Northwest **Power** and **Conservation** Council

July 7, 2015

MEMORANDUM

TO: **Council members**

FROM: **Tom Eckman, Ben Kujala and John Ollis**

SUBJECT: **Discussion of Scenario Analysis Results**

BACKGROUND:

Presenter: Tom Eckman and Ben Kujala

Summary: On June 26th staff presented the initial results for Scenarios 1B, 2B, 2C and 3A at a webinar for the Power Committee. At that webinar staff indicated that all of these scenarios would be re-run with updated model inputs to improve the consistency between the RPM and GENESYS models treatment of the use of hydro-system to provide short-term *peaking capacity* when additional resources that can supply *energy* are added to the system.

Staff will present revised results for four Scenarios. The scenarios that will be discussed are:

- 1B - Current policy without any incremental cost for carbon included
- 2B – Considers carbon cost equivalent to the Social Cost of Carbon
- 2C - Considers uncertainty in the cost of carbon ranging from $0 to $110/metric ton
- 3A – All coal plants and inefficient gas plants (i.e., plants with heat rates above 8,500 Btu/kWh) retired

In addition staff will present the results of one sensitivity study (S3). This study assumes that Demand Response resources are not available.

These results will reflect the final inputs and model revisions for these scenarios for use in the development of draft Plan.

Workplan: 1. B. Develop Seventh Power Plan and maintain analytical capability

Background: The RPM or Regional Portfolio Model was recently redeveloped by Navigant for the Council. The RPM estimates the regional costs and risks associated with pursuing resource development strategies and it uses optimization to look for strategies that minimize the estimated cost and risk. Results from the RPM will be used to inform the components of the resource strategy set forth by the Council in its Seventh Power Plan.

More Info: None at this time.

July 7, 2015

MEMORANDUM

TO: **Council members**

FROM: **Tom Eckman**

SUBJECT: Proposed Seventh Plan Development Process and Schedule

BACKGROUND:

Presenter: Tom Eckman

Summary: Staff is proposing that the draft plan adoption be delayed one month, until October to provide additional time to conduct scenario and sensitivity study analysis and to discuss these results with the Council. Staff requested guidance from the Power Committee on this scope and schedule for scenario and sensitivity analysis at the June 26th webinar. Staff is seeking guidance from the full Council at its July meeting.

The original schedule called for final plan adoption at the December 2015 Council meeting. However, in order to provide for a 60 day comment period and sufficient time to respond to comment and accommodate holiday schedules, staff proposes that the Council use its December and January meetings to consider how it wishes to respond to public comments. Final Plan adoption would be scheduled for February of 2016 Council meeting.

Attached is a calendar showing the major milestones in the plan development process assuming that reflects the staffs' recommendation regarding the one month delay of the draft plan's adoption is acceptable to the Council. This calendar shows Council adoption of a draft plan at the October 13th - 14th meeting. To provide time to include any final editorial and conforming changes agreed to at the Council meeting the draft Plan would be released for comment the following week (October 23rd). The 60-day public comment

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period, including time for hearings in each state, would close the December 18th, the Friday following the Council meeting.

Table 1, below, shows the staff's proposed scenarios and sensitivity studies.

Table 1 - Proposed Scenario and Sensitivity Analysis Schedule		
No.	**Scenario Description**	**Completion Date**
1A	Existing Policy without Uncertainty, w/o GHG reduction risk	July 10th
1B	Existing Policy with Uncertainty, w/o GHG reduction risk	July 10th
2C	Existing Policy with Uncertainty and with uncertain GHG reduction risk/target - $0 - $110/MMTE Carbon Cost	July 10th
2B	Existing Policy with Uncertainty and with GHG reduction target based on the GHG Damage Cost estimated by the federal Interagency Working Group on the Social Cost of Carbon.	July 10th
3A	Lowering carbon emissions with current technology	July 10th
4C	Major Resource Uncertainty – Faster Pace of Conservation Deployment	July 10th
4D	Major Resource Uncertainty – Slower Pace of Conservation Deployment	July 10th
4A	Major Resource Uncertainty - Unexpected Loss of Major Non-GHG Emitting Resource (i.e., long-term loss of generation or transmission access to generation without the ability to pre-plan for replacement resources)	July 17th
4B	Major Resource Uncertainty - Anticipated Loss of Major Non-GHG Emitting Resource (i.e., long-term loss of generation or transmission access to generation with the ability to pre-plan for replacement resources)	July 17th
5B	Southwest Market Liquidity Variability - Scenarios 1B and 2C w/Greater Access to Extra-regional Market (i.e., lower ARMs, higher limits on imports)	July 24th
3B	Lowering carbon emissions with emerging technology (e.g., storage, CO2 heat pumps, SSL, DG) - Narrative Only, Not Modeled	July 31st
No.	**Sensitivity Study Description**	**Schedule**
S1	Scenarios 1B and 2C w/o Centralia, Boardman or Valmy Retirements	July 24th
S2	Scenarios 1B and 2C w/Lower Natural Gas Prices	July 24th
S3	Scenarios 1B and 2C w/o Demand Response	July 31st
S4	Scenarios 1B and 2C w/Lower Winter Peak Contribution from Conservation	July 31st

Relevance: Development of the Regional Power and Conservation Plan is one the Council's primary obligations under the Power Act

Workplan: 1. B. Develop Seventh Power Plan and maintain analytical capability

- Define resource portfolio
- Complete draft plan resource strategy and draft action plan
- Release draft plan for comment
- Approve Final Plan/Action Plan

Background: The development of the 7th Power Plan enters a critical phase over the course of the summer and fall. At the June Power Committee meeting staff proposed a review schedule for draft sections of the draft plan and for completion of planned scenario analysis. This schedule calls for adoption of a draft plan at the September Council meeting. In order to meet this schedule it does not appear that we will have time to conduct *all* of the proposed scenario analysis and *all* of the sensitivities studies that have been requested by the Systems Analysis Advisory Committee, the Resource Strategies Advisory Committee and other stakeholders.

While sensitivity studies use the findings of one or more prior scenario results they require a comparable amount of time to model, hence they are a about a “one-to-one” tradeoff with respect to time and staff work load.

Even allowing for a one month extension of the draft plan’s adoption, staff recommends that four of the original scenarios proposed for analysis be eliminated in favor of conducting the four sensitivity studies listed above. The four scenarios proposed for elimination and the staffs’ rationales are outline below.

- Scenario 2A - Existing Policy with Uncertainty and with certain GHG reduction risk/target. This scenario was designed to identify resource strategies that would reduce emissions to levels that could be expected to comply with EPA’s proposed Clean Power Plan regulation 111(d). In staffs’ judgment the results from Scenario 2C provide sufficient information to address this question. Moreover, since the final CPP rule is not anticipated to be released until later this summer, it is not possible to model the specific requirements of this regulation.

- Scenario 5A - Integration of Variable Resources (i.e., managing the NW Impact of the "Duck Curve"/50% CA RPS). While it does appear that California is likely to adopt a 50% Renewable Portfolio Standard, it also appears that the state is also taking steps to mitigate the impact of “oversupply and ramping” resulting from the higher RPS. (See NREL Analysis of WECC Solar and Wind Integration at: http://www.nrel.gov/electricity/transmission/western_wind.html). The impact of higher RPS in California on the Northwest market is directly related to one of the critical assumptions used as the basis for establishing the regional adequacy standards (i.e., reliance on external market supplies). Scenario 5B is designed to test the impact on resource portfolio cost and risk of alternative assumptions regarding placing greater reliance on Southwest markets. The results from Scenario 5B will provide some insights into that magnitude of the potential impact of potentially greater reliance on external markets. It may also result in recommendations to the Resource Adequacy Advisory Committee to review the assumptions underlying its assessment of regional resource adequacy. Therefore, staff recommends that modeling of this scenario be delay until its results can be considered as part of a broader discussion of the adequacy standard following plan adoption.

- Scenario 6A - Climate Change Load Impacts Resulting from Direct Effects of Climate Change. This scenario was designed to assess whether potential changes in regional load shape resulting from forecast climate change would alter the region’s resource strategy. Preliminary testing revealed that the changes in load shape (i.e., lower winter loads and higher summer loads) are limited in the near-term and thus do not alter resource decisions required within the period covered by the action plan.

- Scenario 6B – Climate Change Impacts on Hydrogeneration – This scenario was designed to assess the potential impacts of changes in hydroelectric generation resulting from potential climate change. Modeling this scenario requires a projection of changes in amount and timing of run-off. The current data on which such projections are based in both out of date (i.e., covers only 70-year water record, while RPM uses 80-year record) and has known errors. The staff recommends that this scenario be delayed until after the release of an updated set of forecast for climate impacted stream flows based on IPPC-5 is available in 2016.

The rationale for conducting the four sensitivity studies is a follows:

Sensitivity S1 - Scenario 1B and 2C w/o Centralia Boardman or Valmy Retirements
This sensitivity study and Sensitivity S2 were requested by the Public Power Council staff, Specifically, PPC staff indicated that they were interested in determining how the lost of these resources impacted the pace of regional conservation and demand response development.

Sensitivity S2 – Scenarios 1B and 2C w/Lower Natural Gas Prices
This sensitivity was requested members of the SAAC, RSAC and PPC staff. It is designed to assess the impact on resource development of significantly lower natural gas prices.

Sensitivity S3 – Scenarios 1B and 2C w/o Demand Response (DR)
This scenario was requested by members of the SAAC and RSAC. It is designed to determine both the value of DR and the resources that would be required if developments of DR cannot be accomplished at the assumed pace or in the amount identified as achievable over the planning period.

Sensitivity S4 – Scenarios 1B and 2C w/Lower Winter Peak Contribution from Conservation
This scenario was requested by members of the SAAC and RSAC.
It is designed to determine both the value of conservation's peak capacity contribution as well as the resources that would be required if the end use load shape data used to estimate its peak reduction overstates its impacts.

If the Council determines that one or more of the scenarios recommended for elimination or additional sensitivity studies should be modeled as part of the Seventh Plan's development process it *may* be possible to conduct such analysis without extending the plan development schedule beyond what has been proposed. However, the ultimate impact on the schedule for plan adoption is contingent upon agreement among Council members that sufficient analysis and review has occurred to support the issuance of a draft plan.

More Info: See Attached Schedule

Month	Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2 - Packet Day	3	4	5	6
Jun 2015	7	8	9 Council	10 Meeting	11	12	13
	14	15	16	17	18	19 - Scenarios 1A,1B & 2C	20
	21	22	23	24	25 - Scenarios 2B & 3A	26 - Power Committee Webinar	27
	28	29	30 - Scenarios 4C & 4D	1	2	**3 Holiday**	4
Jul 2015	5	6	7 - Packet Day	8	9	10 - Scenarios 4A & 4B	11
	12	13	14 Council	15 Meeting	16	17	18
	19	20	21	22	23	24 - Scenario 5B and Sensitivity Studies S1 & S2	25
	26	27	28	29	30	31 - Scenario 3B and Sensitivities S3 & S4	1
Aug 2015	2	3	4 - Packet Day	5	6	7	8
	9	10	11 Council	12 Meeting	13	14	15
	16	17	18	19	20	21	22
	23	24	25	26	27	28	29
	30	31	1	2	3	4	5
Sep 2015	6	**7 - Holiday**	8 - Packet Day	9	10	11	12
	13	14	15 Council	16 - Meeting	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30	1	2	3

Month	Sun	Mon	Tue	Wed	Thu	Fri	Sat
	27	28	29	30	1	2	3
Oct 2015	4	5	6 - Packet Day	7	8	9	10
	11	12	13 Council	14 Meeting	15	16	17
	18	19	20 - Release Draft for Comment	21	22	23	24
	25	26	27	28	29	30	31
Nov 2015	1	2	3	4	5	6	7
	8	9	10 - Packet Day	11 Holiday	12	13	14
	15	16	17 Council	18 Meeting	19	20	21
	22	23	24	25	26 Holiday	27 Holiday	28
	29	30	1	2	3	4	5
Dec 2015	6	7	8 - Packet Day	9	10	11	12
	13	14	15 Meeting - Summary of Public Hearing Comments	16 Council - Preliminary Scope of Analysis for Draft Plan Revisions	17	18 - Close of Public Comment	19
	20	21	22	23	24	25 - Holiday	26
	27	28	29	30	31	1 - Holiday	2
Jan 2016	3	4	5 - Packet Day	6	7	8	9
	10	11	12 Council - Summary of Public Comment	13 Meeting - Discuss Proposed Revisions	14	15	16
	17	18 - Holiday	19	20	21	22	23
	24	24	26	27	28	29	30

Month	Sun	Mon	Tue	Wed	Thu	Fri	Sat
	31	1	2 - Packet Day	3	4	5	6
Feb 2016	7	8	9 Council	**10 Meeting - Adopt Final Plan**	11	12	13
	14	**15 - Holiday**	16	17	18	19	20
	21	22	23	24	25	26	27
	28	1	2	3	4	5	6

Proposed Scope and Schedule for Scenario and Sensitivity Analysis

Power Committee and Council Meeting

July 14-15, 2015

Proposed Revision to 7th Plan Schedule

- Draft Plan Adoption – October 13-14, 2015
- Public Comment – October 23 – December 18, 2015
- Final Plan Adoption – February 9-10, 2016

Rationale – Provide additional time for Council review of scenario analysis, sensitivity studies and draft plan action plan and chapters.

Proposed Revisions to Scenario Scope Eliminate Four Scenarios

- **Scenario 2A - Existing Policy with Uncertainty and with certain GHG reduction risk/target.**
  - In staffs' judgment the results from Scenario 2C provide sufficient information to address this question. Moreover, since the final CPP rule is not anticipated to be released until later this summer, it is not possible to model the specific requirements of this regulation.
- **Scenario 5A - Integration of Variable Resources (i.e., managing the NW Impact of the "Duck Curve"/50% CA RPS).**
  - Staff recommends that modeling of this scenario be delay until its results can be considered as part of a broader discussion of the regional adequacy standard following plan adoption. This scenario requires as "WECC-wide" view of loads and resources and might be significantly impacted by the emergence of SCED/EIMs.
- **Scenario 6A - Climate Change Load Impacts Resulting from Direct Effects of Climate Change.**
  - Staff recommends that modeling this scenario be dropped since preliminary testing revealed that the changes in load shape (i.e., lower winter loads and higher summer loads) are limited in the near-term and thus do not alter resource decisions required within the period covered by the action plan and long term impacts are subject to a wide range of uncertainty.
- **Scenario 6B – Climate Change Impacts on Hydrogeneration.**
  - Modeling this scenario requires a projection of changes in amount and timing of run-off. The current data on which such projections are based in both out of date (i.e., covers only 70-year water record, while RPM uses 80-year record) and has known errors. The staff recommends that this scenario be delayed until after the release of an updated set of forecast for climate impacted stream flows based on IPPC-5 is available in 2016.

Proposed Revisions to Scenario Scope
Add Four Sensitivity Studies

- **Sensitivity S1 - Scenario 1B and 2C w/o Centralia Boardman and Valmy Retirements**
  - This sensitivity study and Sensitivity S2 were requested by the Public Power Council staff. Specifically, PPC staff indicated that they were interested in determining how the lost of these resources impacted the pace of regional conservation and demand response development.
- **Sensitivity S2 – Scenarios 1B and 2C w/Lower Natural Gas Prices**
  - This sensitivity was requested members of the SAAC, RSAC and PPC staff. It is designed to assess the impact on resource development of significantly lower natural gas prices.
- **Sensitivity S3 – Scenarios 1B and 2C w/o Demand Response (DR)**
  - This scenario was requested by members of the SAAC and RSAC. It is designed to determine both the value of DR and the resources that would be required if developments of DR cannot be accomplished at the assumed pace or in the amount identified as achievable over the planning period.
- **Sensitivity S4 – Scenarios 1B and 2C w/Lower Winter Peak Contribution from Conservation**
  - This scenario was requested by members of the SAAC and RSAC. It is designed to determine both the value of conservation's peak capacity contribution as well as the resources that would be required if the end use load shape data used to estimate its peak reduction overstates its impacts.

Power Committee Feedback

- Okay with proposed schedule revisions
- Some concern about dropping climate change scenarios (6A and 6B)
  - Potential Impact on Hydrogeneration and Loads will be discussed in Appendix M - *Climate Change Impacts to Loads and Resources*
- Highest Priority Sensitivity Studies are S2-Lower Natural Gas Prices and DR and S3- No DR
- Lowest Priority Sensitivity Study is S1-Assume none of the announced coal plant retirements take place

Seeking Council Guidance

- Revisions to the proposed schedule
- Scenario vs. Sensitivity study tradeoff
  - Which ones are priorities
  - How to handle additional requests
    - From Council members
    - From stakeholders
- Draft Chapter Review Process
  - Should draft documents be publically available prior formal adoption as draft Plan?
    - If so, when?

Selected Findings from Scenario and Sensitivity Analysis Conducted To Date

SEVENTH
NORTHWEST
POWER PLAN

July 14, 2015

Progress Since The June Power Committee Webinar – Model Inputs

- RPM inputs have been updated:
  - Revised Social Cost of Carbon input for Scenario 2B to reflect most recent (July 2015) Interagency Working Group estimates (slightly reduced value)
  - Revised inputs for the system capacity impact of combined cycle combustion turbines and energy efficiency to reflect hydro generation operational flexibility

Progress Since The June Power Committee Webinar – Reason for Model Structure Revision

- GENESYS was used to test resource adequacy of the least cost resource portfolio from Scenario 1B
  - Results indicated that RPM was significantly "overbuilding" resources (i.e., LOLP was less than 1%)
  - Review of results revealed that difference was due to interaction between the hydro-system's peaking capacity and the dispatch other resources that provide energy in GENESYS
  - GENESYS meets hourly capacity needs with hydro and stores water needed for peaking with energy saved by conservation and generated by wind and gas turbines.

Progress Since The June Power Committee Webinar– Model Structure Revision

- RPM logic and inputs were revised to allow peak/energy substitution reflecting NW hydro-system operation that is more consistent with GENESYS
- Revised assumptions were run through RPM to generate a new least cost portfolio
  - Revised portfolio tested in GENESYS to confirm that it achieved ~ 5 % LOLP

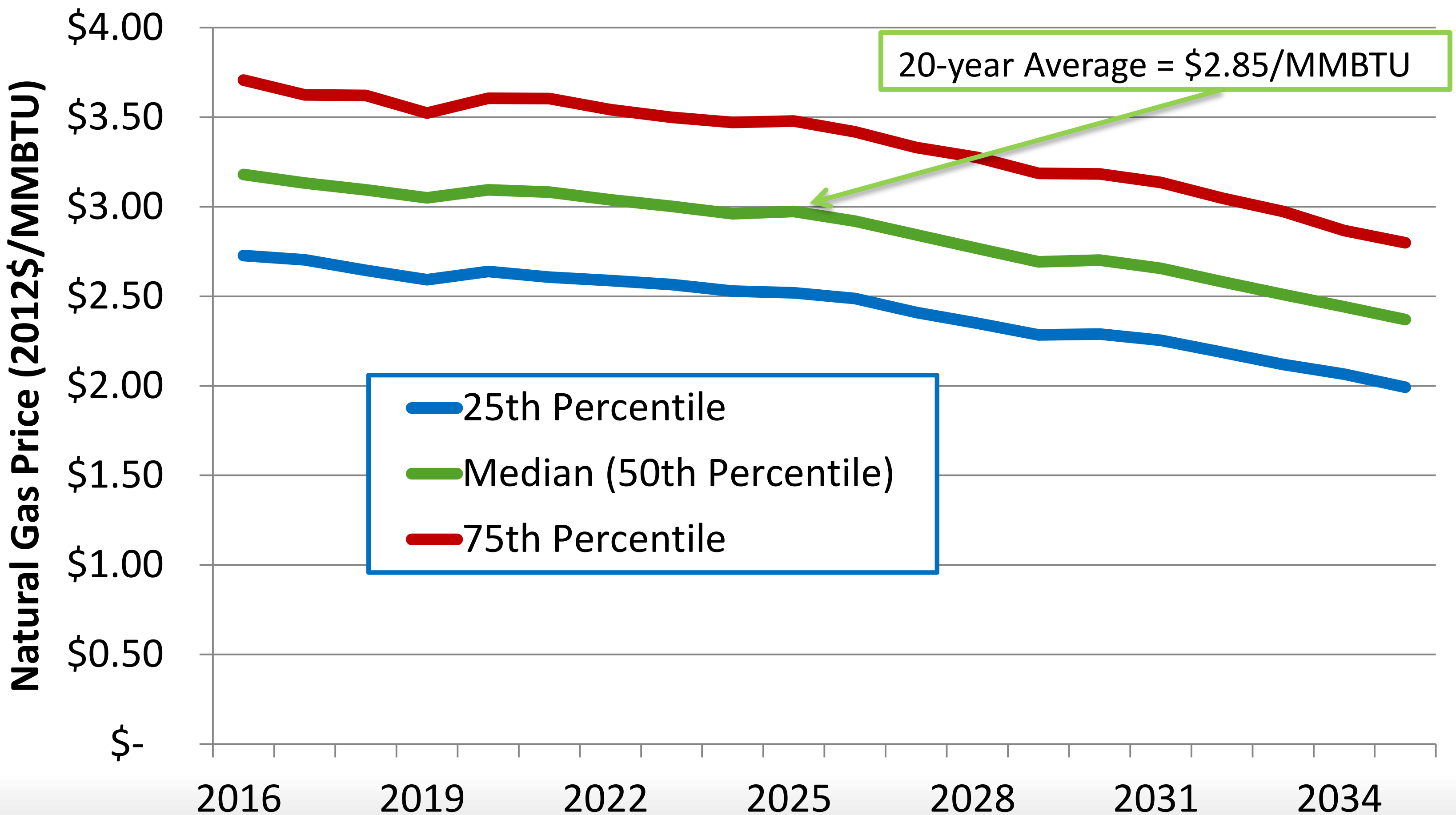
Scope of Today's Presentation Scenario and Sensitivity Study Results

- Scenario Analysis Results
  - Scenario 1B – Existing Policies, No Carbon Risk
  - Scenario 2B – Social Cost of Carbon
  - Scenario 2C – Carbon Risk
  - Scenario 3A – Maximum Carbon Reduction with Current Technology
  - Scenarios 4C and 4D – Alternative Conservation Near Term Maximum Acquisition Rates

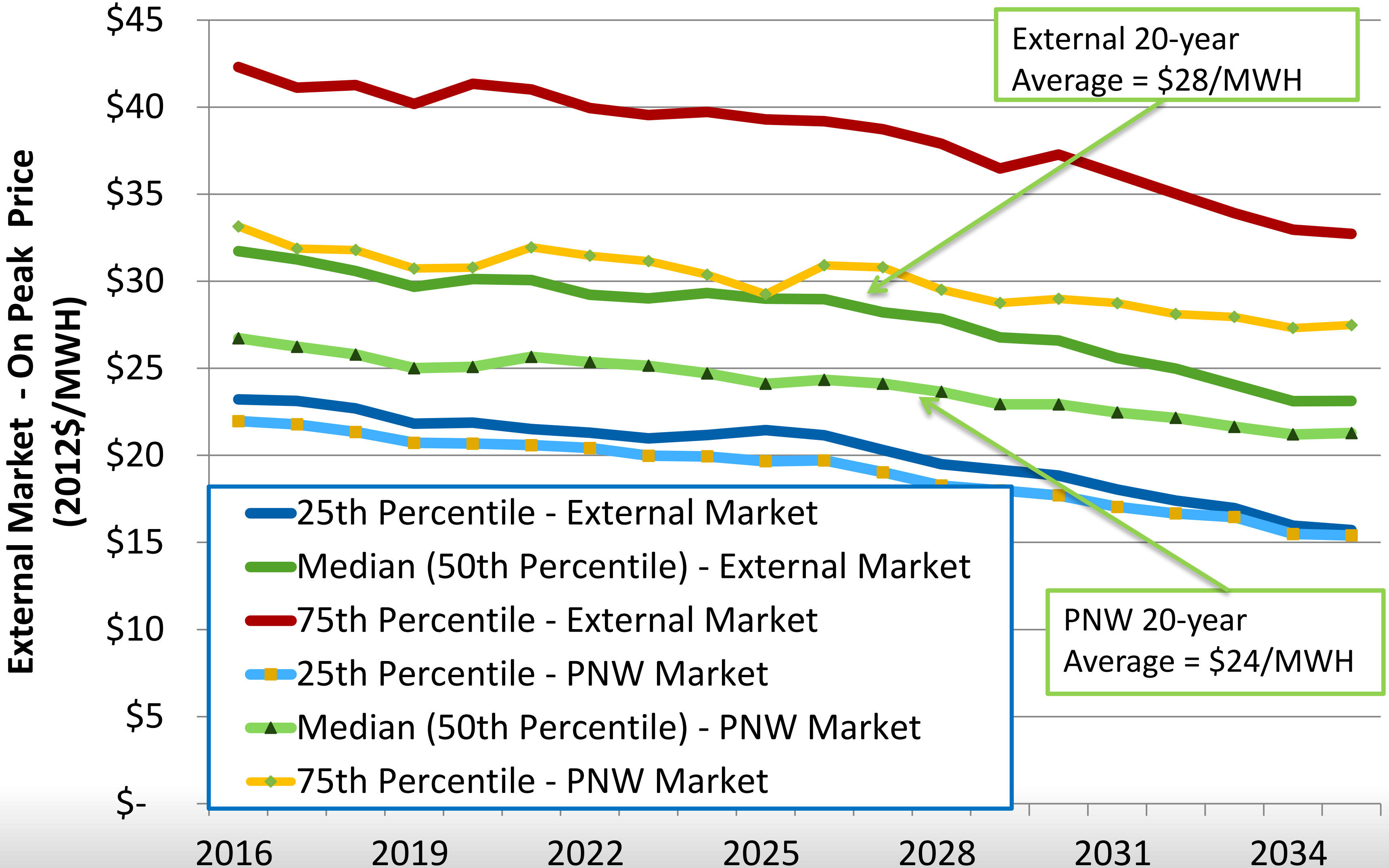
- Sensitivity Study Results
  - Sensitivity S2 – Scenario 1B w/Lower Natural Gas Prices
  - Sensitivity S3 – Scenario 1B w/o Demand Response (DR)
  - Scenario 2B.1 – Social Cost of Carbon @ 95^{th} Percentile estimate of damage cost (Added to the list of sensitivity studies after seeing 3A results)

Summary of Findings To Date: New Sensitivity Studies

Sensitivity Study S2 –
Scenario 1B with Low Gas Price Assumptions



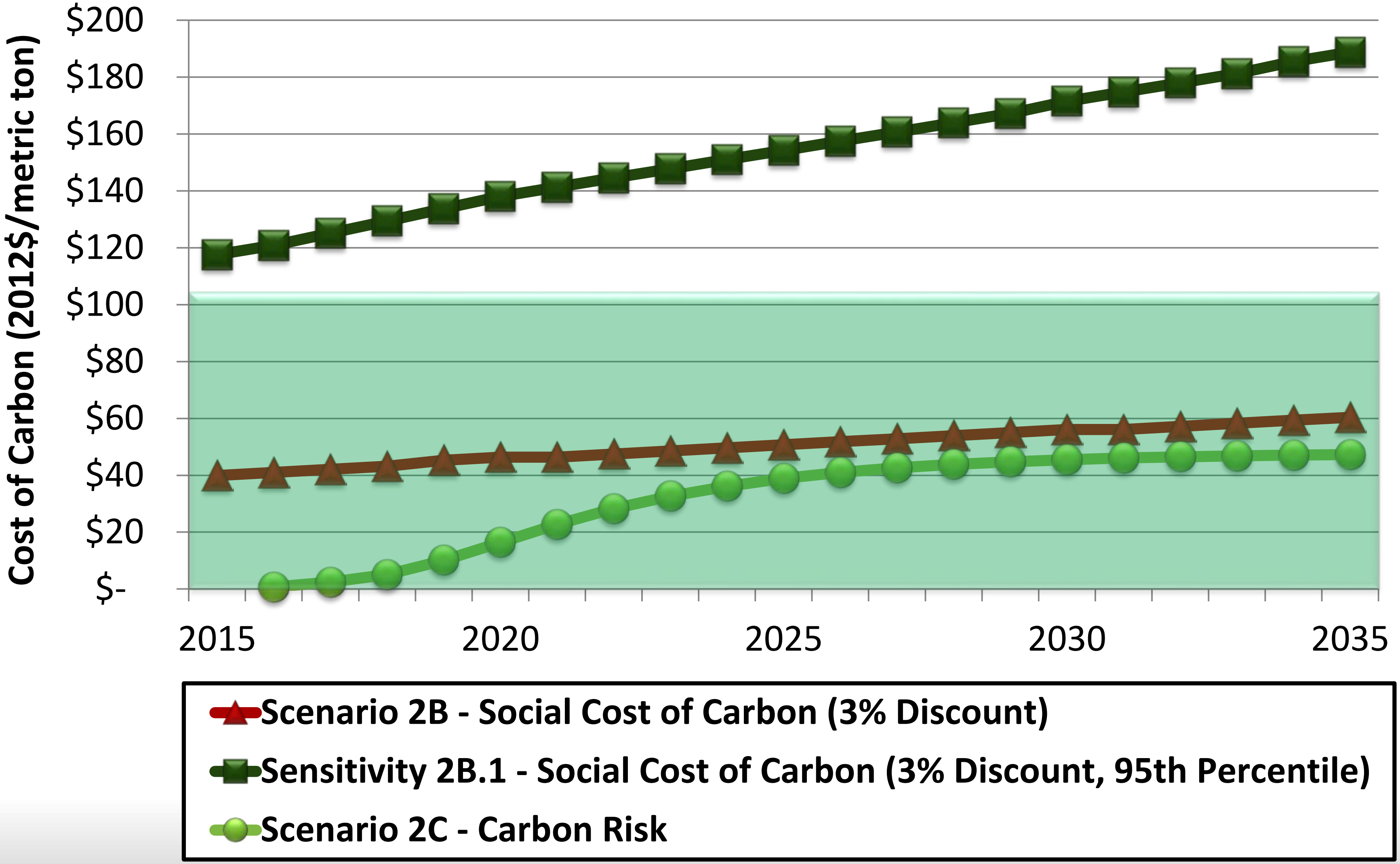
Sensitivity Study S2 – Scenario 1B Electricity Market Price Assumptions



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

- Compared to 1B – Existing Policy, No Carbon Risk
  - Slightly decreased conservation development
    - 2021 = -17 aMW
    - 2026 = -74 aMW
    - 2035 = -300 aMW
  - DR development is nearly identical
  - Slightly increased (40 aMW) renewable resource development by 2021, but reduces renewable development by 90 aMW by 2035
  - Significantly reduced 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

Sensitivity Study 2B.1 (New)
Social Cost of Carbon Set At 95th Percentile Estimate of Damage Cost

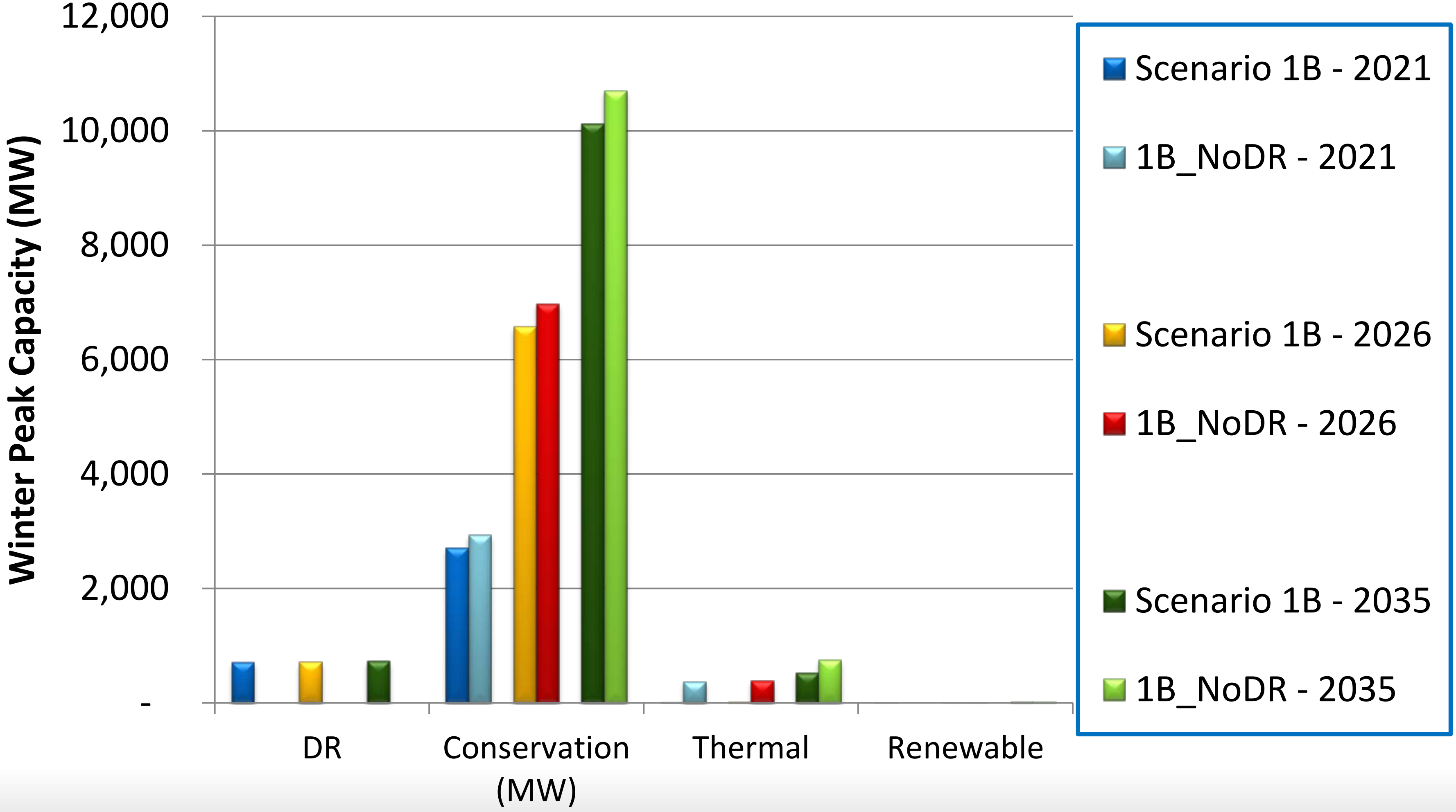


Sensitivity Study 2B.1 – Scenario 2B with Social Cost of Carbon @ 95th Percentile

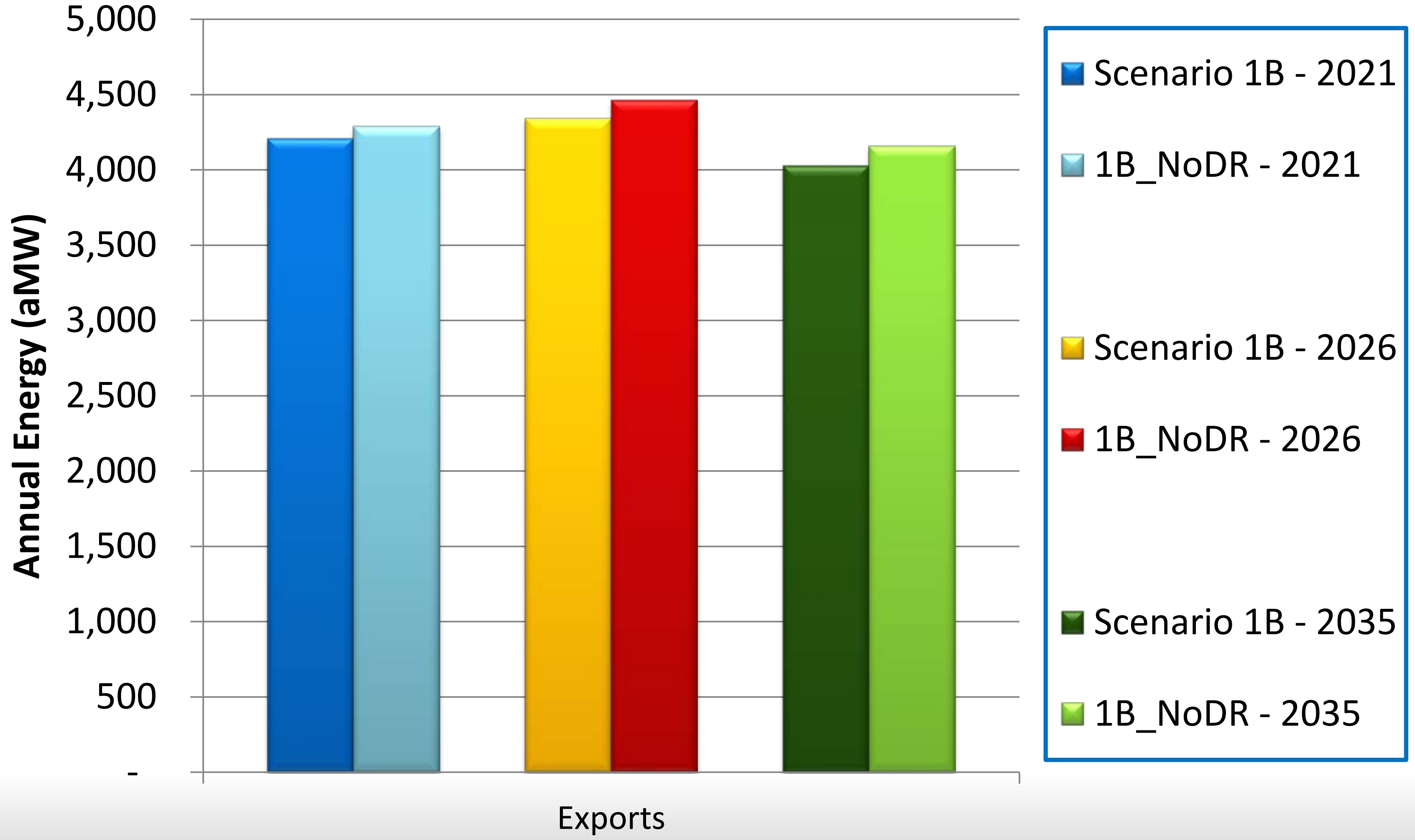
- Compared to 1B – Existing Policy, No Carbon Risk
  - Slightly increased conservation development
    - 2021 = +75 aMW
    - 2026 = +130 aMW
    - 2035 = +170 aMW
  - DR development similar until 2026, then increases by ~150 – 200 MW
  - Slightly increased (30 aMW) renewable resource development
  - Effectively eliminated coal generation
    - - 3,200 aMW
  - Significantly increased new natural gas generation capacity
    - 225 MW vs. 2,400 MW in 2035
  - Slightly increased regional exports (+700 aMW)

Sensitivity S3 – Scenario 1B with No Demand Response

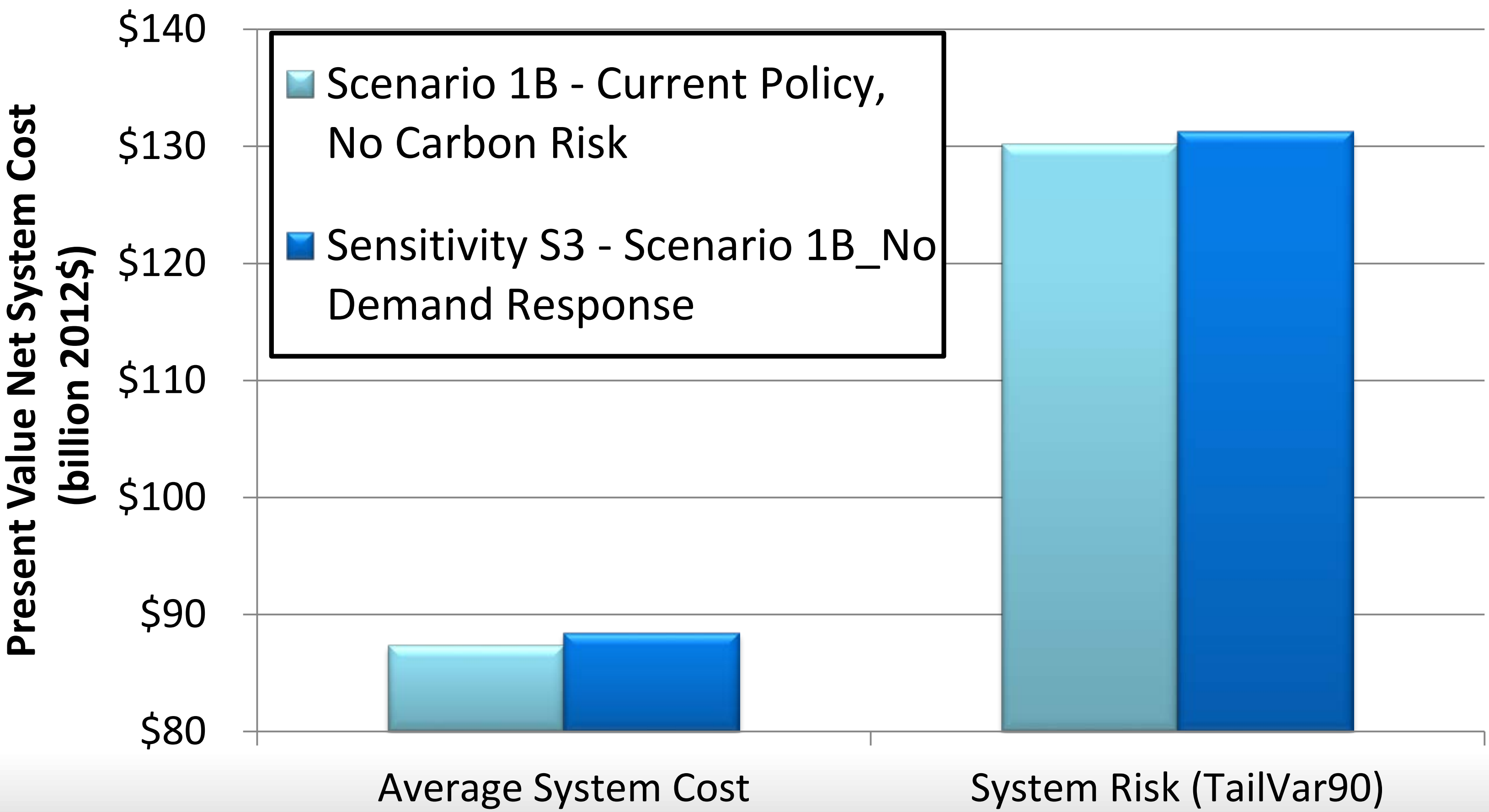
~700 MW of DR is Replaced by EE and Thermal Resources



Sensitivity S3 – Scenario 1B with No Demand Response The Additional EE Resources Result in Slightly Larger Regional Energy Exports



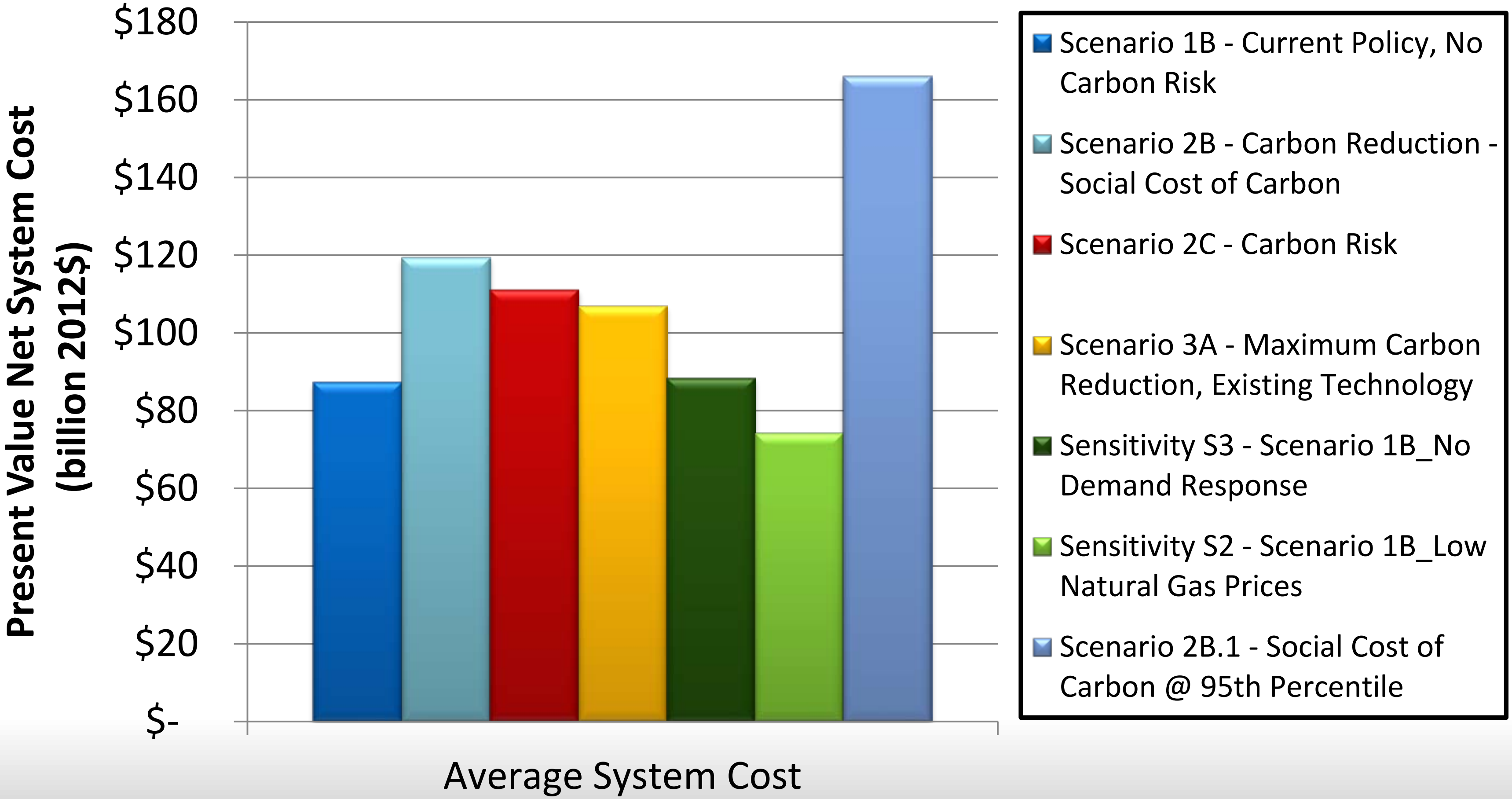
Sensitivity S3 – No Demand Response Without DR Both Net Present Value System Cost and System Risk Increase by ~$1 billion



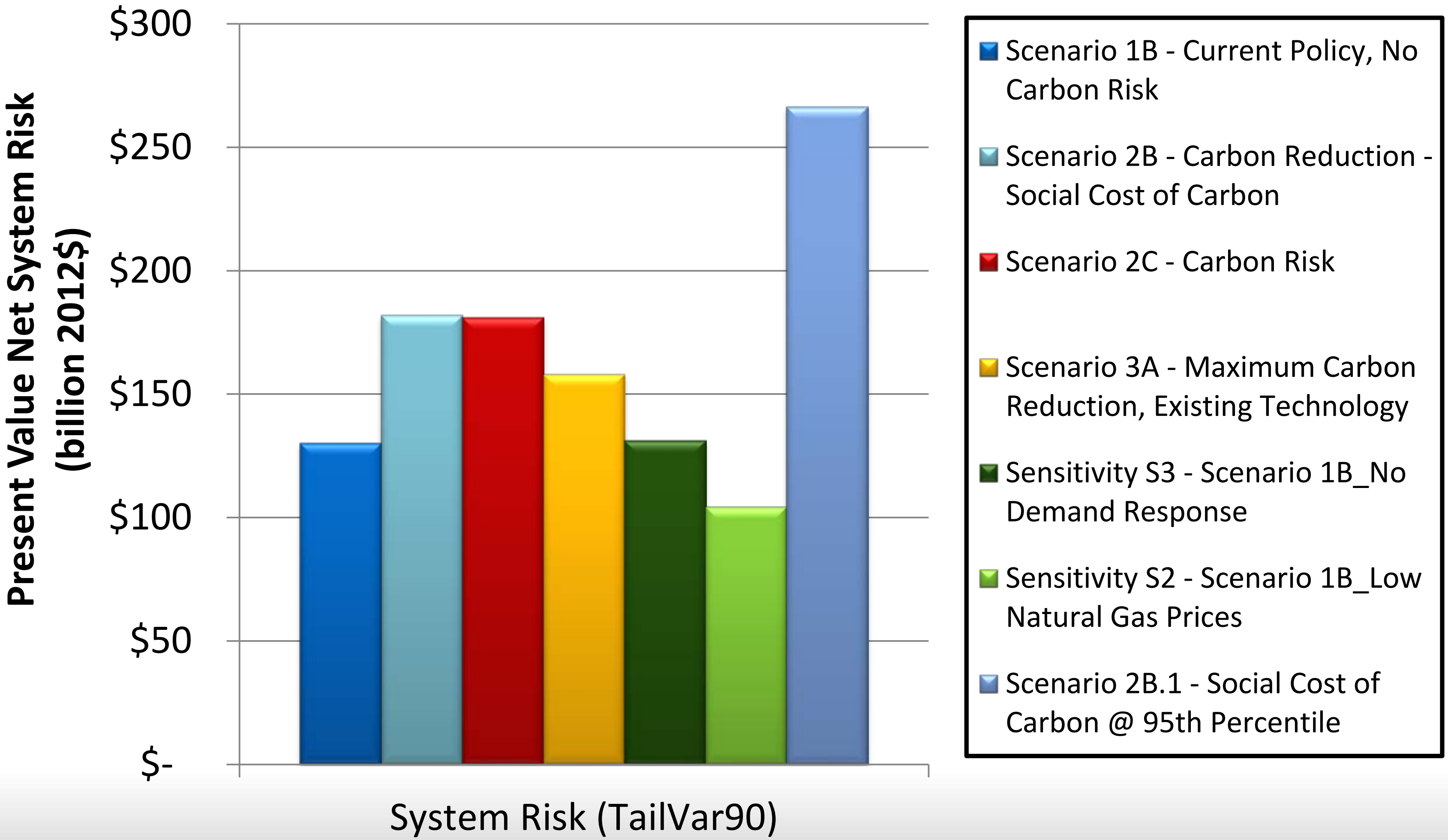
Summary of Findings To Date: All Scenarios and Sensitivity Studies Completed To Date

The Average Present Value Net System Cost for Least Cost Strategies *Without* Carbon Cost:

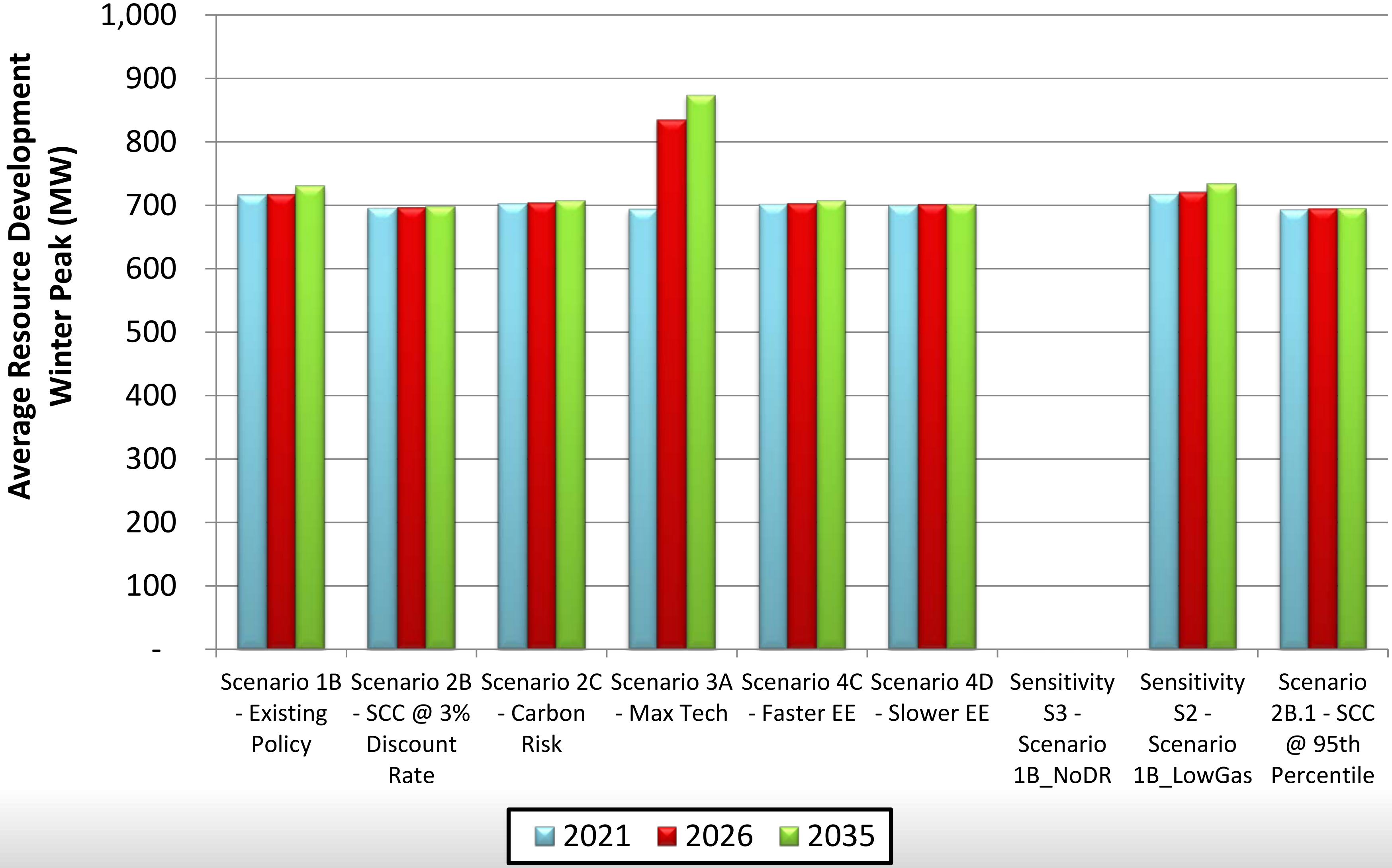
NPV System Cost for Scenarios Vary Over a Wide Range – Primarily Due to the Cost of Carbon Emissions Reductions



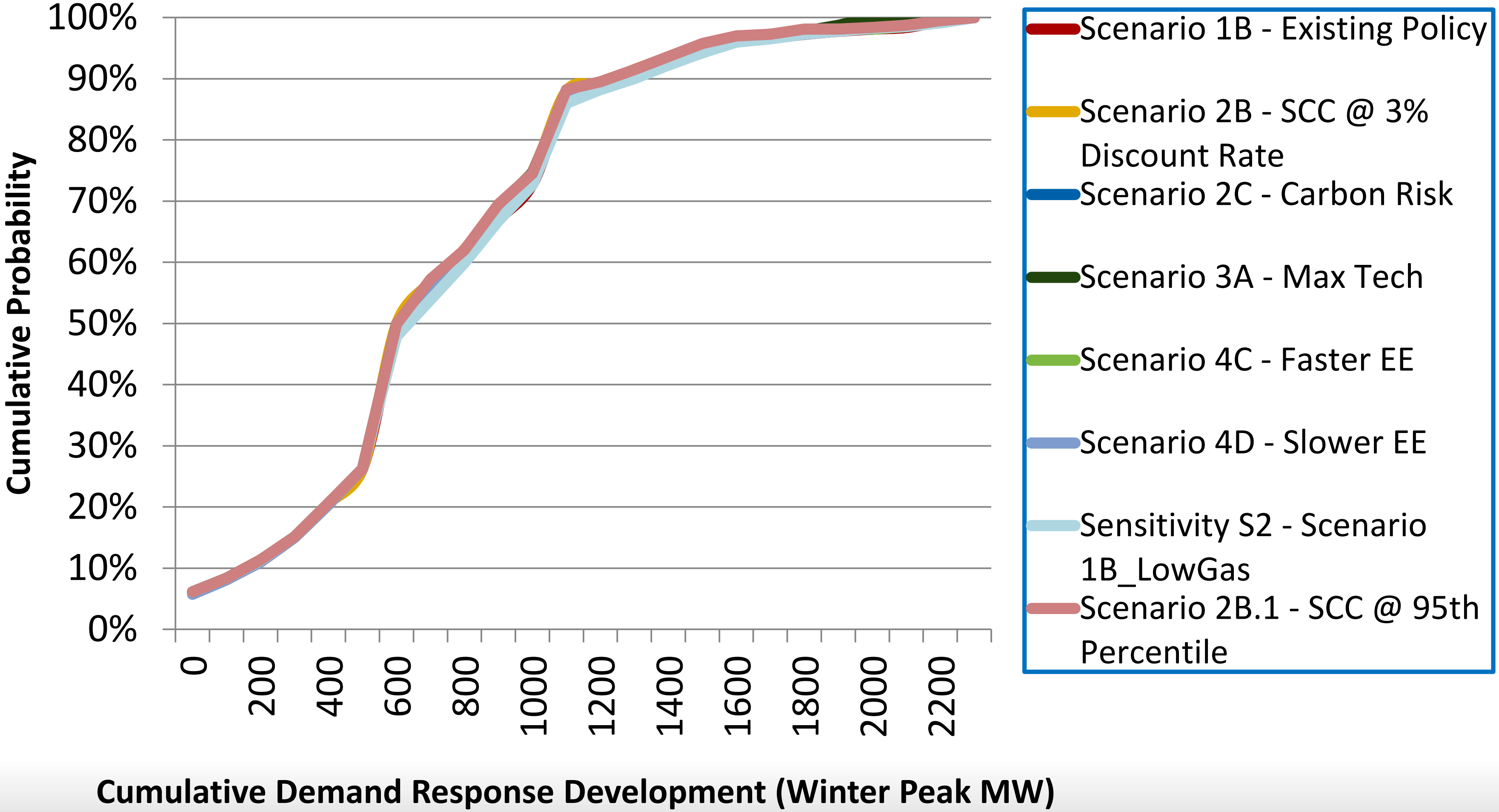
The Average Present Value Net System Risk for Least Cost Strategies *Without* Carbon Cost
High Risk is A Function of Carbon Cost Assumptions



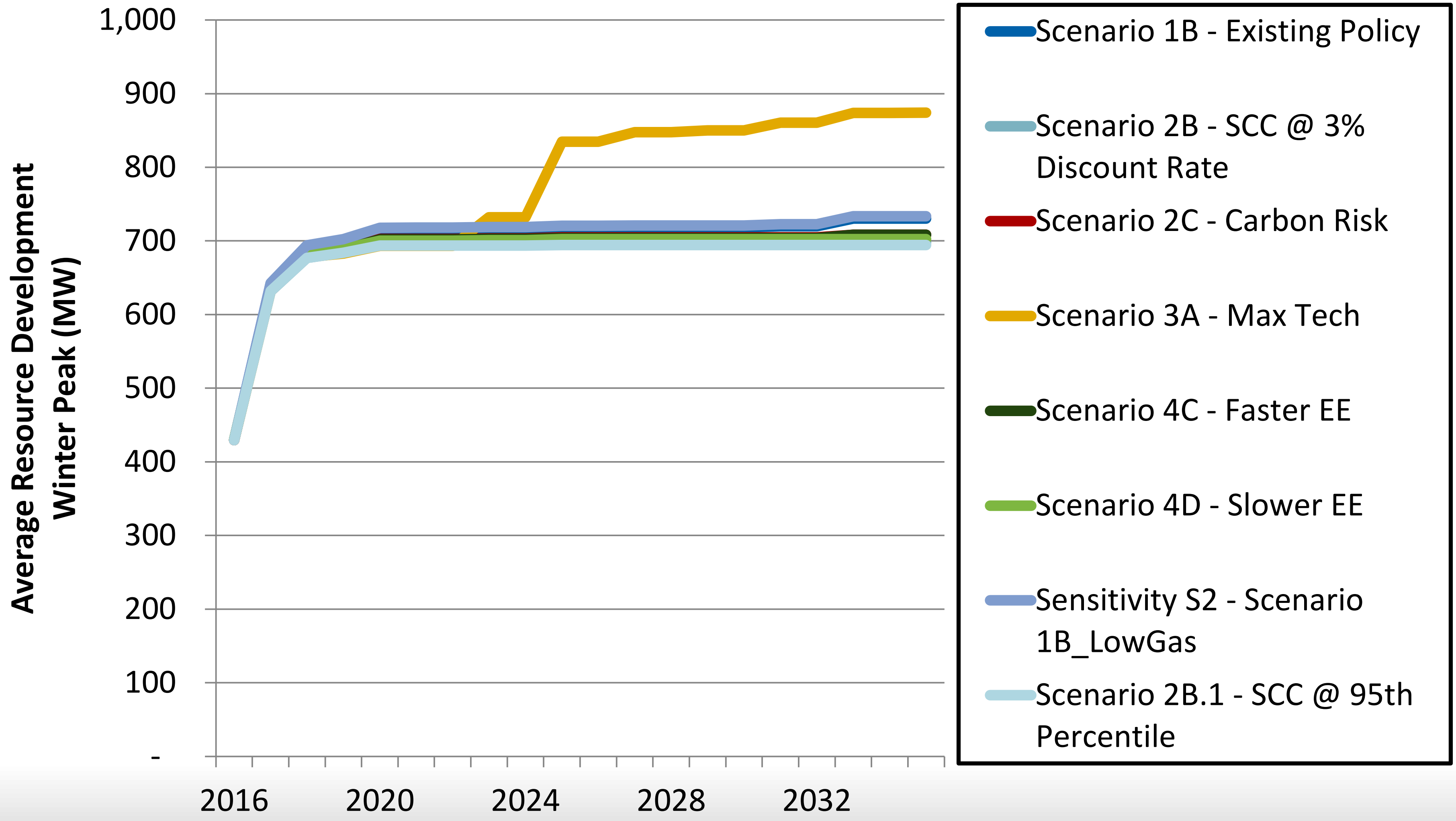
Average Demand Response Development Across Scenarios Is Nearly Identical, But Increases Through Time With Full Coal and Inefficient Gas Retirement



Both the Probability and Magnitude of Demand Response Development by 2021Are Nearly Identical Across All Scenarios



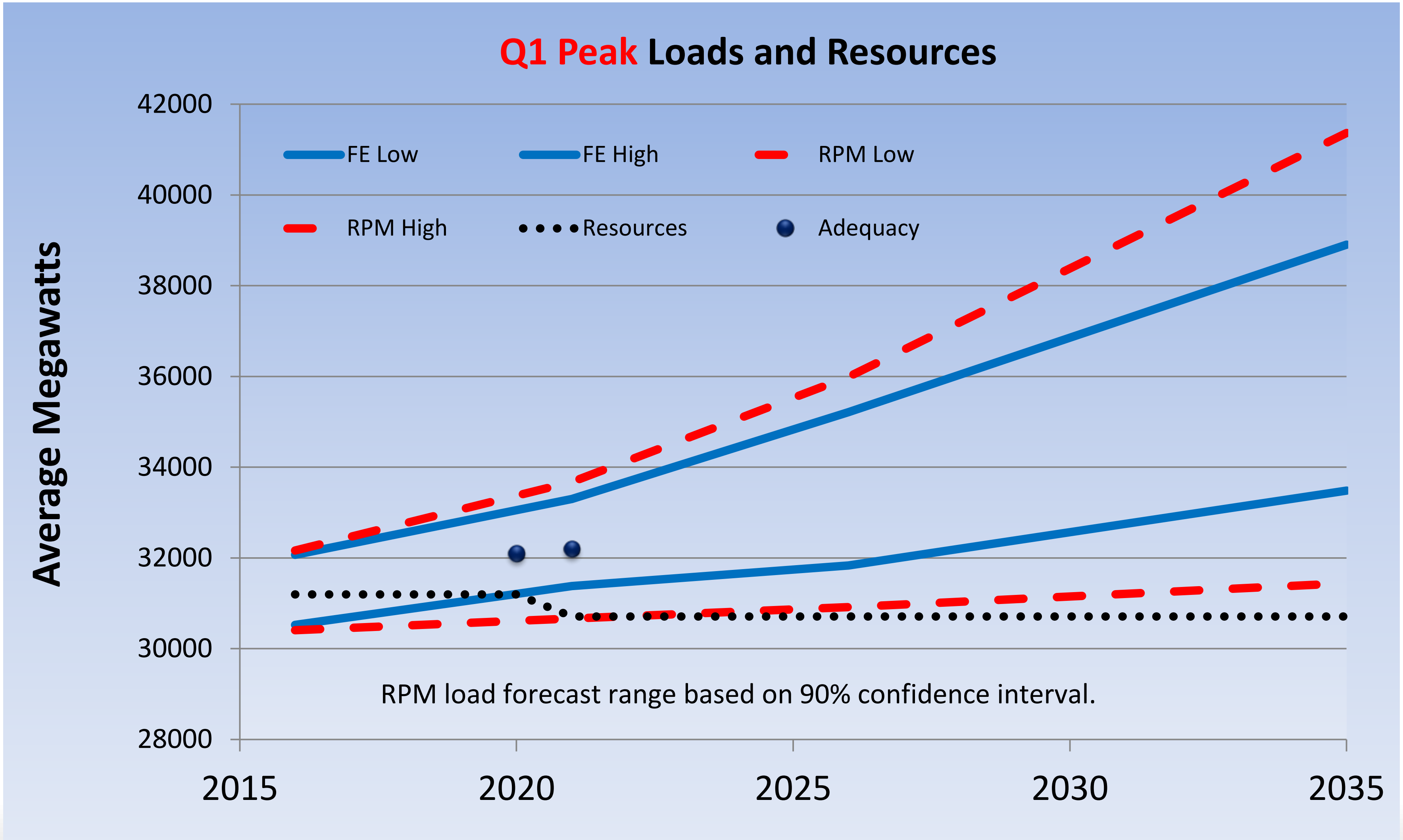
Demand Response Is Developed Almost ***Immediately*** To Satisfy Regional Resource Adequacy Standards



How Does This Finding Compare to the 2021 Regional Resource Adequacy Assessment?

- RPM explores a wider range of potential futures
  - RPM considers “economic cycle” and “weather” caused variation in loads
  - RA considers only variation due to “weather”
- Both RPM and Resource Adequacy Assessment (RA) find regional near term energy surplus
- Both RPM and Resource Adequacy Assessment (RA) find “non-zero” probability of capacity shortfall (LOLP = 5%)

Capacity Loads & Resources 2016-35



Uncertainty in 2020 LOLP

Load Adjust> / Spot Import	Low -2.5%	-1.5%	Med 0%	+1.5%	High +2.5%
0	10.1%	10.2%	13.3%	14.2%	17.5%
1500 MW	4.4%	5.0%	6.2%	7.3%	8.3%
2500 MW	3.2%	3.8%	4.8%	5.9%	6.9%
3400 MW	1.4%	1.9%	2.7%	3.4%	3.9%
4500 MW	0.2%	0.4%	0.7%	1.3%	1.7%

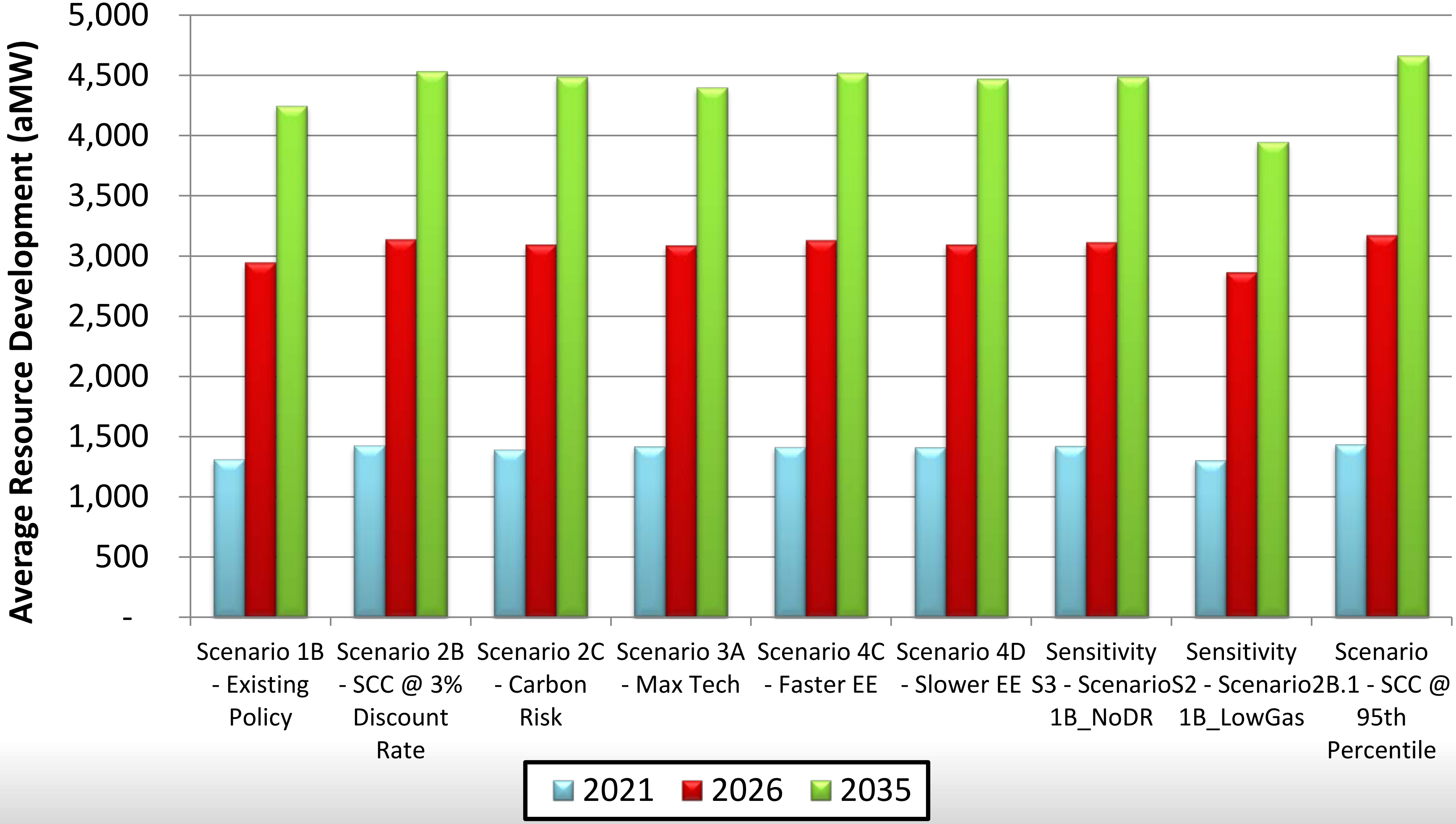
Even though the 2020 power supply is expected to be adequate (i.e. LOLP < 5%) there remains a significant likelihood that it will not be (red vs. green squares).

Observations from Scenarios To Date: Demand Response

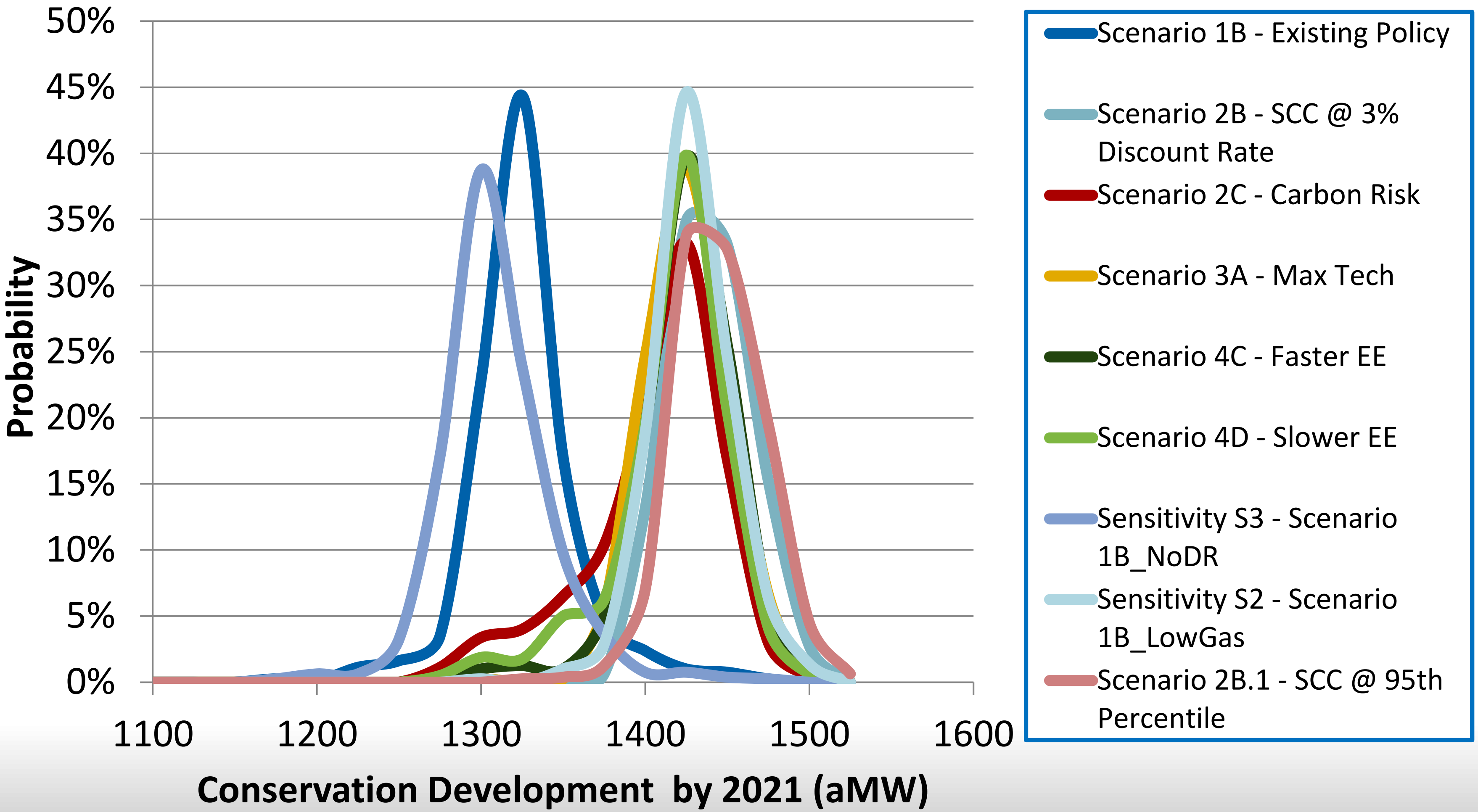
- Demand Response is the preferred resource to meet short-term peaking capacity requirements*
- Why
  - It is lowest cost option for maintaining capacity reserves
  - It has a shorter lead-time and comes in more “modular” sizes than generation
    - About 1000 MW of DR resources *can be* optioned and built before SCCT can be built (Q1 2018)
    - DR defers the size of the SCCT build until after 2030.
  - It does not have fuel price risk
  - It does not produce significant “energy” in an already energy surplus market

*Assumes that the limits to reliance on external market imports for winter capacity used in the Regional Resource Adequacy are constraining additional market purchases.

Average Conservation Development Across Scenarios Increases When Carbon Risk Are Considered But Does Not Significantly Increase With Full Coal Retirement or Consideration of the 95th Percentile Estimate of the Social Cost of Carbon



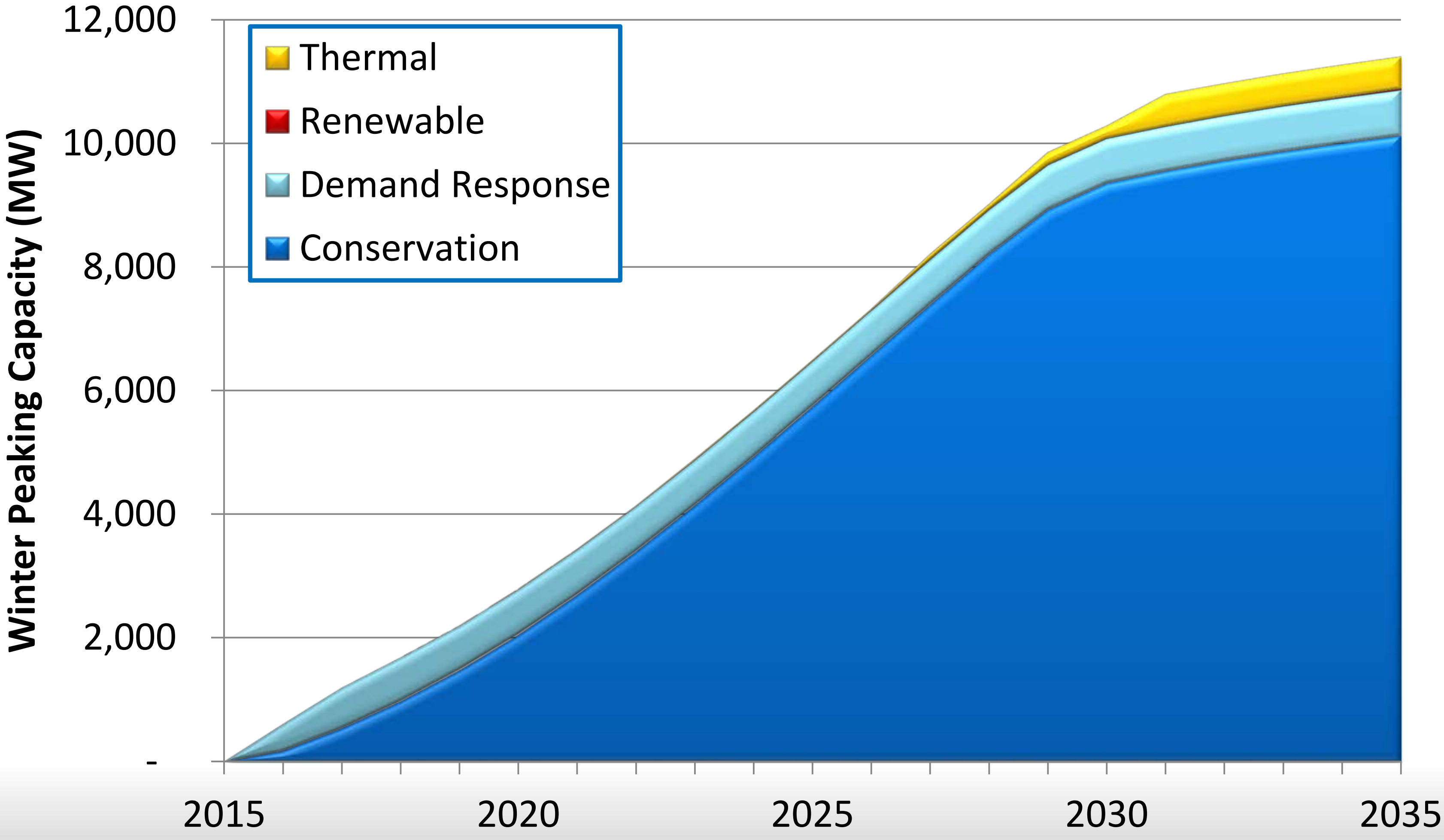
- **Scenarios That Consider Carbon Risk Develop Similar Amounts (~1400 aMW) of Conservation by 2021**
- **Scenarios That Assume Low Gas Prices or No Carbon Risk Develop Slightly Less (~130 aMW) Conservation by 2021**



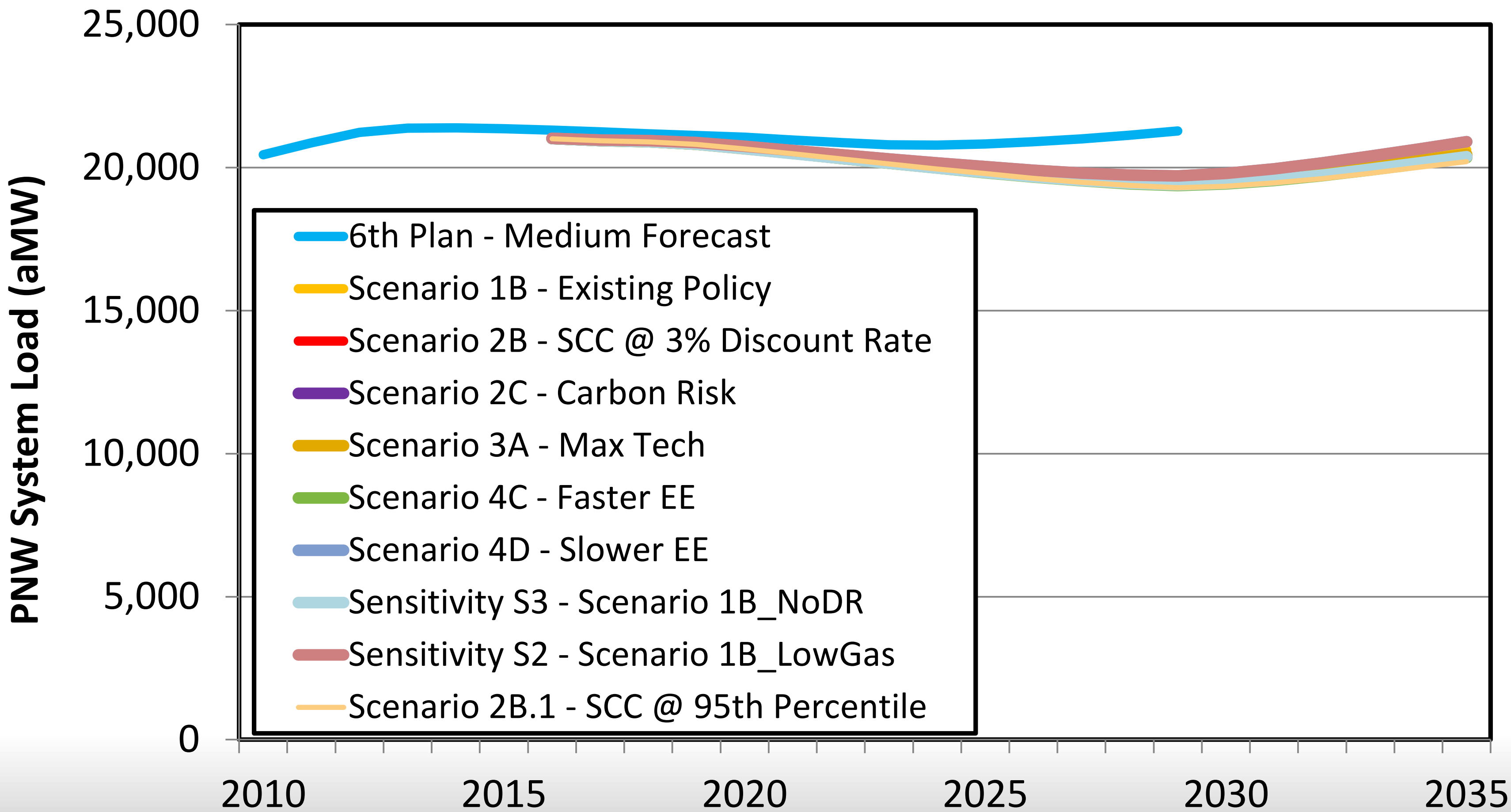
Range of Average Conservation Development Across Scenarios and Sensitivity Studies Conducted To Date

	2021	2026	2035
Minimum (1B_Low Gas)	1,300	2,870	3,945
Maximum (2B.1 SCC-95th)	1,430	3,170	4,665
Average Across All	1,390	3,070	4,420
Range	135	305	720

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



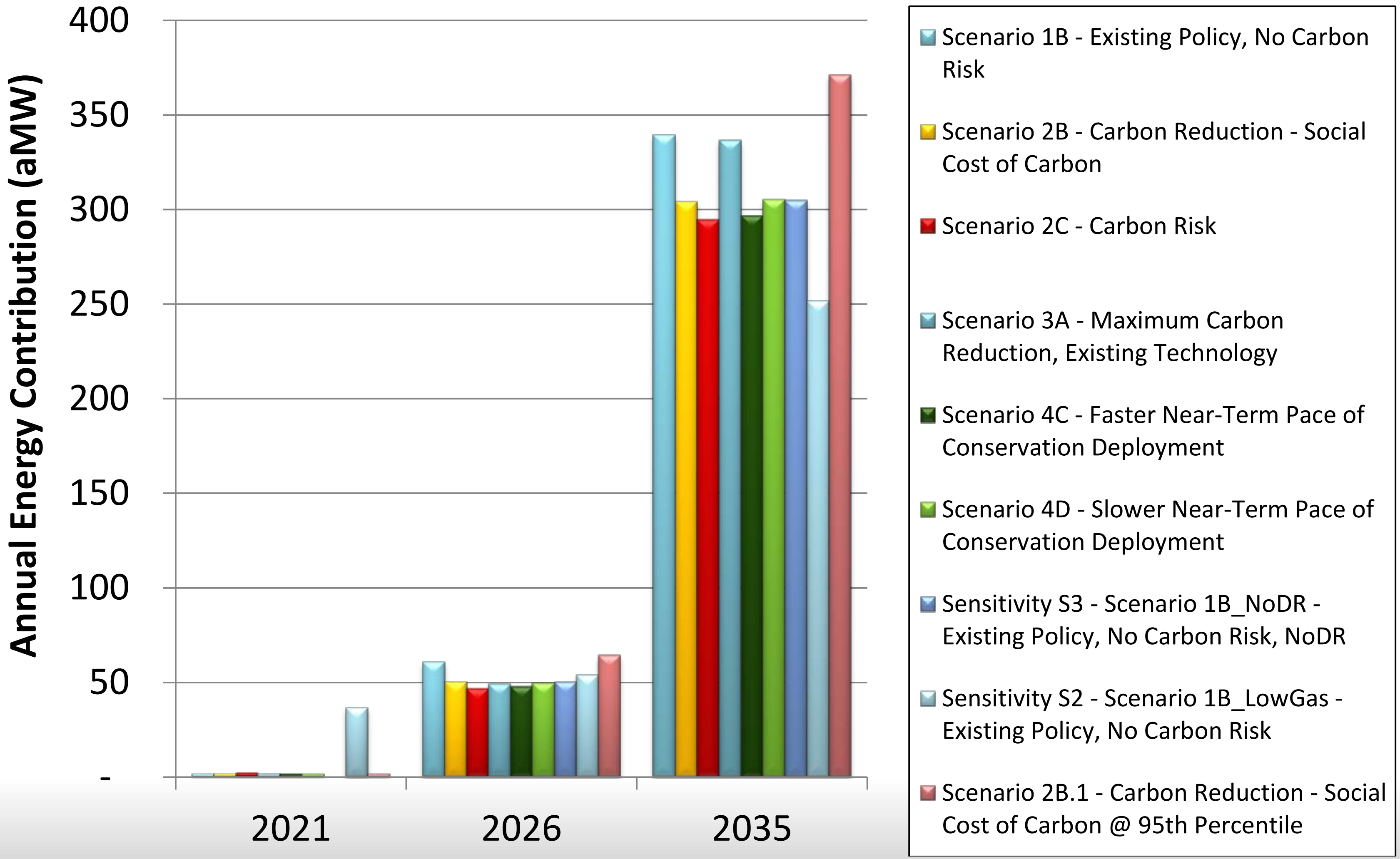
- **Regional Net Load After Conservation Remains "Flat On Average" Through 2035 Under the Least Cost Strategy for All Scenarios and Sensitivity Studies**
- **This Result is Very Similar To The Findings in the 6th Plan**



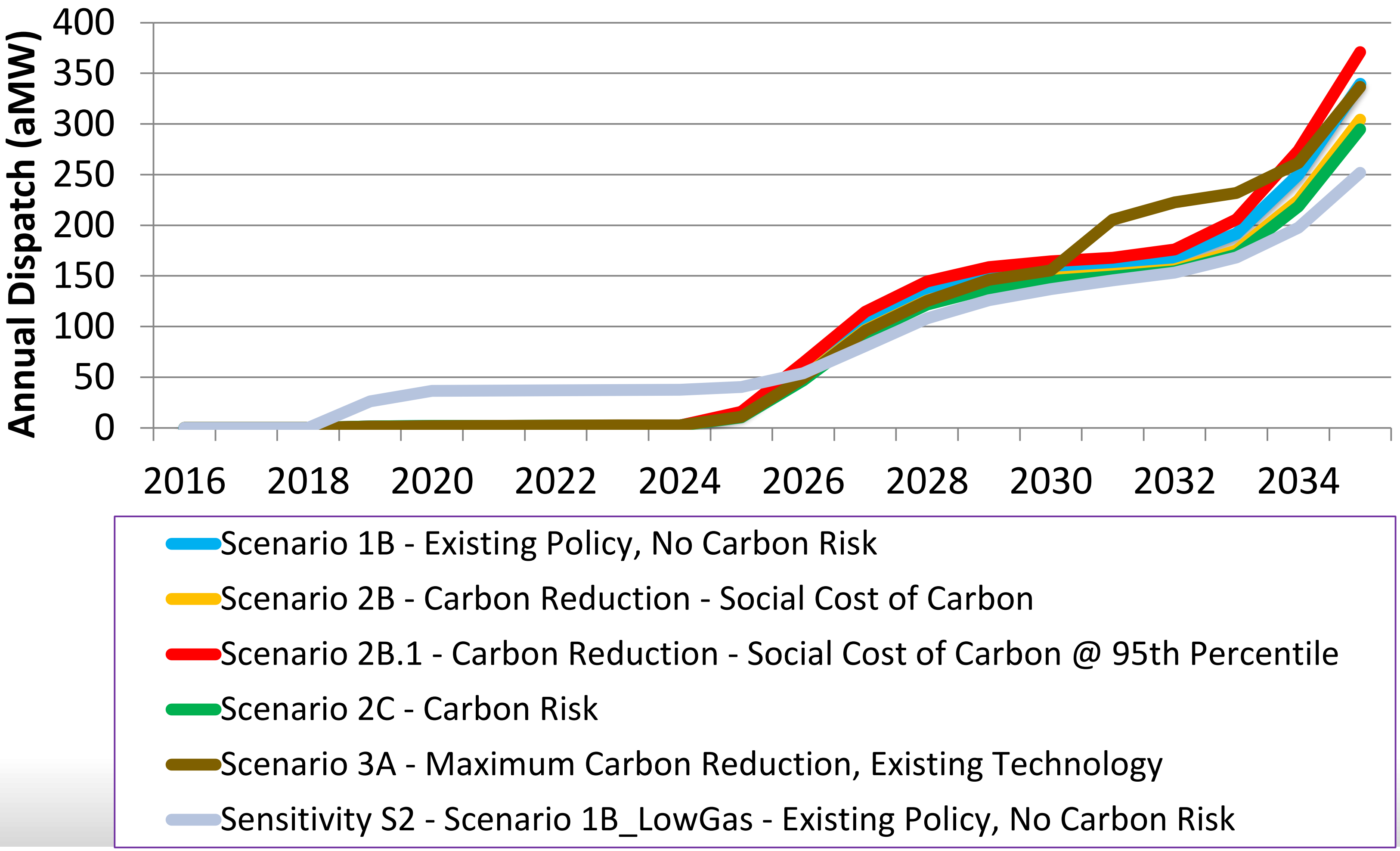
Observations from Scenarios To Date: Energy Efficiency

- 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

Average Renewable Resource Development for Energy Occurs After RECs are Used and Loads Begin To Increase



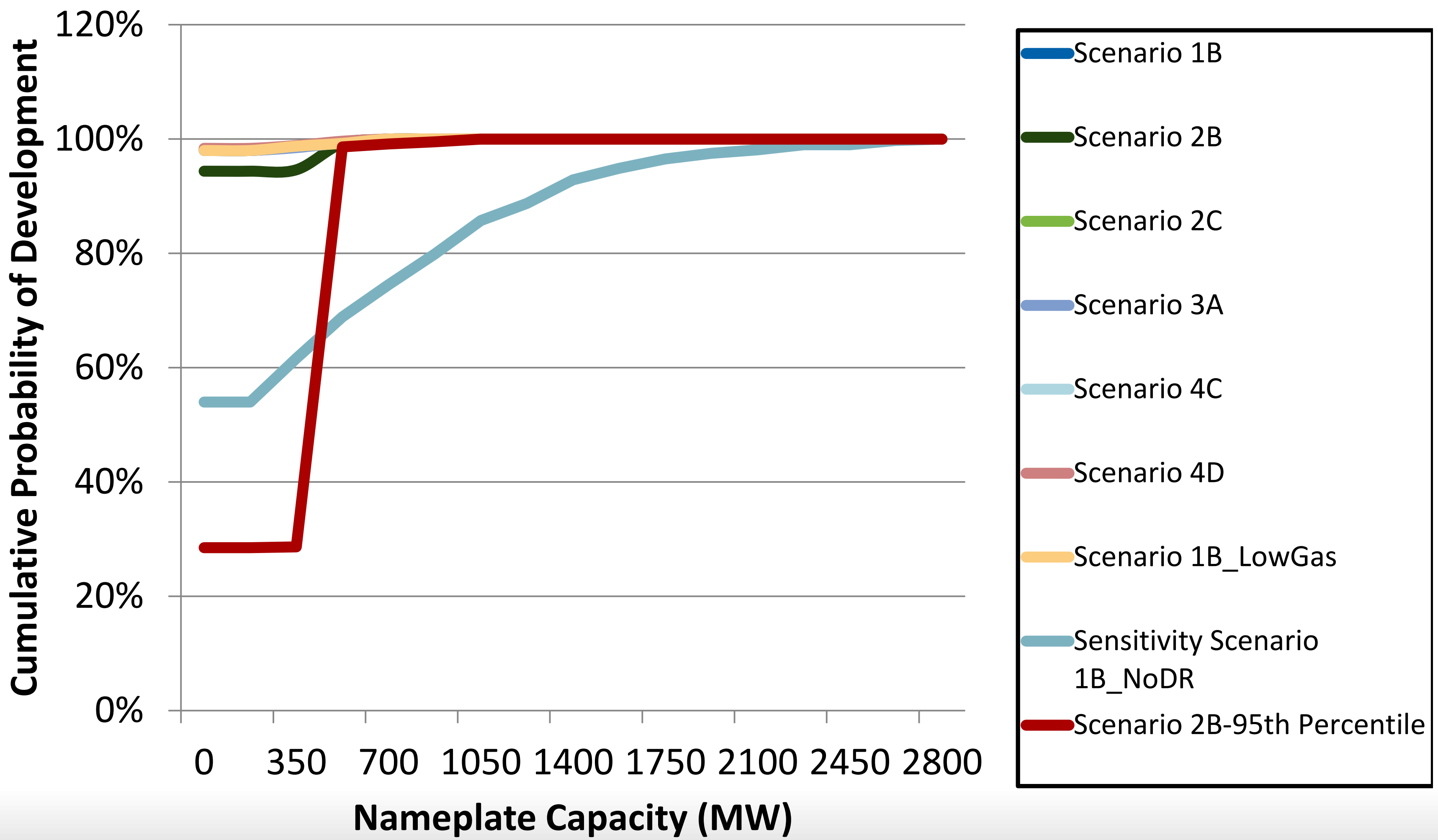
New Renewable Resource Development Is Not Significantly Increased In Carbon Emissions Reduction Policy Scenarios



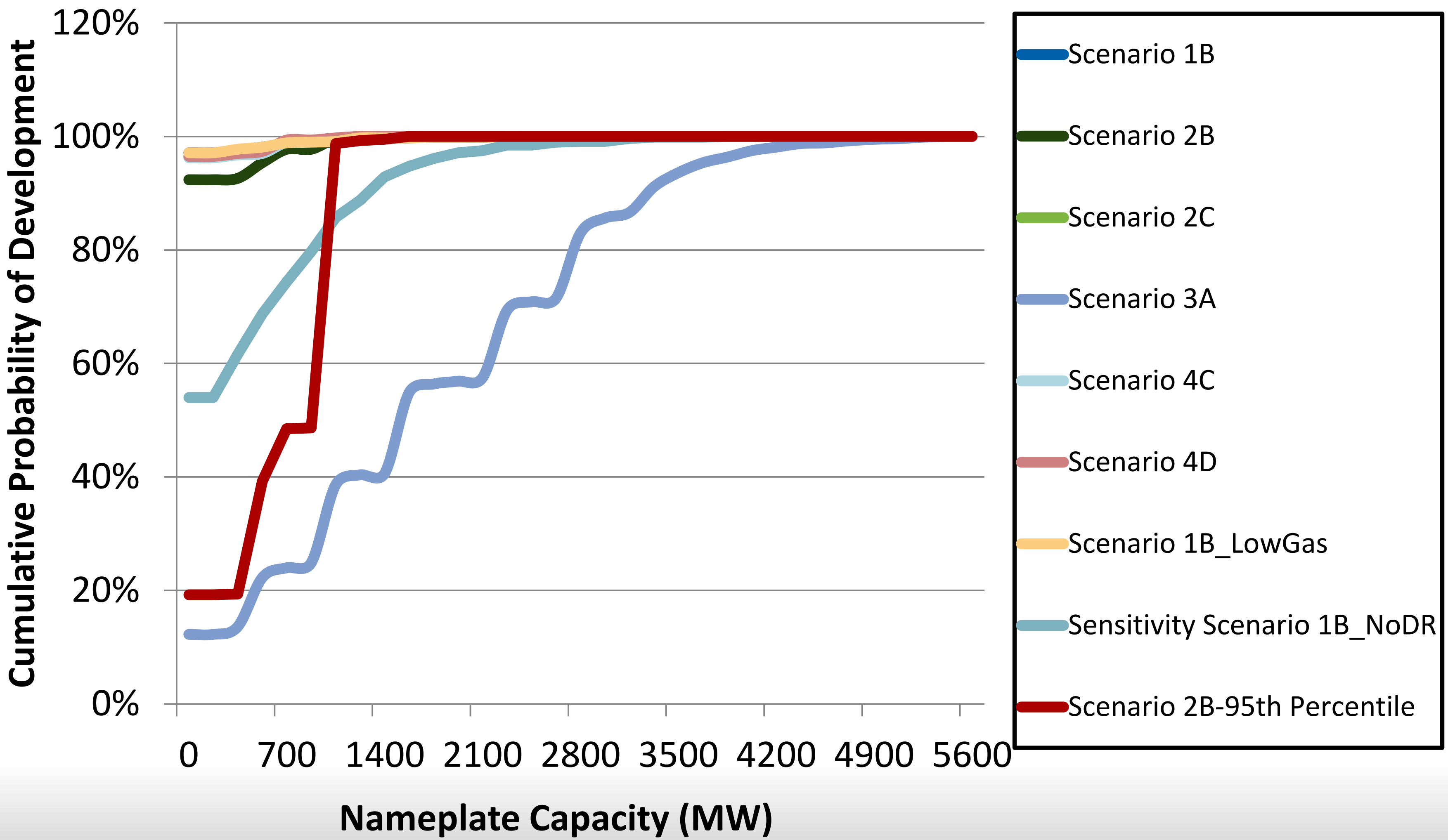
Observations from Scenarios To Date: Renewable Resources

- All least cost resource strategies build renewable resources to satisfy state RPS requirements
- Why
  - REC banking delays the need for constructing RPS resources until well past the action plan period
- Renewable resources are not deployed to mitigate future carbon risk/cost even when the 95^{th} Percentile estimate of the Social Cost of Carbon and future resource cost reductions (15% for solar PV and 5% for wind by 2030) are assumed
- Why
  - GHG gas reductions are achievable at a lower cost through energy efficiency and the substitution of (mostly existing) natural gas for existing coal generation
  - Currently commercially available Renewable Resources (solar PV and wind) provide *limited or no* winter peaking capacity, hence are not good matches for system need

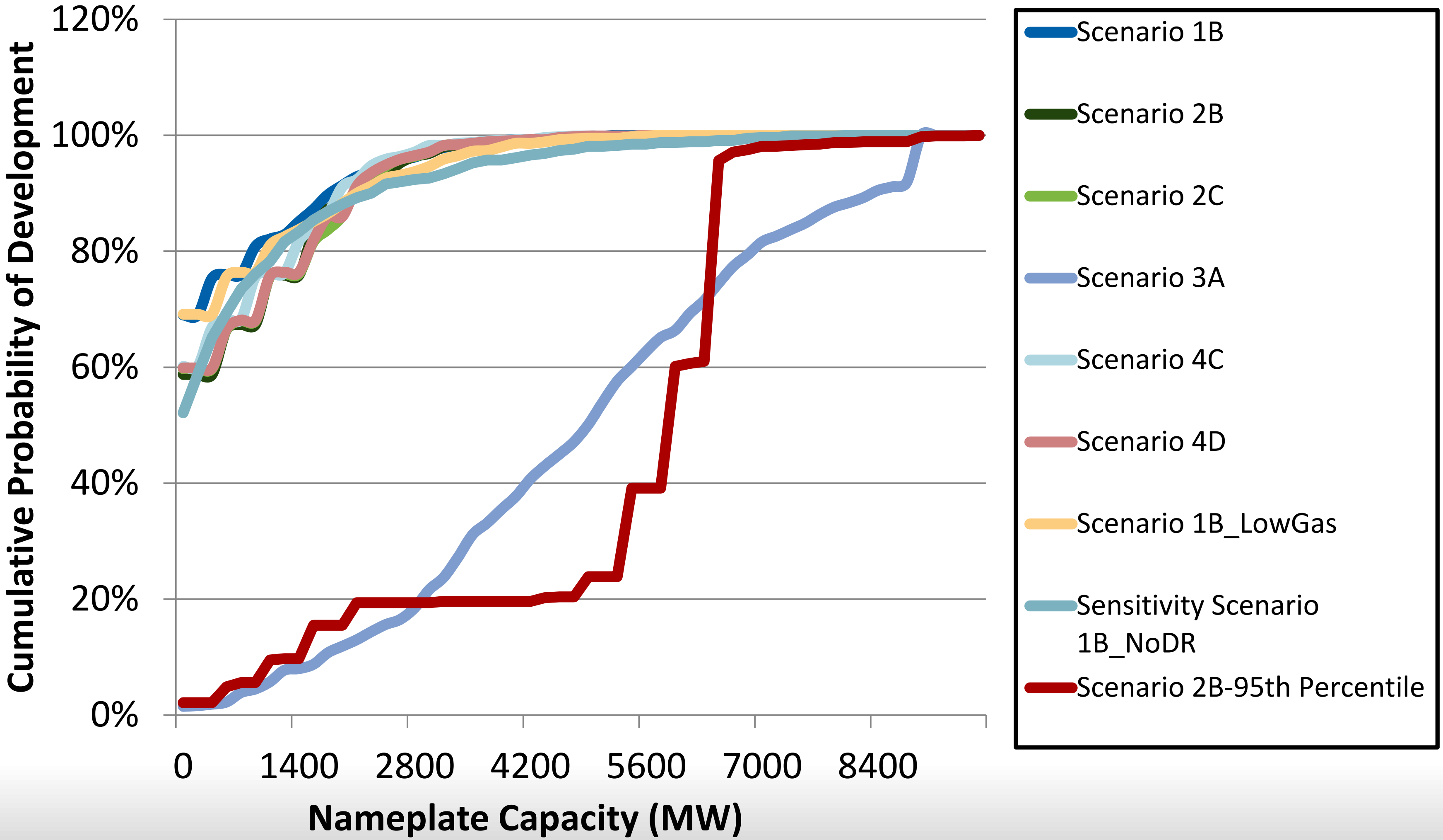
Cumulative Probability of Thermal Development by 2021



Cumulative Probability of Thermal Development by 2026



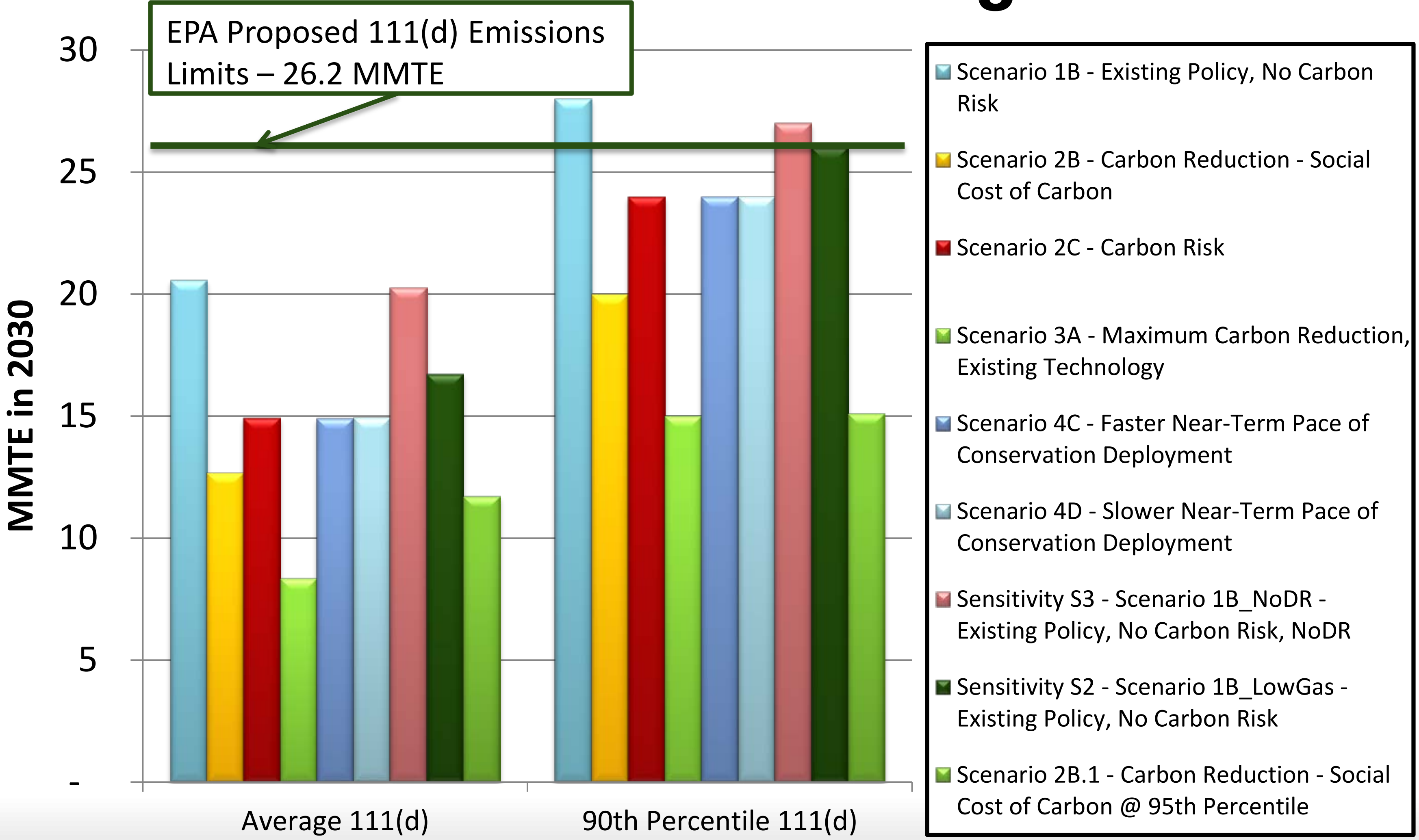
Cumulative Probability of Thermal Development by 2035



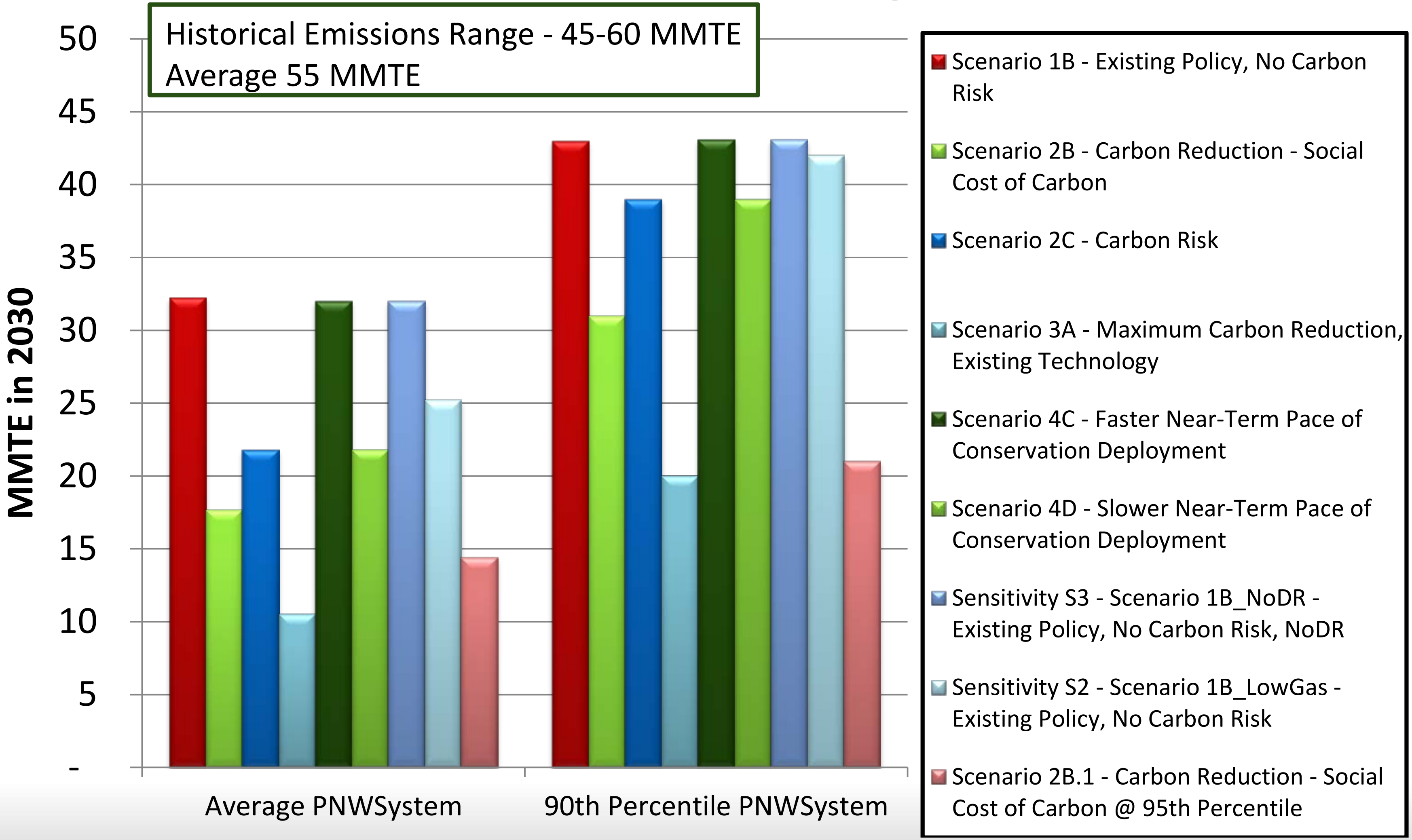
Observations from Scenarios To Date: Thermal Resources

- While there appears to be a need for thermal resource options, there is a low probability that such options will need to be exercised.
- Thermal resource construction is driven by announced coal plant retirements
- Why
  - Energy efficiency and demand response meet most near term capacity needs
- Combined cycle combustion turbines appear to be favored over less efficient "peakers."
- Why
  - Future carbon risk, and to some extent fuel price risk, favor more efficient gas-fired generation technologies
  - ***Note: This finding is limited to meeting the region's capacity and energy needs and does not address the need for flexibility and balancing resources***

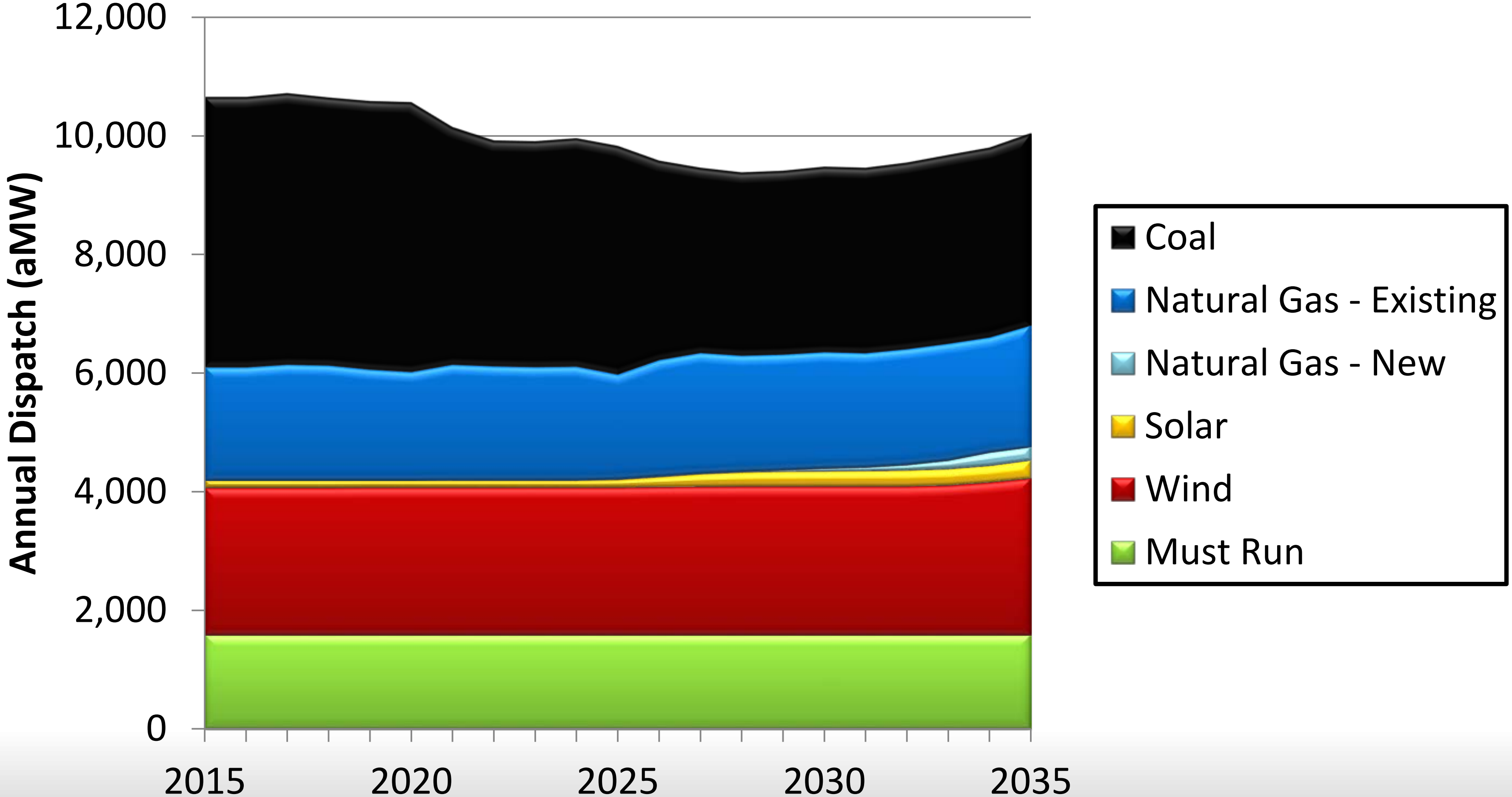
111(d) “System” CO2 Emissions Across Least Cost Resources Strategies - 2030



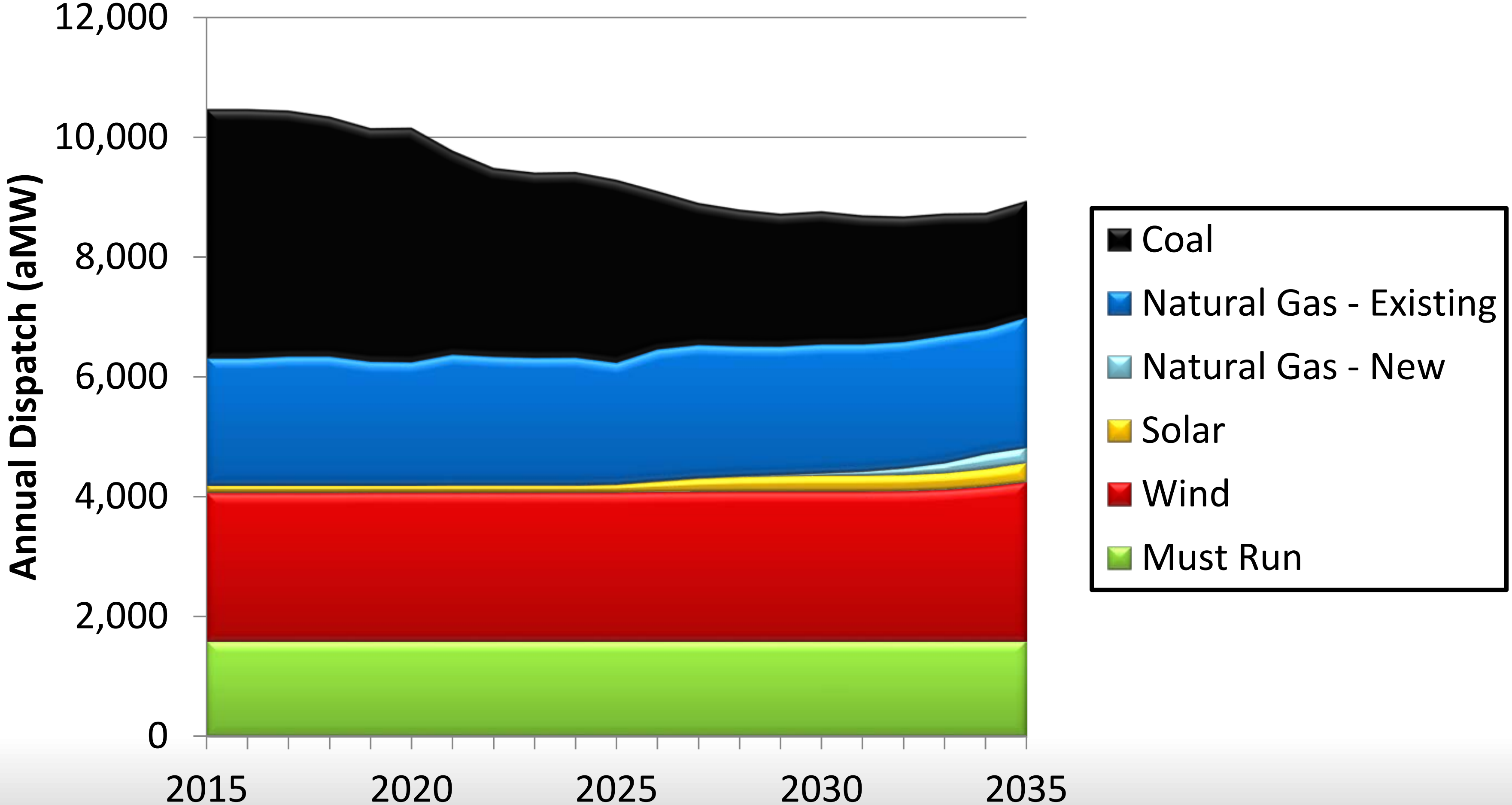
PNW System CO2 Emissions Across Least Cost Resources Strategies - 2030



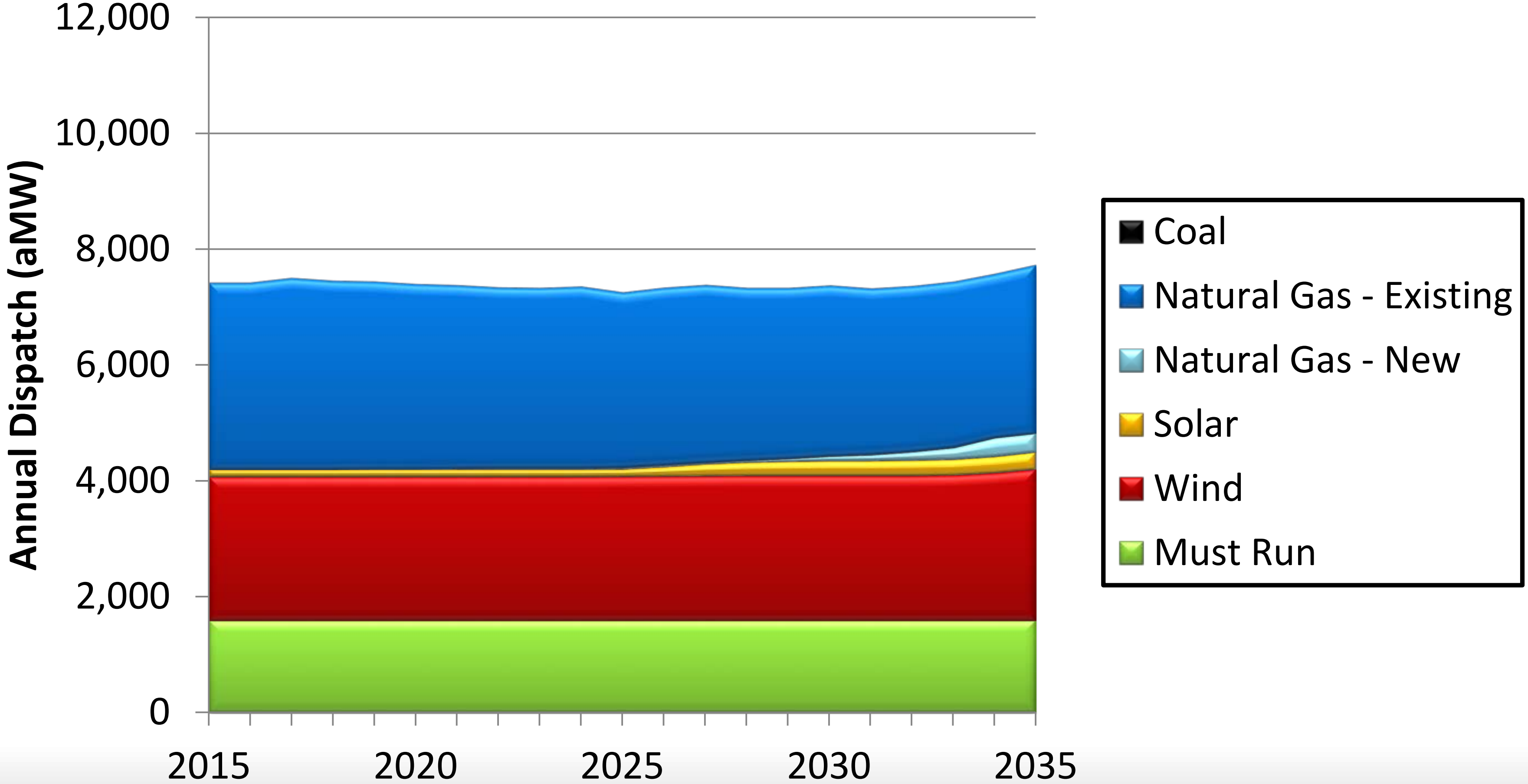
Changes in Thermal Resource Dispatch in the No Carbon Risk Scenario (1B) Are Driven by Announce Coal Plant Retirements



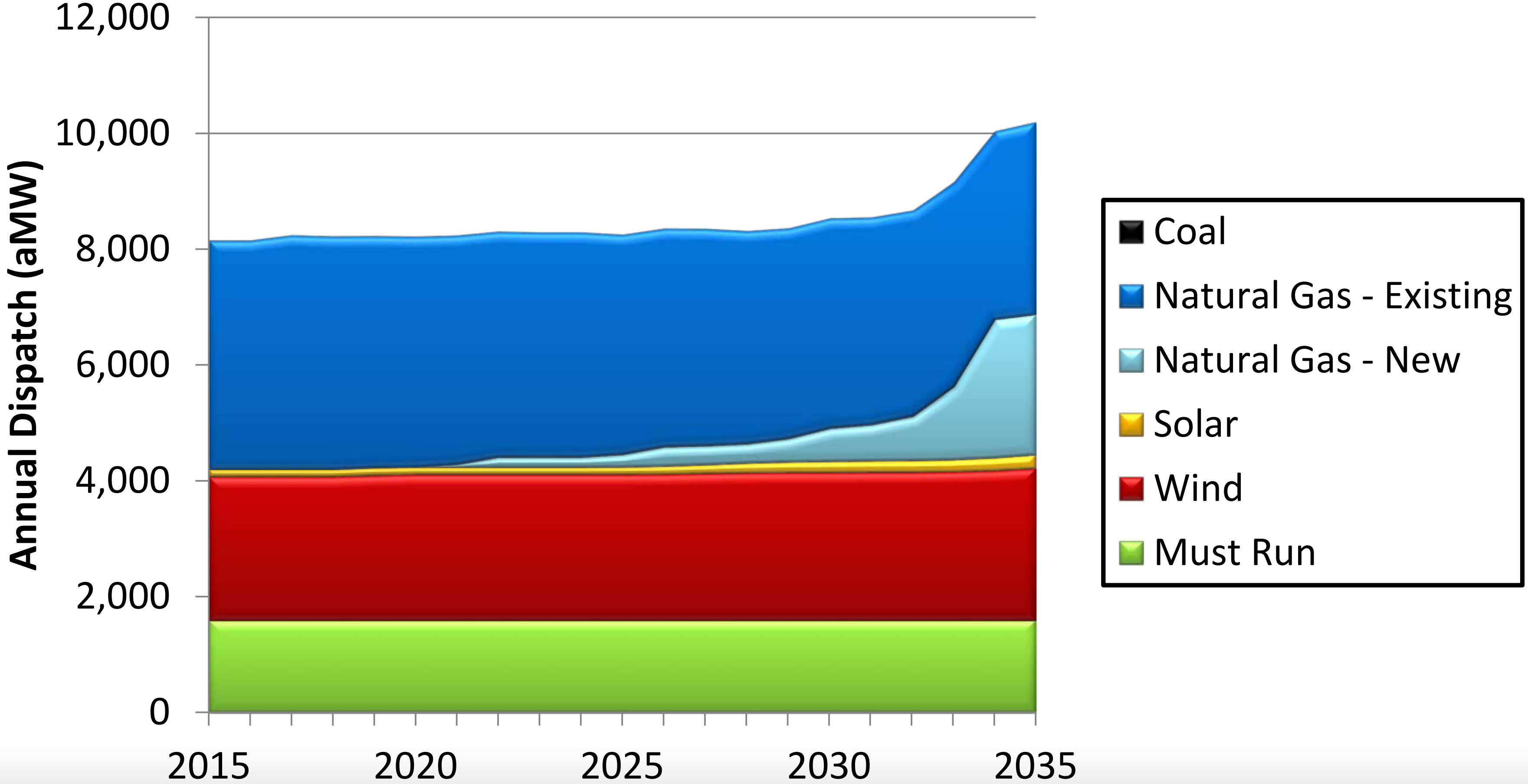
Changes in Thermal Resource Dispatch in the Low Gas Price Sensitivity Study (S2) Are Driven by The Increased Competiveness of Existing Gas-Fired Generation



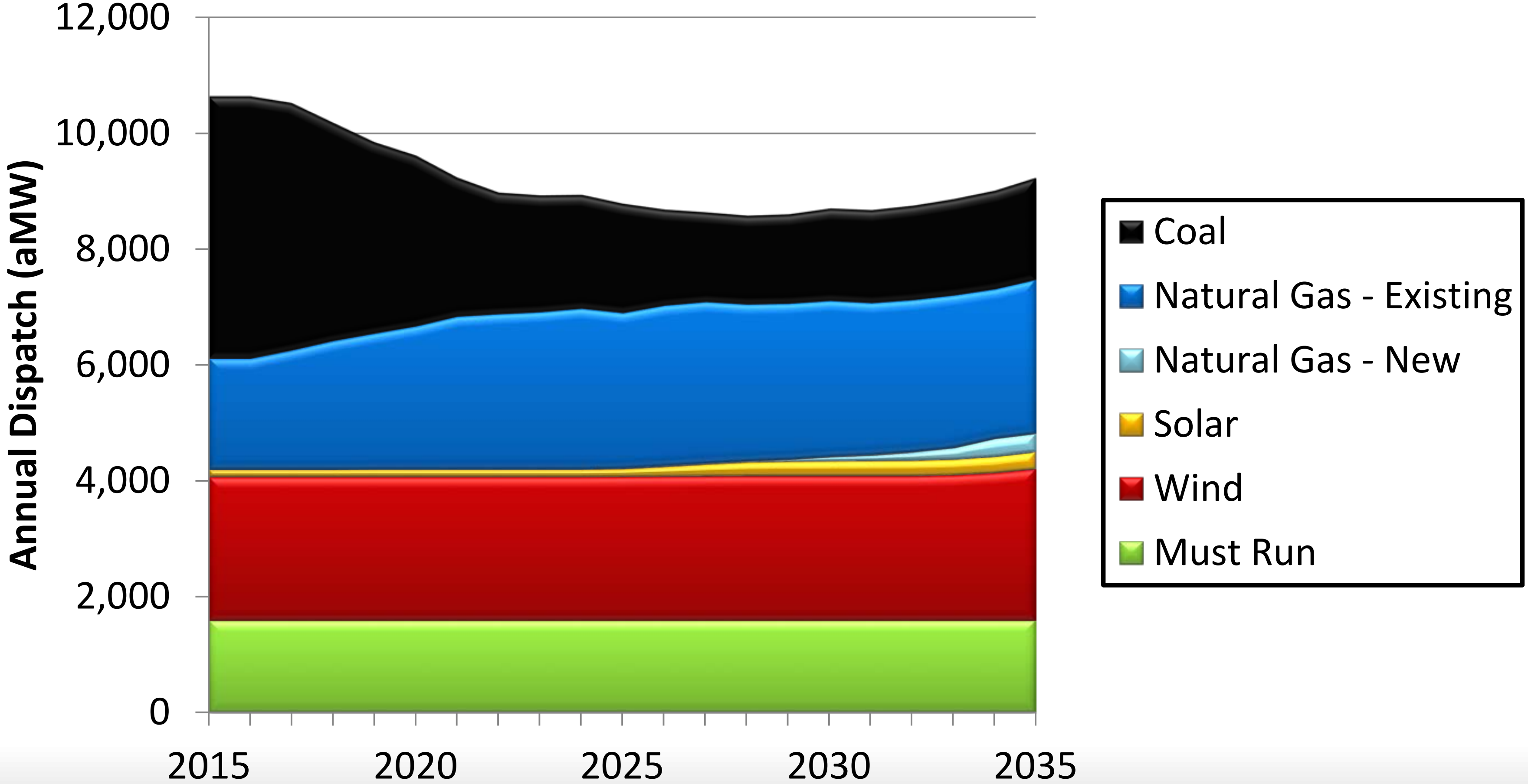
Changes in Thermal Resource Dispatch in the Social Cost of Carbon Scenario (2B) Are Driven by Increased Competiveness of *Existing* Gas-Fired Generation Compared to Coal-Fired Generation When Carbon Cost Are Imposed



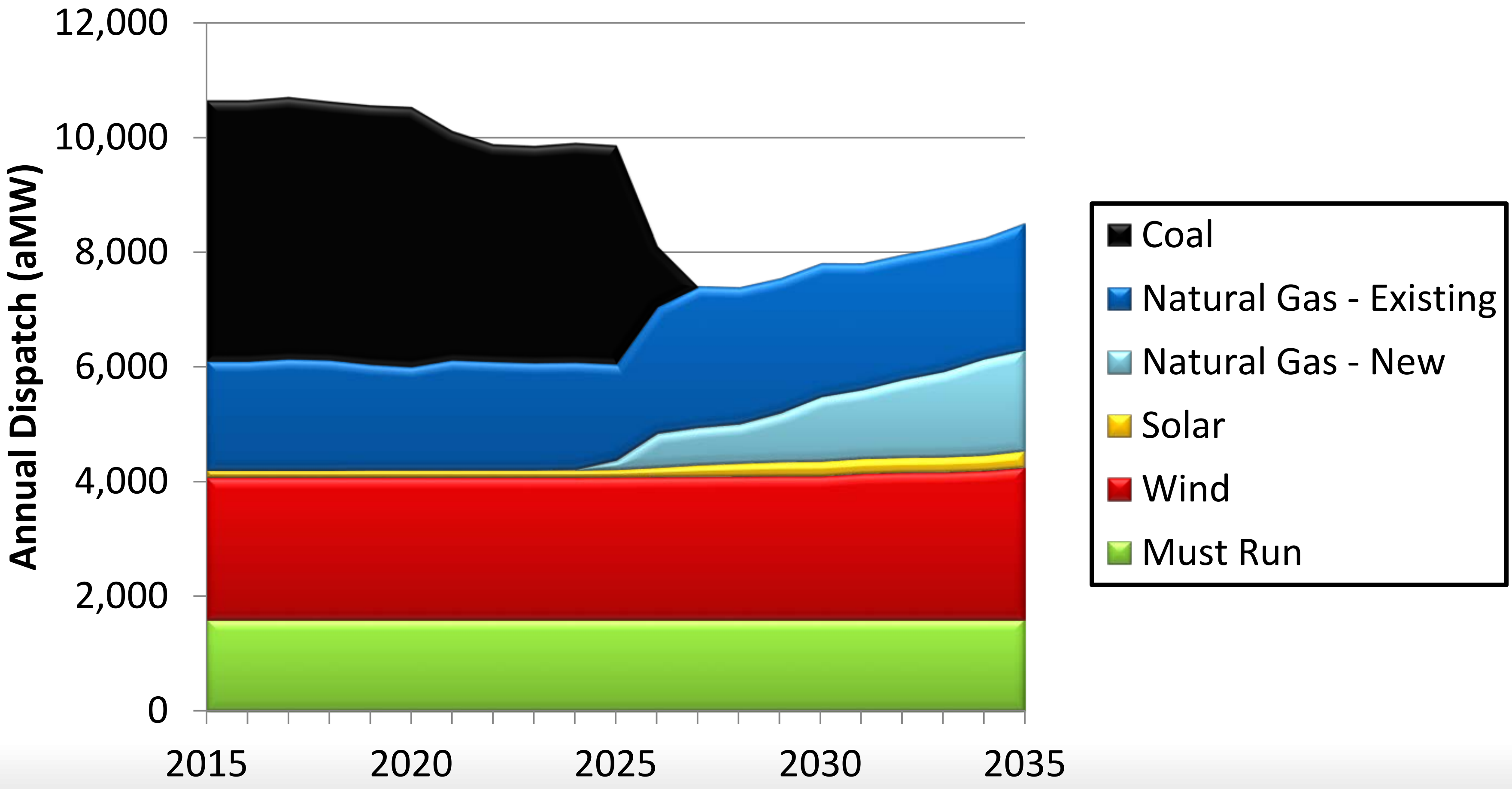
Changes in Thermal Resource Dispatch in the Social Cost of Carbon Sensitivity Study (Scenario 2B.1) Are Driven by Increased Competiveness of *New and Existing* Gas-Fired Generation Compared to Coal-Fired Generation When Carbon Cost Are Imposed



Changes in Thermal Resource Dispatch in the Carbon Risk Scenario(2C) Are Driven by The Increased Competiveness of Existing Gas-Fired Generation Compared to Existing Coal-Fired Generation When Carbon Cost are Imposed



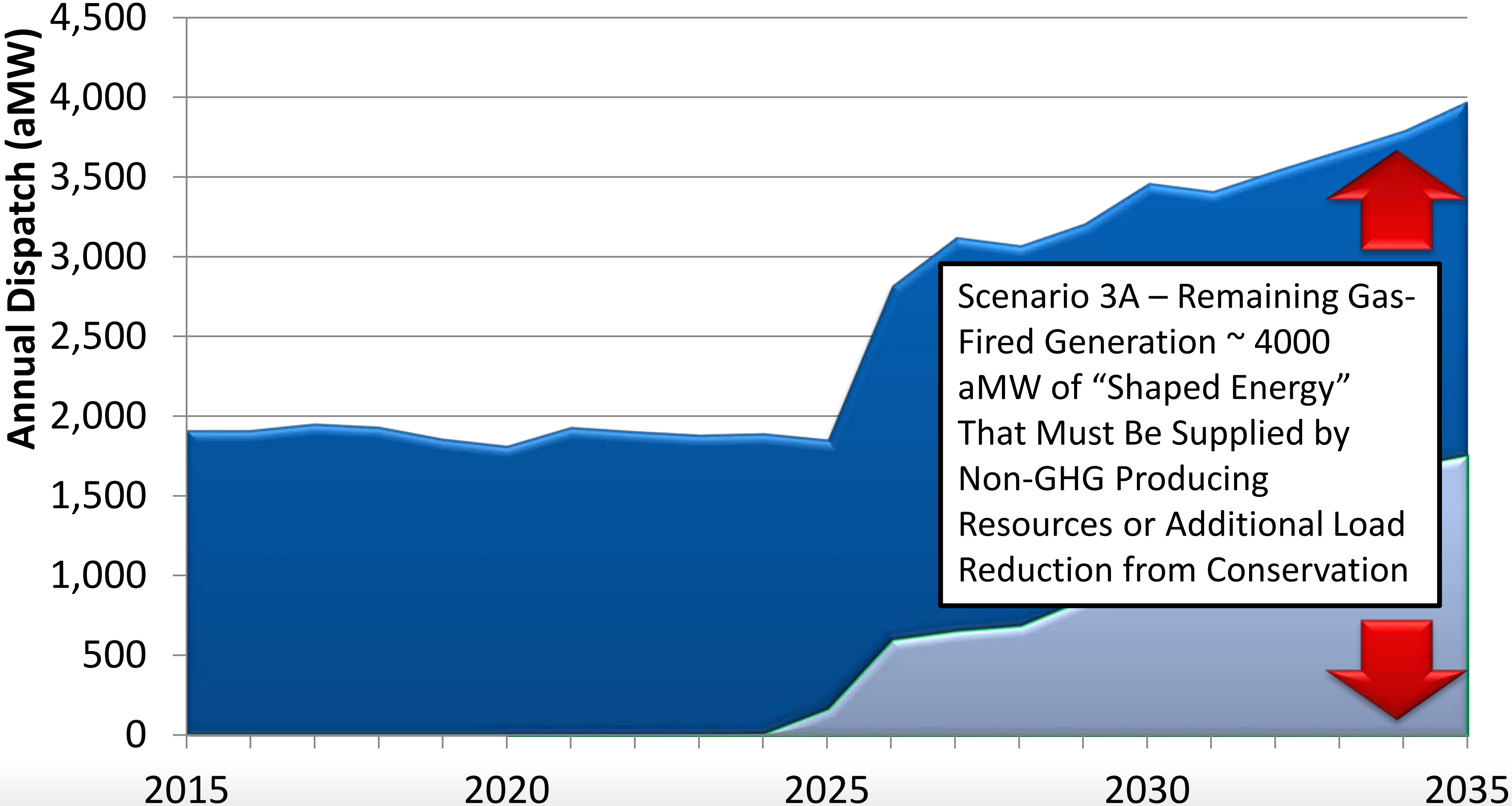
Changes in Thermal Resource Dispatch in the Maximum Carbon Reduction with Existing Technology Scenario (3A) Are Driven by Assumed Coal and Inefficient Gas Generation Retirements



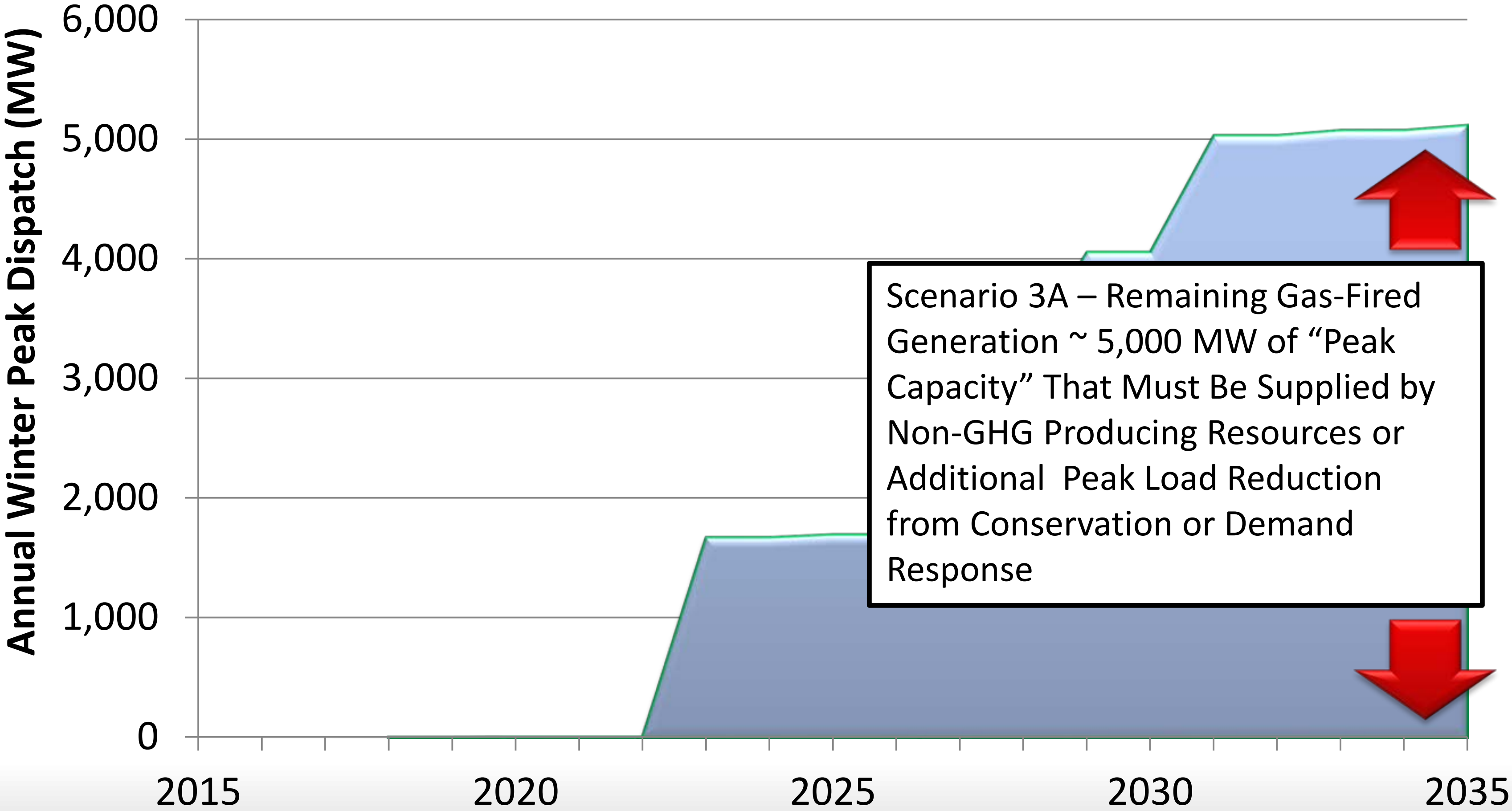
Observations from Scenarios To Date: Carbon Emissions Reduction

- The least cost resource strategies that meet proposed CO2 Emissions Limits *at the regional level:*
  - Meet all (or nearly all) load growth with energy efficiency
  - Meet near term needs for capacity with demand response
  - Replace retiring existing coal plans with increase gas-fired generation, primarily from existing gas resources and later with combined cycle combustion turbines
  - Do not significantly expand the use of renewable resources
- Why
  - The lowest cost strategy to achieve CO2 reductions
  - Currently commercially available Renewable Resources (solar PV and wind) provide limited or no winter peaking capacity, hence are not good matches for system need

Scenario 3B – Carbon Reduction with Emerging Technology "The Energy Problem Statement"



Scenario 3B – Carbon Reduction with Emerging Technology "The Capacity Problem Statement"



Next Steps

- Power Committee Webinar August 6th
  - Present Results for Scenarios
    - 1A – No Uncertainty
    - 4A – Unplanned Major Resource Loss
    - 4B – Planned Major Resource Loss
    - 5A – Increased External Market Access
- Recommend Eliminating Sensitivities
  - S1 – Assume no coal plant retirements
    - Expect results very similar to S2 – 1B_Low Gas Prices. Very small decrease in near term EE and DR.
  - S4 – Lower capacity contribution from EE
    - Expect results similar to prior analysis using prior to adjusting for system capacity contribution. Higher NPV with slightly more DR and gas turbines

Backup Slides

What Is
"Associated System Capacity Contribution "?

- Associated System Capacity Contribution (ASCC) is the capacity credit of resources (e.g. wind, solar PV, CCCT) when they are integrated into an existing power system.☐
- A Resource's ASCC may exceed the nameplate capacity of a plant in power systems like the NW that have significant storage
  - This *would not* be the result in systems without significant storage

Why Does Associated System Capacity Contribution Matter in the RPM?

- NW Hydro-generation can be used to provide "peaking" and/or "energy" capability
- There are "tradeoffs"
  - Adding resources, like DR, that primarily provide peaking capacity, allows the hydro system to be used more for energy production
  - Adding resources, like conservation and CCCTs, that can provide both energy and capacity, allows the hydro system to be used either more for peaking capacity or for energy production
  - Adjusting resource characteristic to reflect their system capacity contribution allows the RPM to recognize resources that provide *energy* can also "release" hydro-generation to meet short term peaking requirements

How ASCC Is Calculated?

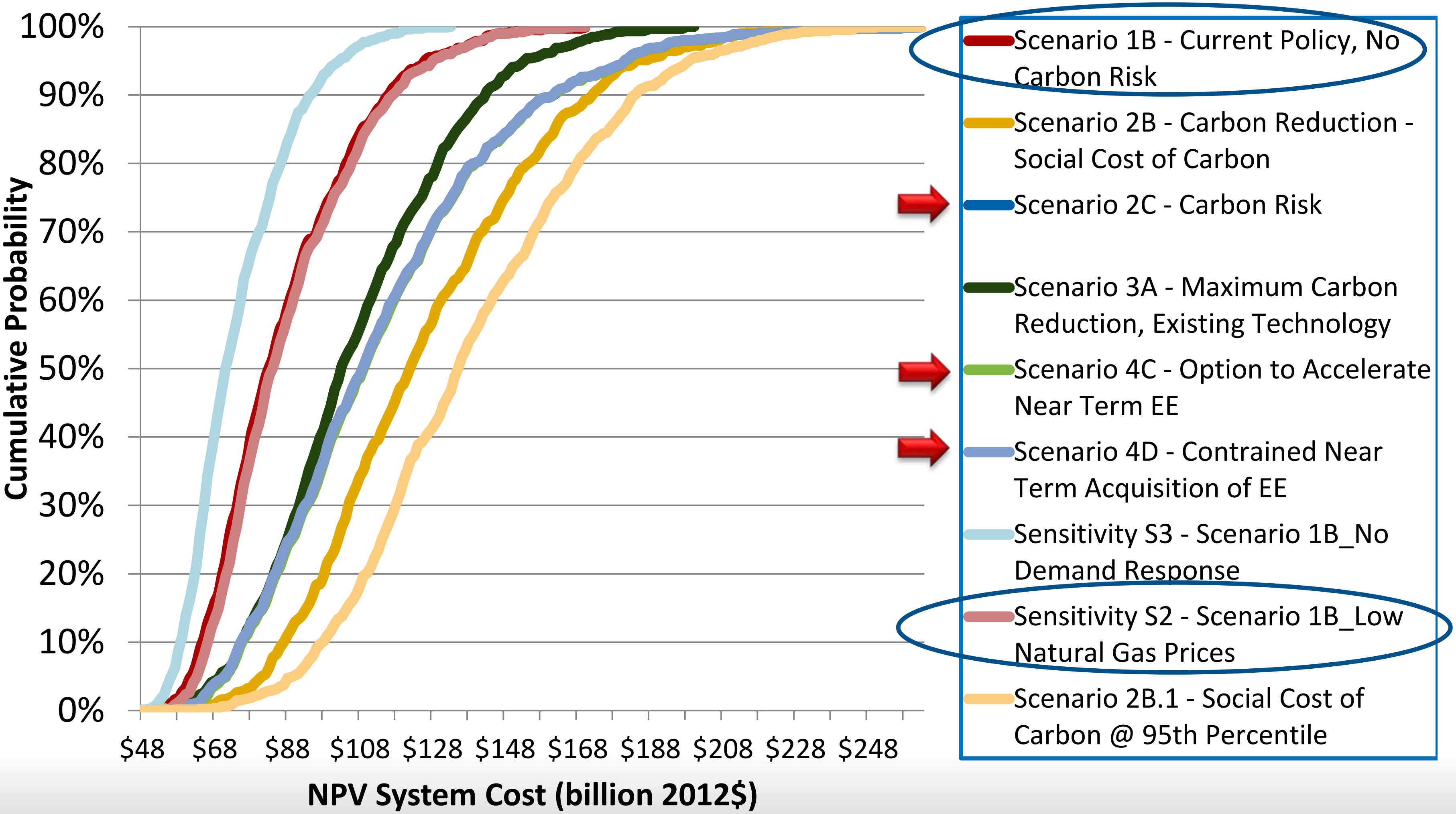
- Use GENESYS to estimate LOLP without resource additions
- Ratio of the amount of capacity needed to achieve LOLP of 5% and the actual "nameplate" of generating resources or "annual energy savings" of conservation added to the system to achieve 5% LOLP = ASCC
- Examples:
  - Adding 4400 MW (nameplate) of CCCT was sufficient to meet 5850 MW of capacity need in GENESYS
    - 5850/4400 = 1.3 so for CCCT estimated ASCC is 1.3 * Capacity de-rated for outages
  - Reducing load through EE by 3400 aMW was sufficient to meet 5850 MW of capacity need in GENESYS
    - 5840/3400 = 1.7 so for EE estimated ASCC is:

    EE Capacity from the supply curves plus 1.7 * aMW EE purchased

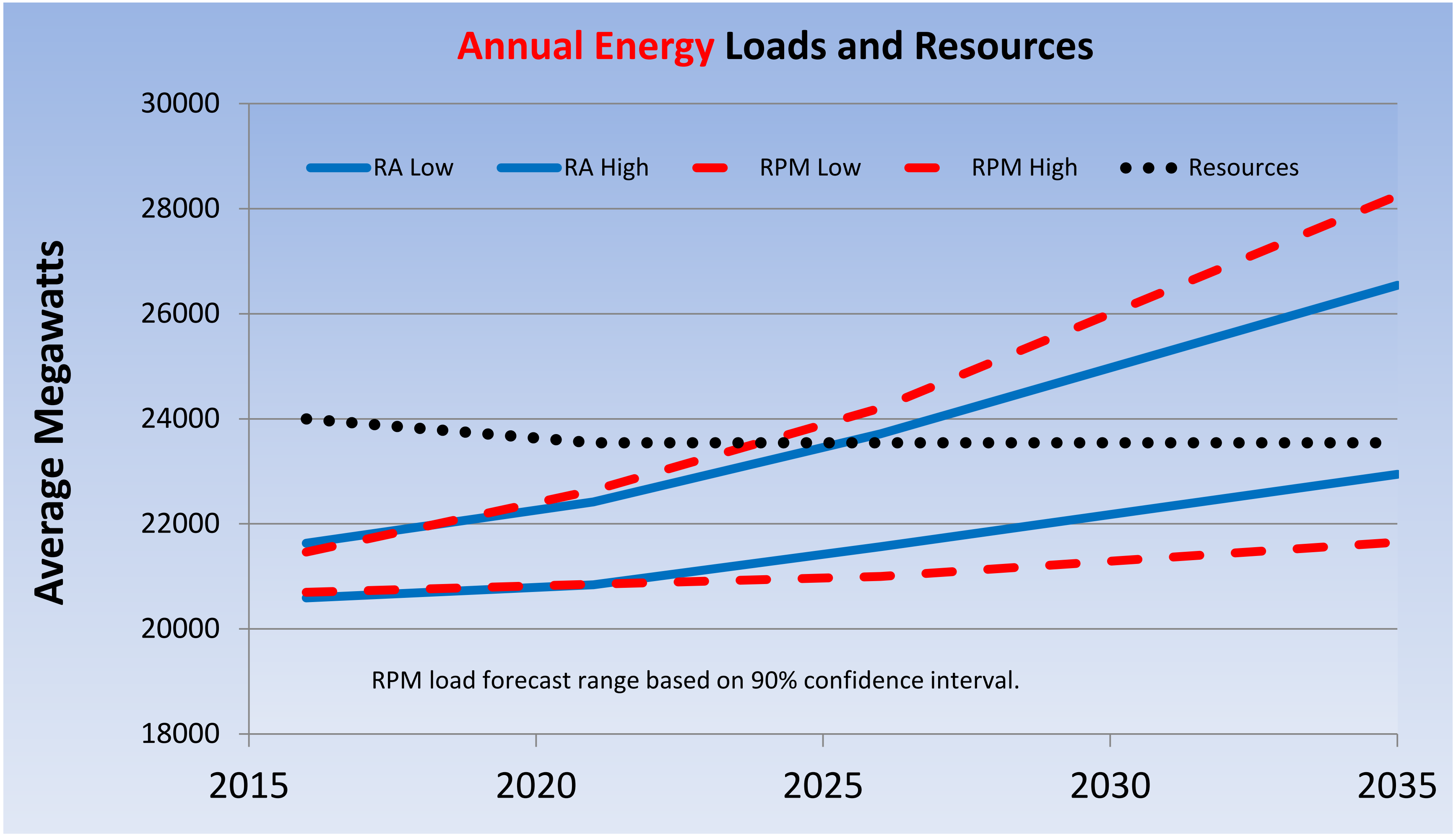
RPM Adequacy Test with ASCC

- Using the same Adequacy Reserve Margins (from GENESYS based on a 5% LOLP)
- Without using the ASCC the LOLP for year 2026 of RPM iteration 781 was 0.3%
- Result = overbuilding
- With ASCC LOLP for same study is 4.4%
- Within the acceptable range (3-5%) for the adequacy test

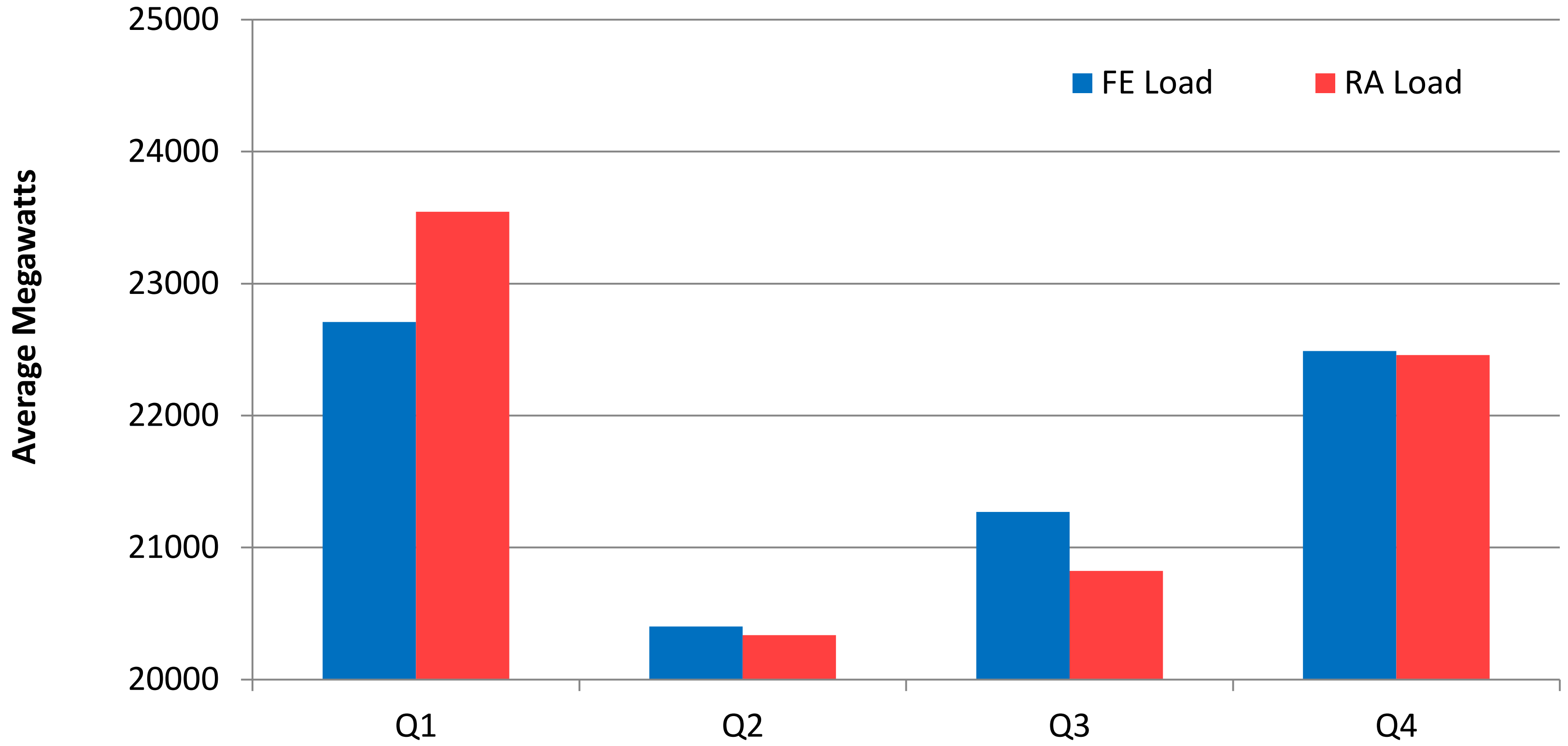
Scenario Comparisons and Observations
Six of the Nine Scenarios/Sensitivity Studies Have Significantly Different Cost and Risks



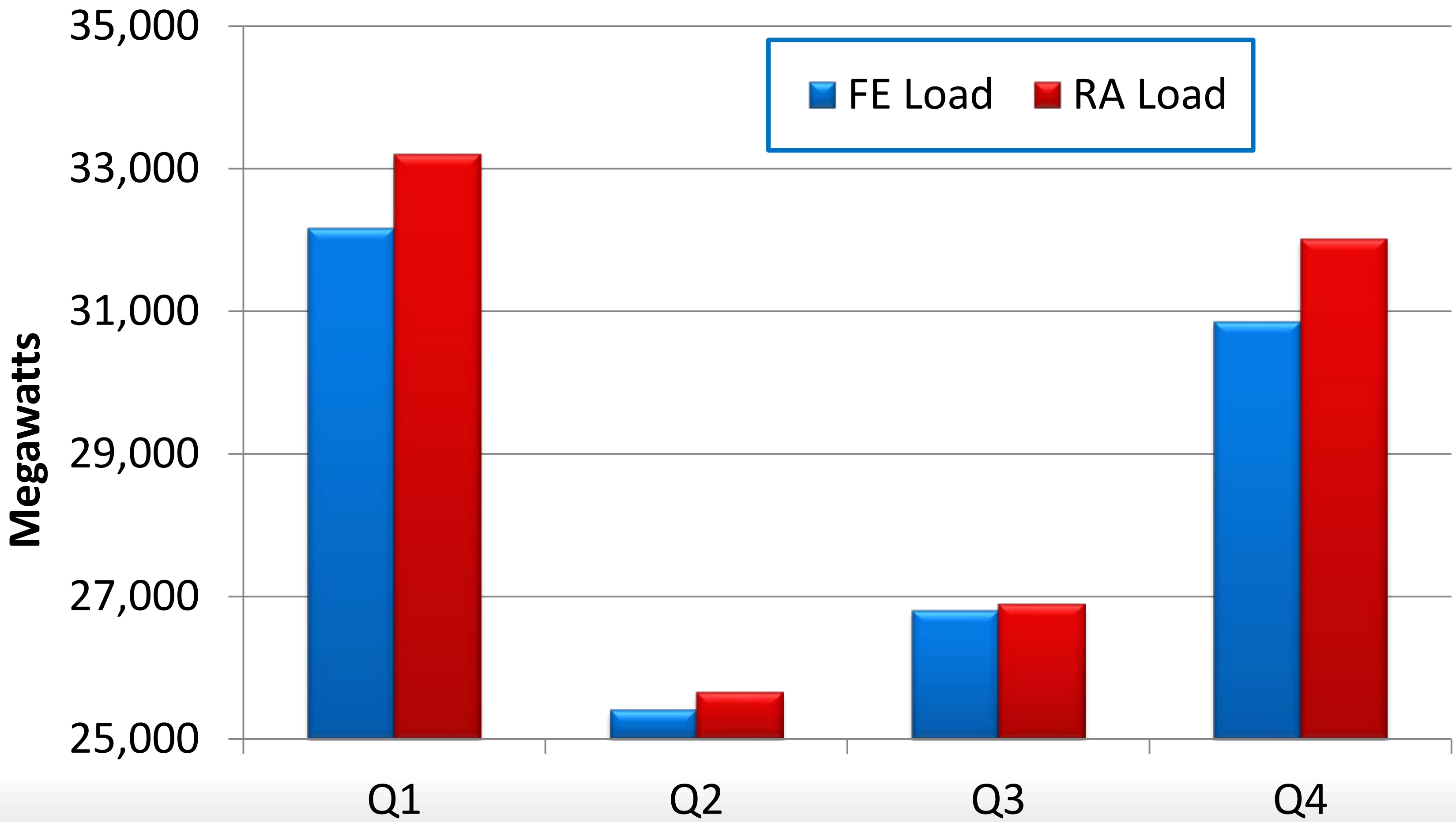
Energy Loads & Resources 2016-35



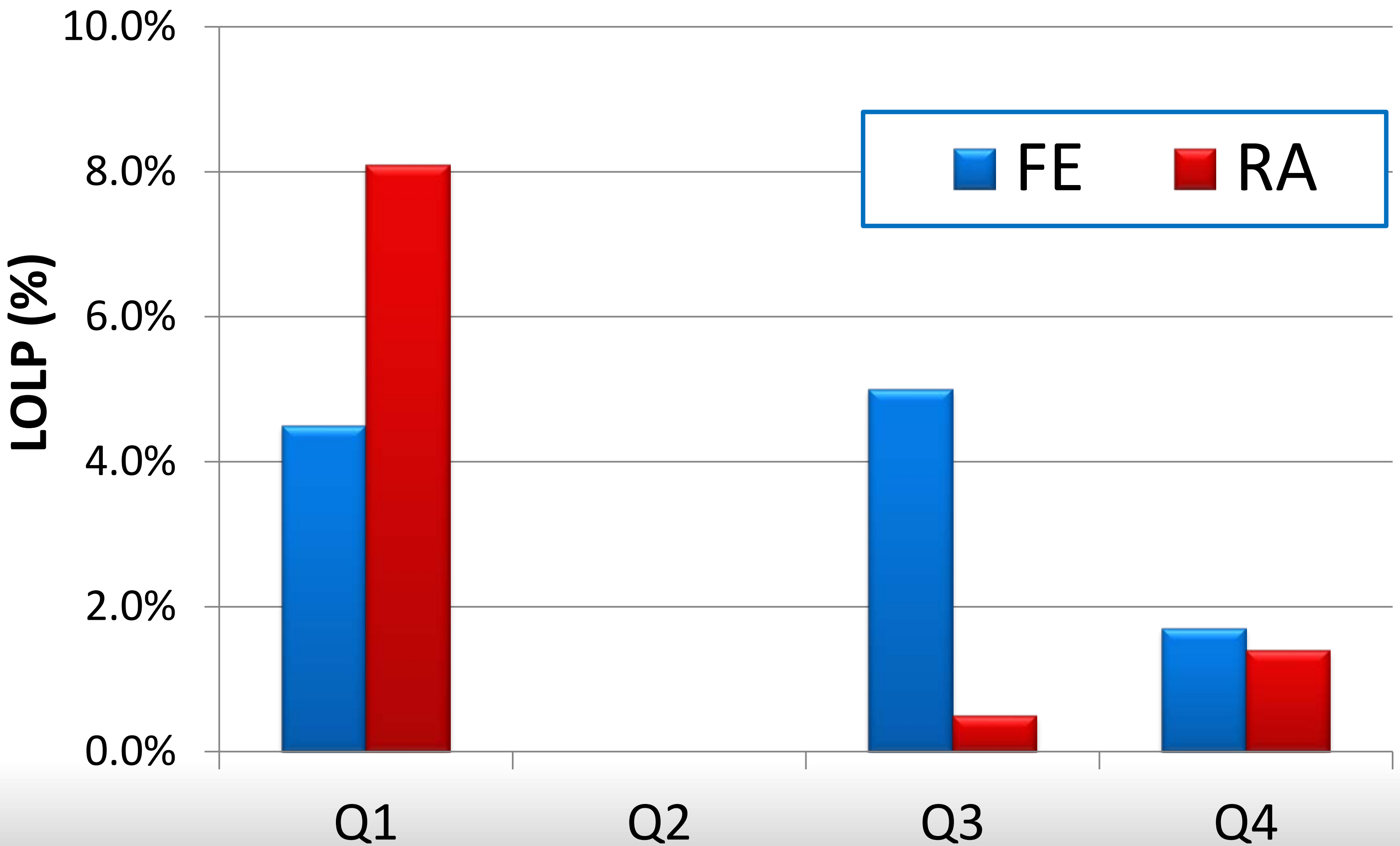
Average Energy Loads (2021 Medium Forecast)



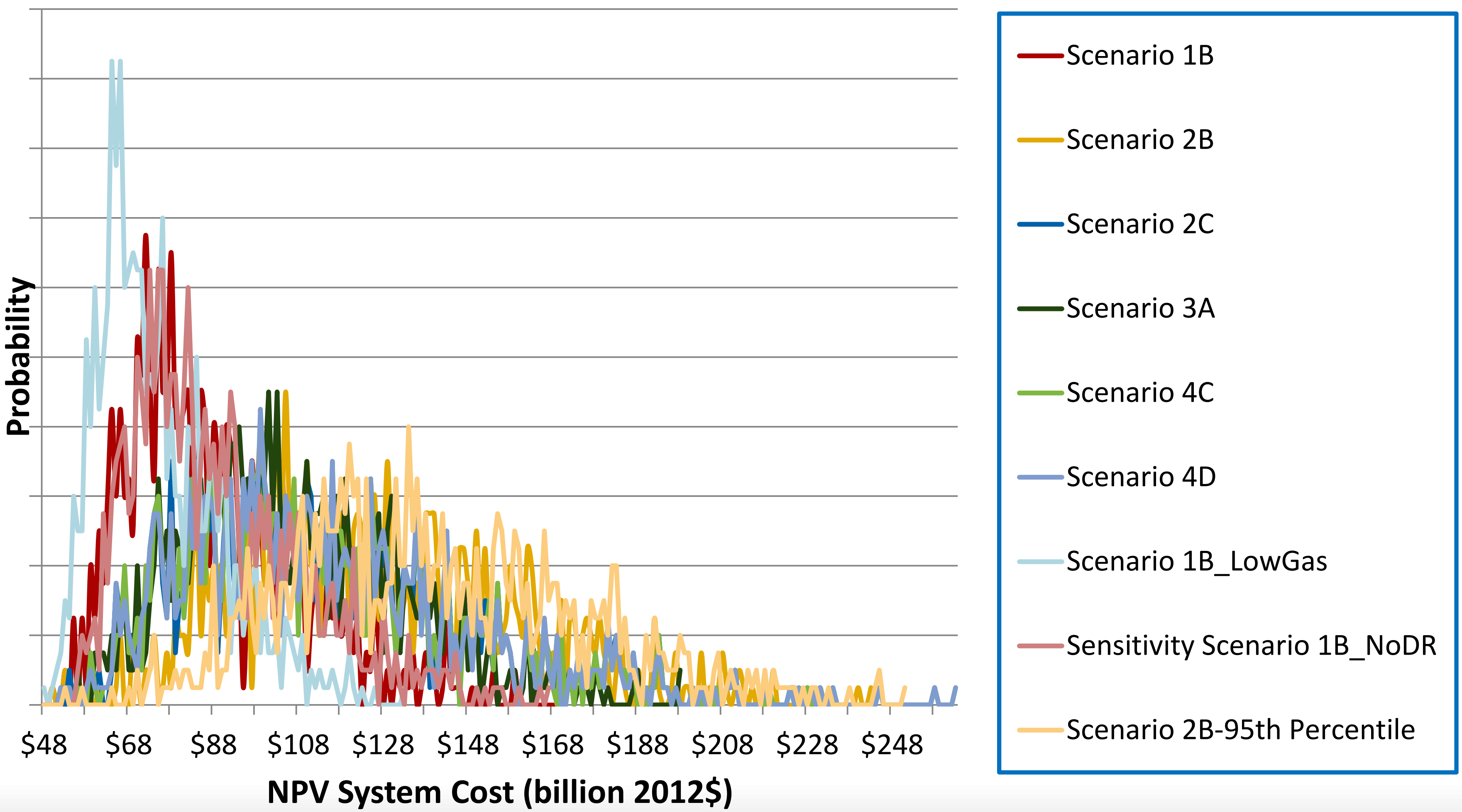
Expected Peak Load (2021 Medium Forecast)



Quarterly LOLP Values (2021 Medium Forecast)

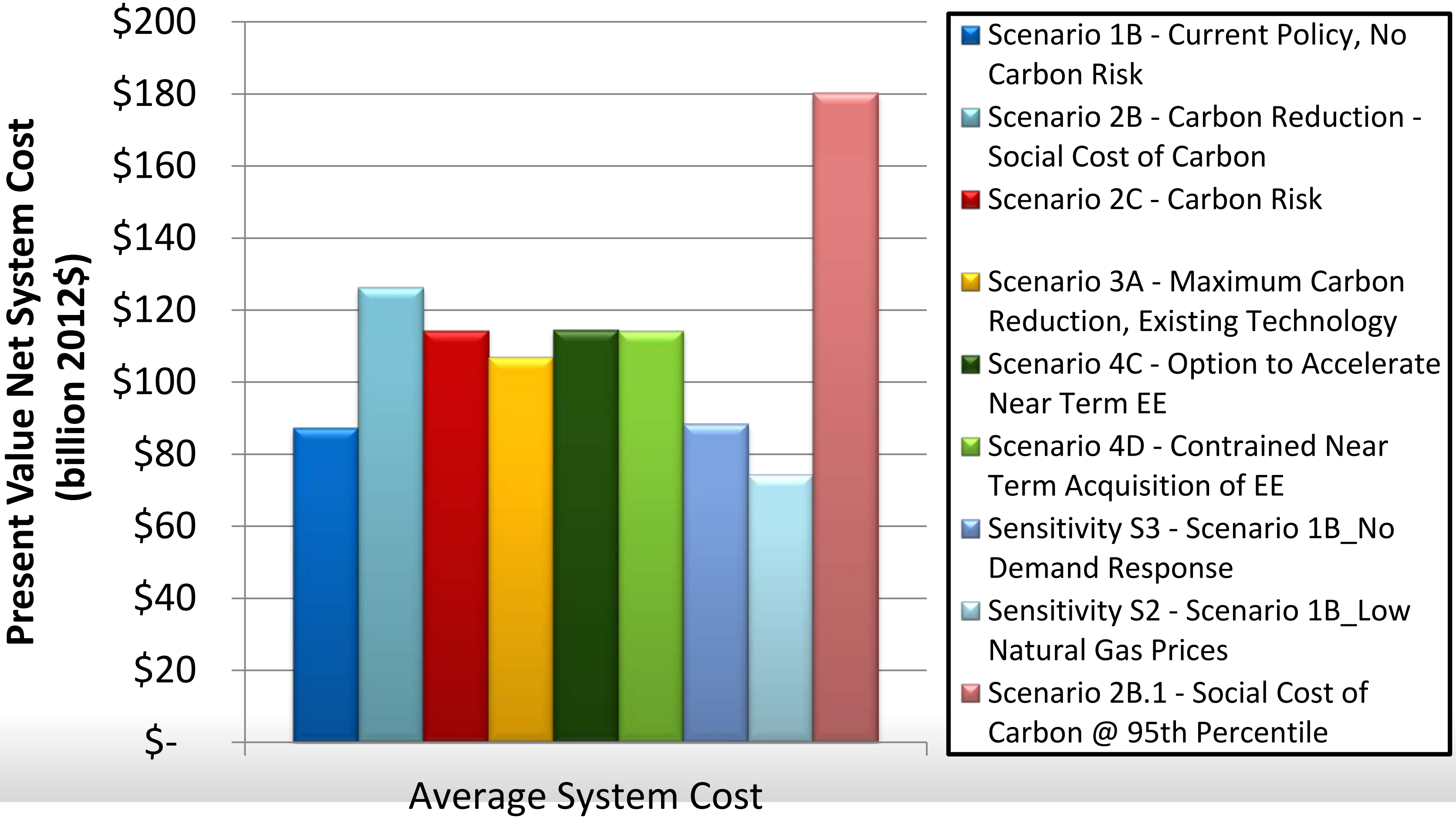


Distribution of Net Present Value System Cost Across Scenarios

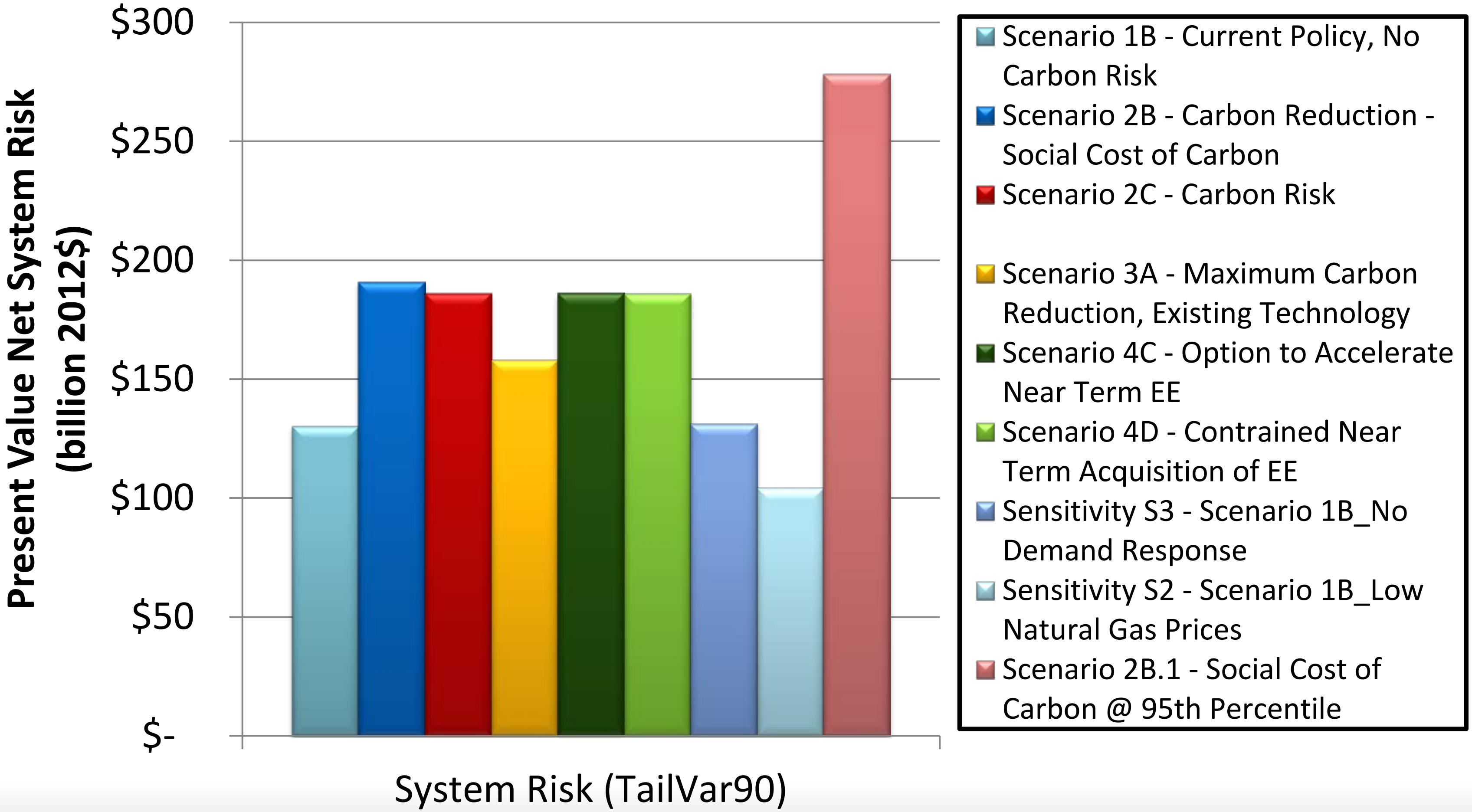


The Average Present Value Net System Cost for Least Cost Strategies with Carbon Cost:

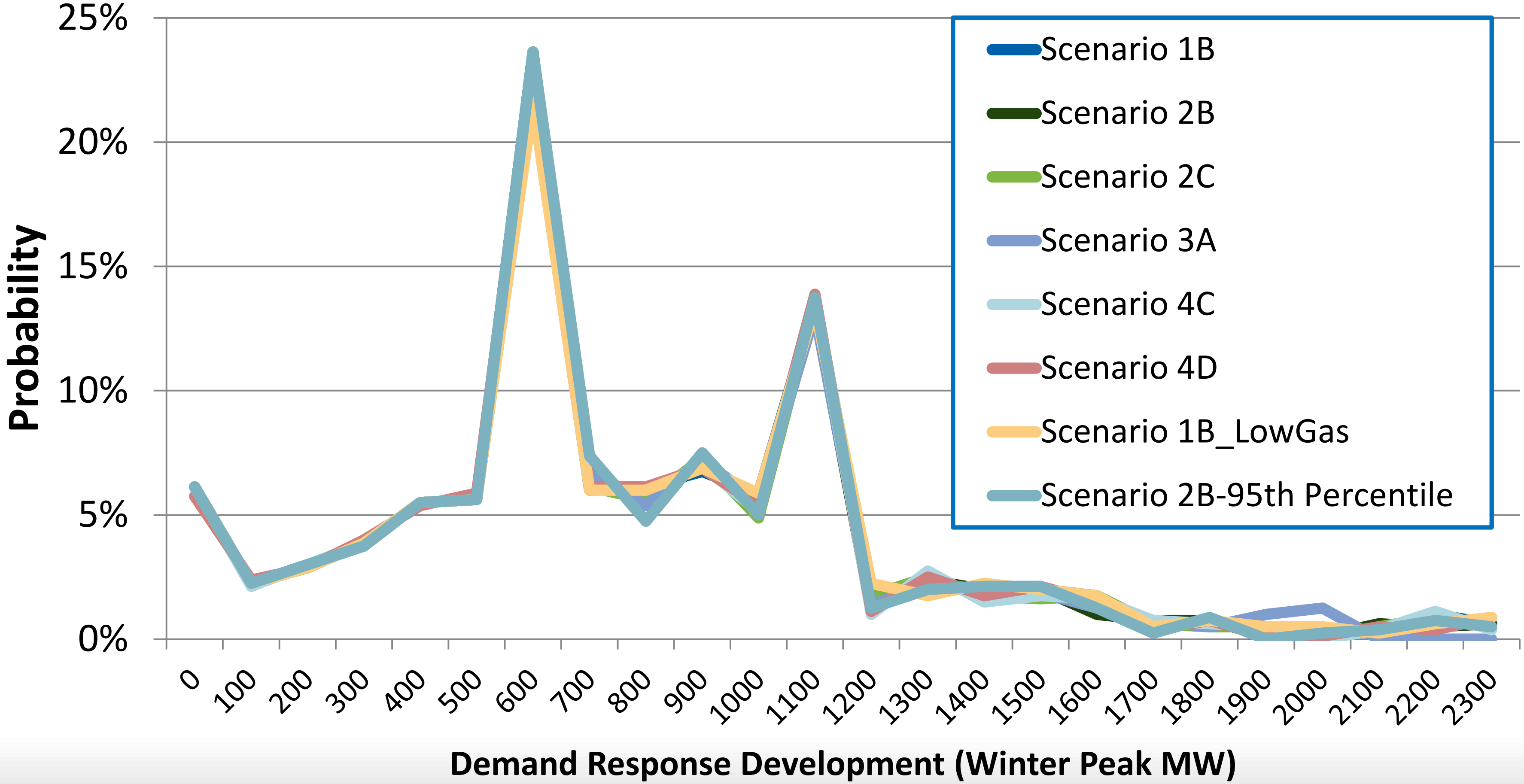
NPV System Cost for Scenarios Vary Over a Wide Range – Primarily Due to the Assumed Cost of Carbon Emissions Reductions



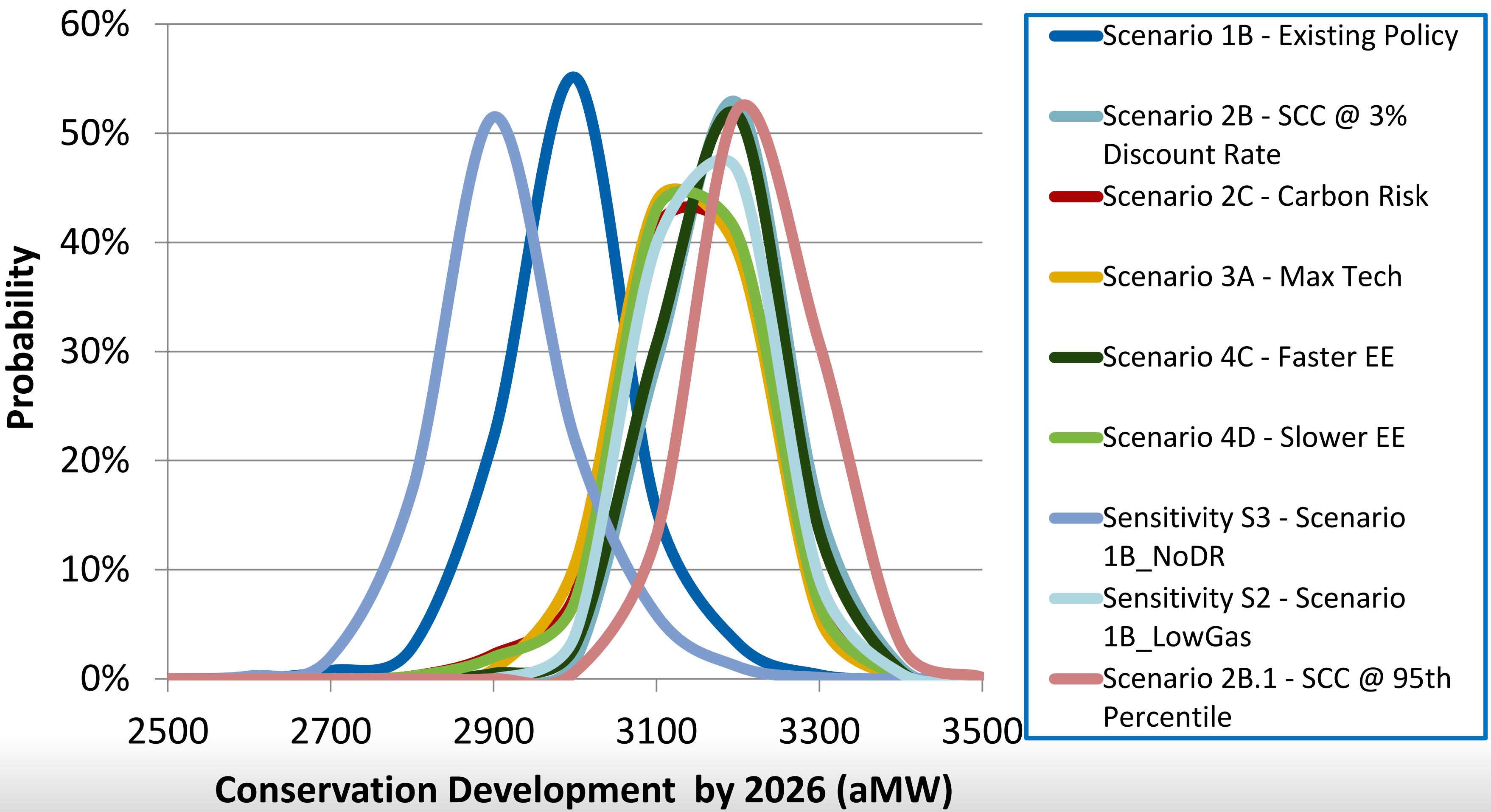
The Average Present Value Net System Risk for Least Cost Strategies with Carbon Cost
High Risk is A Function of Carbon Cost Assumptions



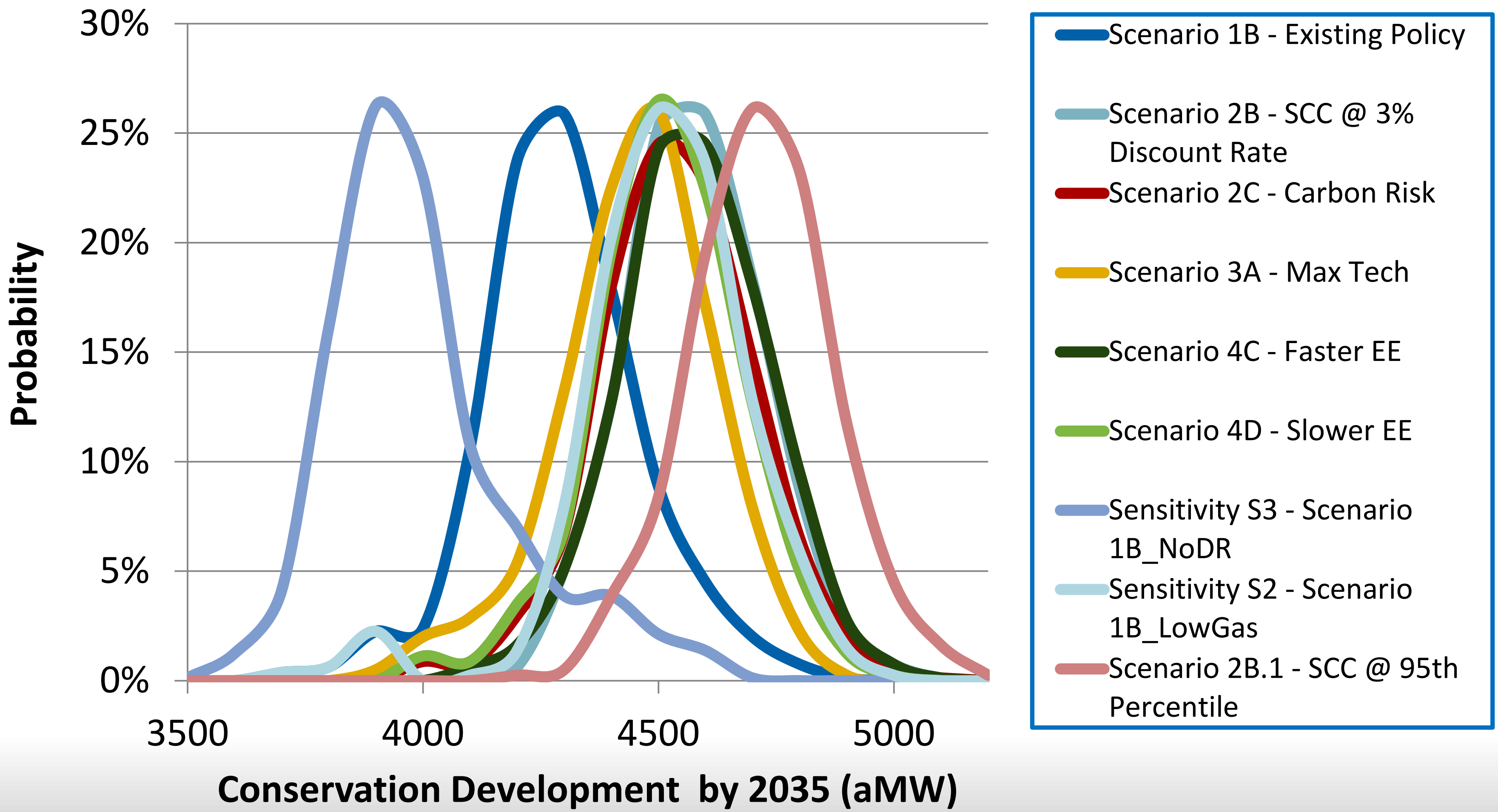
Both the Probability and Magnitude of Demand Response Is Development by 2021 is Nearly Identical Across All Scenarios



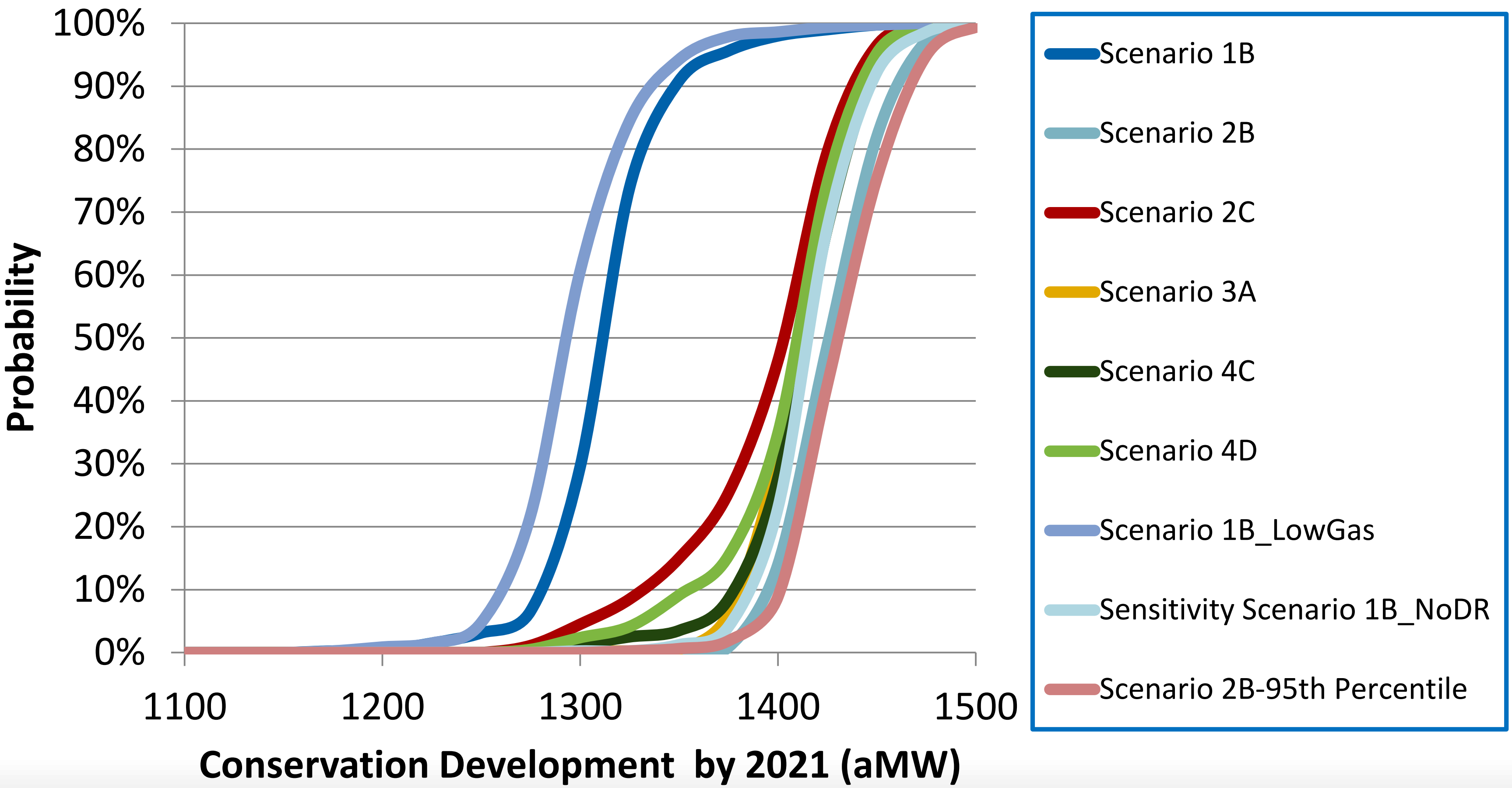
- **Scenarios That Consider Carbon Risk Develop Similar Amounts (~3200 aMW) of Conservation by 2026**
- **Scenarios That Assume Low Gas Prices or No Carbon Risk Develop Slightly Less (~300 aMW) Conservation by 2026**



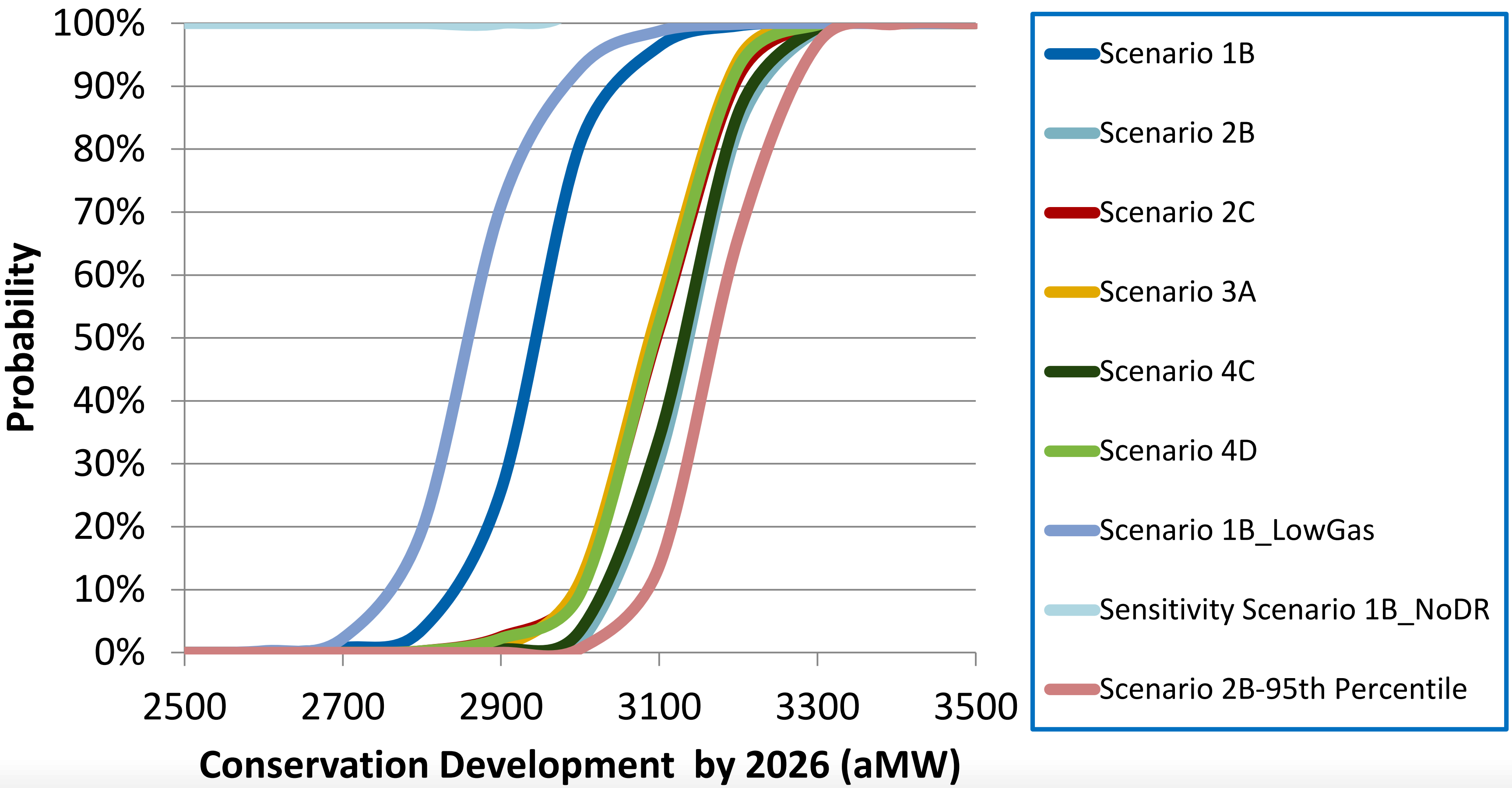
- **Scenarios That Consider Carbon Risk Develop Similar Amounts (~4400 aMW) of Conservation by 2035**
- **Scenarios That Assume Low Gas Prices or No Carbon Risk Develop Less (~700 aMW) Conservation by 2035**



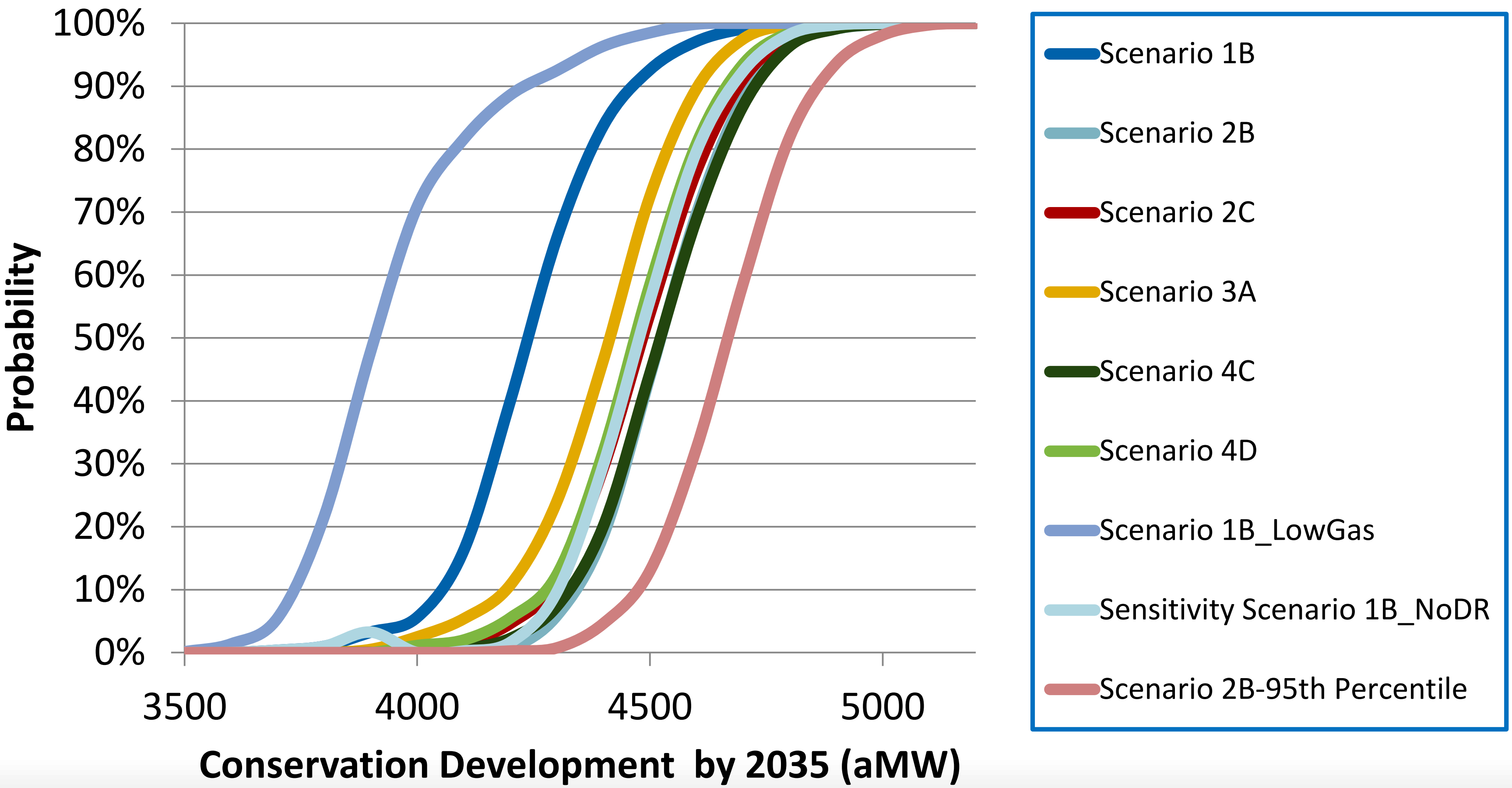
- **Scenarios That Consider Carbon Risk Develop Similar Amounts (~1400 aMW) of Conservation by 2021**
- **Scenarios That Assume Low Gas Prices and No Carbon Risk Develop Slightly Less (~130 aMW) Conservation by 2021**



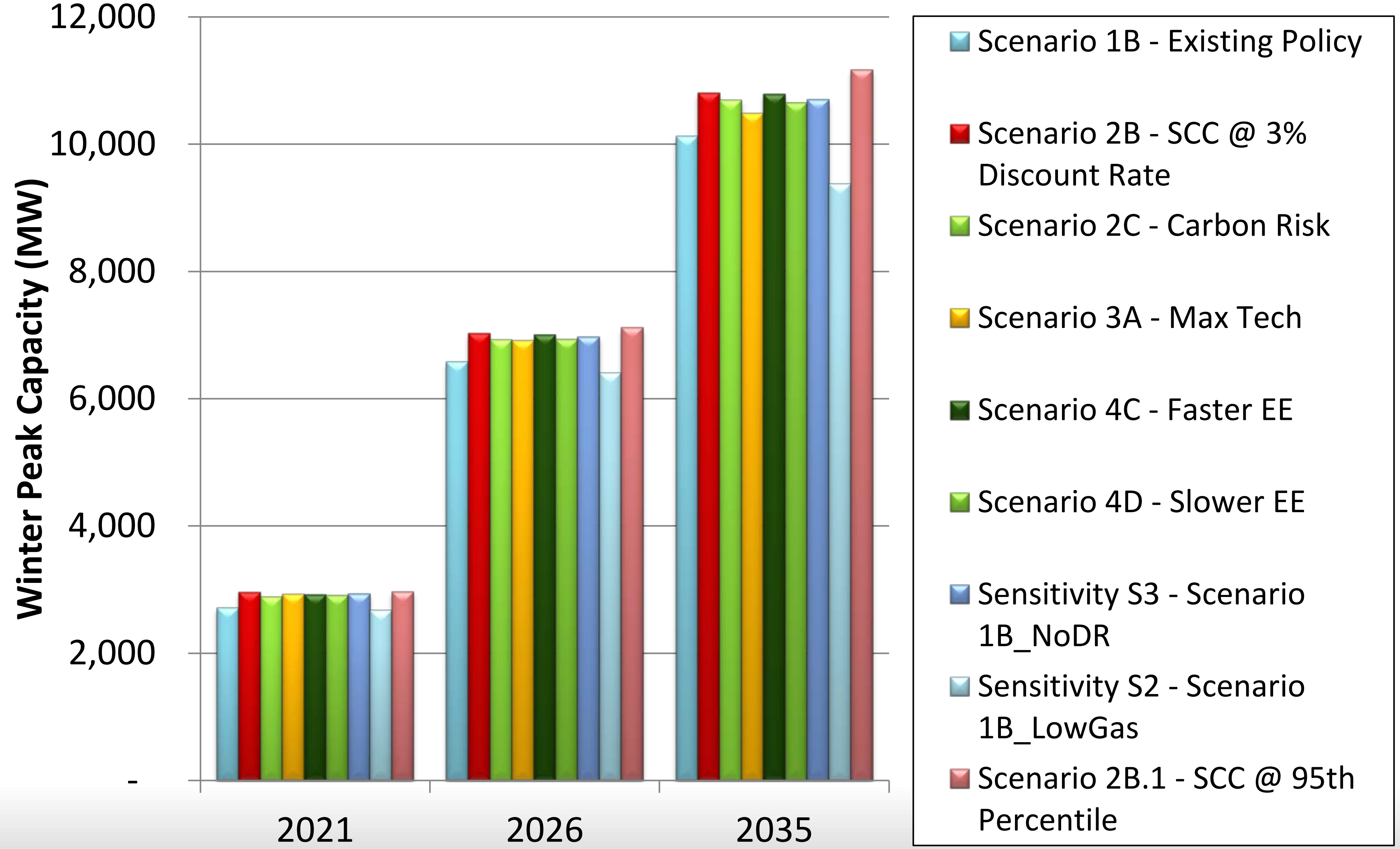
- **Scenarios That Consider Carbon Risk Develop Similar Amounts (~3200 aMW) of Conservation by 2026**
- **Scenarios That Assume Low Gas Prices and No Carbon Risk Develop Slightly Less (~300 aMW) Conservation by 2026**



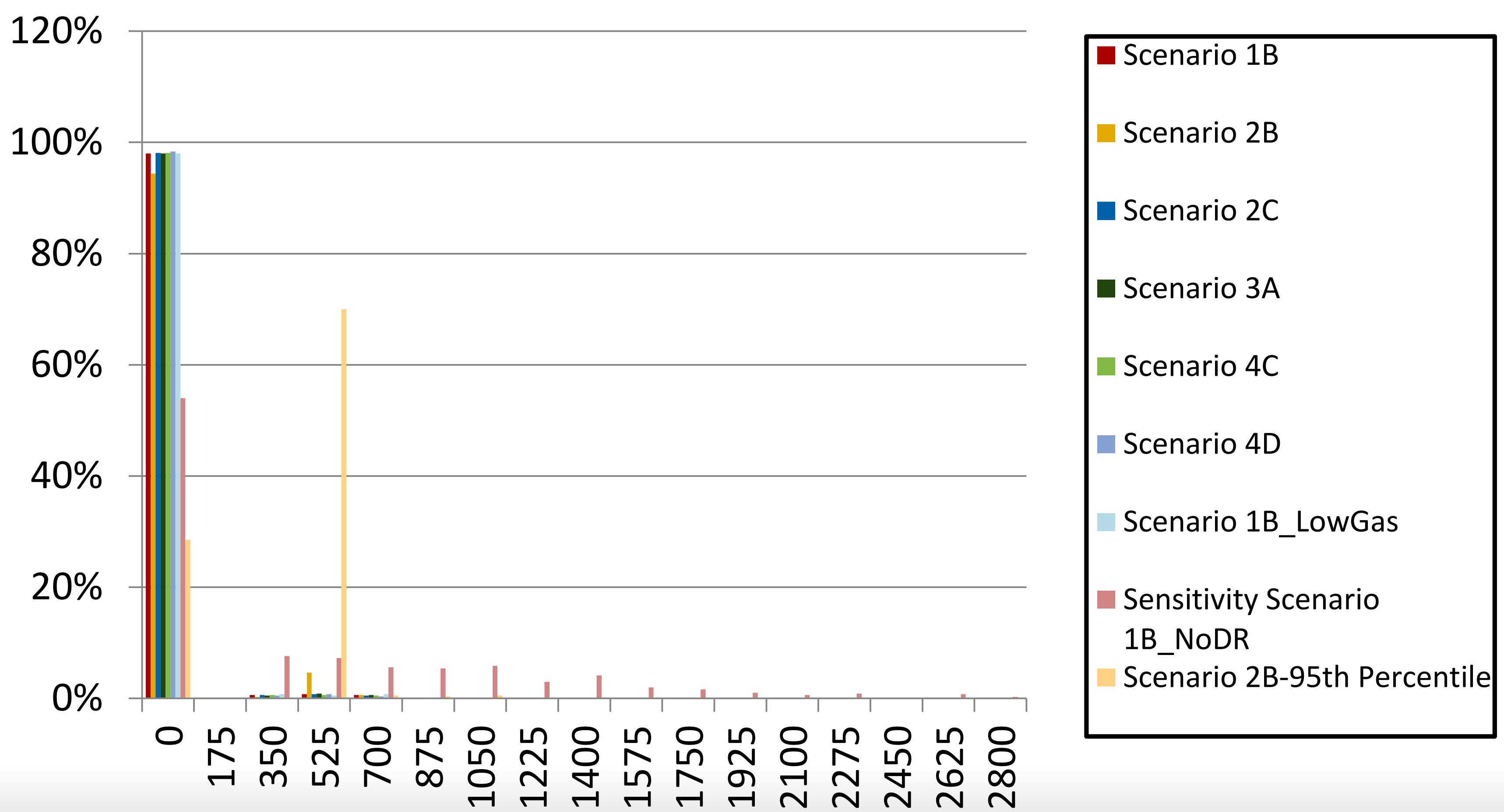
- **Scenarios That Consider Carbon Risk Develop Similar Amounts (~4400 aMW) of Conservation by 2035**
- **Scenarios That Assume Low Gas Prices and No Carbon Risk Develop Less (~700 aMW) Conservation by 2035**



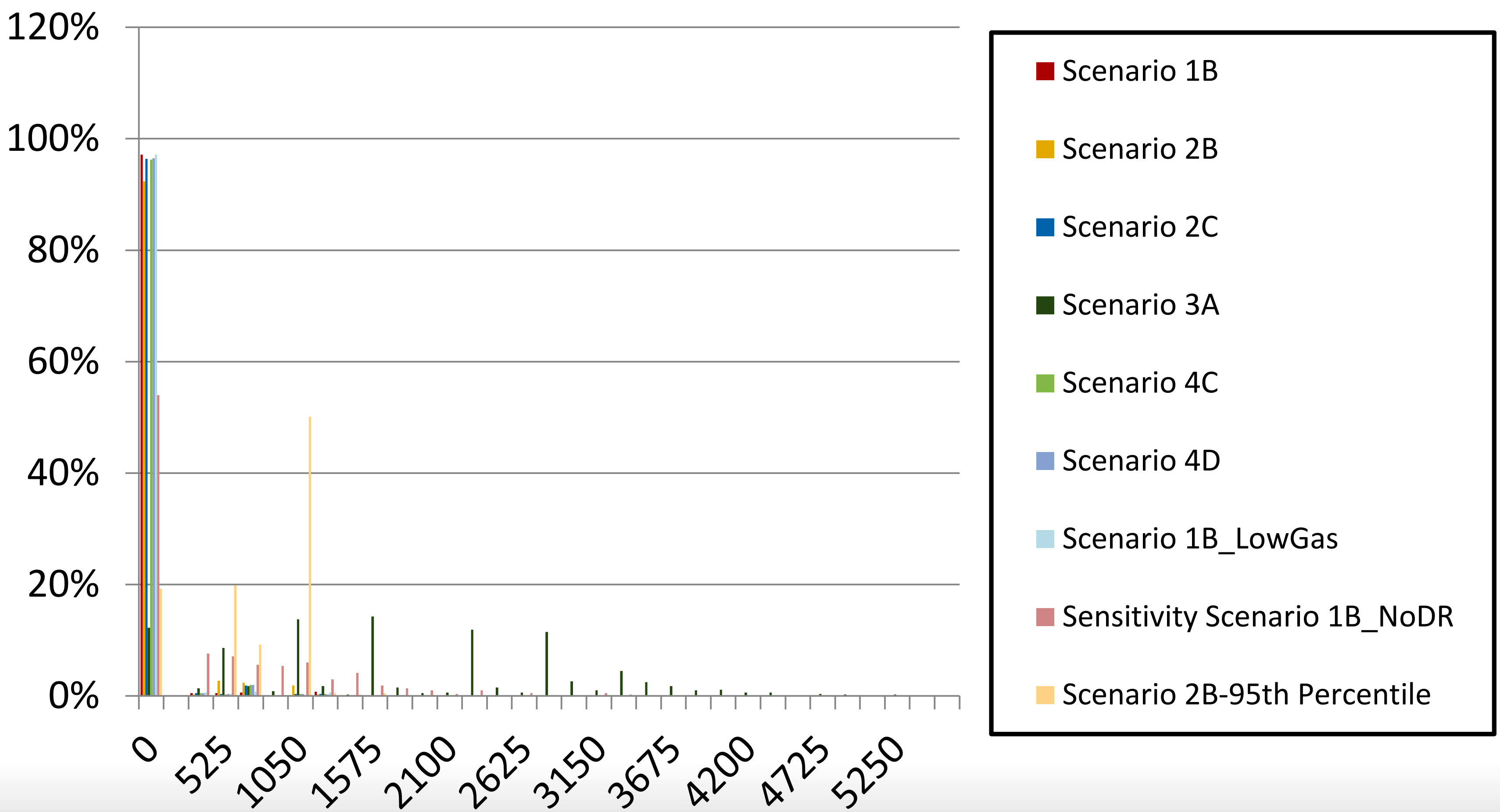
Conservation Is A Significant Source of Winter Peak Development in All Least Cost Resource Strategies



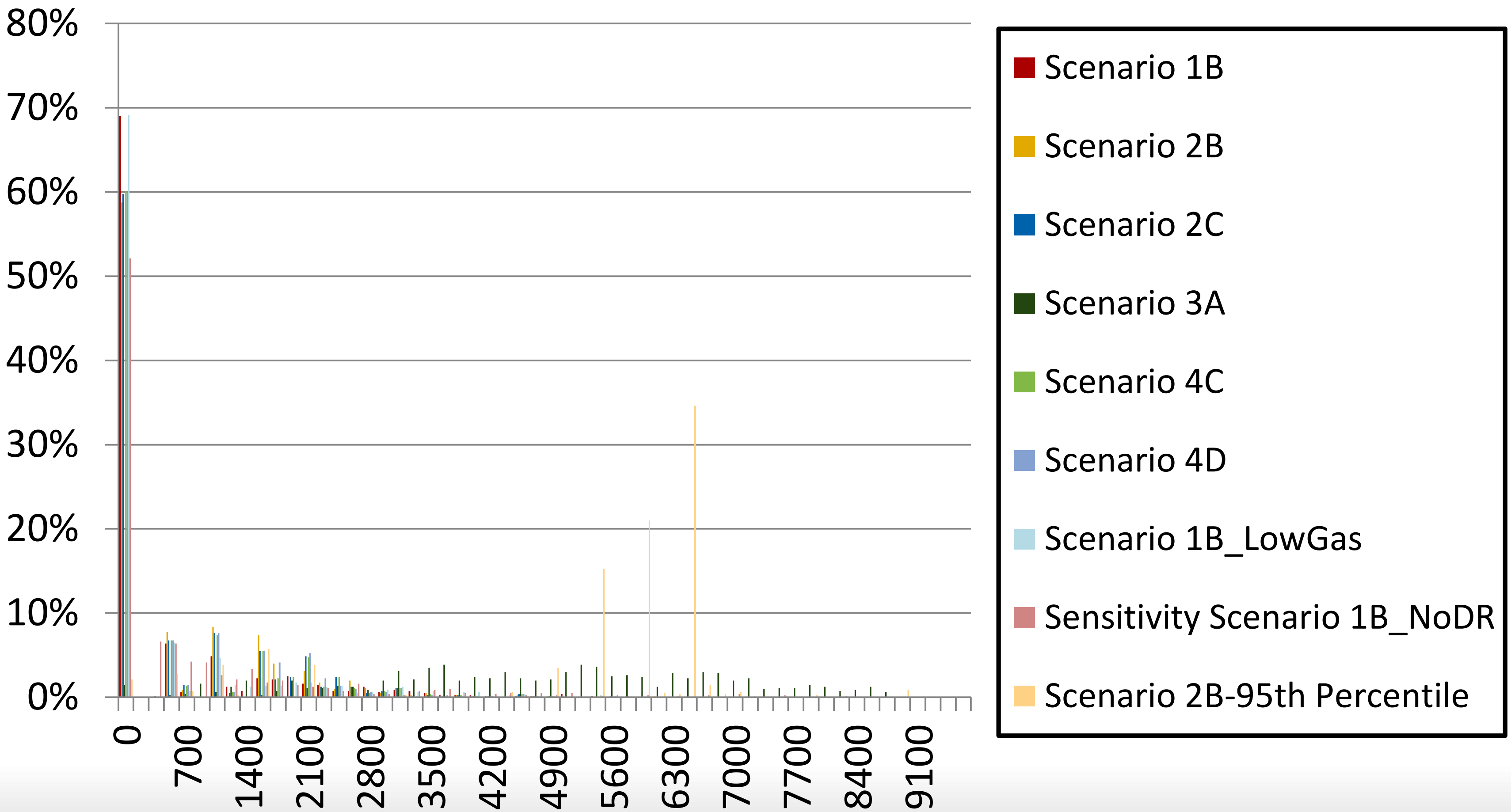
Probability of Thermal Development by 2021



Probability of Thermal Development by 2026

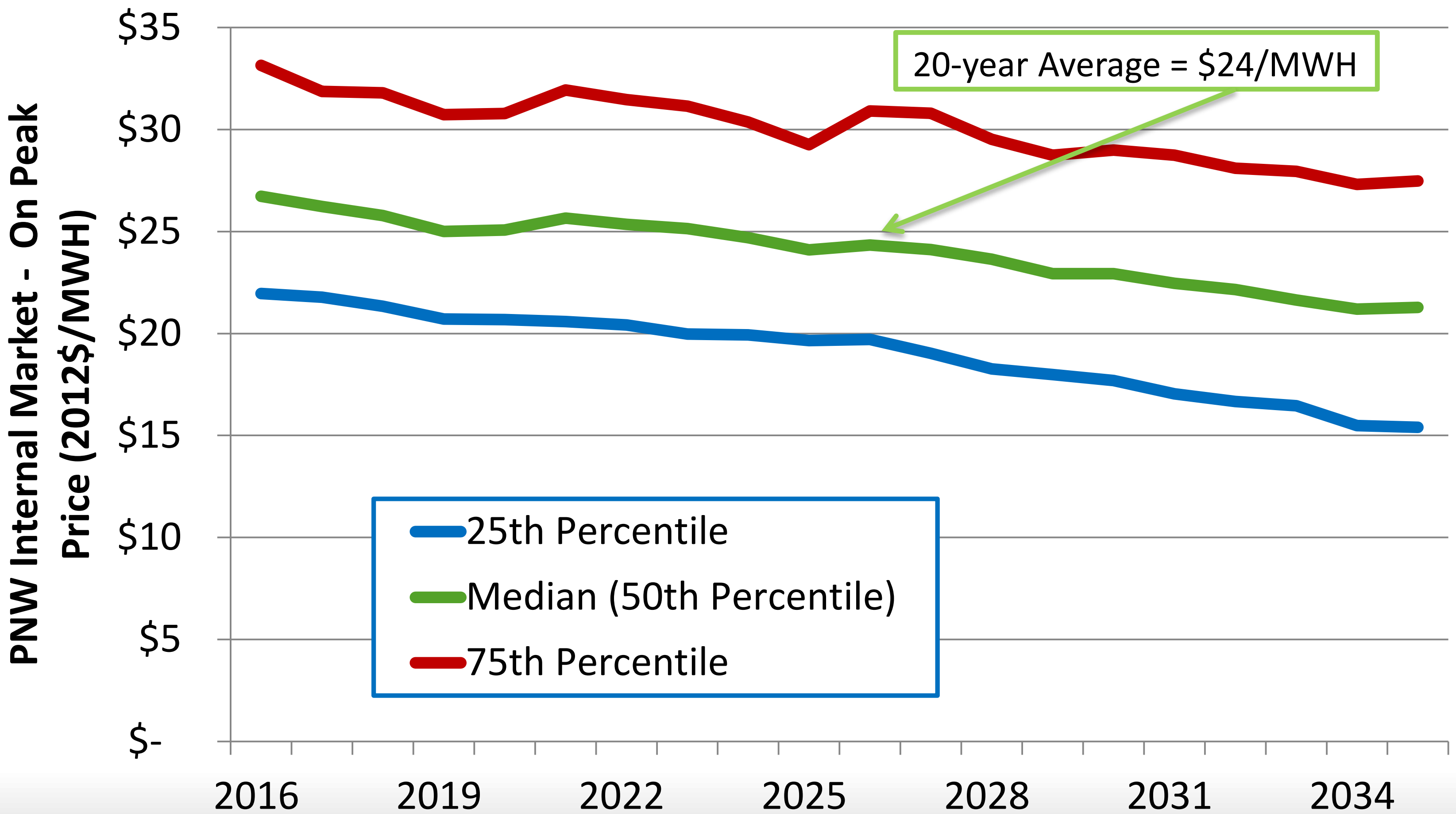


Probability of Thermal Development by 2035

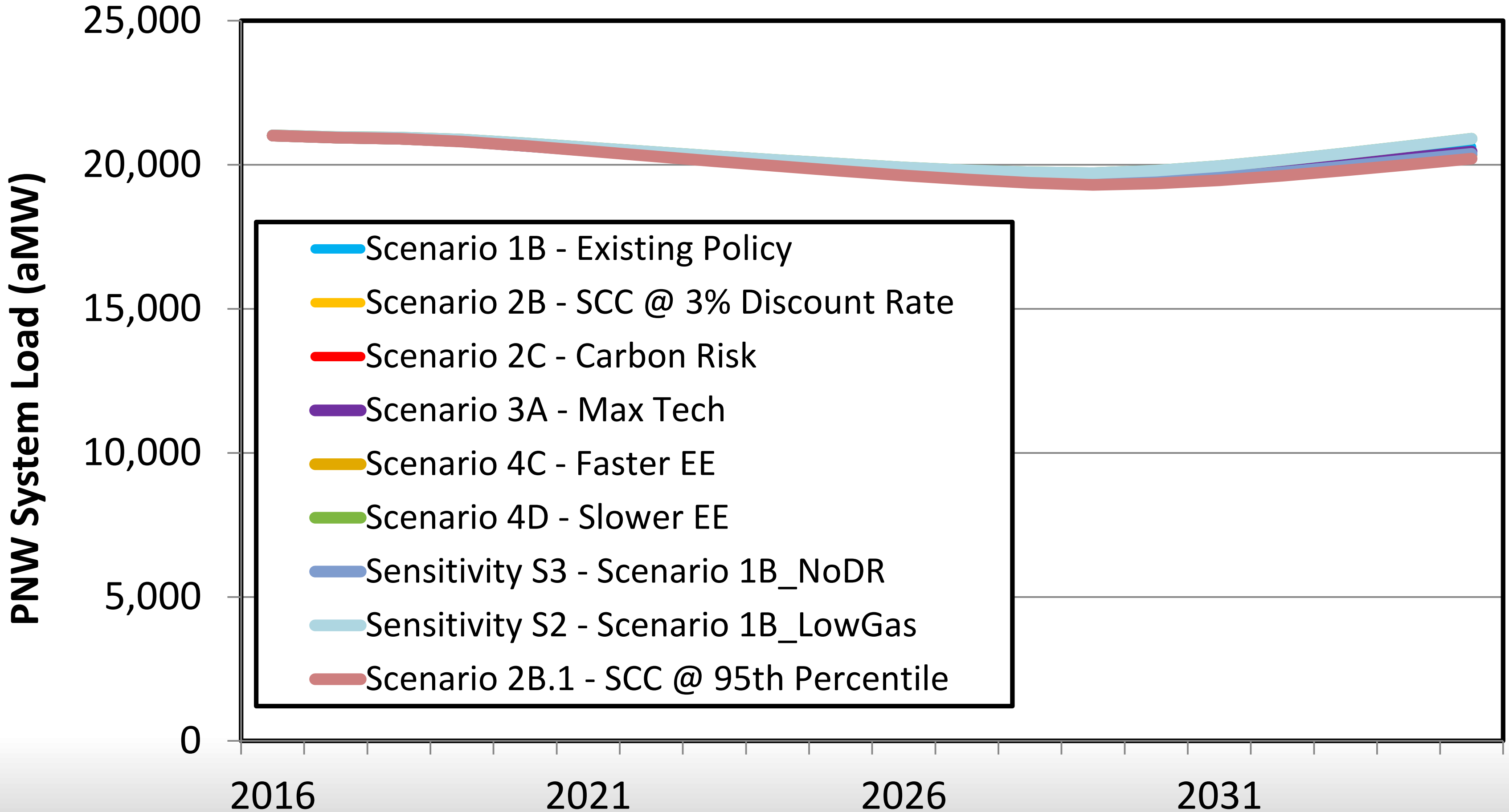


Sensitivity Study S2 –

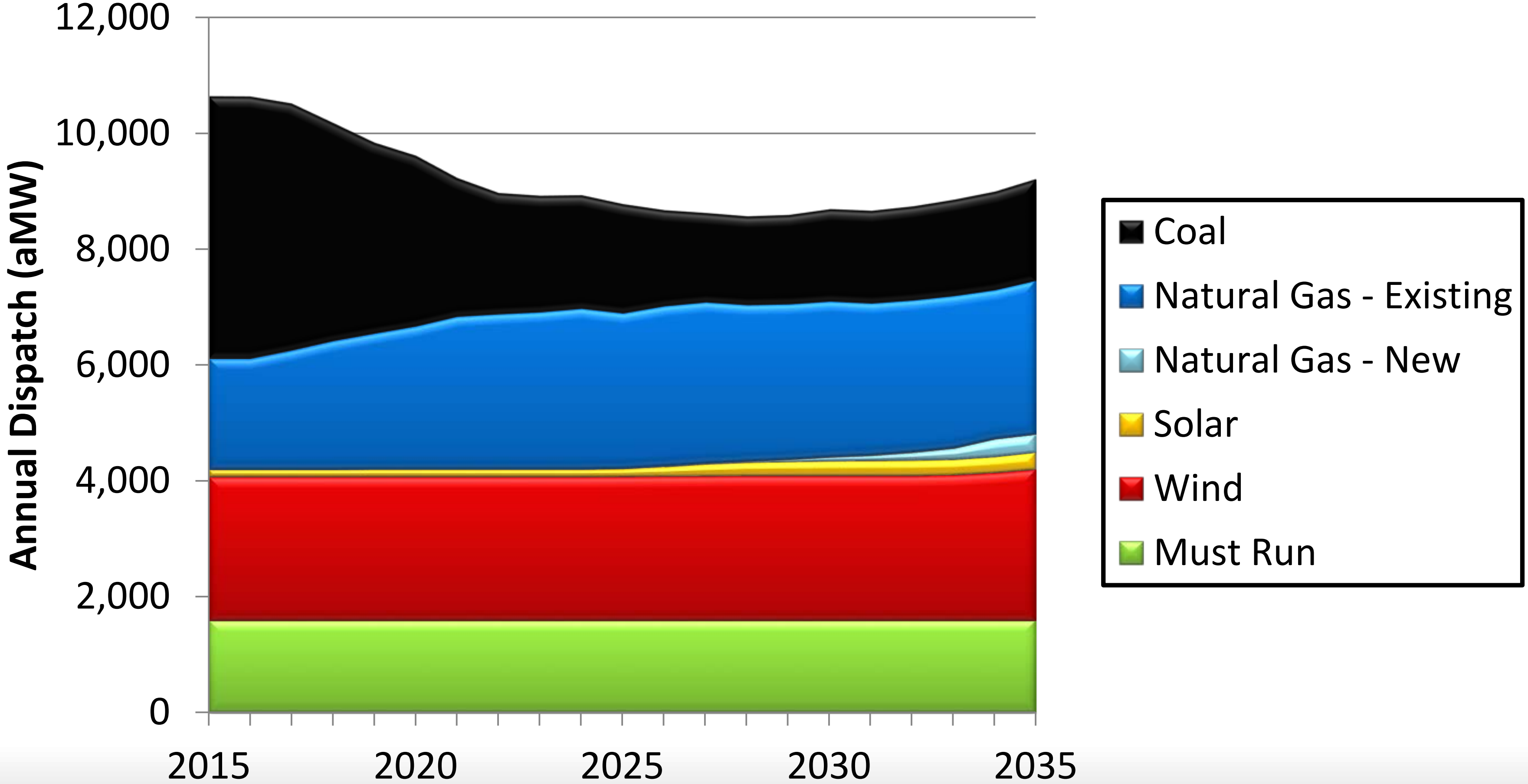
Scenario 1B PNW Electricity Market Price Assumptions



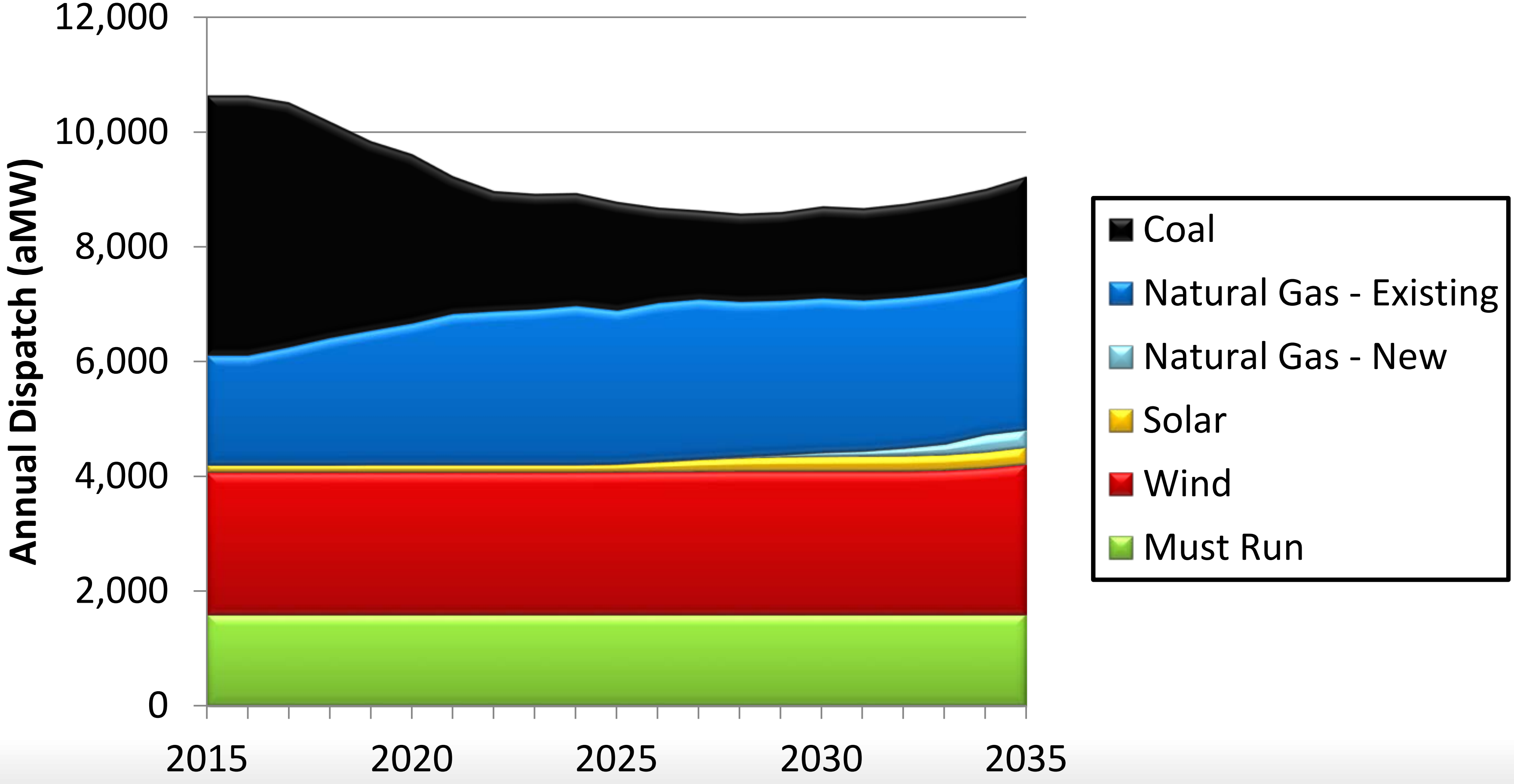
Regional Net Load After Conservation Remains "Flat On Average" Through 2035 Under the Least Cost Strategy for All Scenarios and Sensitivity Studies



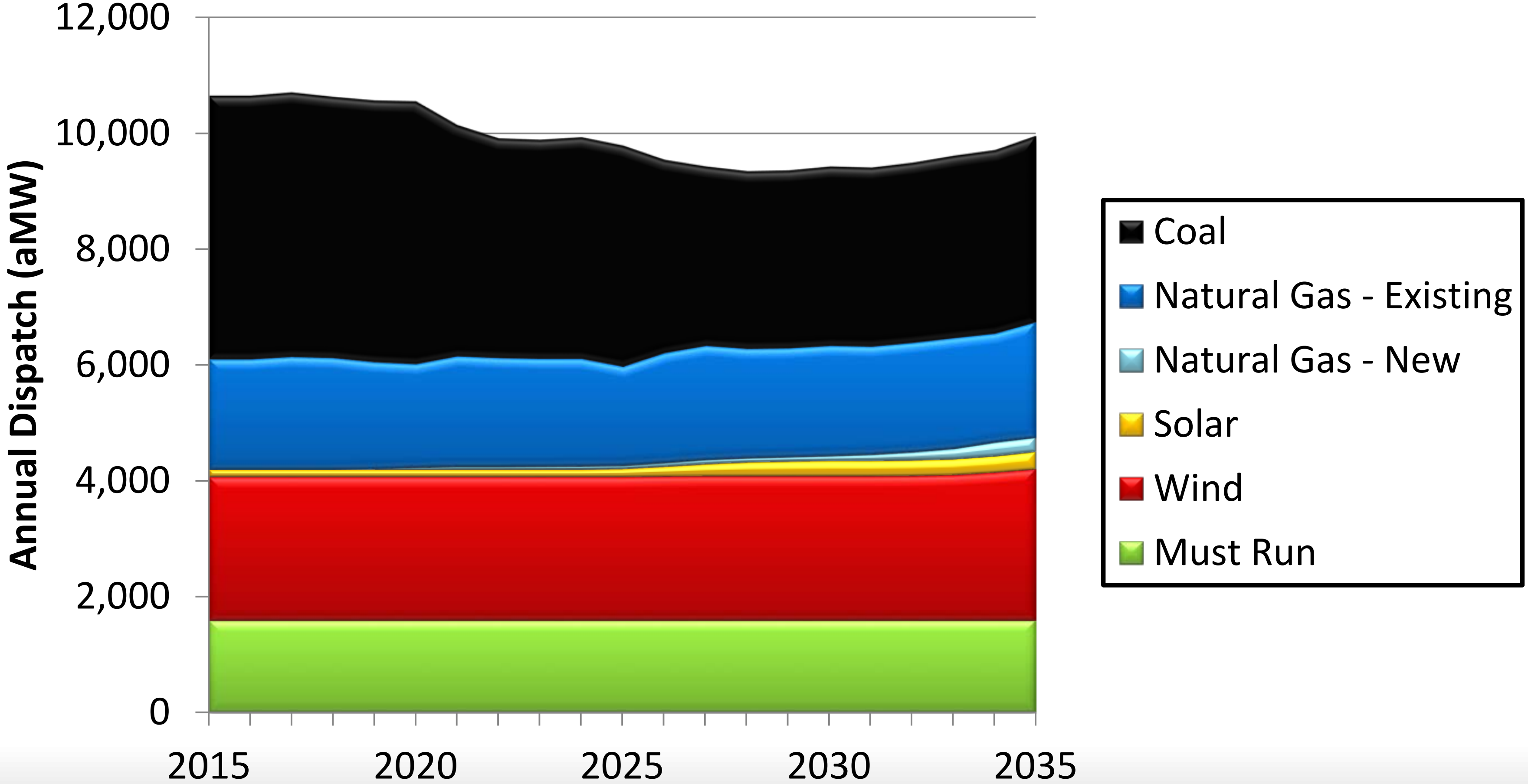
Thermal Resource Dispatch
Scenario 4C -Faster Conservation Development



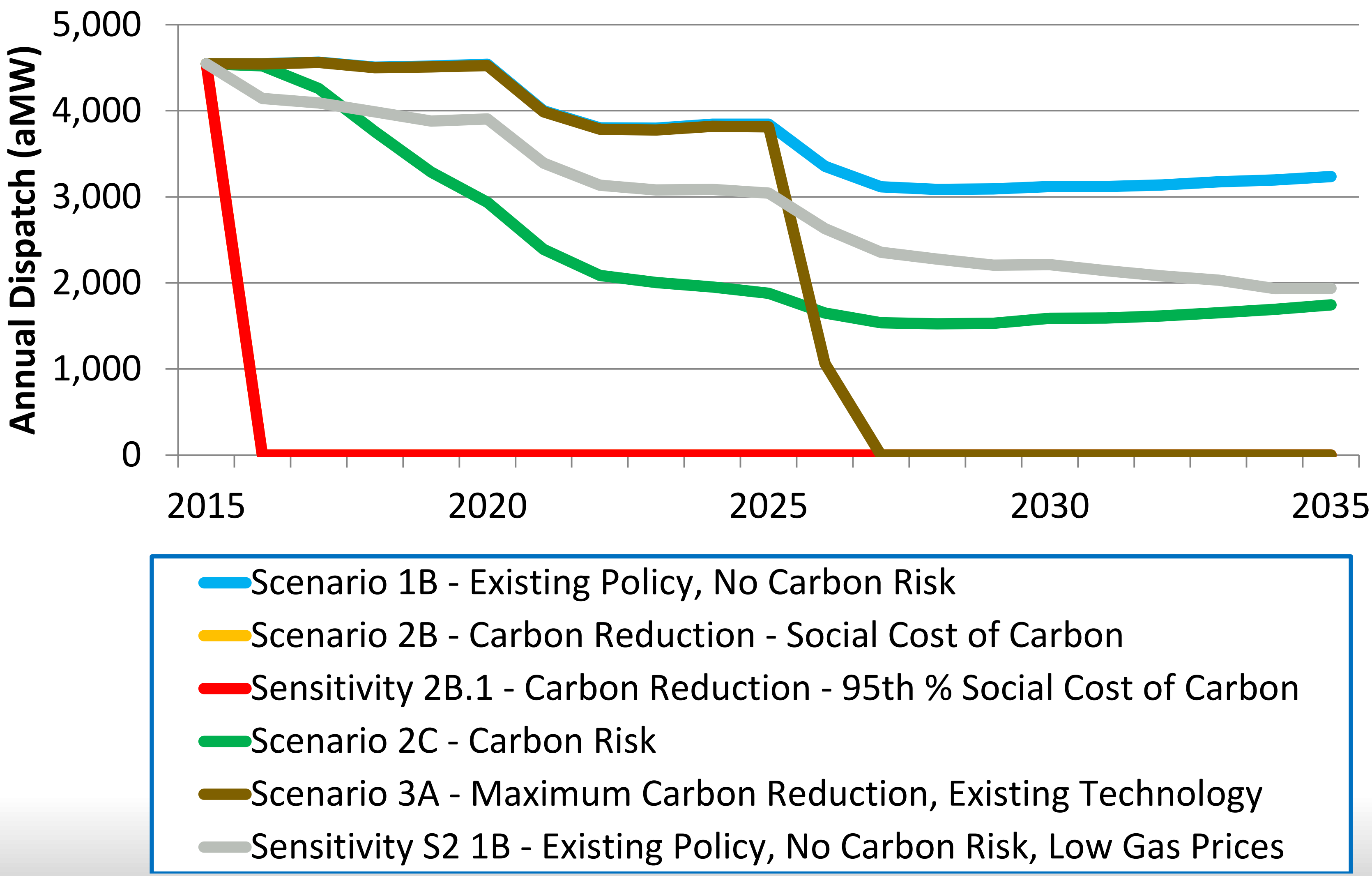
Thermal Resource Dispatch
Slower Conservation Development – Scenario 4D



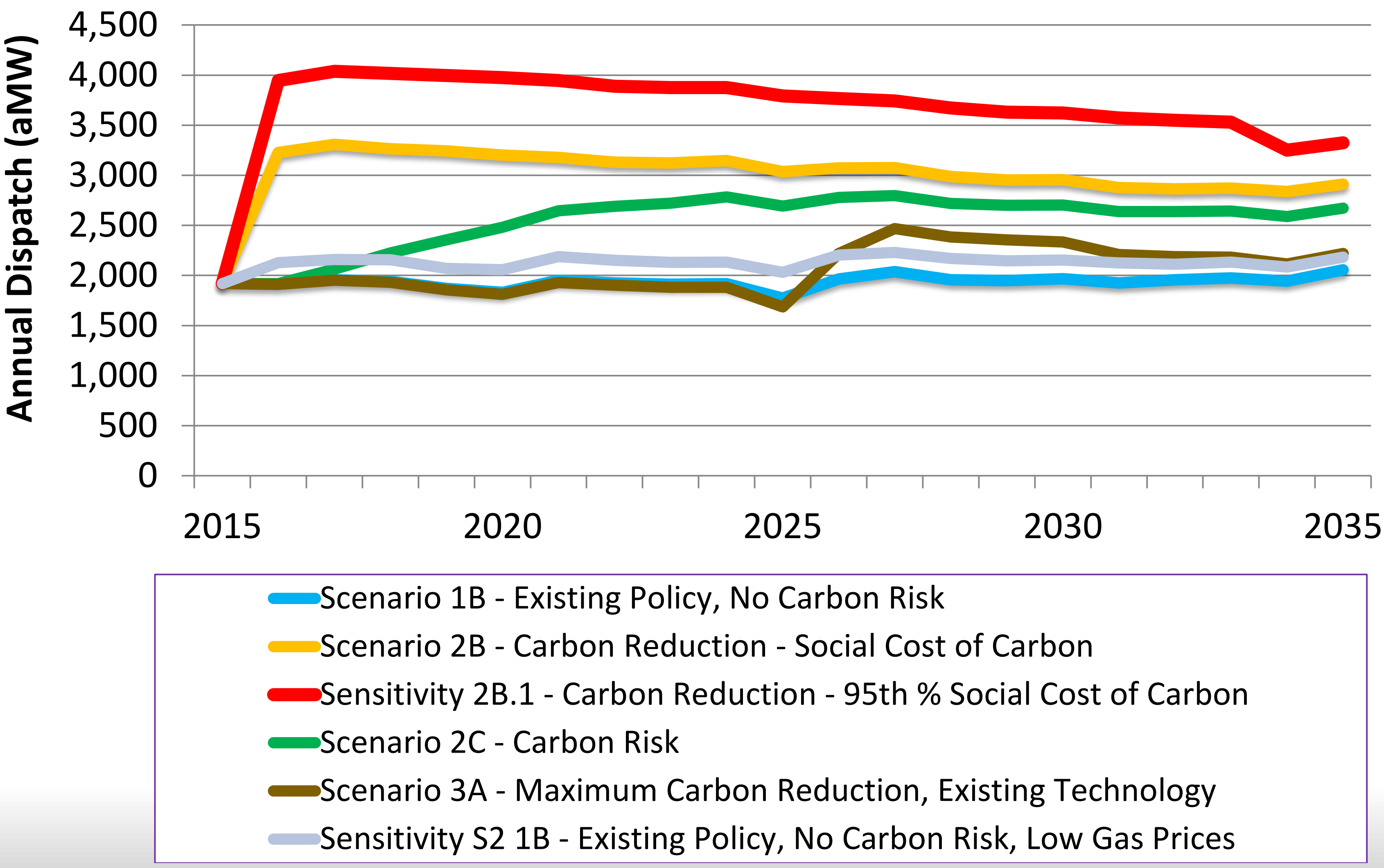
Thermal Resource Dispatch
Sensitivity S3 1B_NoDR - No Demand Response



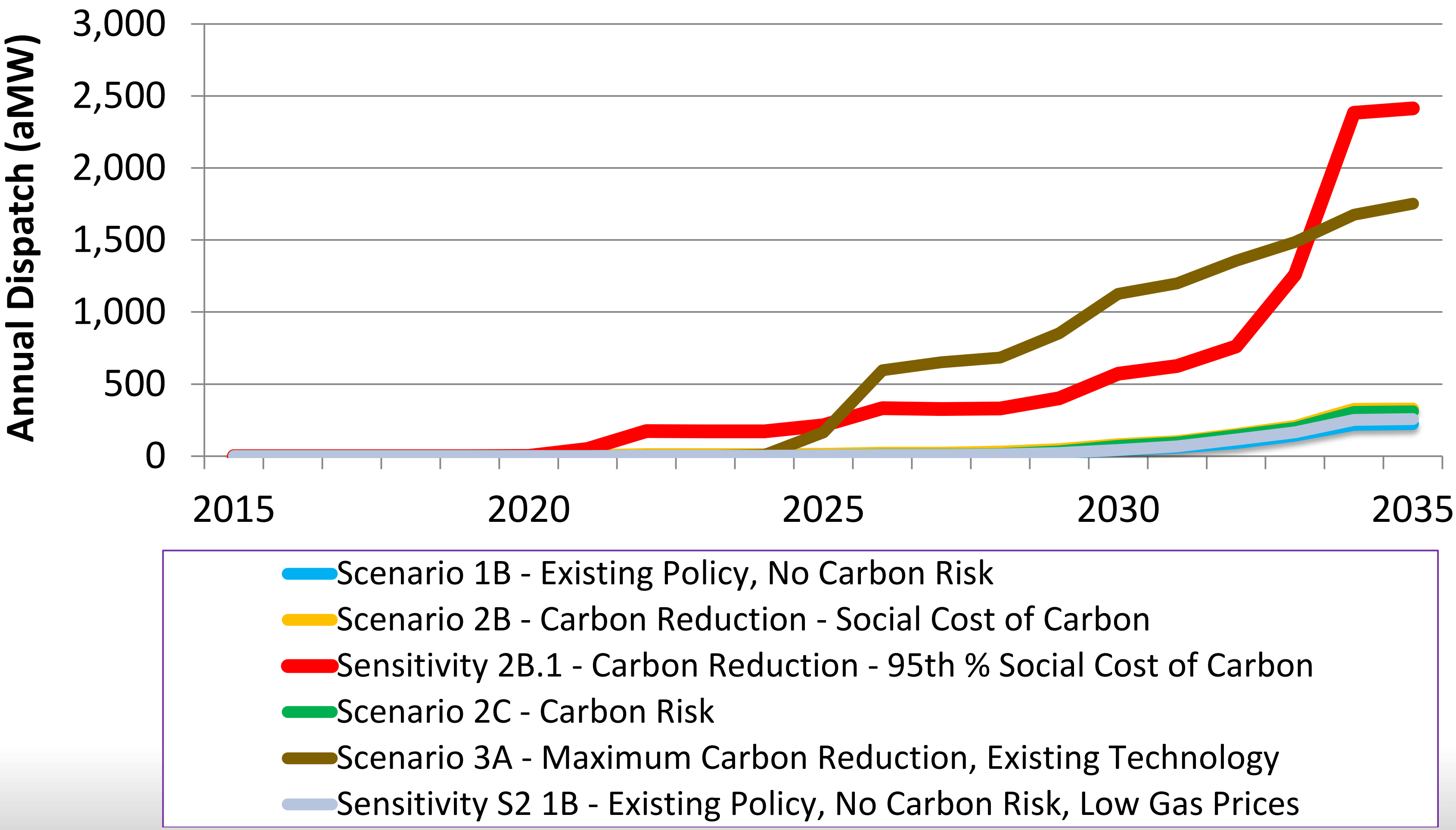
Changes in Coal Generation Dispatch Under Scenarios 1B, 2B, 2B.1, 2C, 3A and 1B_LowGas



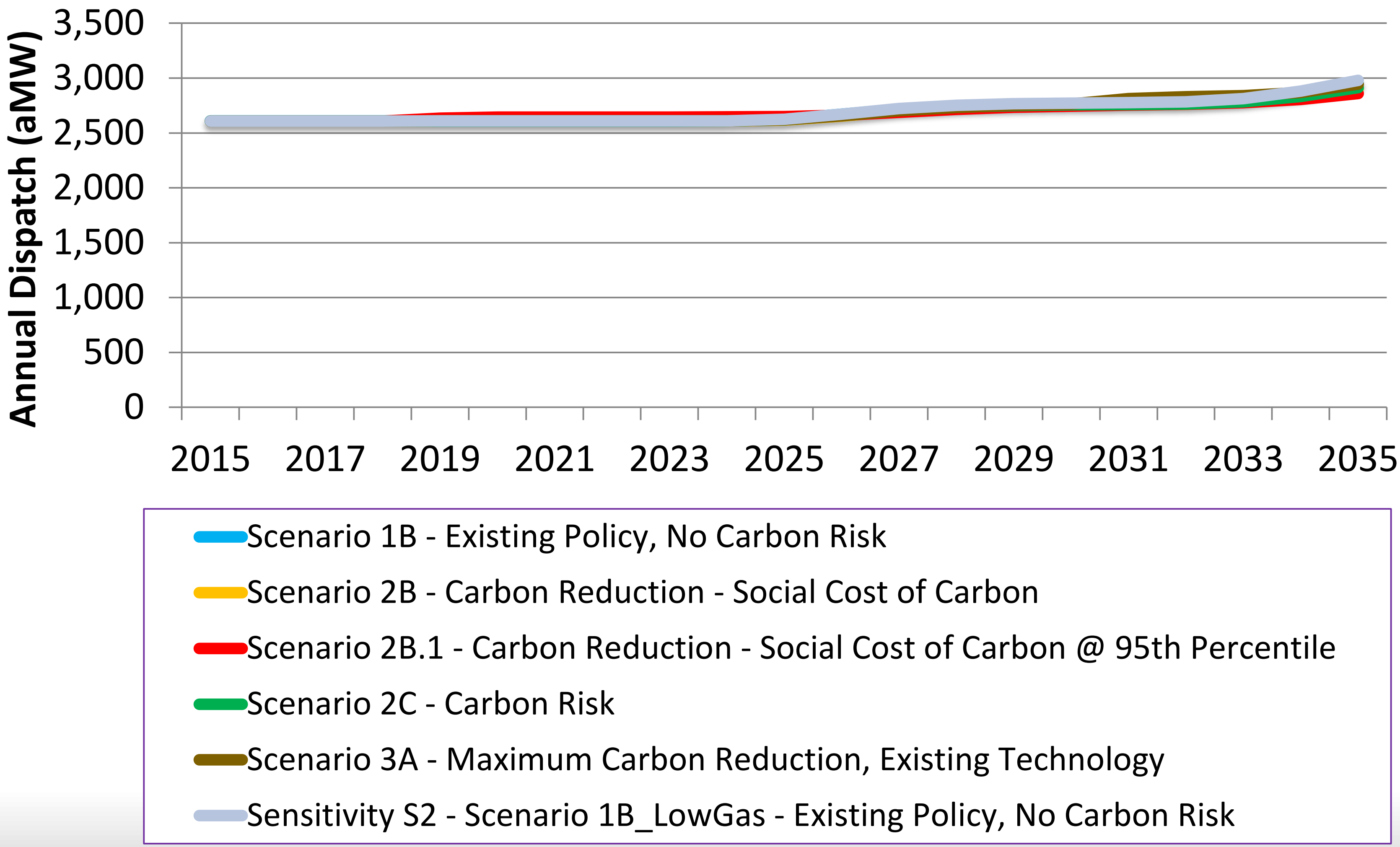
Changes in Existing Gas Generation Dispatch Under Scenarios 1B, 2B, 2B.1, 2C, 3A and 1B_LowGas



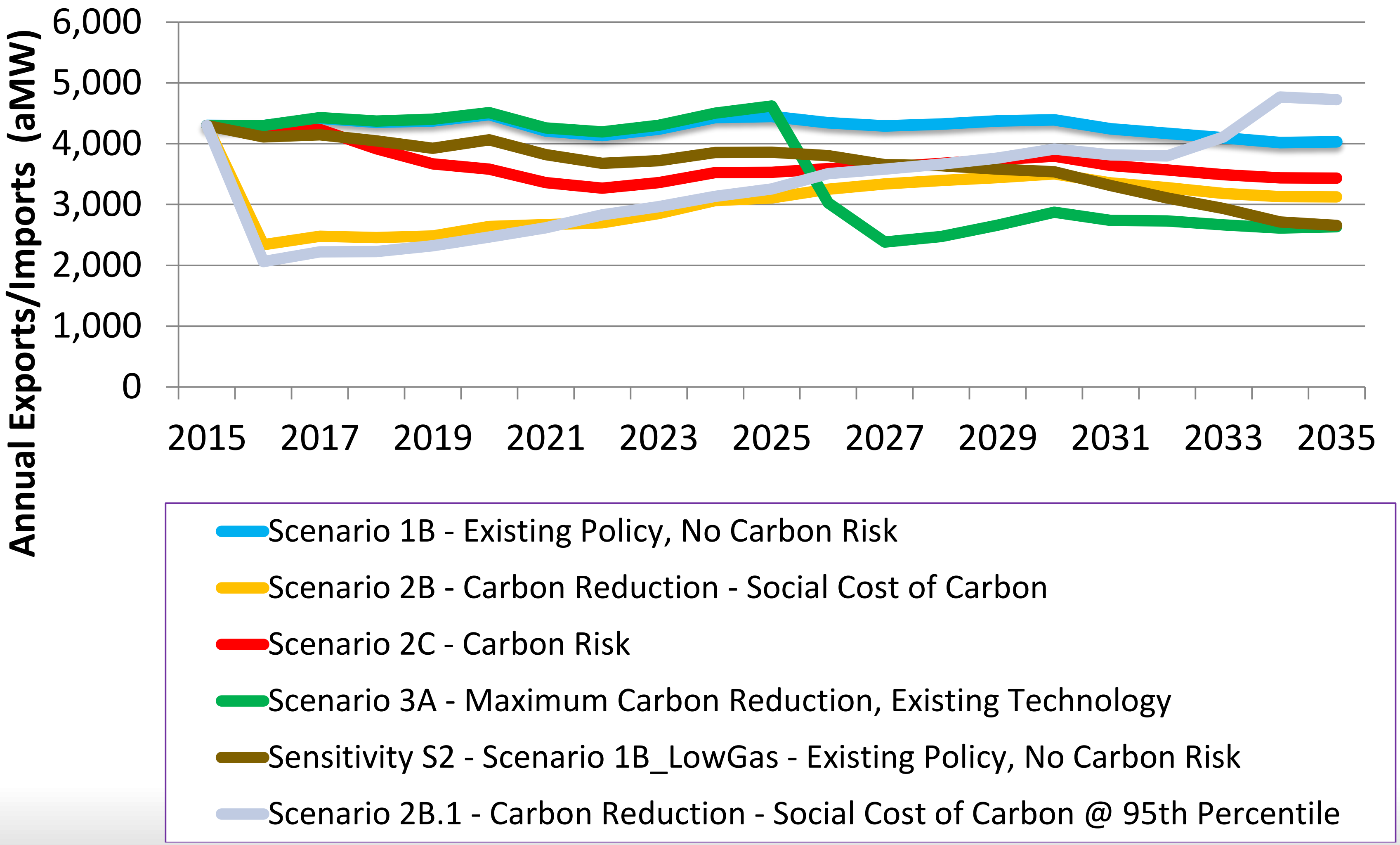
Changes in New Gas Generation Dispatch Under Scenarios 1B, 2B, 2B.1, 2C, 3A and 1B_LowGas



Change in Renewable Resource Dispatch Under Scenarios 1B, 2B, 2B.1 2C, 3A and 1B_LowGas



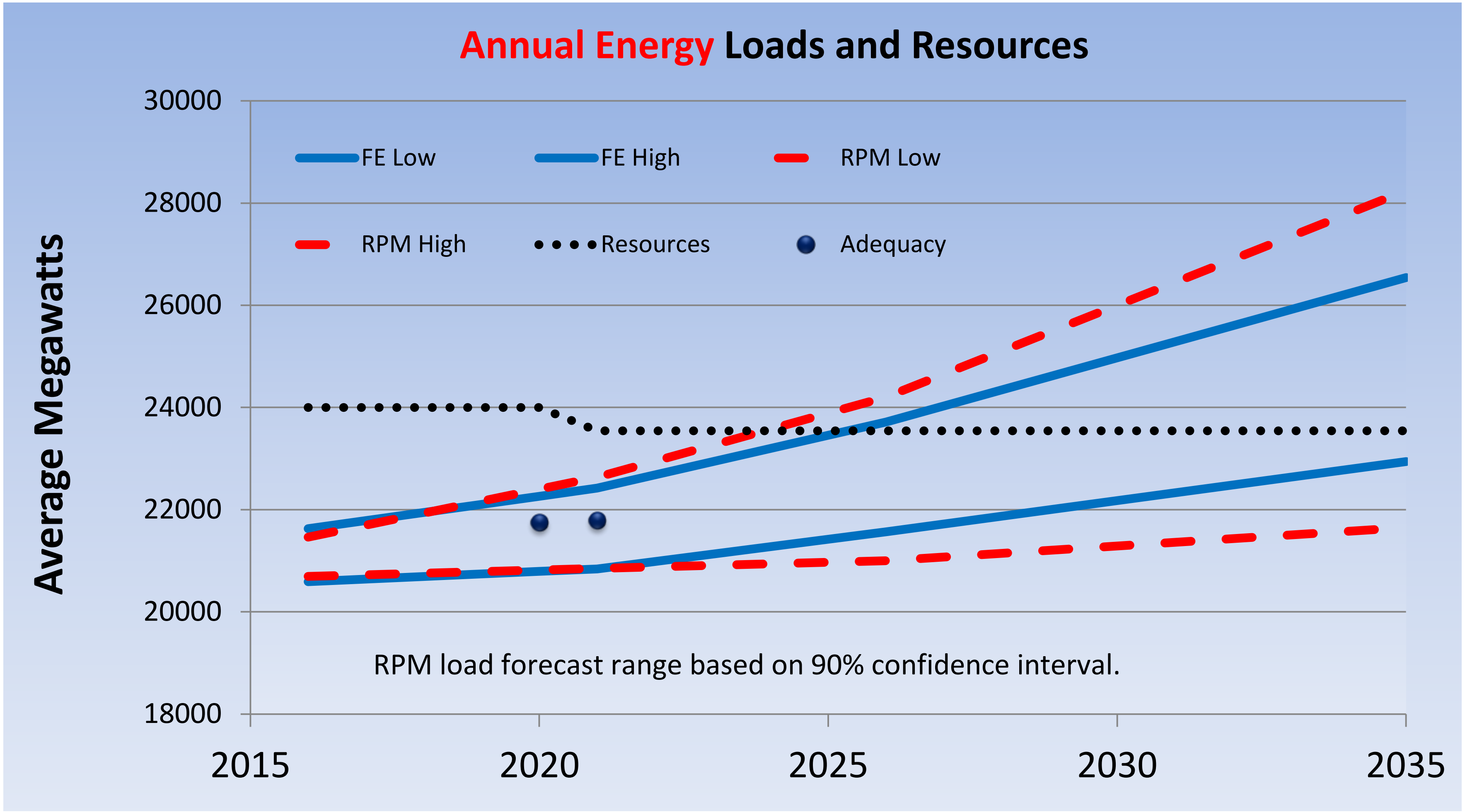
Change in Regional Exports Under Scenarios 1B, 2B, 2B.1, 2C, 3A and 1B_LowGas



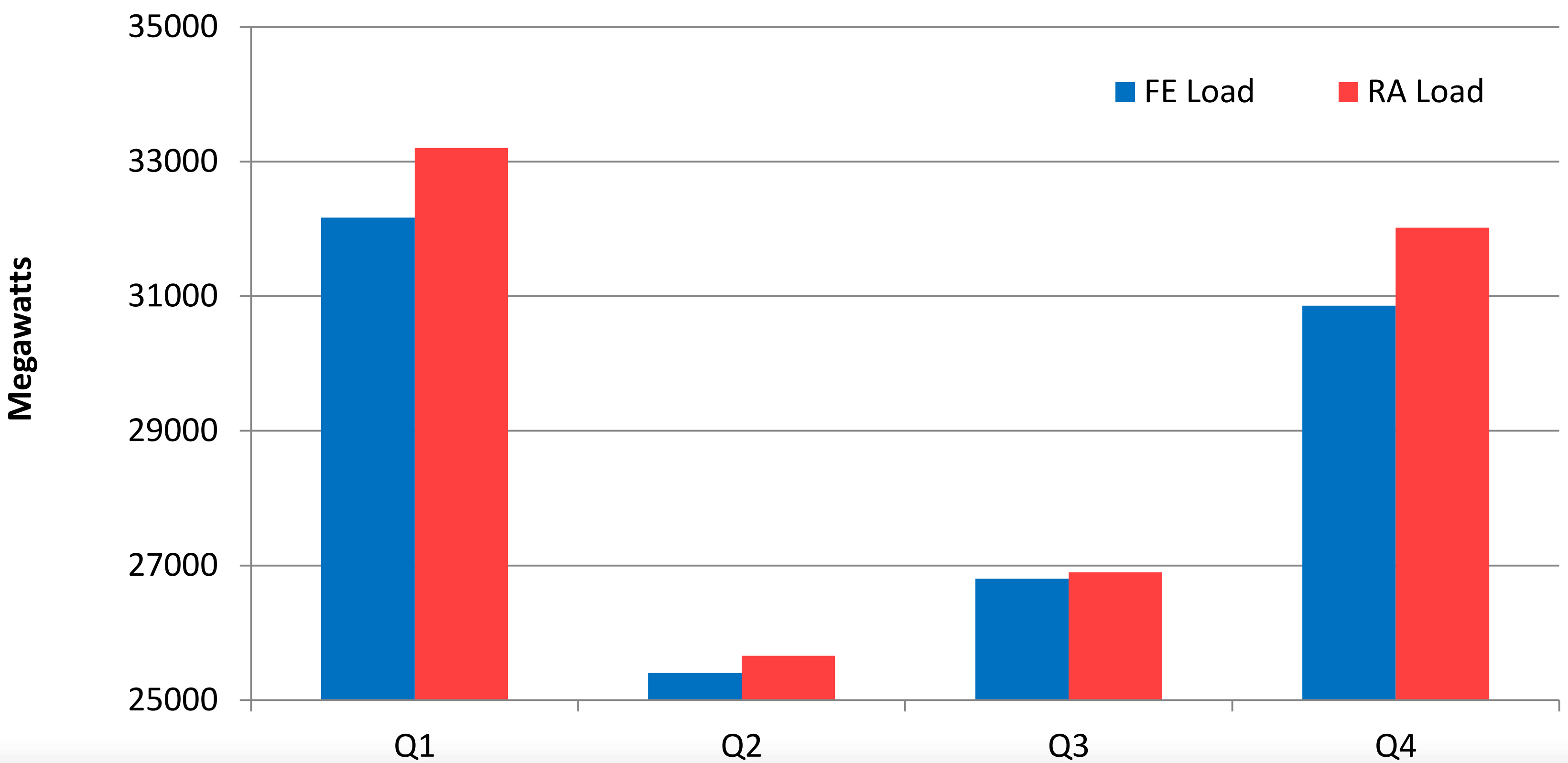
Adequacy vs. Resource Needs

NW Power and Conservation Council
Power Committee Meeting
Spokane, Washington
July 14, 2015

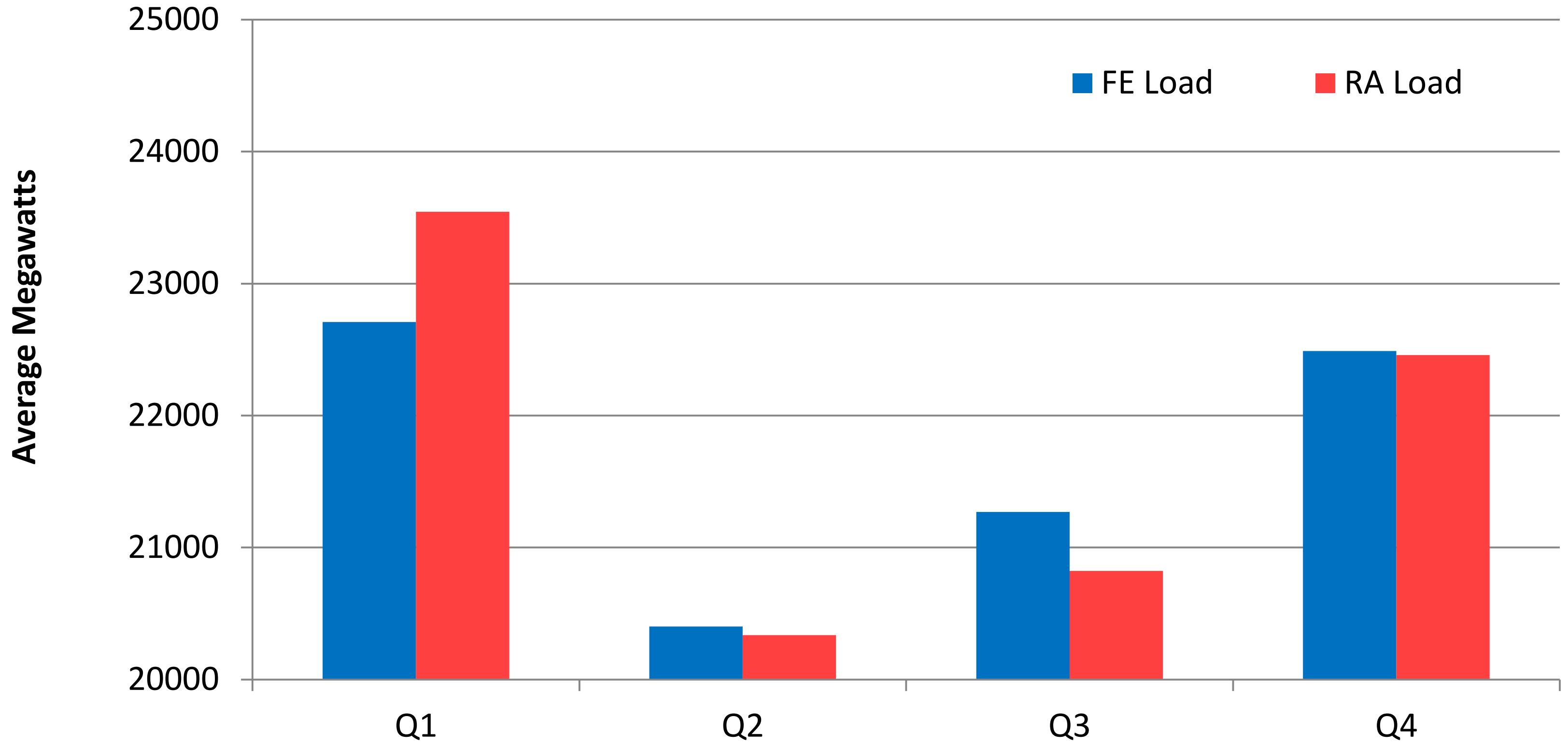
Energy Loads & Resources 2016-35



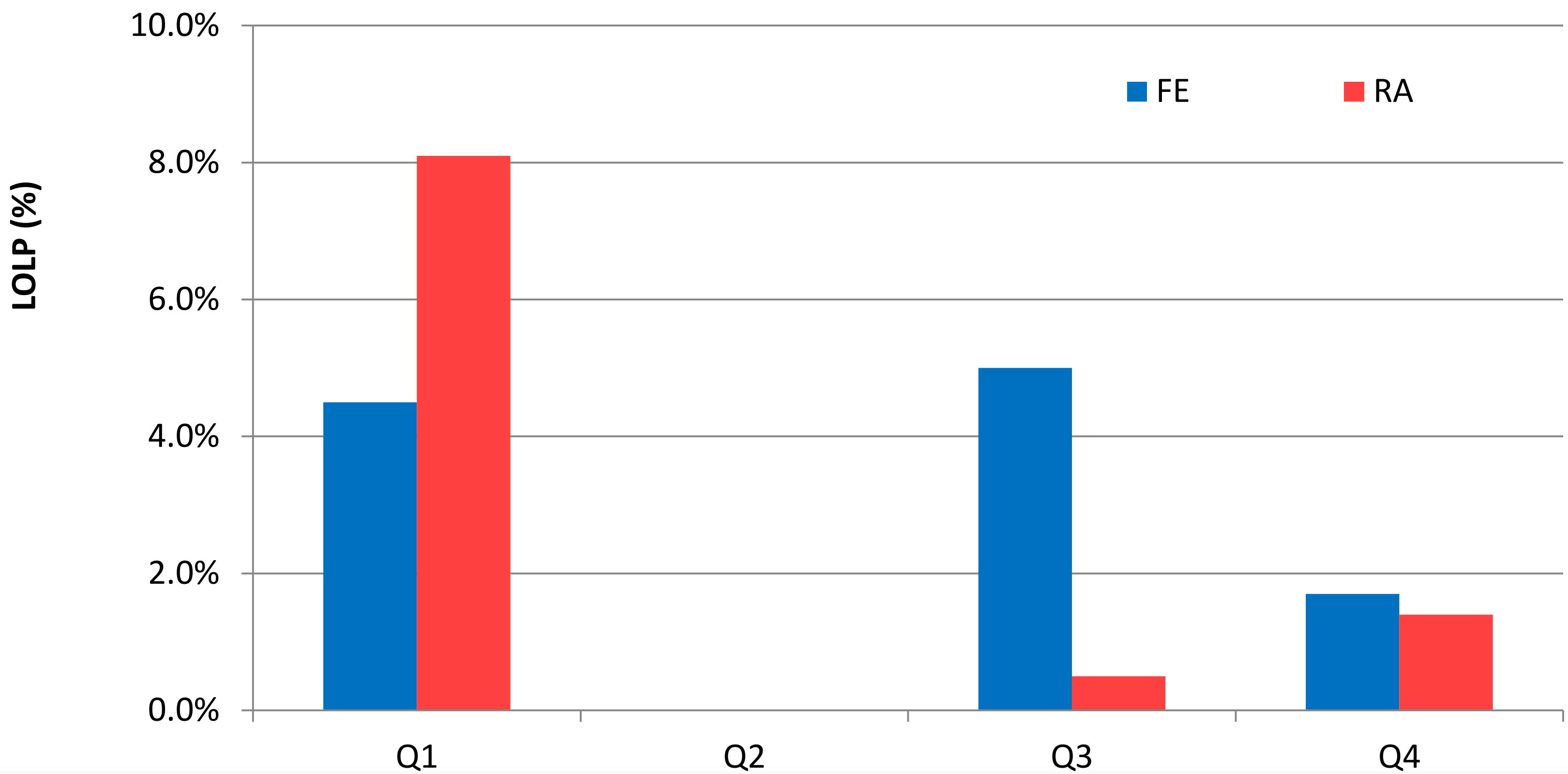
Expected Peak Load (2021 Medium Forecast)



Average Energy Loads (2021 Medium Forecast)



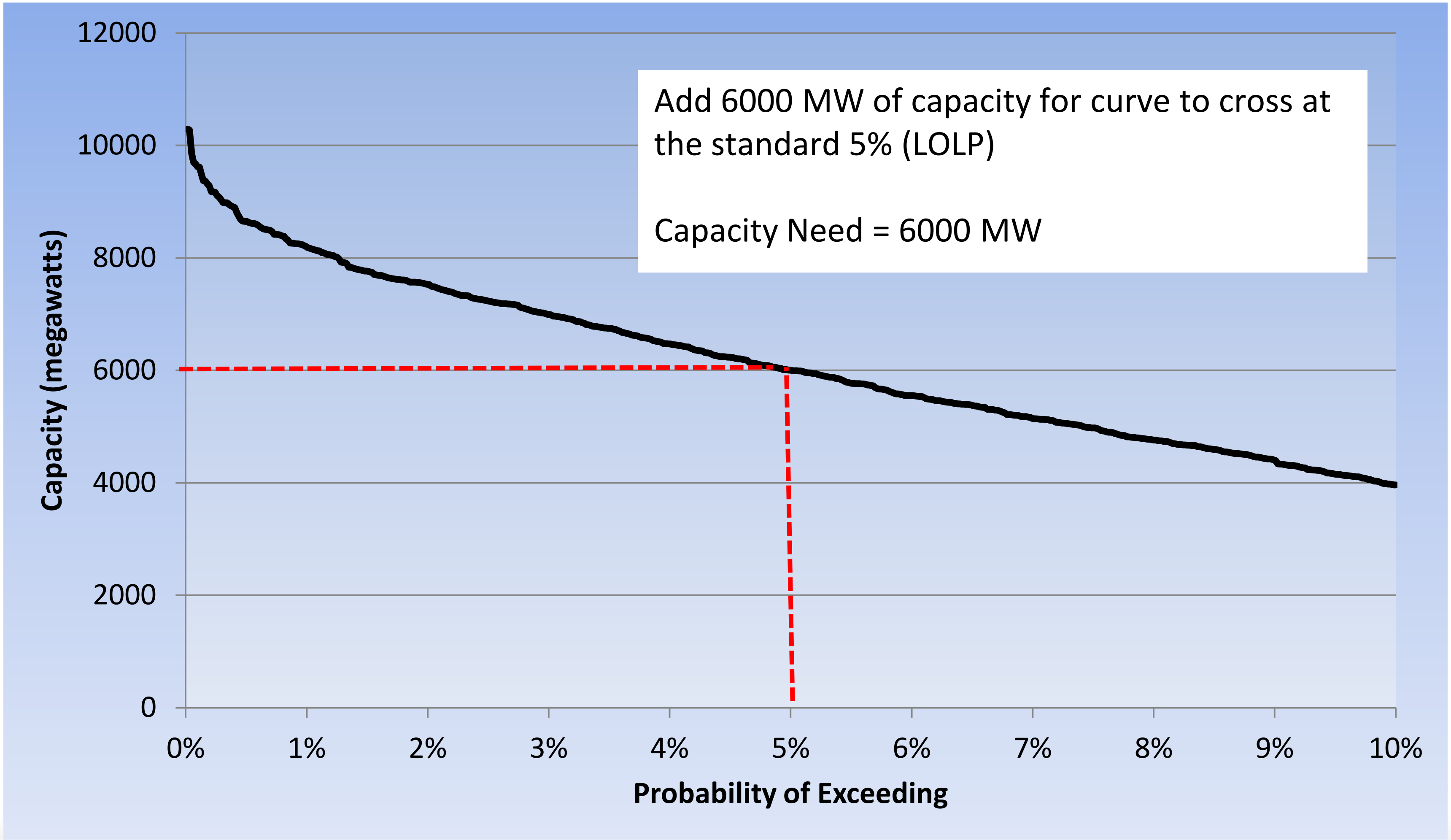
Quarterly LOLP Values (2021 Medium Forecast)



Calculating the

Associated System Capacity Contribution (ASCC)

Sample Peak-Hour Outage Duration Curve



Resource Needs[1] Assessment

Energy (average megawatts)

Load Forecast	2021	2026	2035
Low	0	5	55
High	15	105	800

Capacity (megawatts)

Load Forecast	2021	2026	2035
Low	0	1945	4315
High	3010	5850	10570

[1]To get to a 5% LOLP

Calculating ASCC for 2026

- Run 2026 high load case to generate peak-hour curtailment duration curve
- Assess the capacity need – 5,850 MW
- Run 2026 case with sufficient CCCT to get LOLP down to 5% – 4,400 MW
- ASCC (CCCT) = 5,850/4,400 = 1.33%

- Same process for EE
- ASCC (EE) = 5,850/3,400 = 1.72%