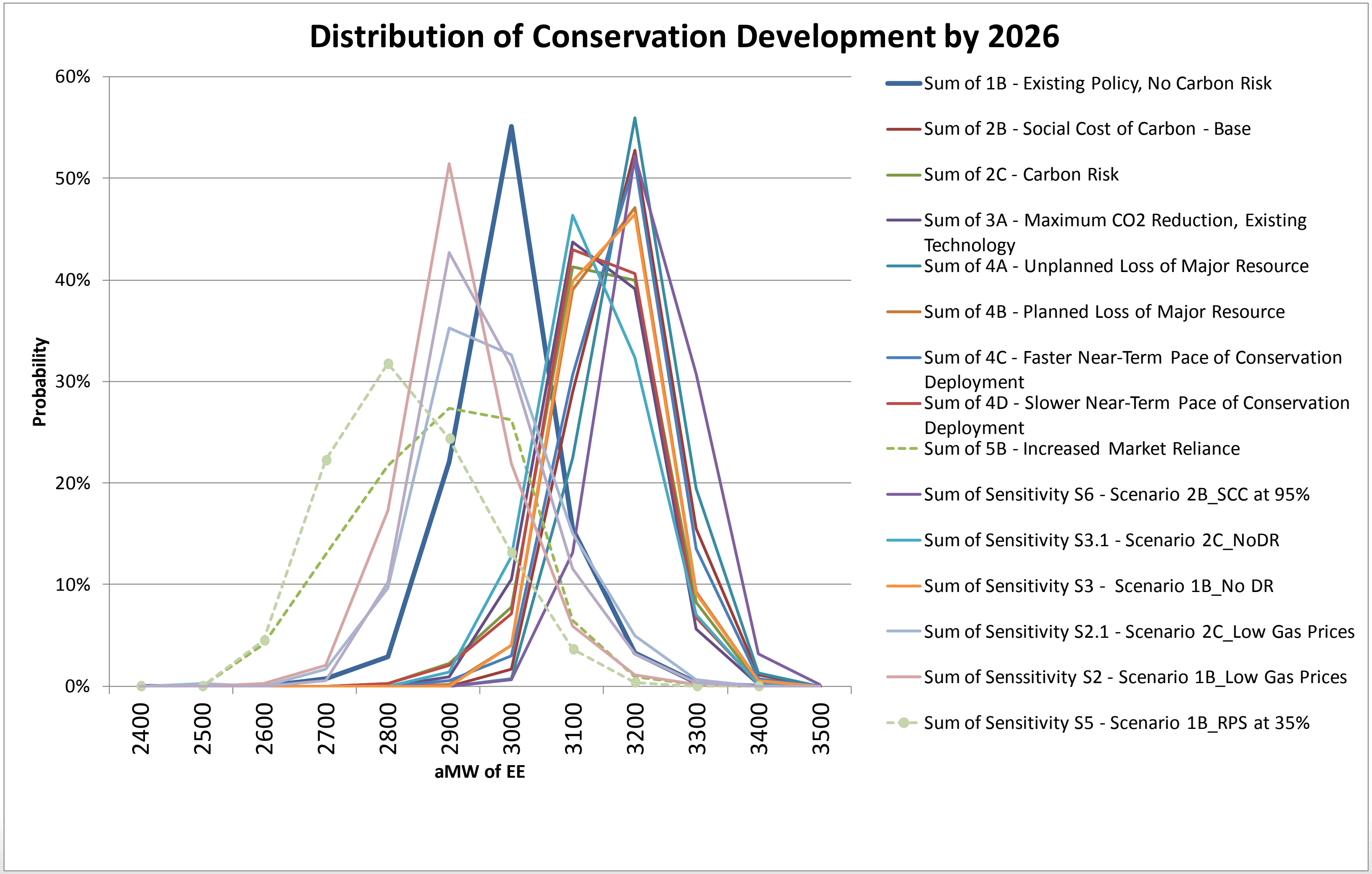




Plus or minus 100 aMW from mean by 2026 (+-3%) for ~90% of futures

Plus or minus 200 aMW from mean by 2035 (+-5%) for ~90% of futures

Most Scenarios Show Narrow Ranges of EE Build for Least-Cost Resource Strategies



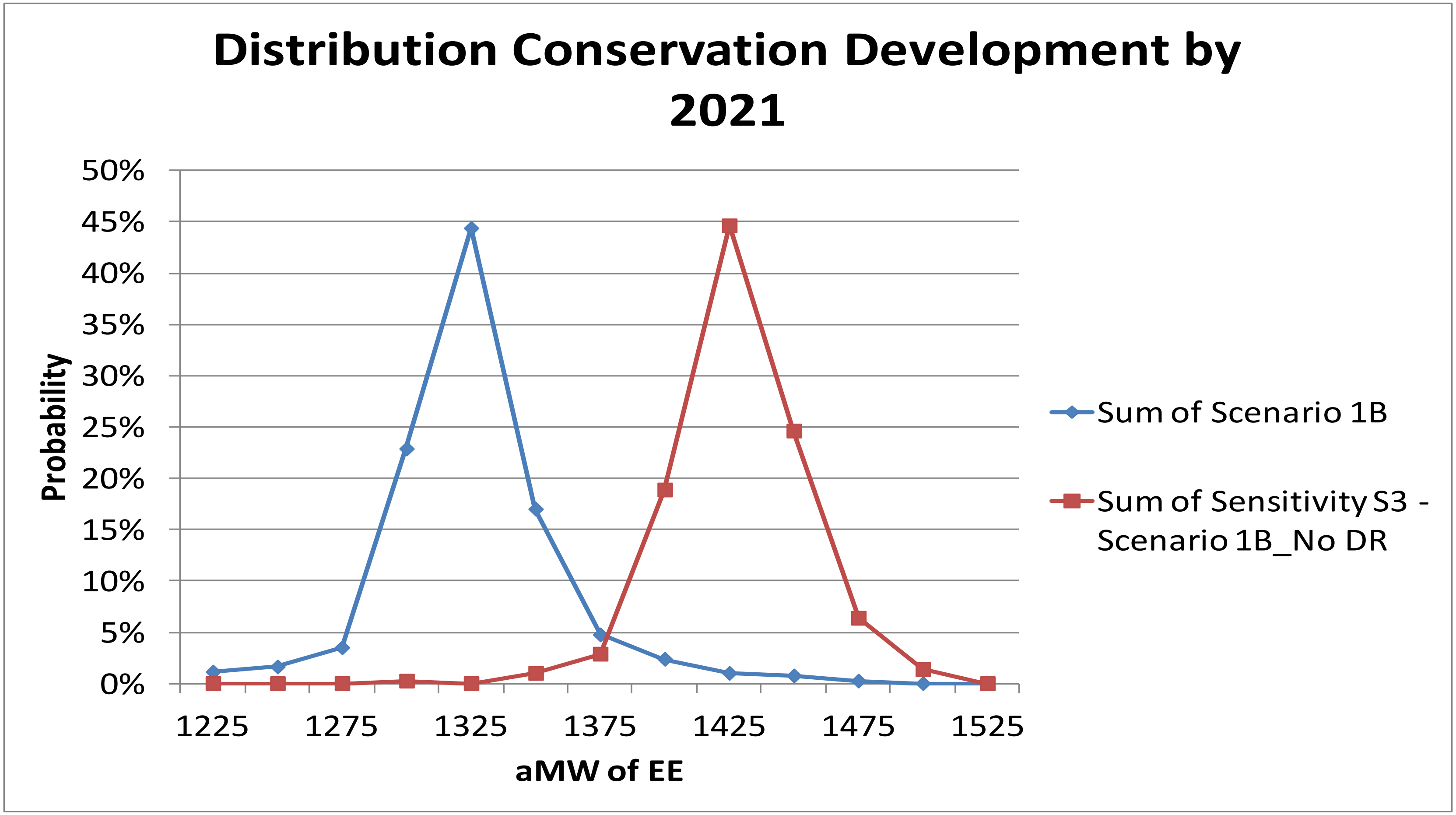
Why Narrow Range of EE Build?

- Building for adequacy in near term
- Reduced range of uncertainties
  - Gas price, load forecast, fixed carbon scenarios
- Most variance due to changes in growth
  - Higher EE potential when more new additions
  - Narrow range of load growth

Building for Adequacy?

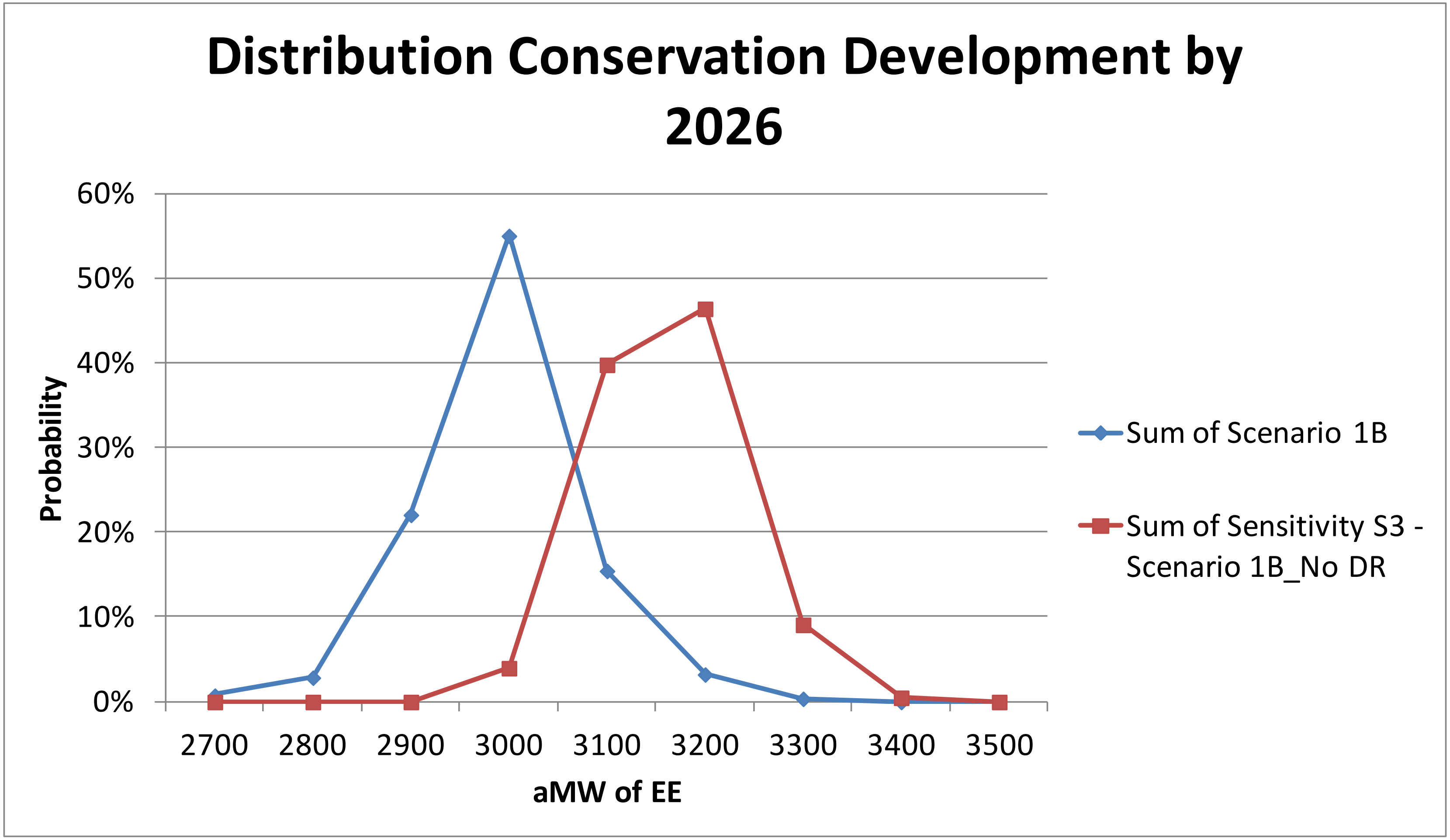
- Compare 1B with and without DR

With No DR, More EE Built 2021



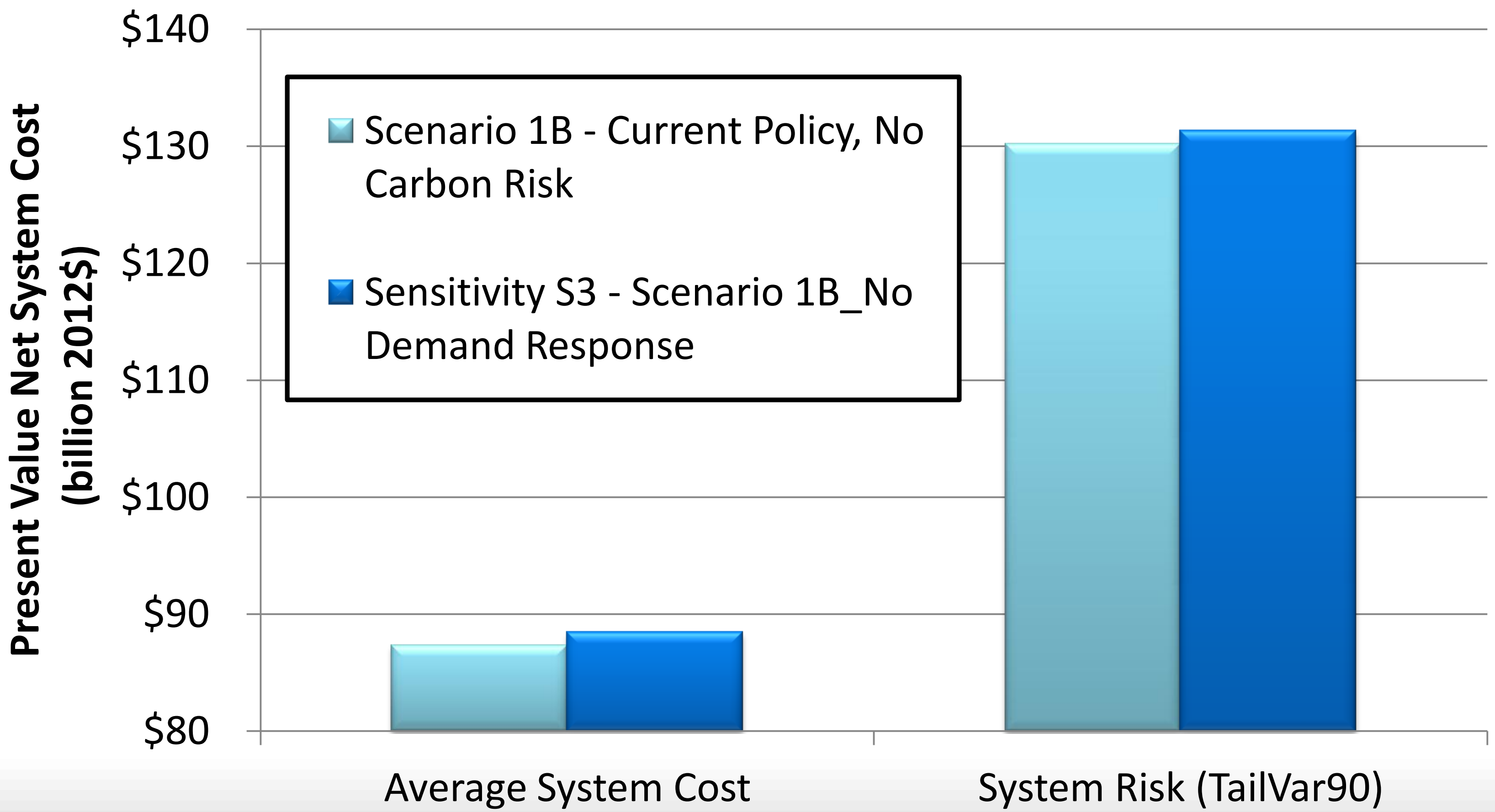
Scenario 1B: Existing Policy, No Carbon Risk

With No DR, More EE Built 2026



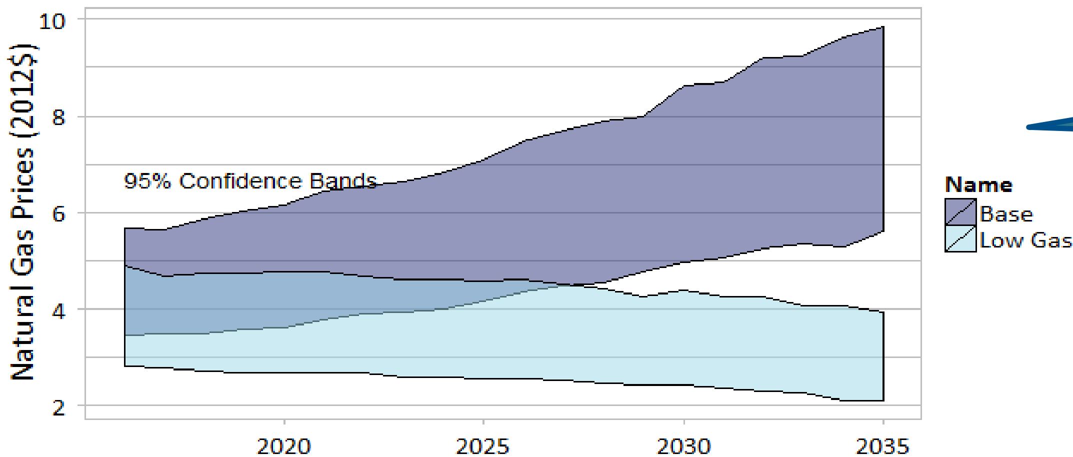
Scenario 1B: Existing Policy, No Carbon Risk

Sensitivity S3 – No Demand Response Without DR Both Net Present Value System Cost and System Risk Increase by ~$1 billion



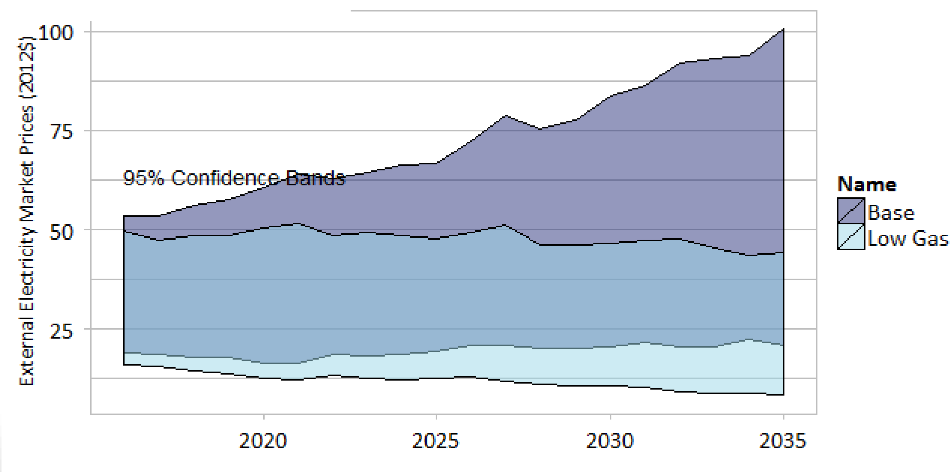
What About Low Gas Prices?

Scenario S2: Lower Gas & Electric Spot-Market Prices

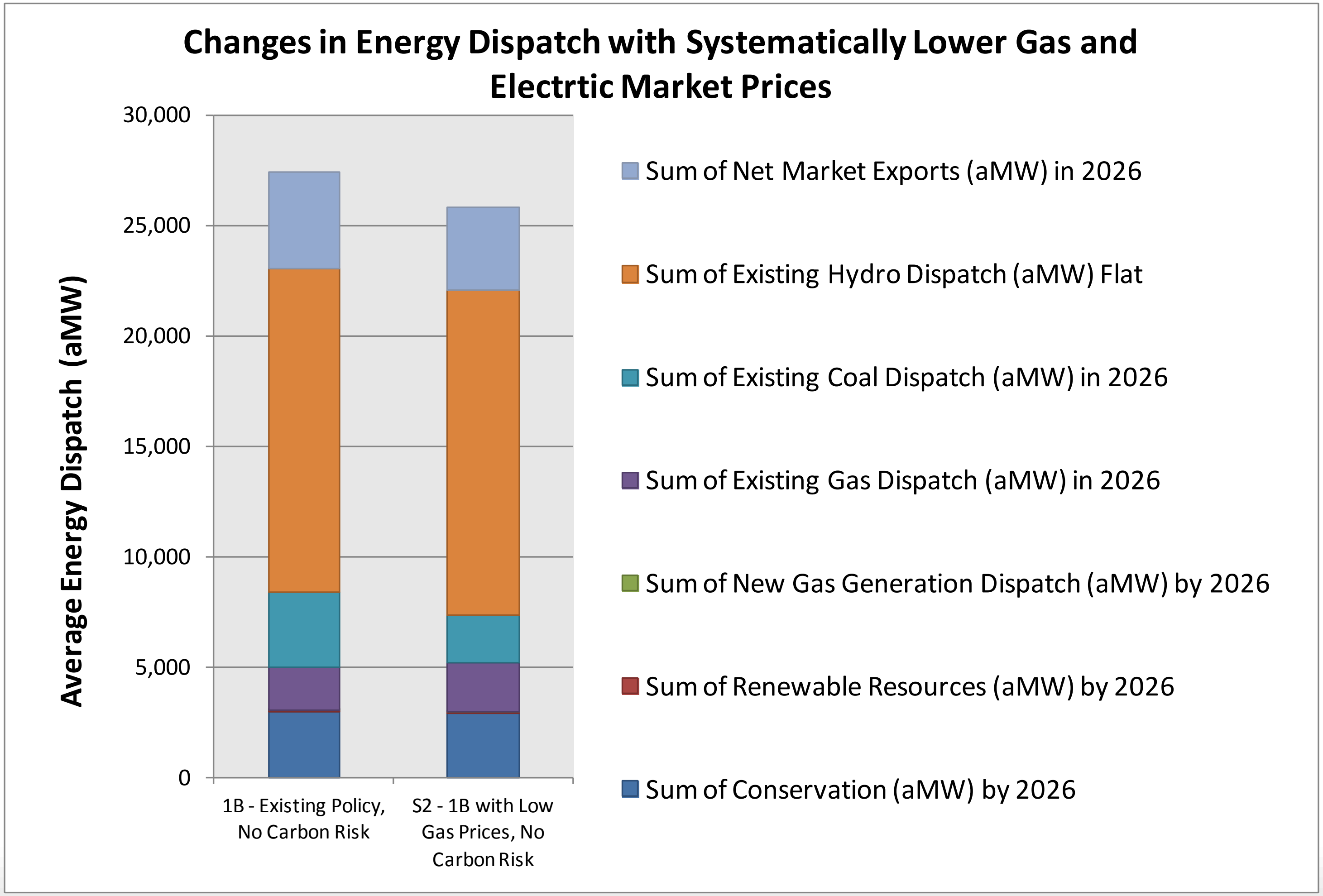


Natural Gas Prices (95% CI)

Spot Market Electricity Prices (95% CI)



Lower Gas Prices Reduce Coal Use & Exports, Increase Gas Use, Little Change in EE

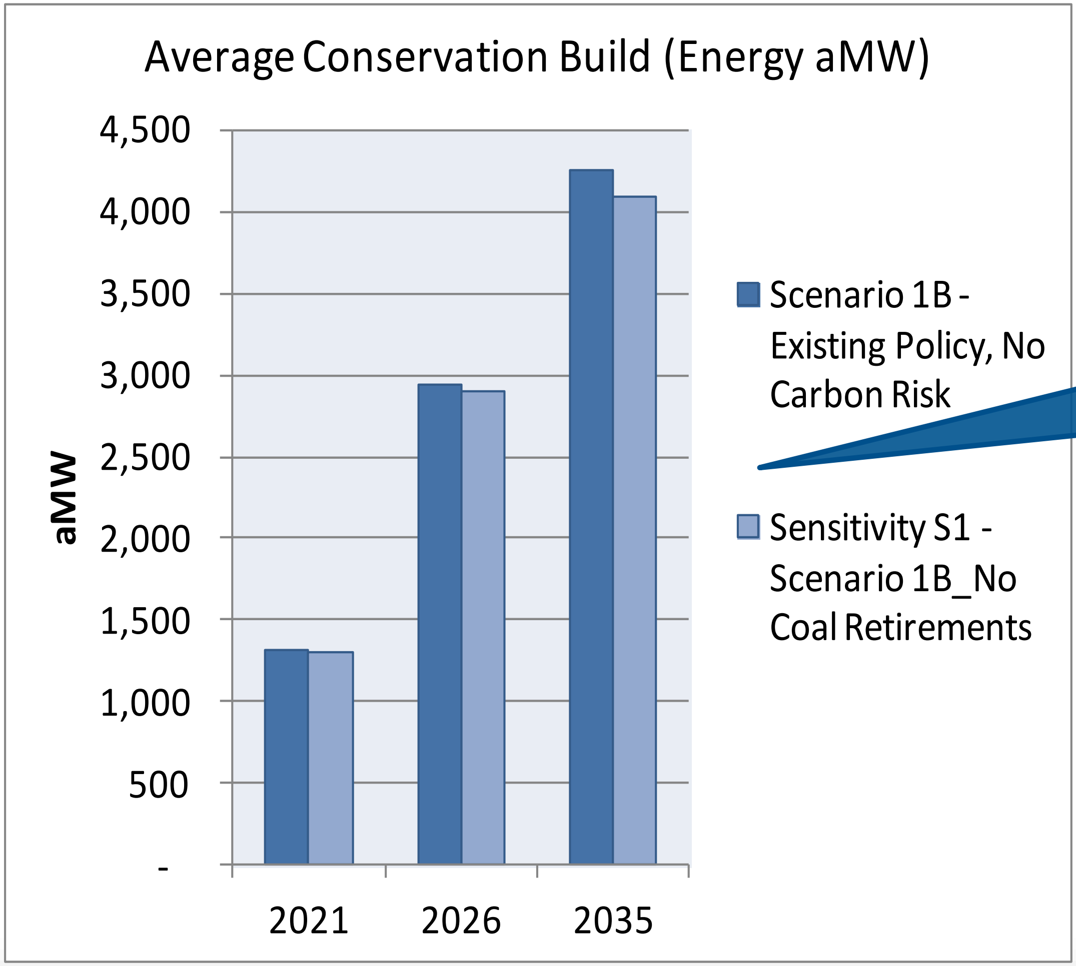


Results of Sensitivity Study S2
Scenario1B – Existing Policy, No Carbon Risk, Low Gas Prices

Compared to 1B – Existing Policy, No Carbon Risk

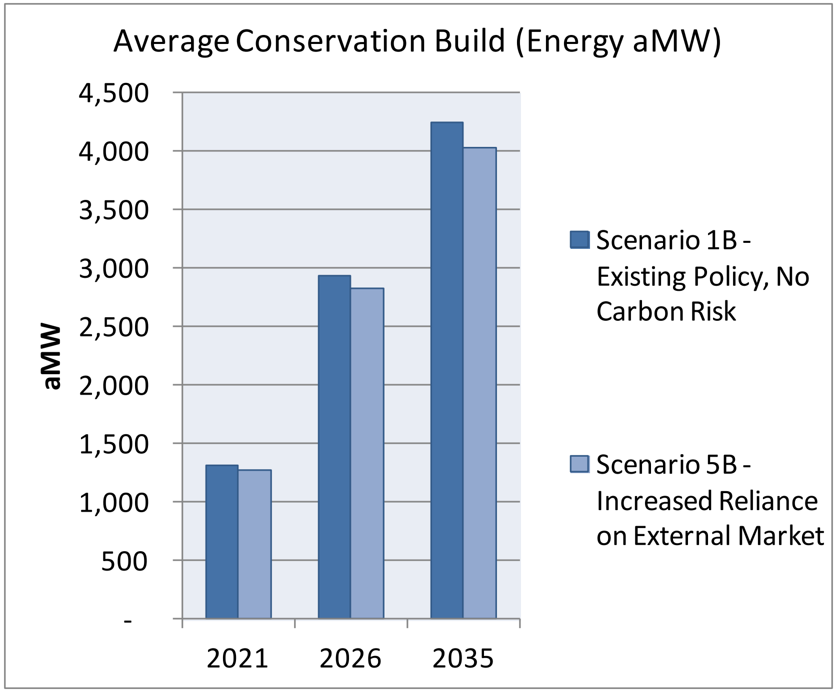
- Slightly decrease conservation
  - -17 aMW by 2021
  - -74 aMW by 2026
  - -300 aMW by 2035
- Demand response development is nearly identical
- Slightly change in renewables
  - 40 aMW by 2021
  - -90 aMW by 2035
- Large reduction coal generation
  - -1800 aMW in 2021
  - -1150 aMW in 2026
  - -1050 aMW in 2035
- Slightly increased new natural gas generation
  - +35 aMW in 2035
- Slightly increased existing natural gas generation
  - +235 aMW in 2021 and 2026
  - +125 aMW in 2035
- Slightly decreased regional exports
  - - 390 aMW in 2021
  - -540 aMW in 2026
  - -1375 aMW in 2035

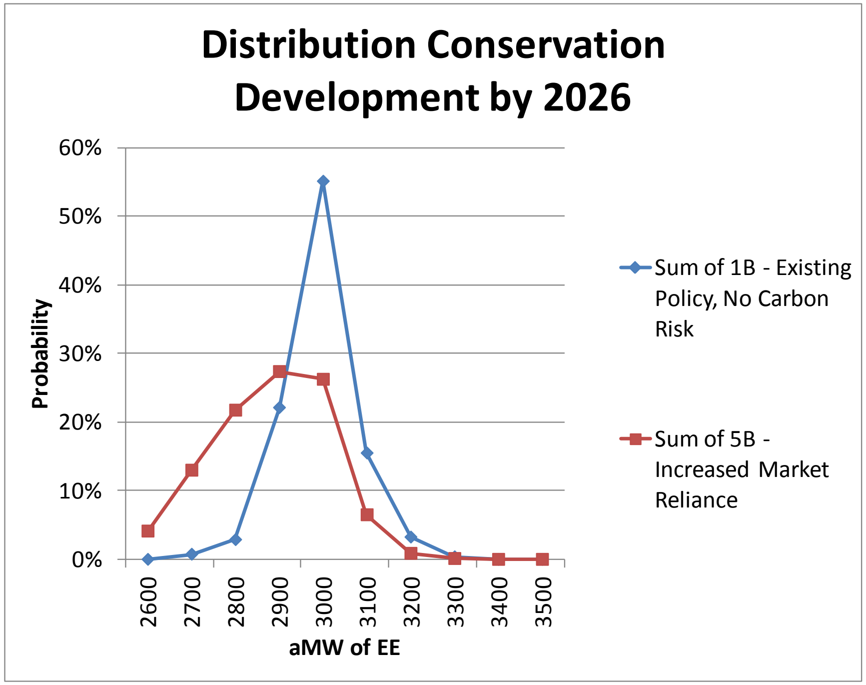
What if Boardman & Centralia Don't Retire?



Minor change in least-cost EE strategy

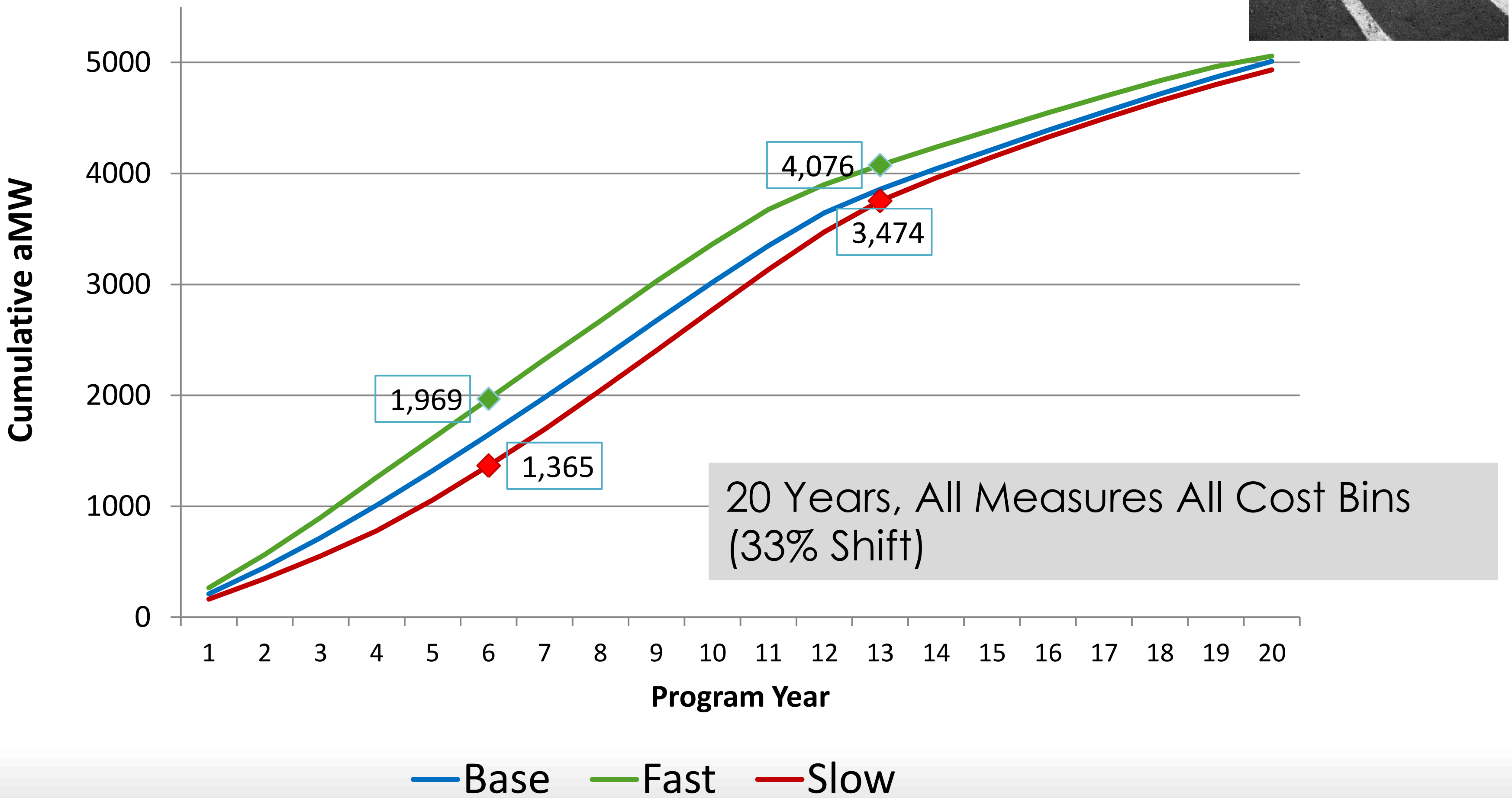
What if We Could Import More Power for Adequacy?



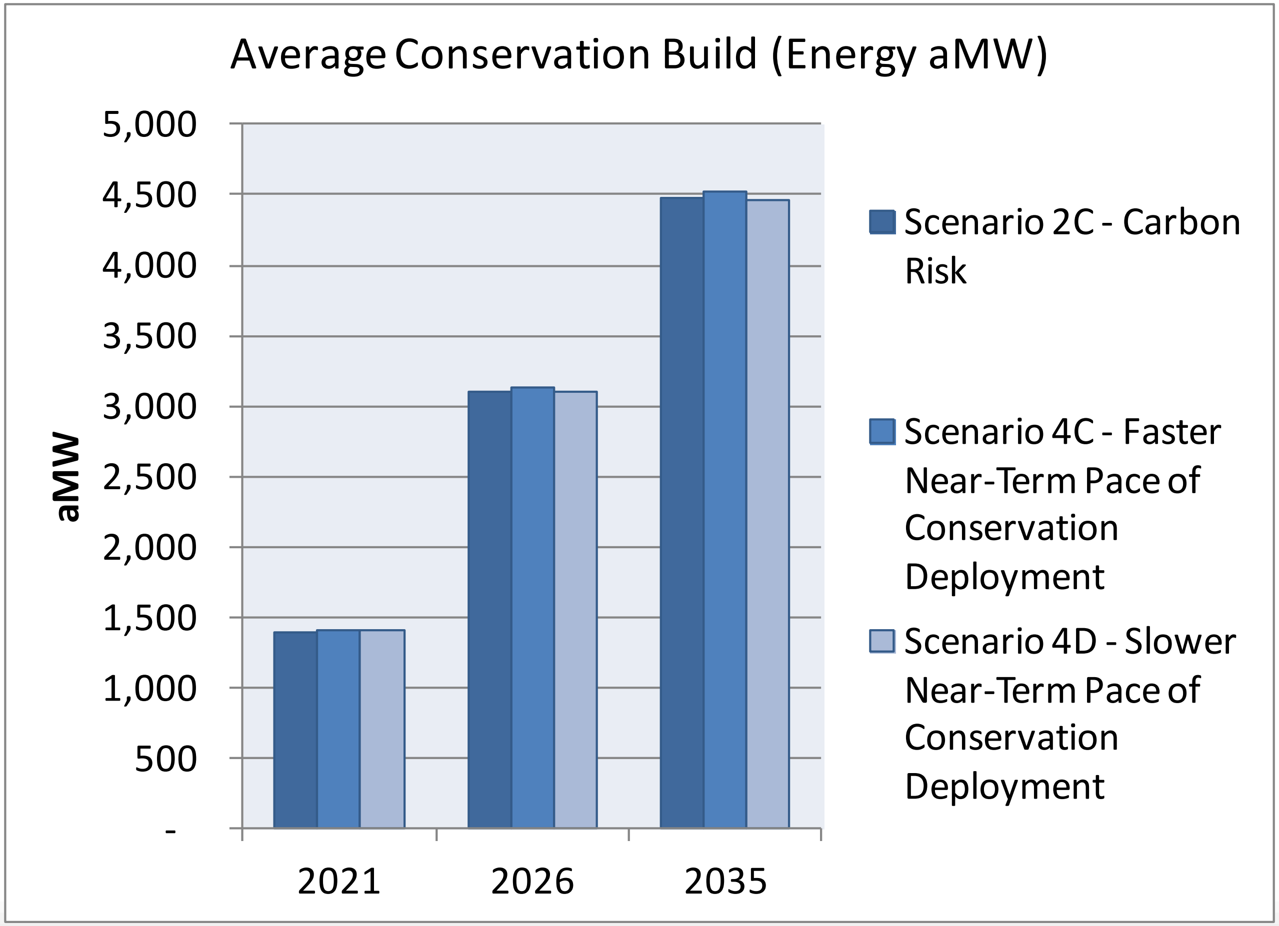


NPV System Costs are also 2 billion $ lower ($85 billion vs $87 billion)
This assumes the market price variance of imports remains ~same

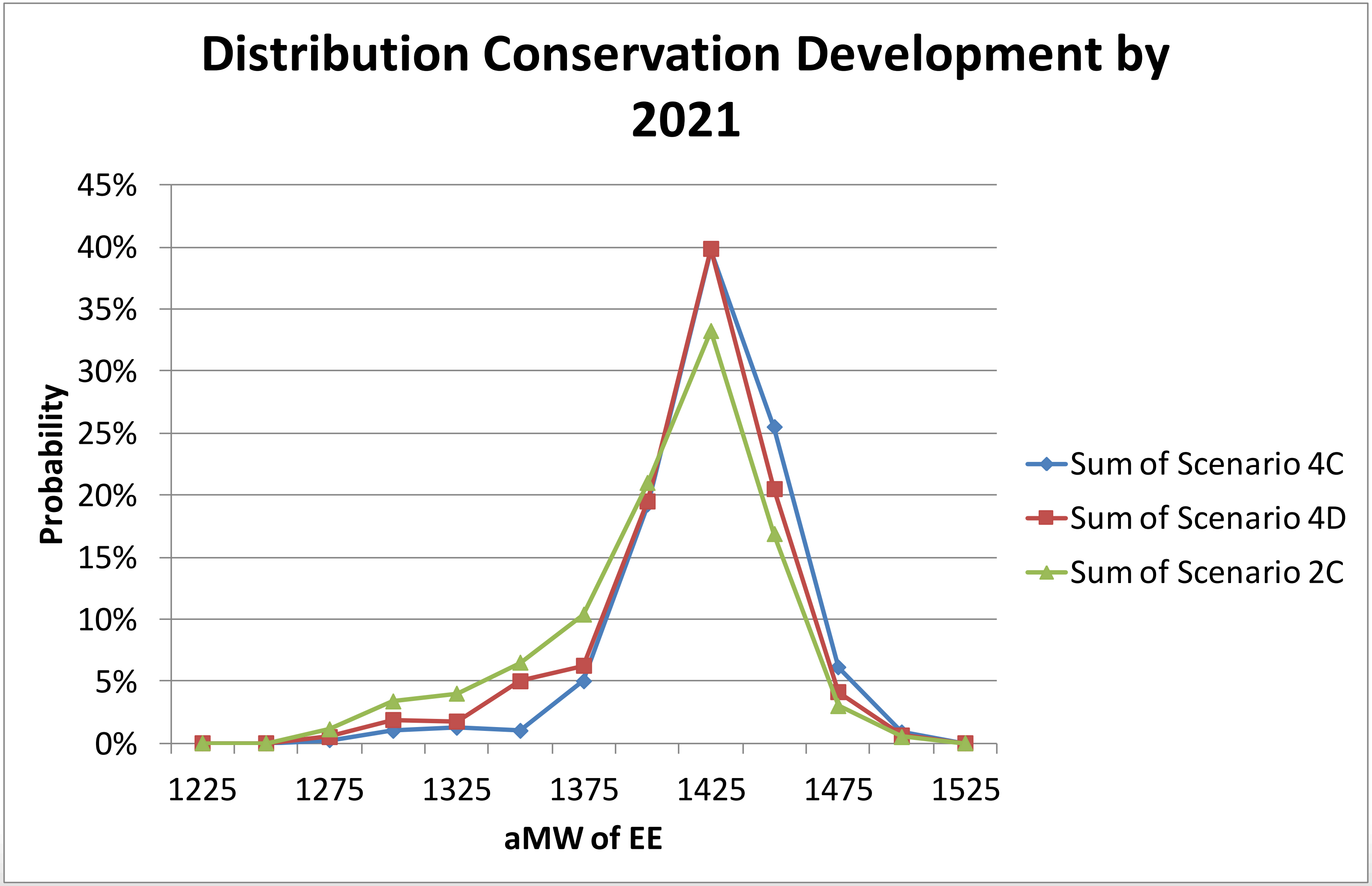
What About Fast-Slow Ramp Rate Sensitivity?



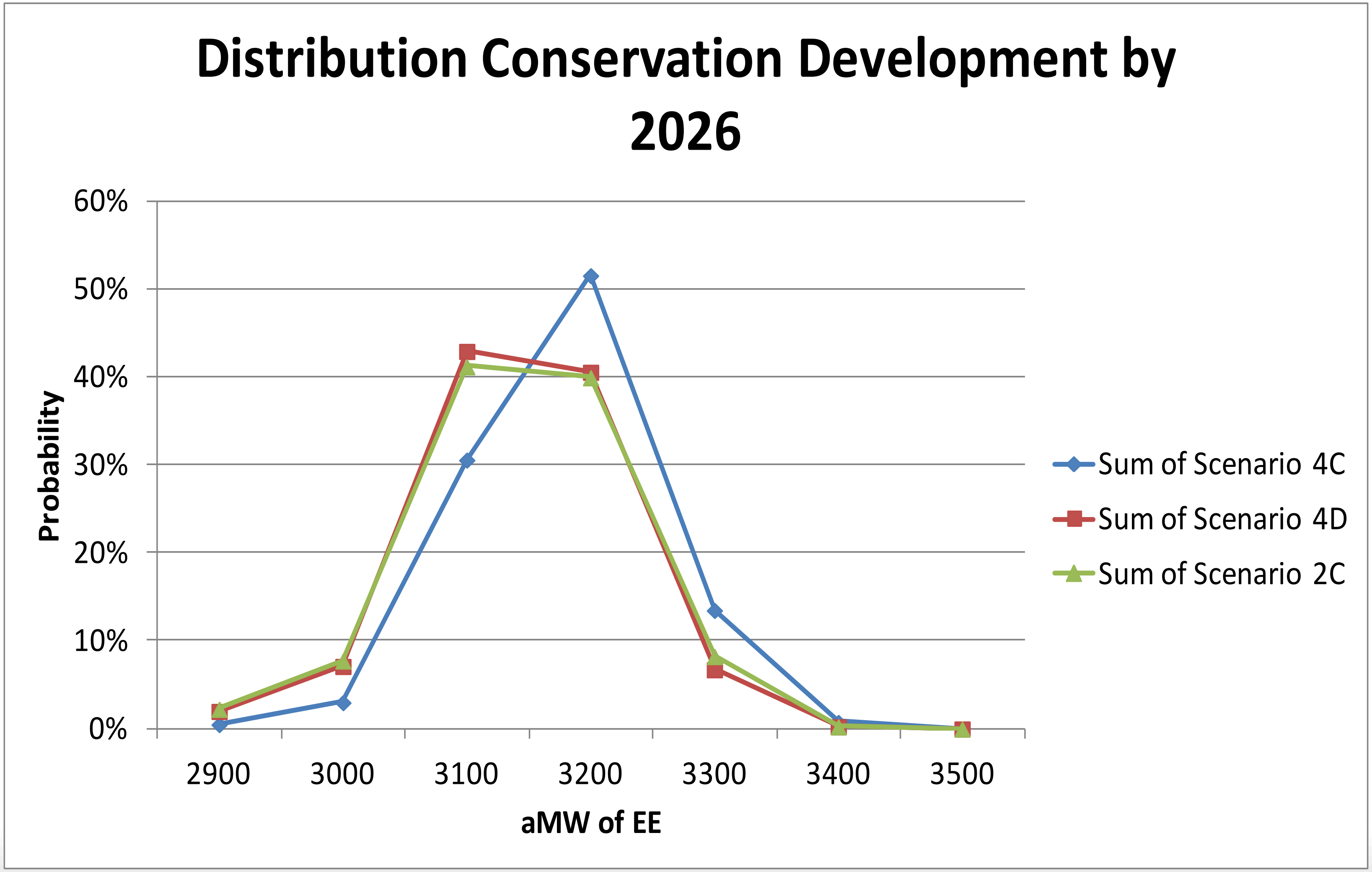
Little Difference in Average Conservation Build



Not Much Difference in Distribution Either (2021)



Nor in 2026



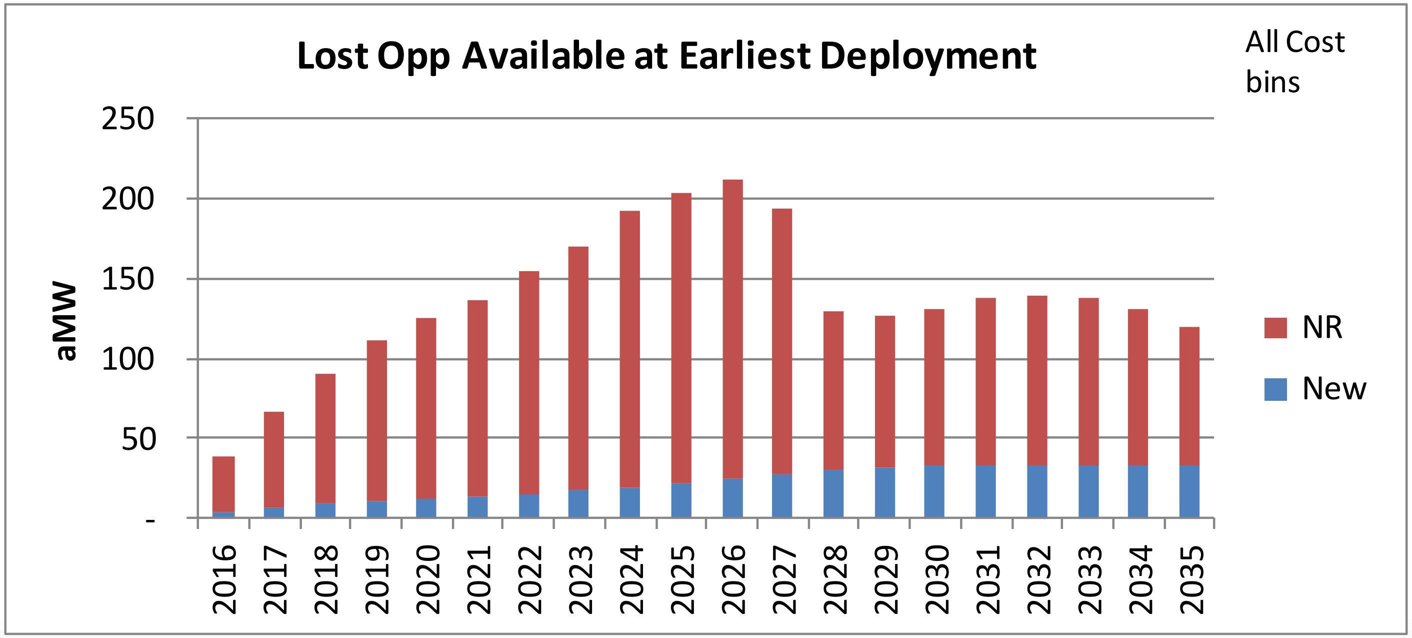
Distribution Conservation Development by 2026
60%
50%
40%
30%
20%
10%
0%
Probability
2900
3000
3100
3200
3300
3400
3500
aMW of EE
Sum of Scenario 4C
Sum of Scenario 4D
Sum of Scenario 2C

Results of Ramp Rate Sensitivity

- Not much difference in EE Build out
- Why:
- In Slow Ramp, RPM builds higher cost EE
  - Building for adequacy
  - EE a low-cost adequacy solution even using higher cost bins
  - Even considering cost of “EE overbuild” for energy

What About Lost-Opp vs Retrofit?

- RPM not finding consistent value preference for Lost-Opp
- Why? New modeling: Most Lost-Opp not lost forever



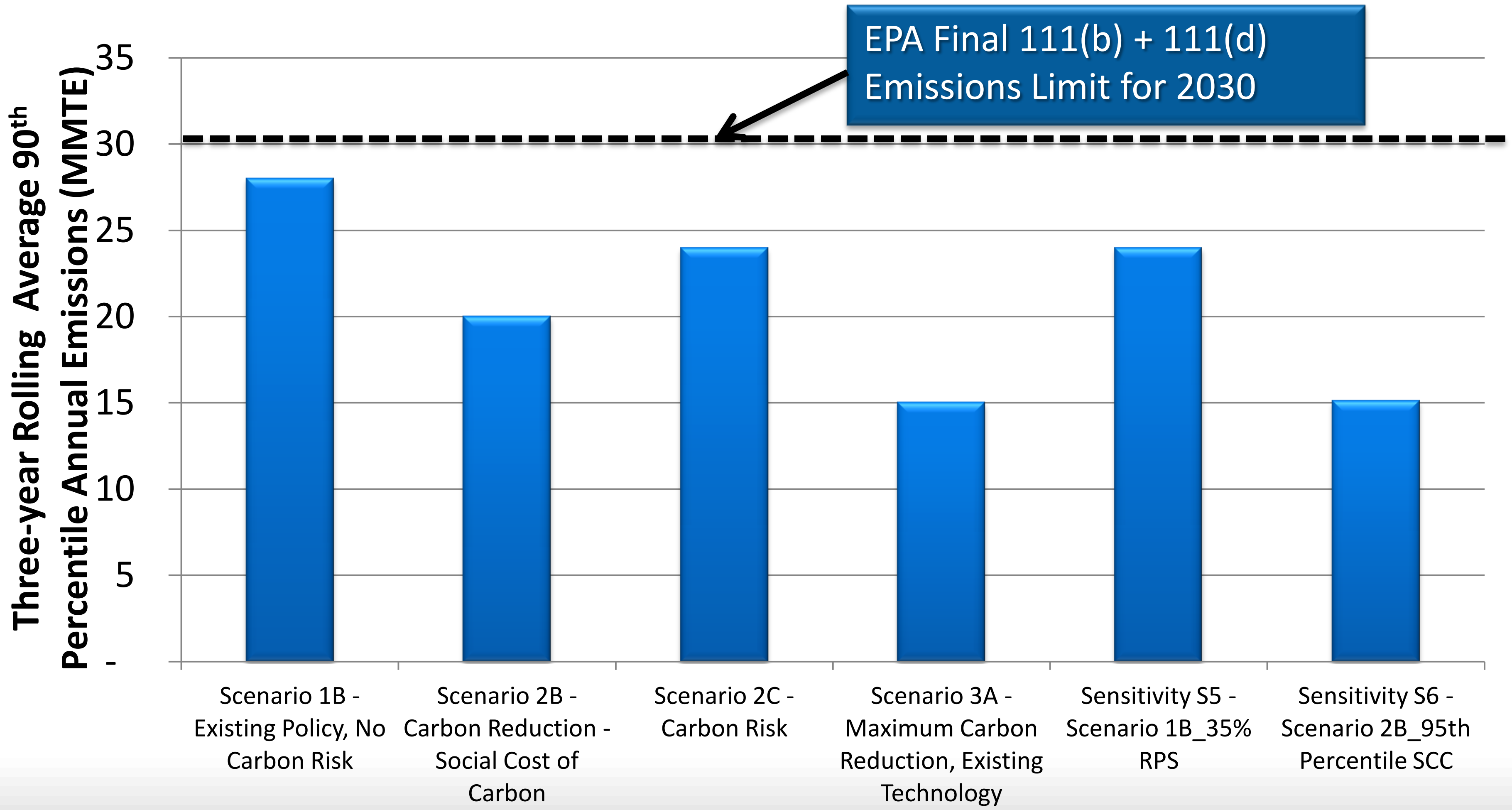
What About Carbon?

Carbon
Reduction
Policy
Comparisons

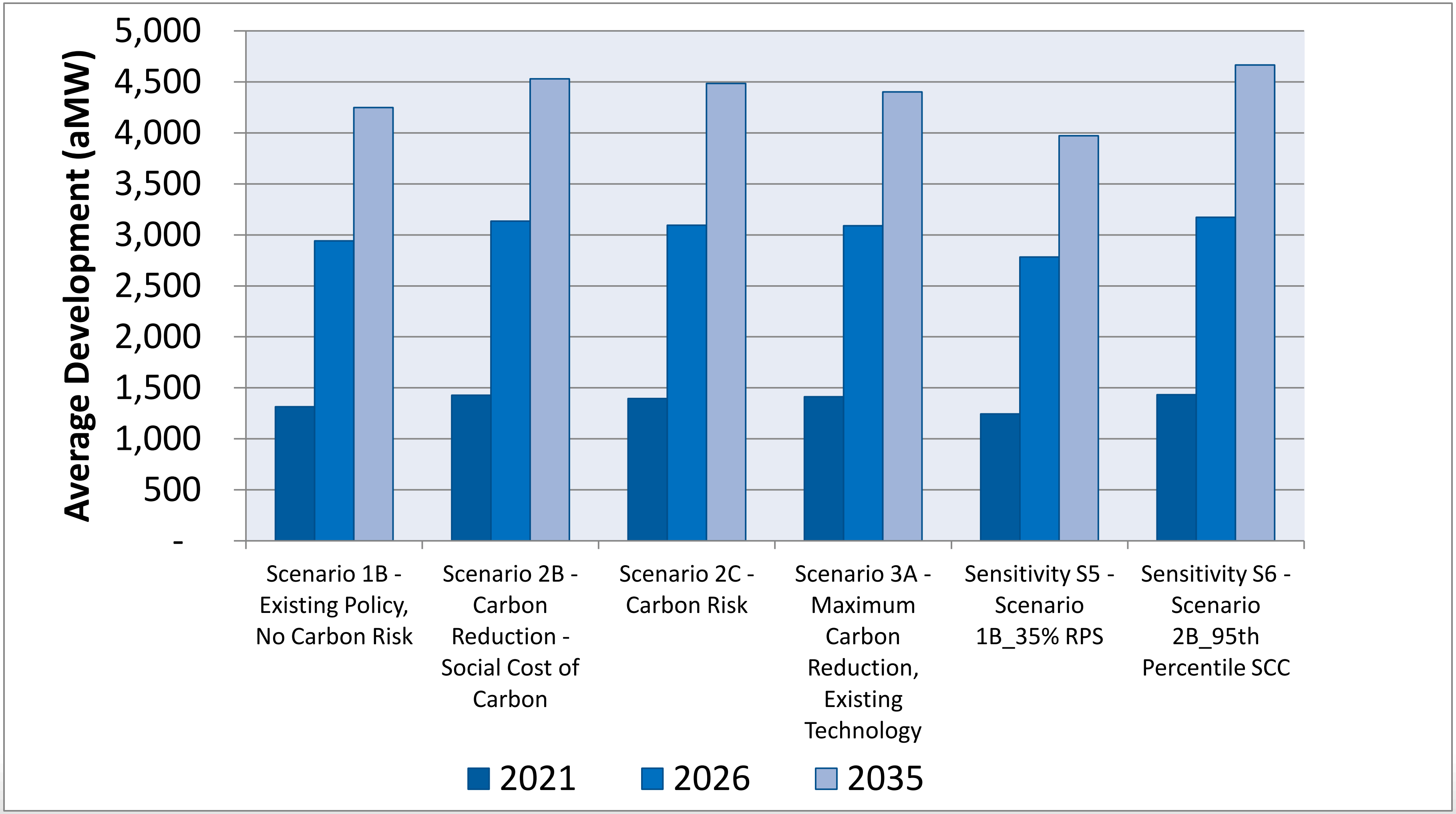
Carbon Reduction Policy Comparisons

- Review of Five Scenarios/Sensitivity Studies
  - Scenario 2B – Social Cost of Carbon (@ 3% Estimate of SCC)
  - Scenario 2C – Carbon Risk
  - Scenario 3A – Maximum Carbon Reduction with Existing Technology
  - Sensitivity S5 – Social Cost of Carbon @ 95% Percentile Estimate of SCC
  - Sensitivity S6 – Renewable Portfolio Standard @ 35%
- Basis of Comparison:
  Scenario 1B – Existing Policies, No Carbon Risk

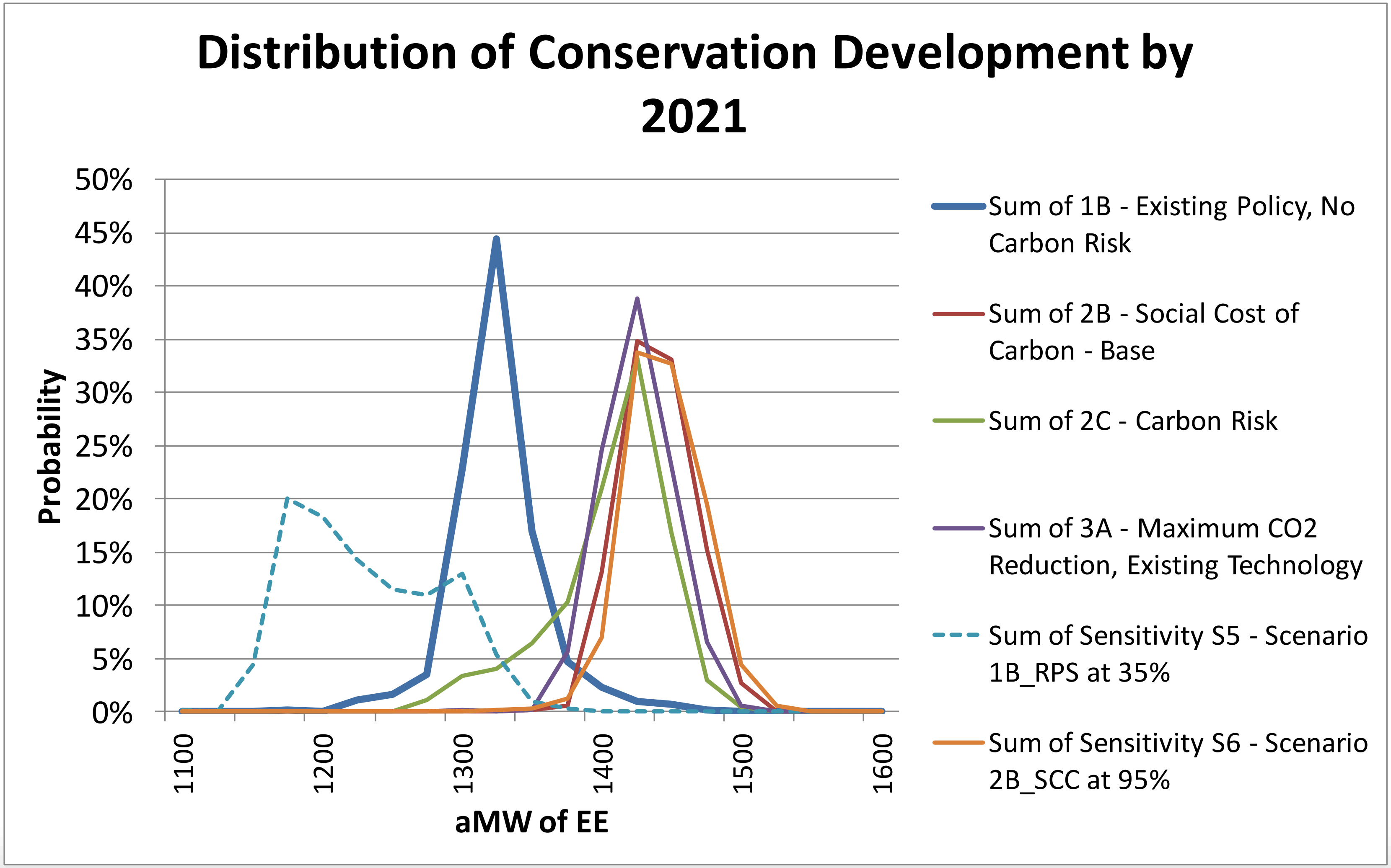
The *90th Percentile* Annual 111(d) System CO_2 Emissions for the Least Cost Resource Strategies for All Scenarios Are Below The EPA's Proposed Limit for 2030



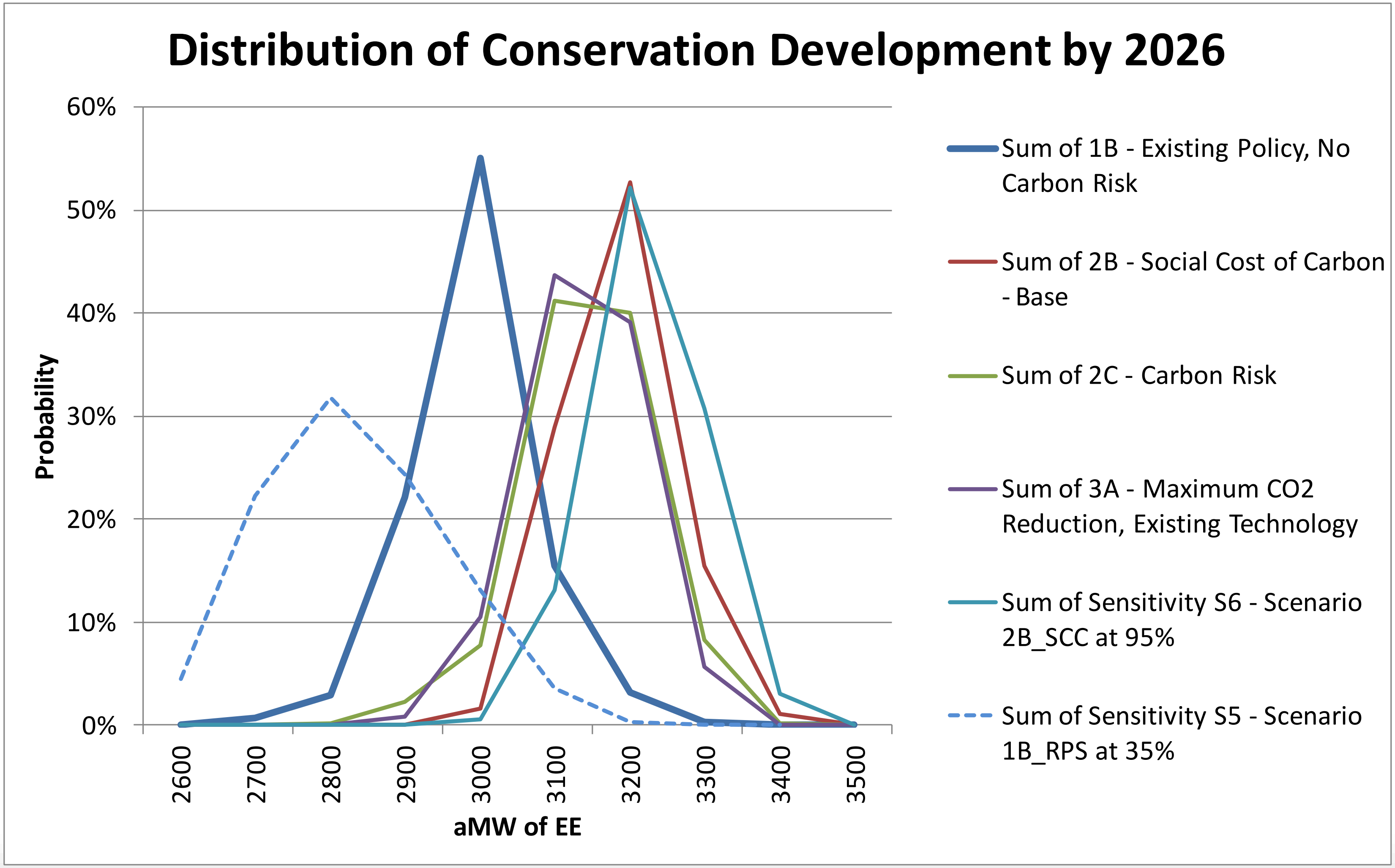
Average Conservation Development Increases Under Alternative Carbon Emissions Reduction Policies Compared to No Carbon Risk - Except for RPS @ 35% Policy



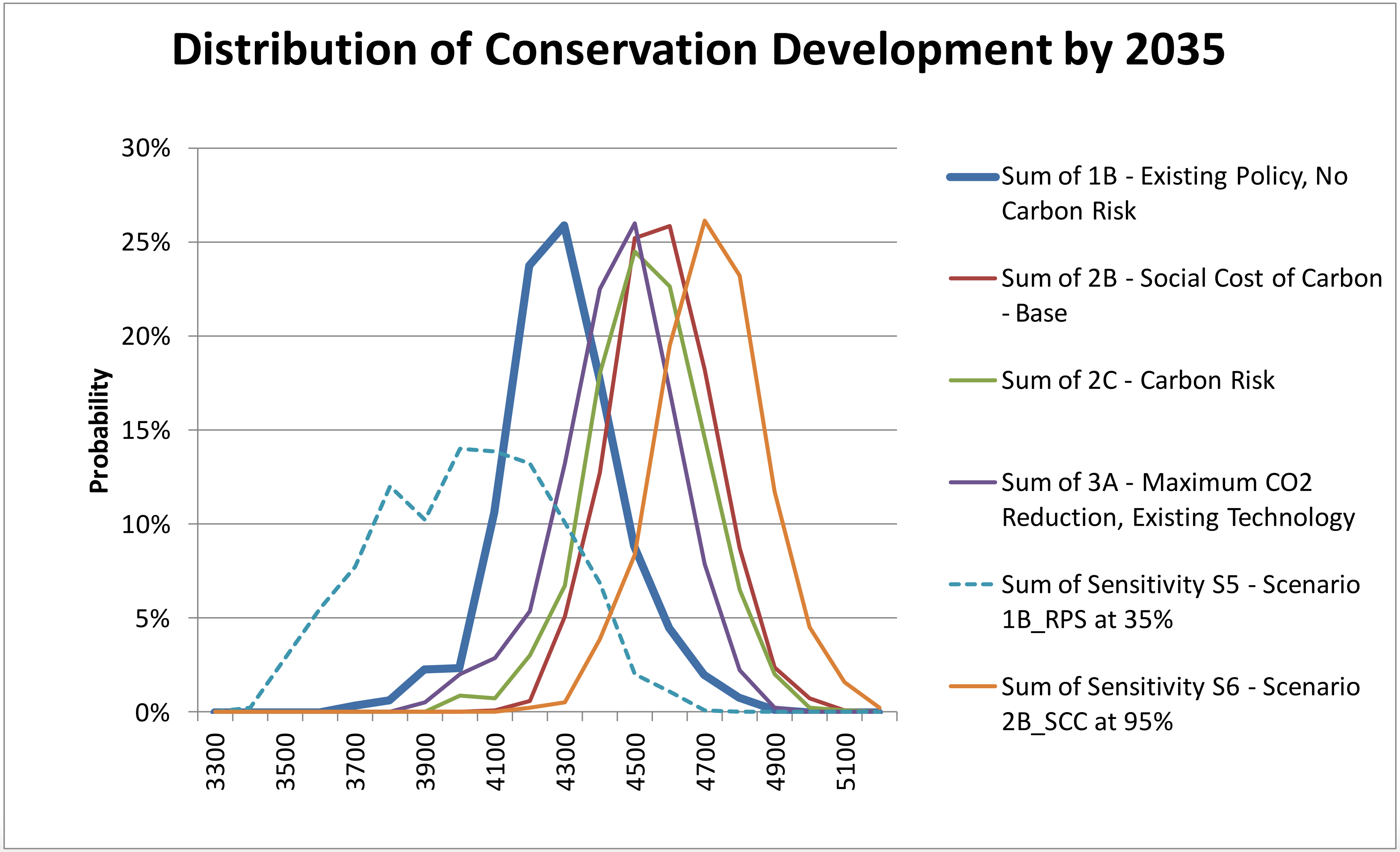
Scenarios That Consider Carbon Risk Develop More EE by 2021 - Except 35% RPS



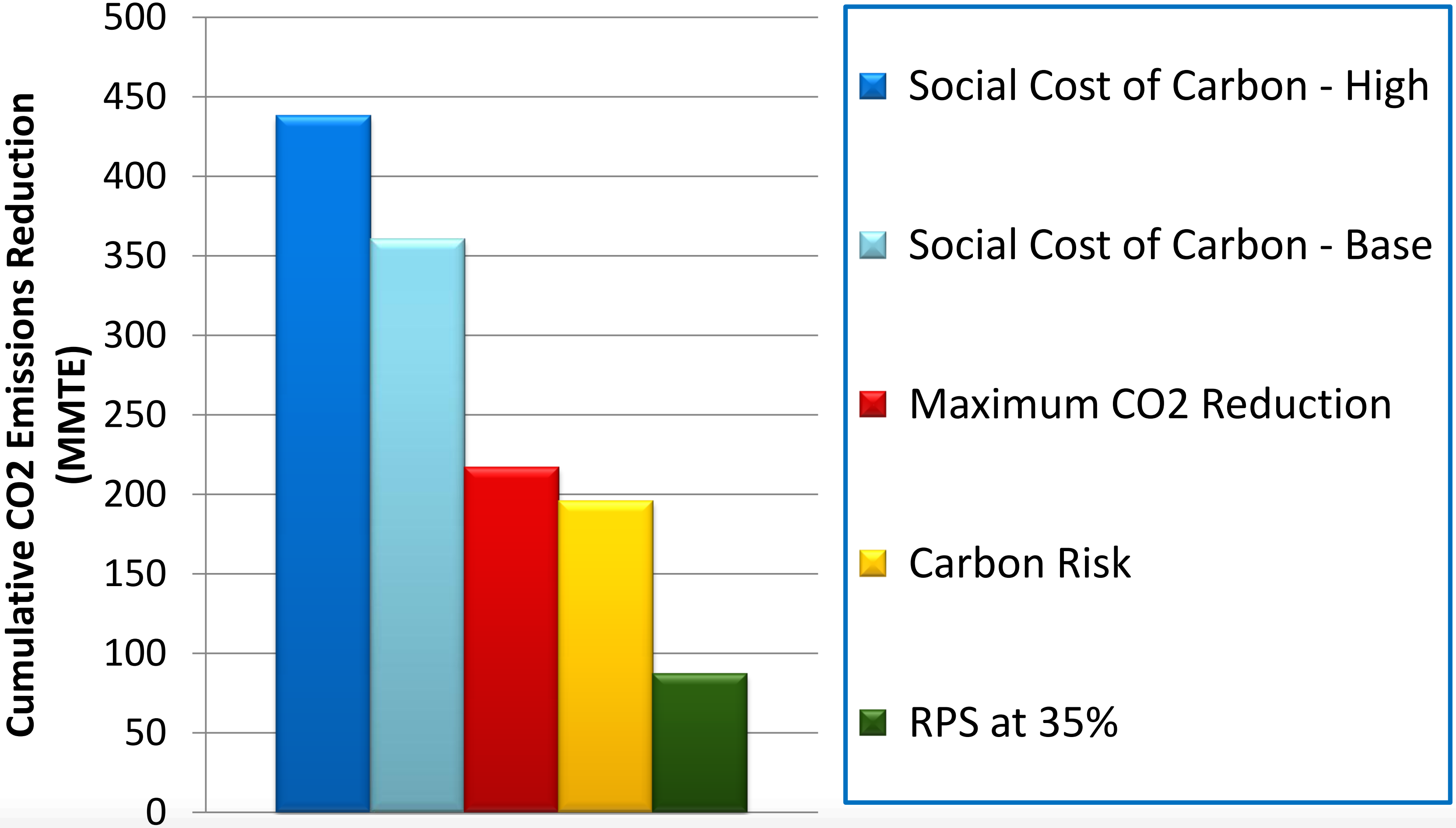
Scenarios That Consider Carbon Risk Develop 100 – 300 aMW More EE by 2026



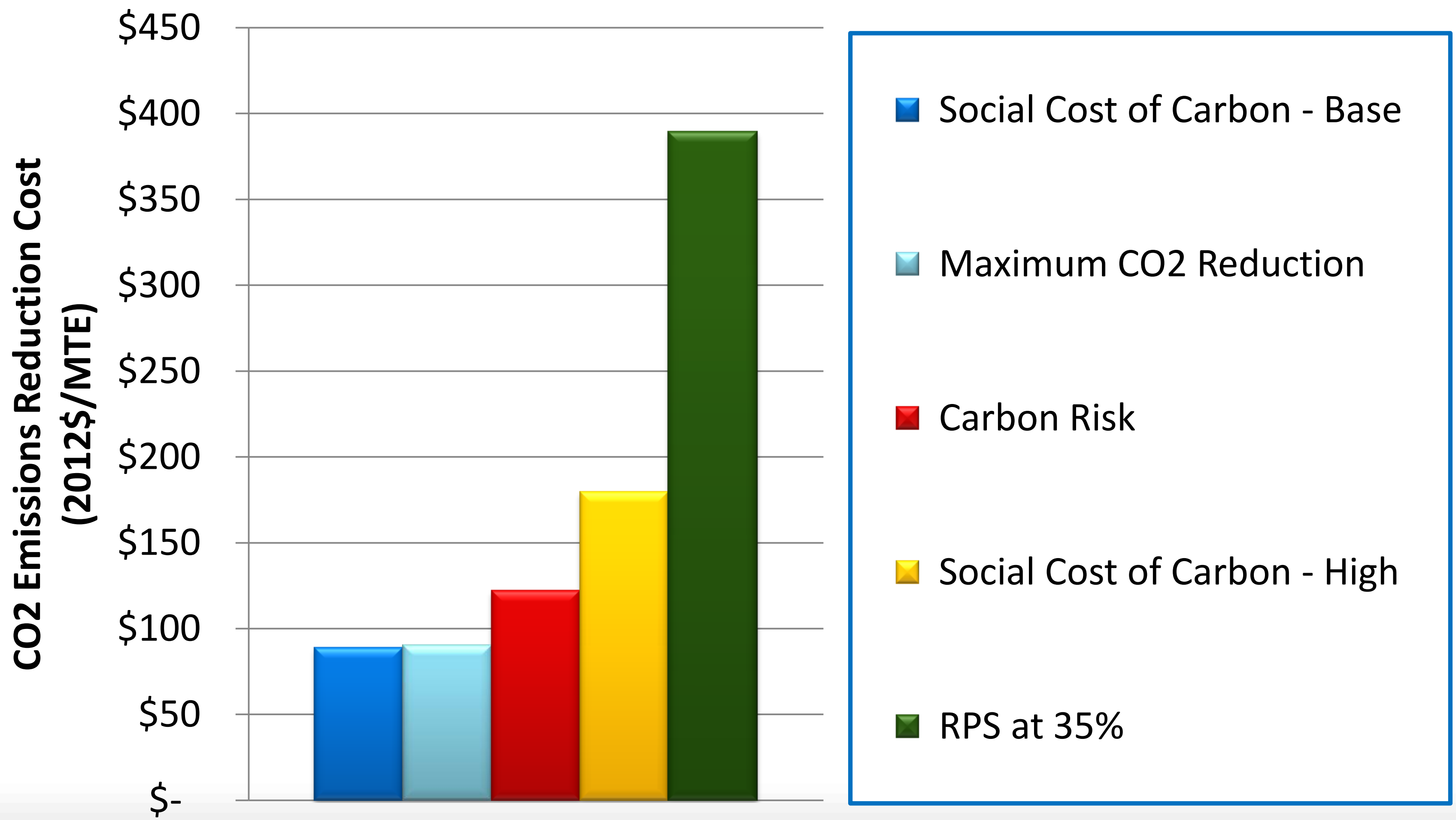
Scenarios That Consider Carbon Risk Develop 200 – 400 aMW More EE by 2035



PNW Cumulative CO2 Emissions Reductions Highest Under Resource Strategies That Must Respond Immediately to Carbon Reduction Policies



Retirement of Coal & Inefficient Gas Generation Are The Lowest Cost PNW Power System CO2 Emission Reduction Resource Strategies



Findings from Carbon Scenarios

Details at: http://www.nwcouncil.org/media/7149441/5.pdf

- EE
  - Carbon scenarios build slightly more EE
- Renewables:
  - Carbon scenarios do not drive RR build higher
  - Solar PV and wind provide limited or no winter peaking capacity
- Demand Response:
  - Carbon scenarios do not drive DR build higher
- Existing Gas Generation
  - All carbon scenarios drive Existing Gas Generation higher, except 35% RPS
  - Running existing gas plants more is a low-cost way to displace coal
- New Gas Generation
  - Two carbon scenarios drive New Gas build higher
  - Maximum Emissions Reduction Scenario (3A) & Social Cost of Carbon at the 95th Percentile Policies
- Exports
  - Somewhat lower in all carbon scenarios except 35% RPS
- Carbon Emissions
  - All scenarios meet new 111(d) and 111(b)
  - Retirement of coal & inefficient gas are lowest cost strategies
  - Earliest action strategies have largest cumulative reduction in CO_2

Summary EE Observations

- All least- cost resource strategies rely heavily on conservation to meet *both* winter capacity and energy needs
- In 90 percent of the futures, energy efficiency meets all load growth through 2030
- Significant amounts are available below projected future market prices
  - 1200 aMW by 2021 and 3500 aMW by 2035 <$30/MWh
- Capacity value of EE is makes it a valuable resource for system adequacy
  - EE produces ~2.0 MW/aMW saved during winter
- EE development is essential to attaining carbon emissions reductions
- EE developed under least cost resources strategies does not significantly increase when carbon risk is considered

PRINCIPLE ELEMENTS OF RESOURCE STRATEGY

Seven Principle Elements of Least-Cost & Least-Risk Resource Strategies

- Develop Conservation
  - 1400 aMW by 2021
  - 3100 aMW by 2026
  - 4500 aMW by 2035
- Expand Use of Demand Response
- Satisfy Existing Renewable Portfolio Standards
- Option limited gas-fired generation for capacity and other ancillary services as dictated by local utility circumstances
- Reducing regional exports in order to serve in-region energy and capacity demand can result in lower total NPV System Cost and less need for new resource development
- Expand Resource Alternatives (EE & Non-GHG emitting)
- Monitor and Be Prepared to Adapt to Changing Conditions