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June 2, 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 May 26th staff [presented](#) the initial results for Scenarios 1A, 1B, 2C, 4C and 4D 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 based on recommendations from the System Analysis Advisory Committee.

Staff expects to present revised results for four Scenarios (1A, 1B, 2C, and 4C). These revised results reflect 1) updated input assumptions for the relationship between weather normalized average loads and weather sensitive peak hourly loads, and 2) revisions to the method used for calculating the capacity and energy resource adequacy requirements derived from GENESYS.

This presentation will look at the least cost and least risk resource strategies for the RPM scenario analyses. The scenarios that will be discussed are:

- 1A - Considers deterministic approach where uncertainty is removed from the model and only generating resources are considered (i.e., Demand Response or Energy Efficiency resources options are excluded)
- 1B - Current policy without any incremental cost for carbon included
- 2C - Considers uncertainty in the cost of carbon ranging from \$0 to \$110/metric ton
- 4C – Same as 2C with increased ramp speed on conservation

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.

Selected Findings from Scenario Analysis Conducted To Date

**Council Meeting
6/10/15**

Today's Presentations

- Comparison of the Least Cost *Resource Strategies* across 800 futures for three *Scenarios*:
 - Existing Policy without Uncertainty, w/o GHG reduction risk **(1A)**
 - Existing Policy with Uncertainty, w/o GHG reduction risk **(1B)**
 - Existing Policy with Uncertainty and with uncertain GHG reduction risk**(2C)** -
- Comparison Metrics
 - Average and Cumulative Probability of conservation development (aMW and MW)
 - Average and Cumulative Probability of Demand Response development (MW)
 - Cumulative Probability of RPS resource development (aMW and MW)
 - Average Probability of Thermal Resource development (aMW and MW)
 - CO2 emissions for Total Regional Power System and Plants Affected by EPA's Proposed 111(d) Regulation
- Observations Regarding Emerging Resource Development Strategies

Today's Presentation

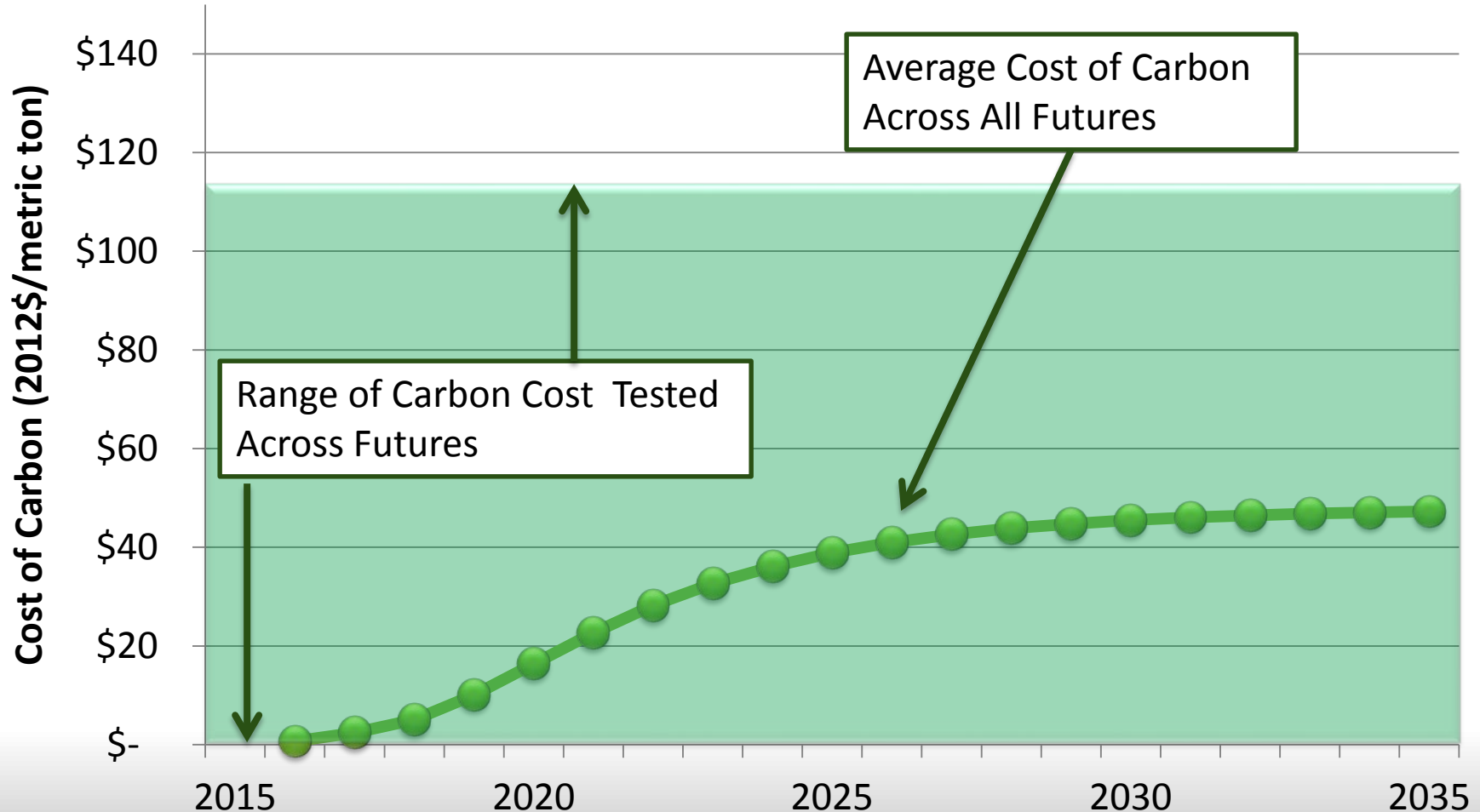
- Reflects fine tuning (since Webinar) of RPM input assumptions for resource adequacy
 - Revised peak load forecasting method now uses historical relationship between temperature and weather sensitive loads
 - Increased expected peak demands
 - Method consistent between GENESYS and RPM
 - Calculation of Adequacy Reserve Margins (ARMs) from GENESYS revised to isolate independent energy and capacity requirements
- RPM input does not yet reflect different seasonal peak capacity values for conservation
 - This will result in lower summer conservation peak impacts
- **Implication – Generalizations Okay, Details May Change – So Don't Fixate On the Exact Numbers!**

Common Elements of *Least Cost Resource Strategies Across Scenarios Analyzed To Date*

- In all scenarios least cost resource strategies rely heavily on conservation to meet both winter capacity and energy needs
- In all scenarios least cost resource strategies rely on low cost Demand Response options to maintain adequate capacity margins
 - DR is optioned because it has a shorter lead time, smaller incremental resource size and lower cost than generation options
- In all scenarios least cost resource strategies build renewable resources to satisfy state RPS requirements
 - REC banking delays the need for constructing RPS resources until well past the action plan period
 - The only exception is the Scenario 4D – Slower Conservation Ramp Rate

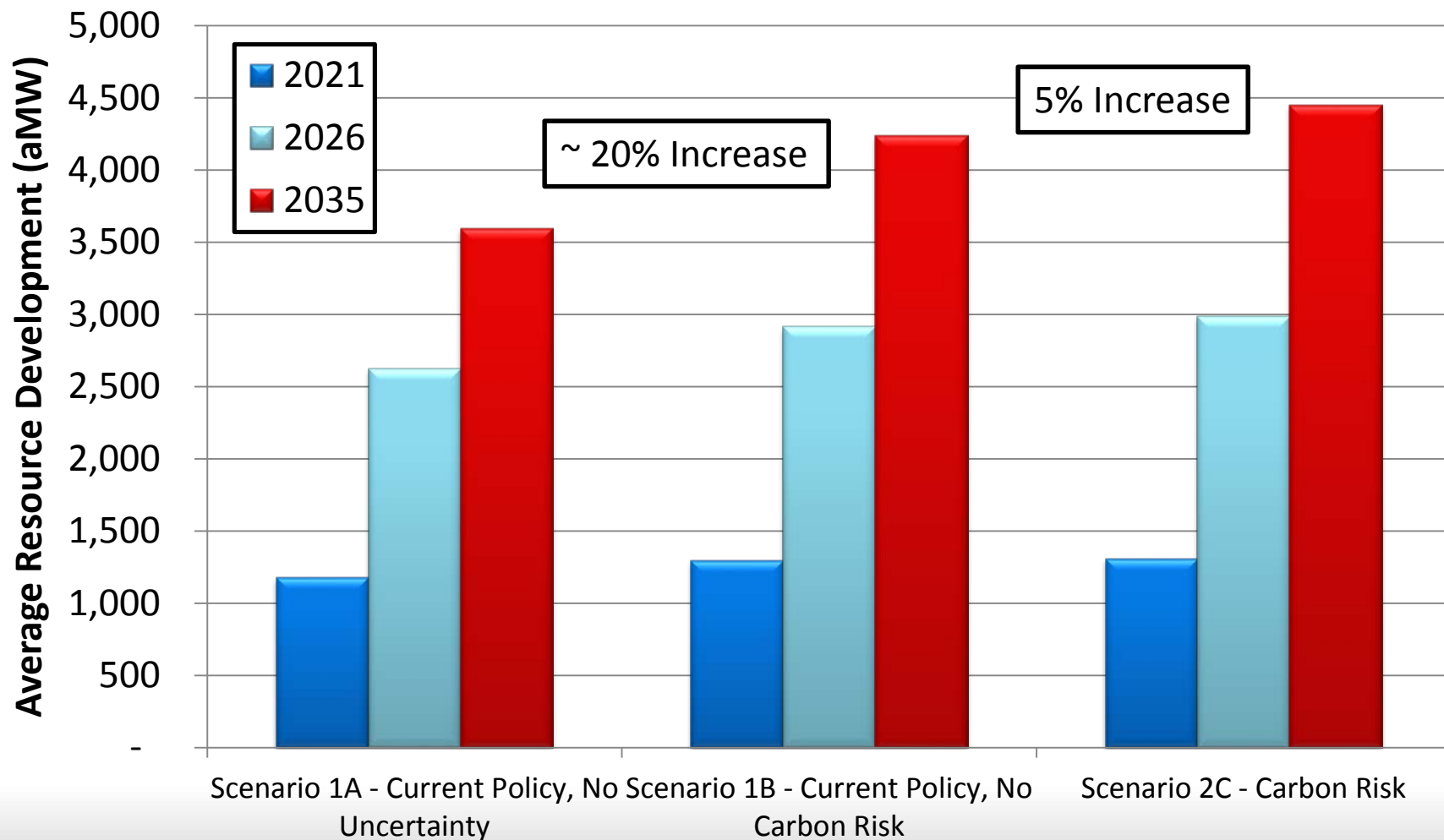
Scenario 2C – Carbon Risk

Cost of Carbon Assumptions

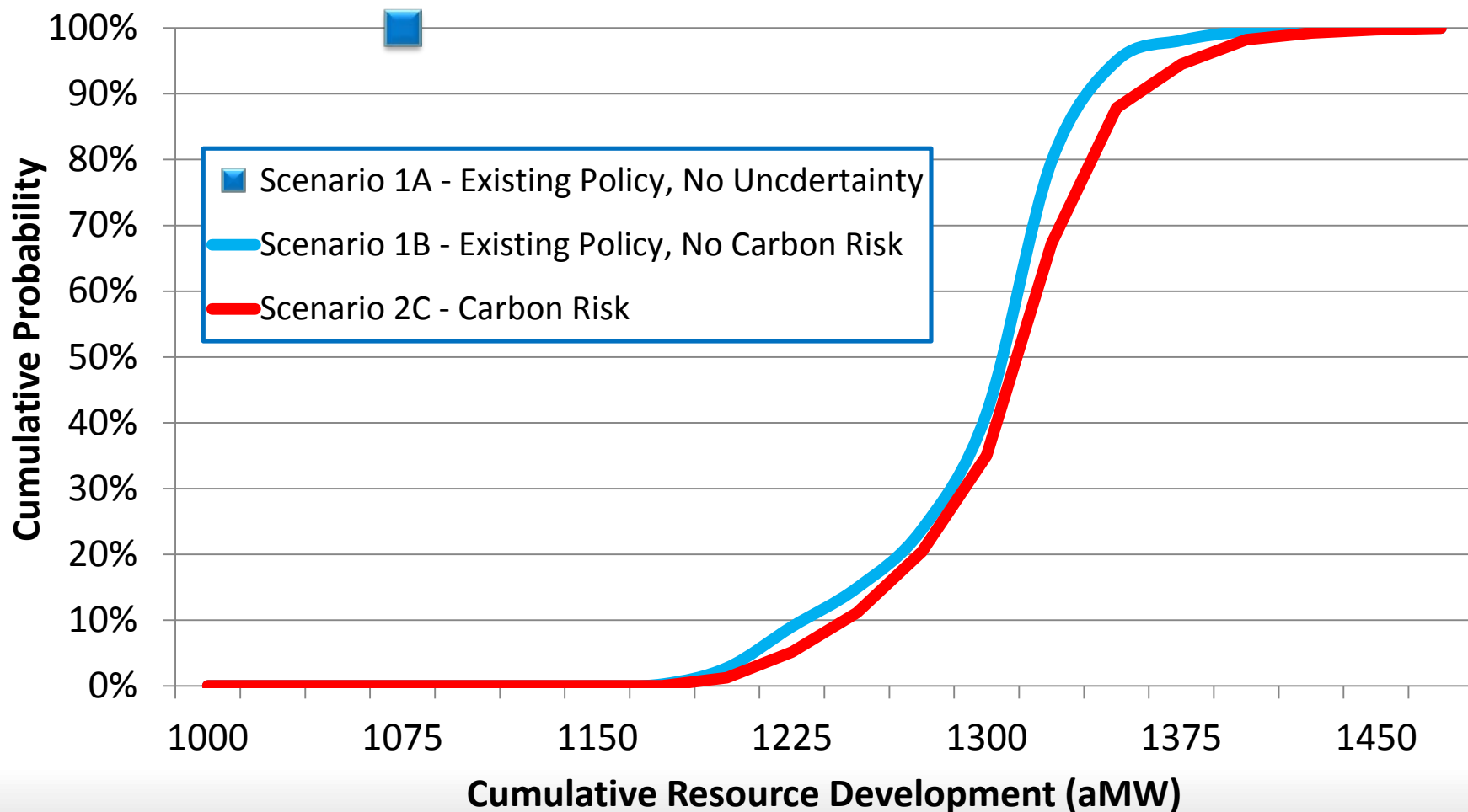


Average Conservation Development Across Scenarios Increases When Uncertainty and Carbon Risk Are Considered

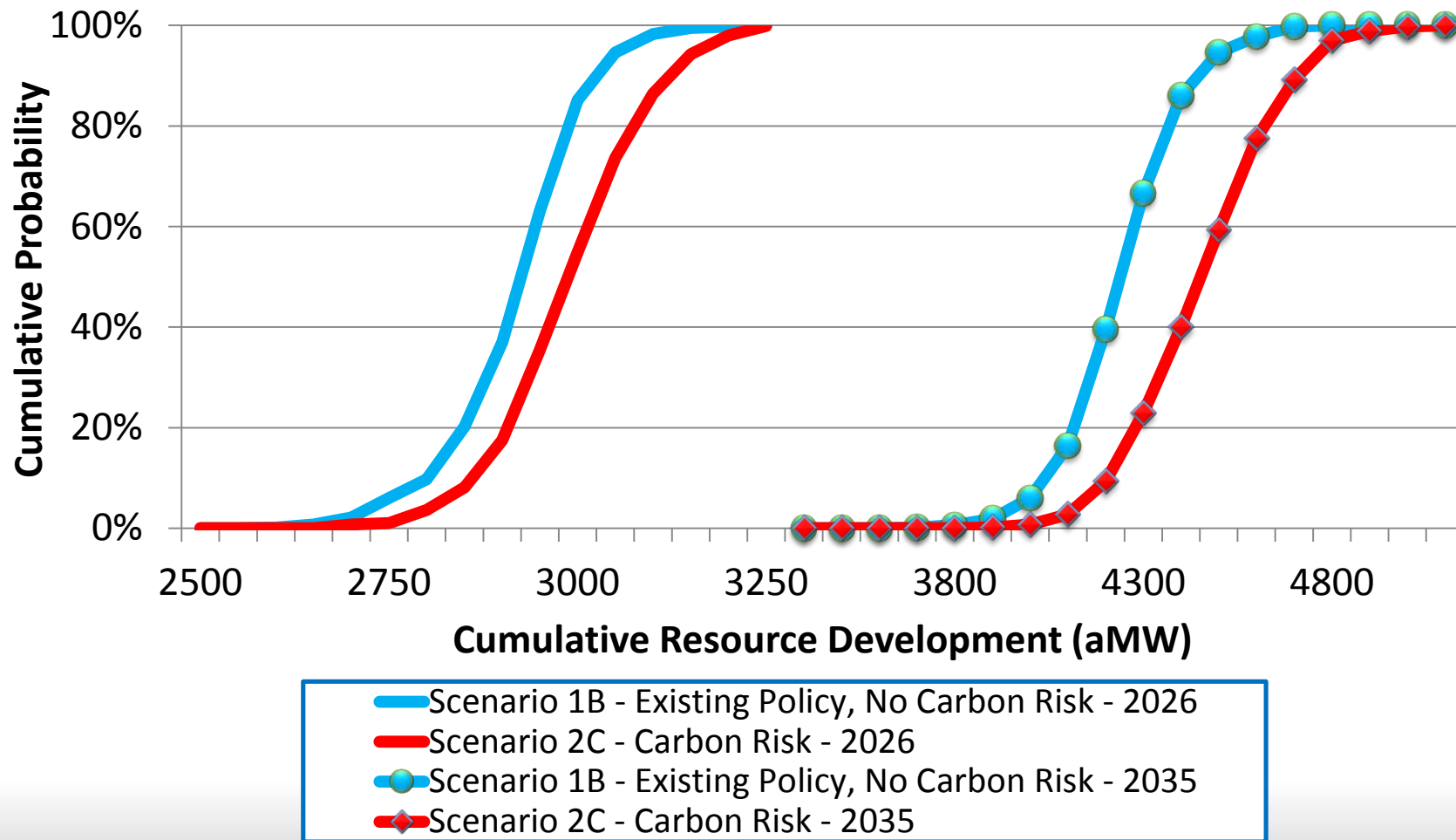
Scenarios 1A,1B and 2C– Least Cost Resource Strategies



The Cumulative Probability of Conservation Development Through 2021 Under The Least Cost Strategies for Scenarios 1B and 2C Is Nearly Identical

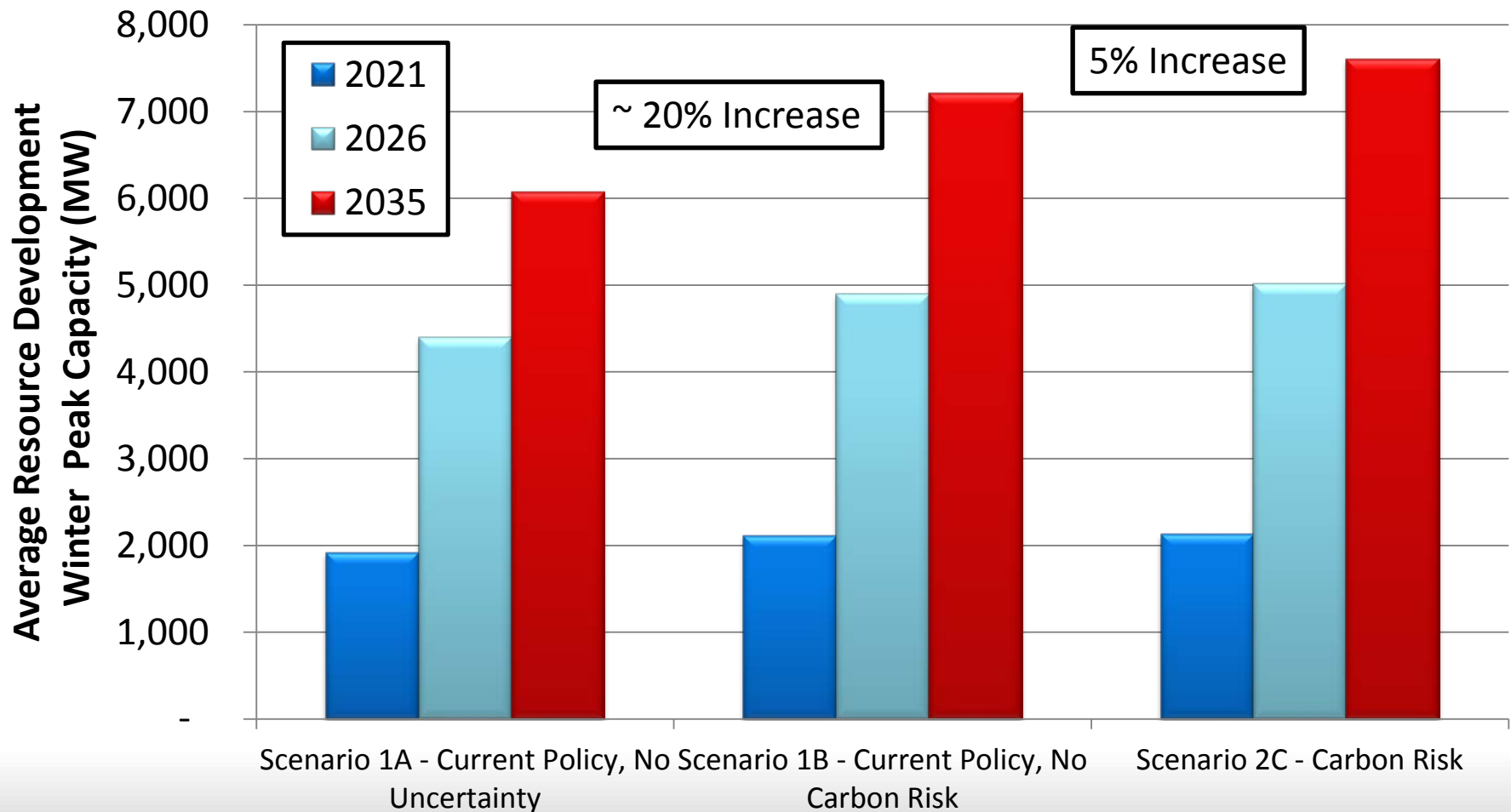


The Cumulative Probability of Conservation Development Through 2026 and 2035 Under The Least Cost Strategies for Scenarios 1B and 2C Are Very Similar



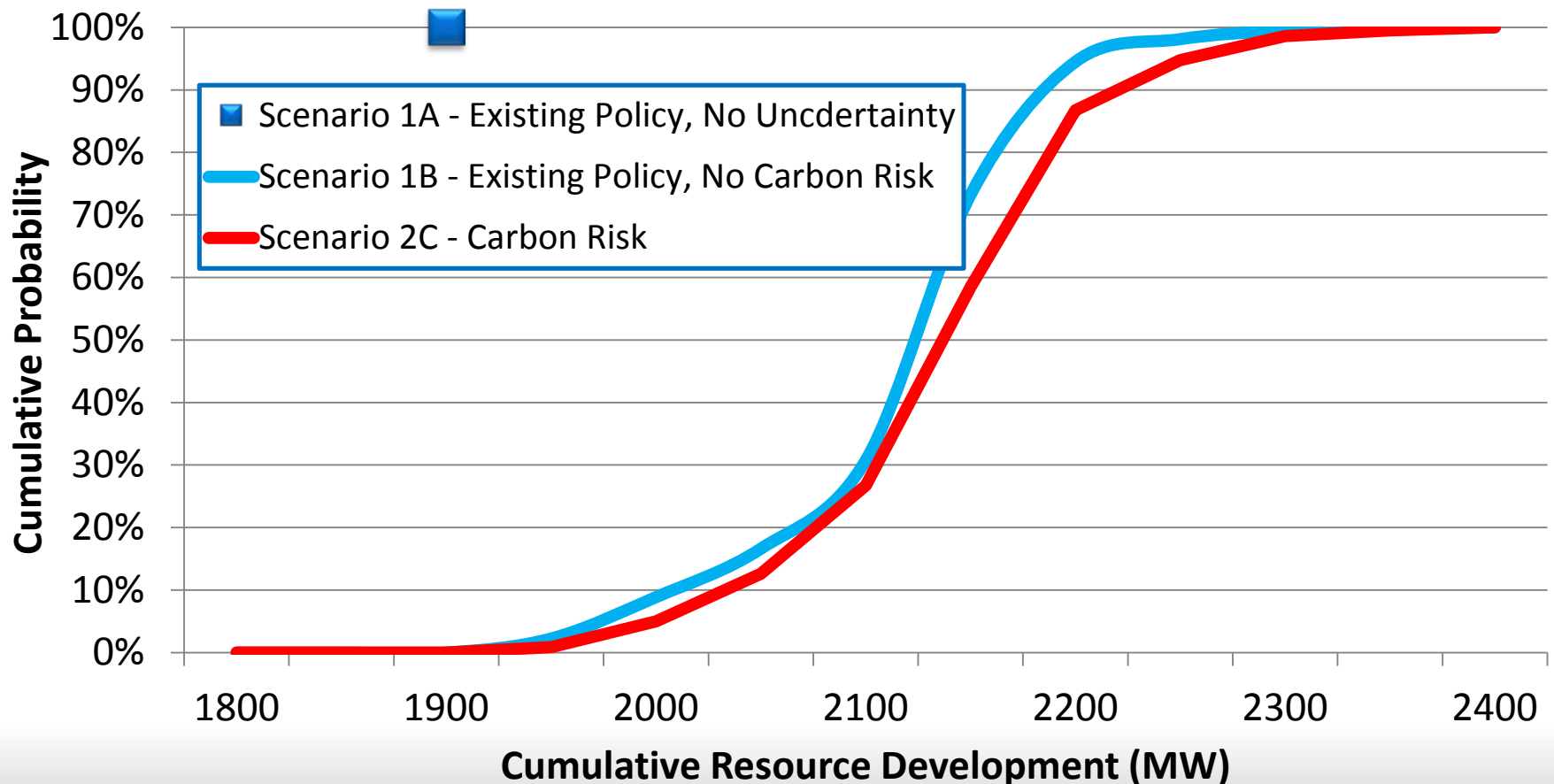
Average Conservation Development for Winter Capacity Across Scenarios Increases When Uncertainty and Carbon Risk Are Considered

Scenarios 1A,1B and 2C– Least Cost Resource Strategies



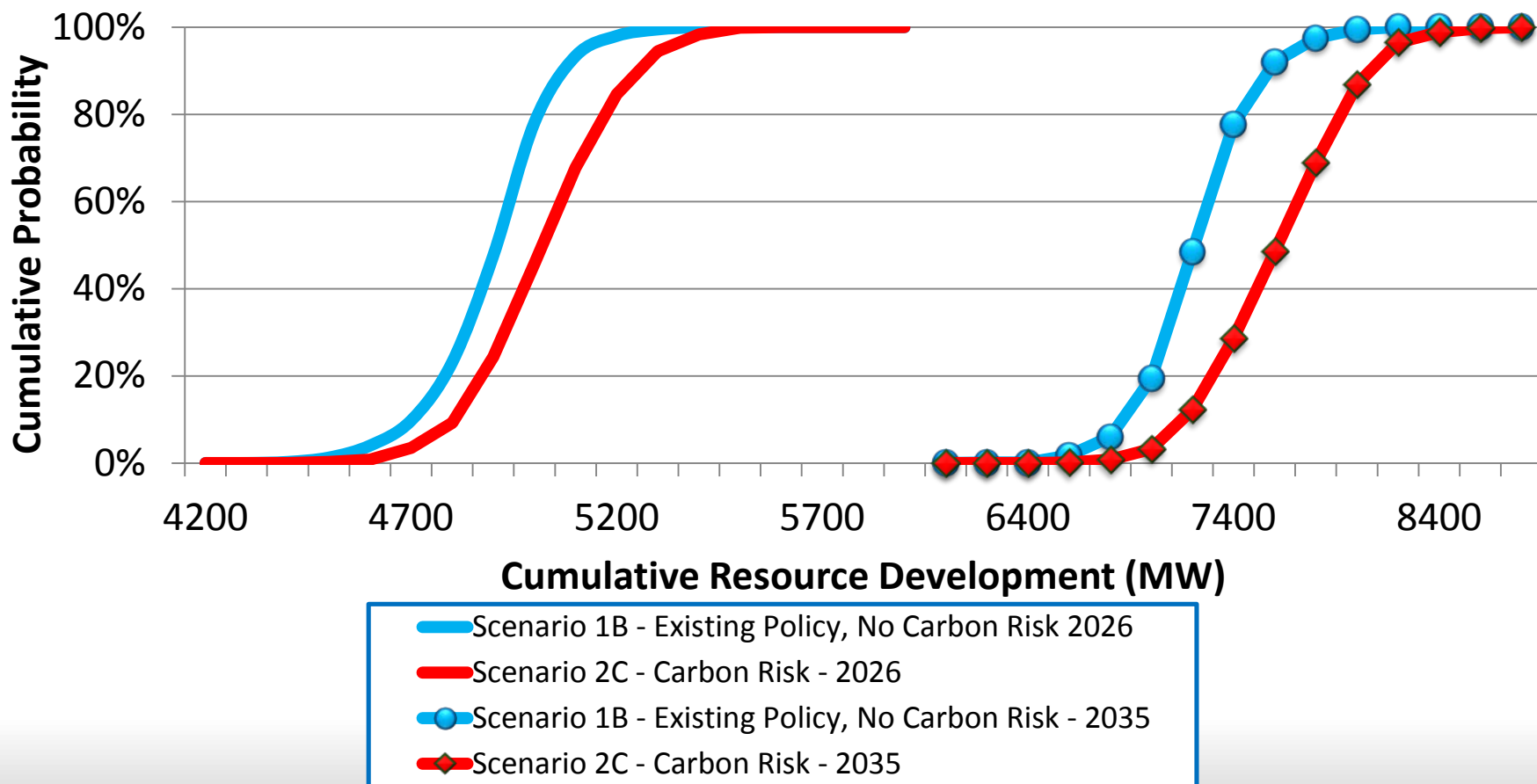
The Least Cost Strategies for Scenarios 1A, 1B and 2C Cumulative Probability of Conservation Development Through 2021

Scenarios 1A, 1B and 2C – Least Cost Resource Strategies

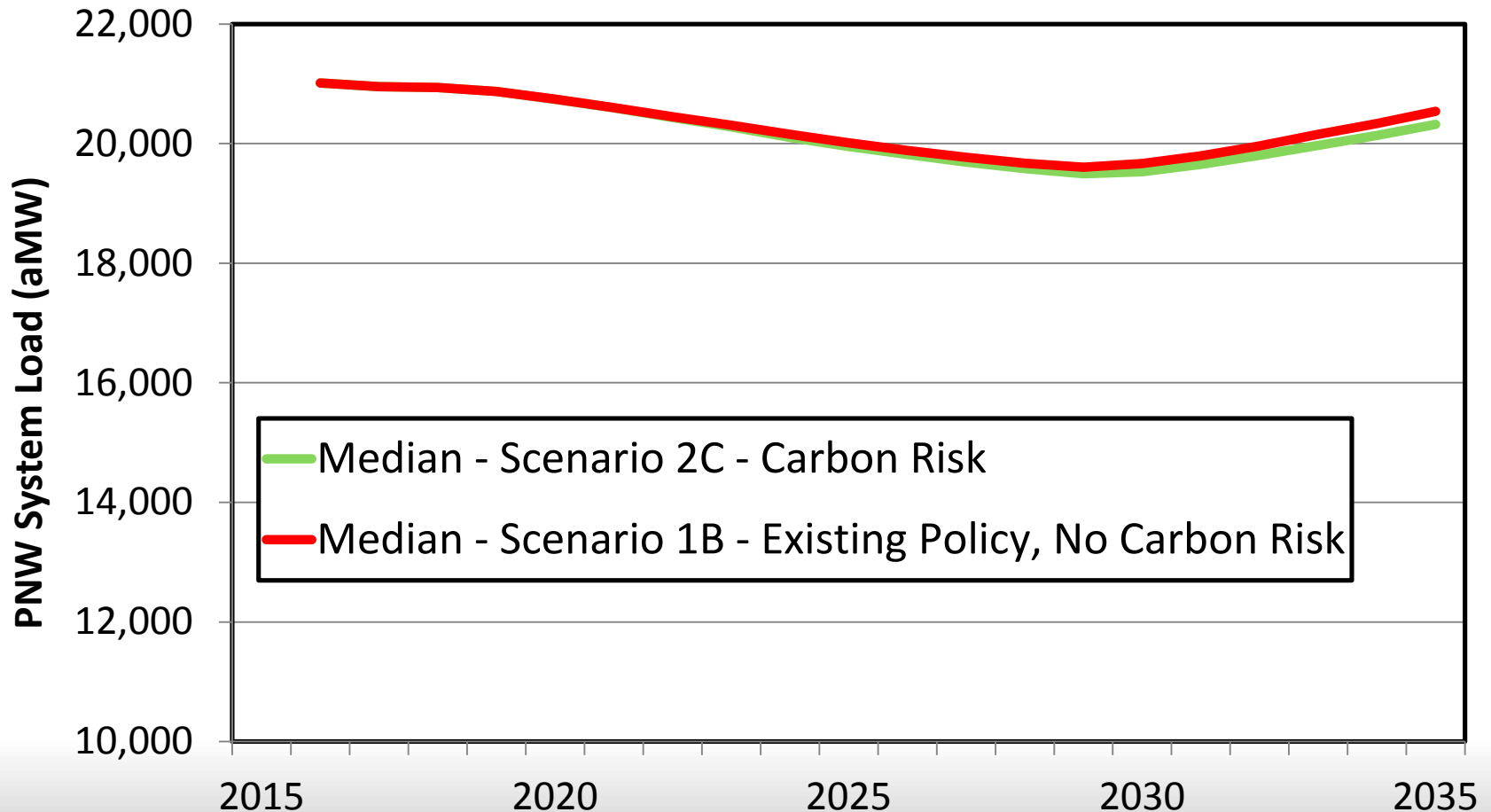


The Least Cost Strategies for Scenarios 1A, 1B and 2C

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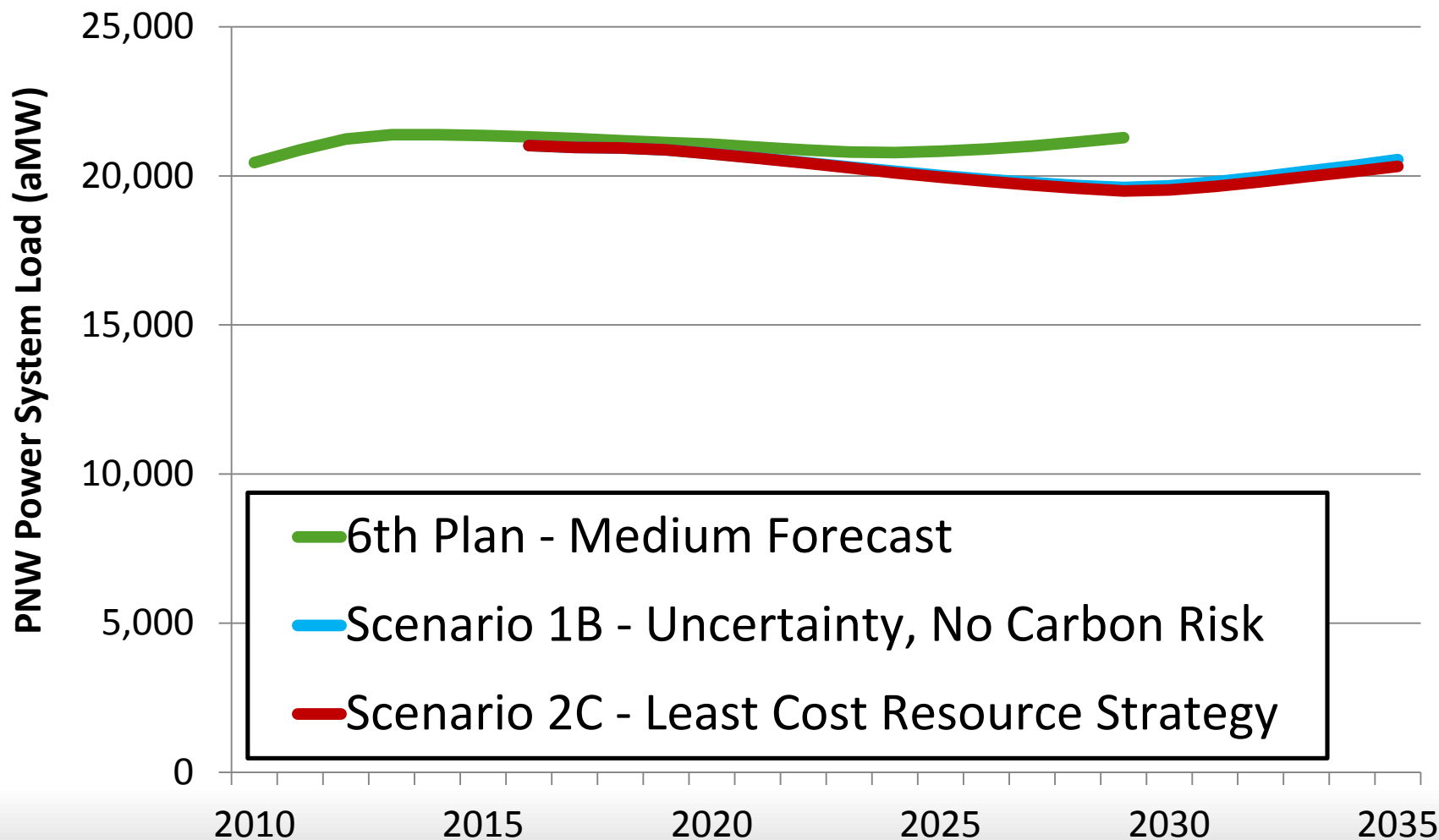


Regional Net Load After Conservation Remains “Flat On Average” Through 2035 Under the Least Cost Strategy in Both Scenarios 1B and 2C



This Result is Very Similar To The 6th Plan

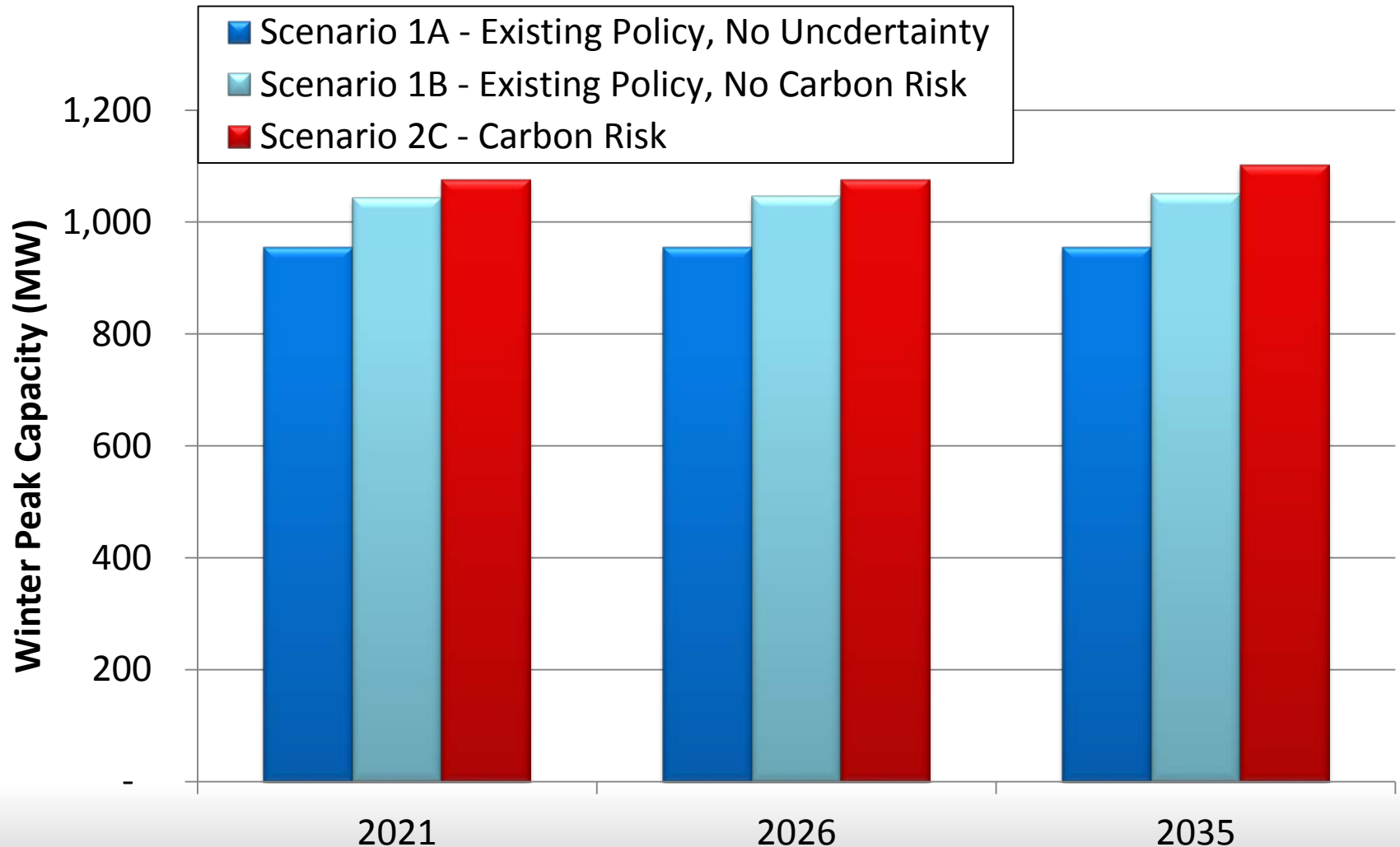
Net Load After Conservation Scenarios 1B and 2C Least Cost Strategy and 6th Plan



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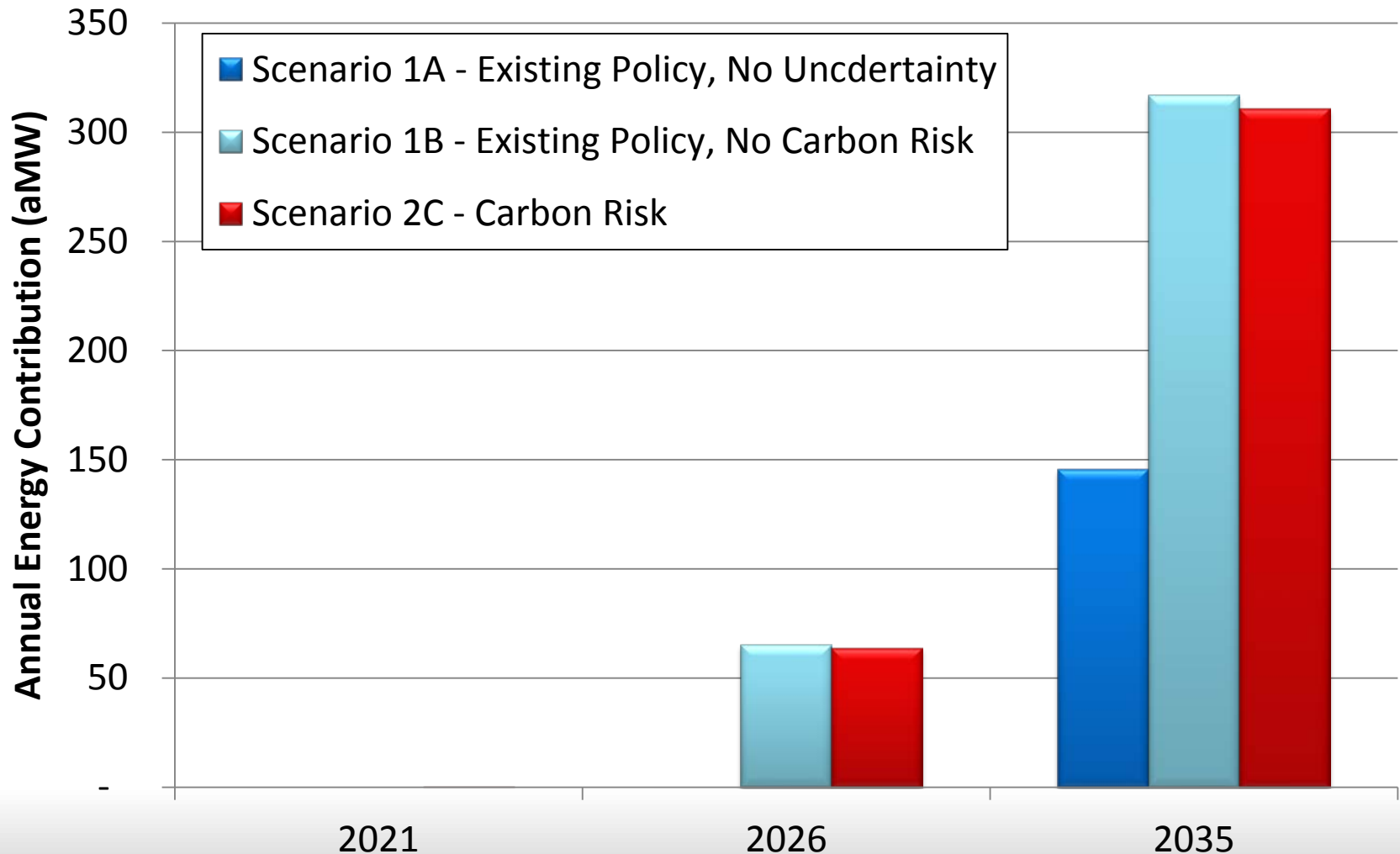
Average Demand Response Winter Peak Development in the Least Cost Resource Strategies for Scenarios 1A, 1B and 2C Are Nearly Identical – And Change Little Through Time



Common Elements of *Least Cost Resource Strategies Across Scenarios Analyzed To Date*

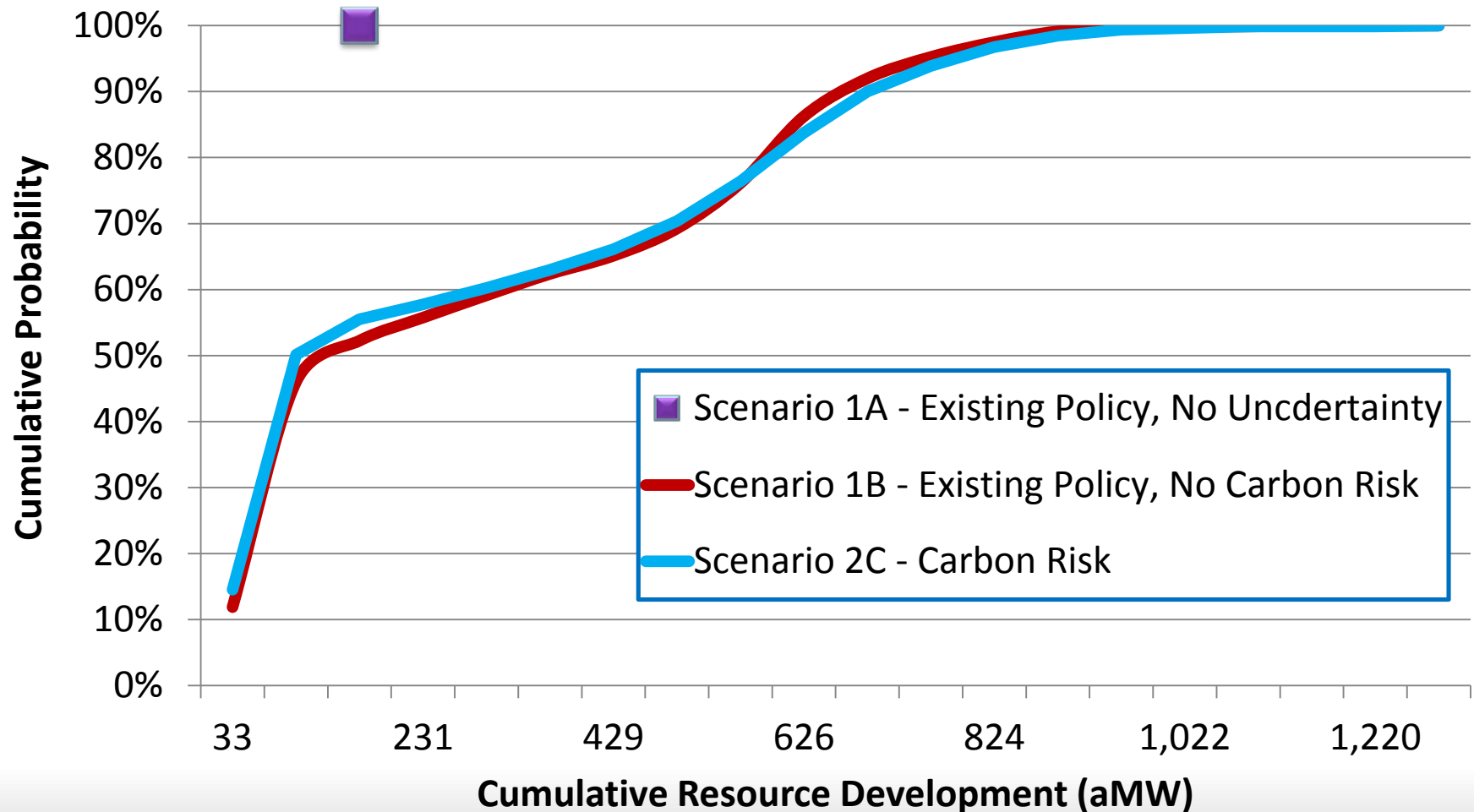
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Average Renewable Resource Development for Energy Occurs After RECs are Used and Loads Begin To Increase



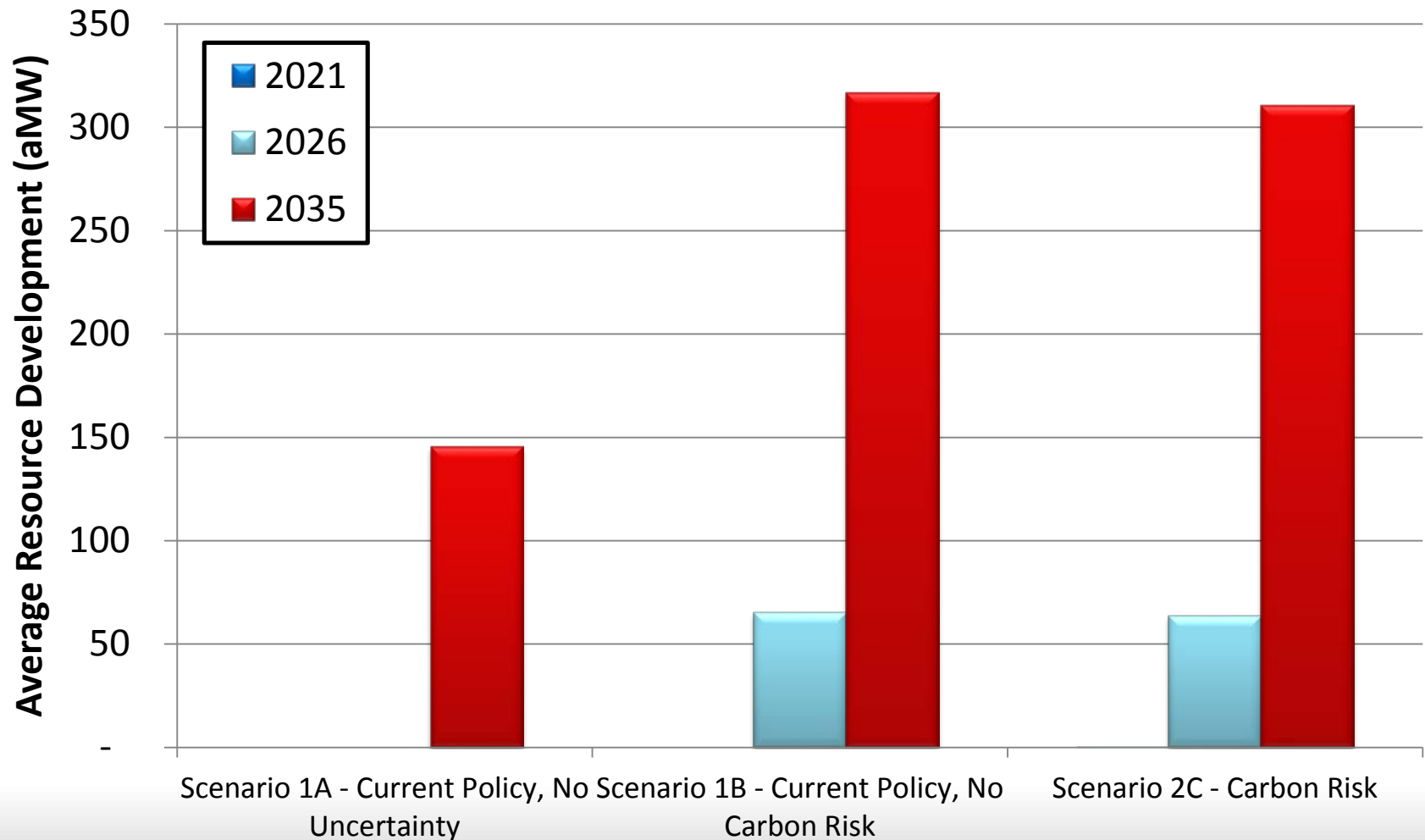
The Least Cost Strategies for Scenarios 1A, 1B and 2C

Cumulative Probability of Renewable Resource Development Through 2035



Average Renewable Resource Development Across Scenarios is Increases When Uncertainty and Carbon Risk Are Considered

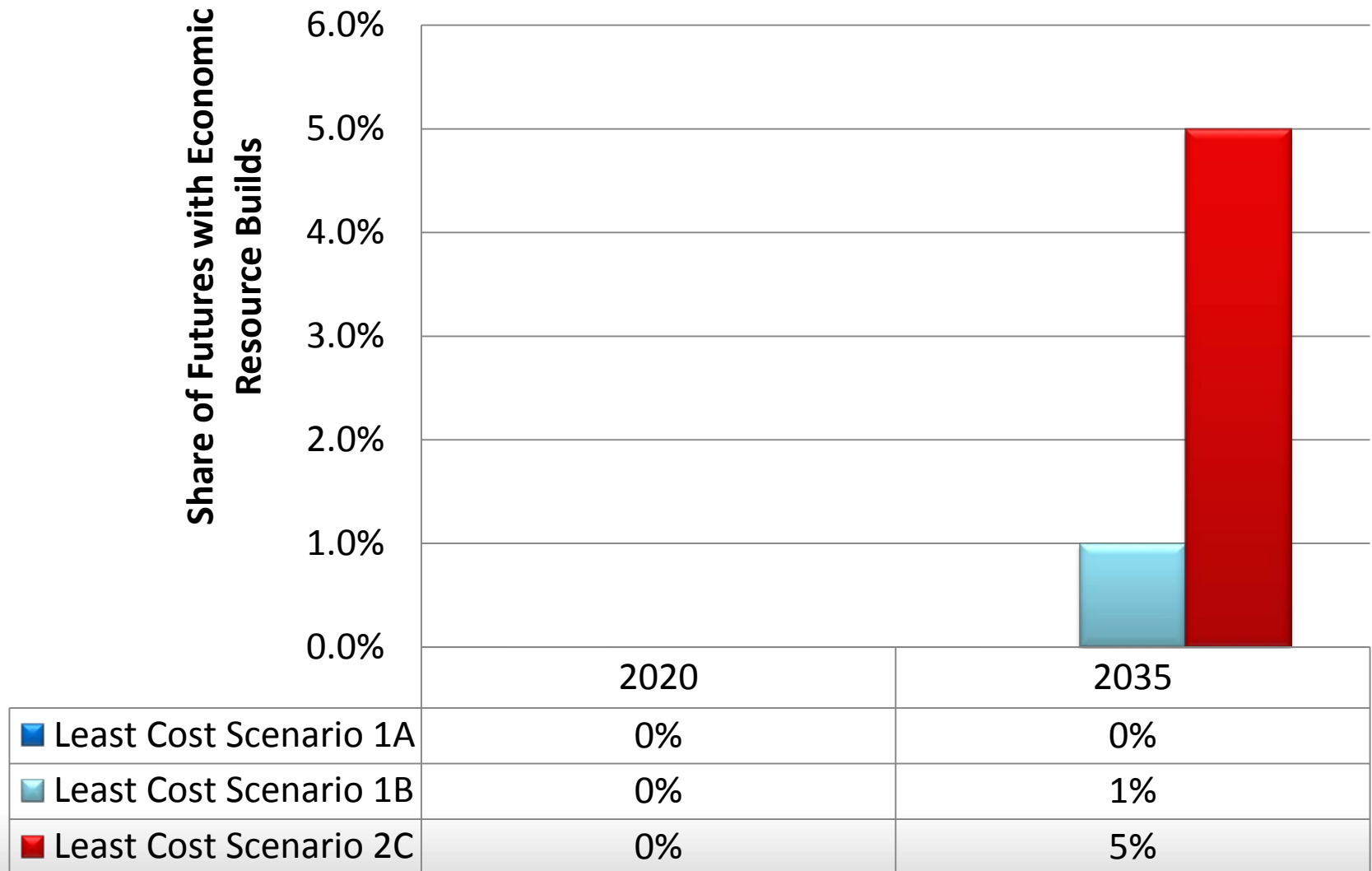
Scenarios 1A,1B and 2C– Least Cost Resource Strategies



Common Elements of Least Cost Resource Strategies Across Scenarios Analyzed To Date (cont)

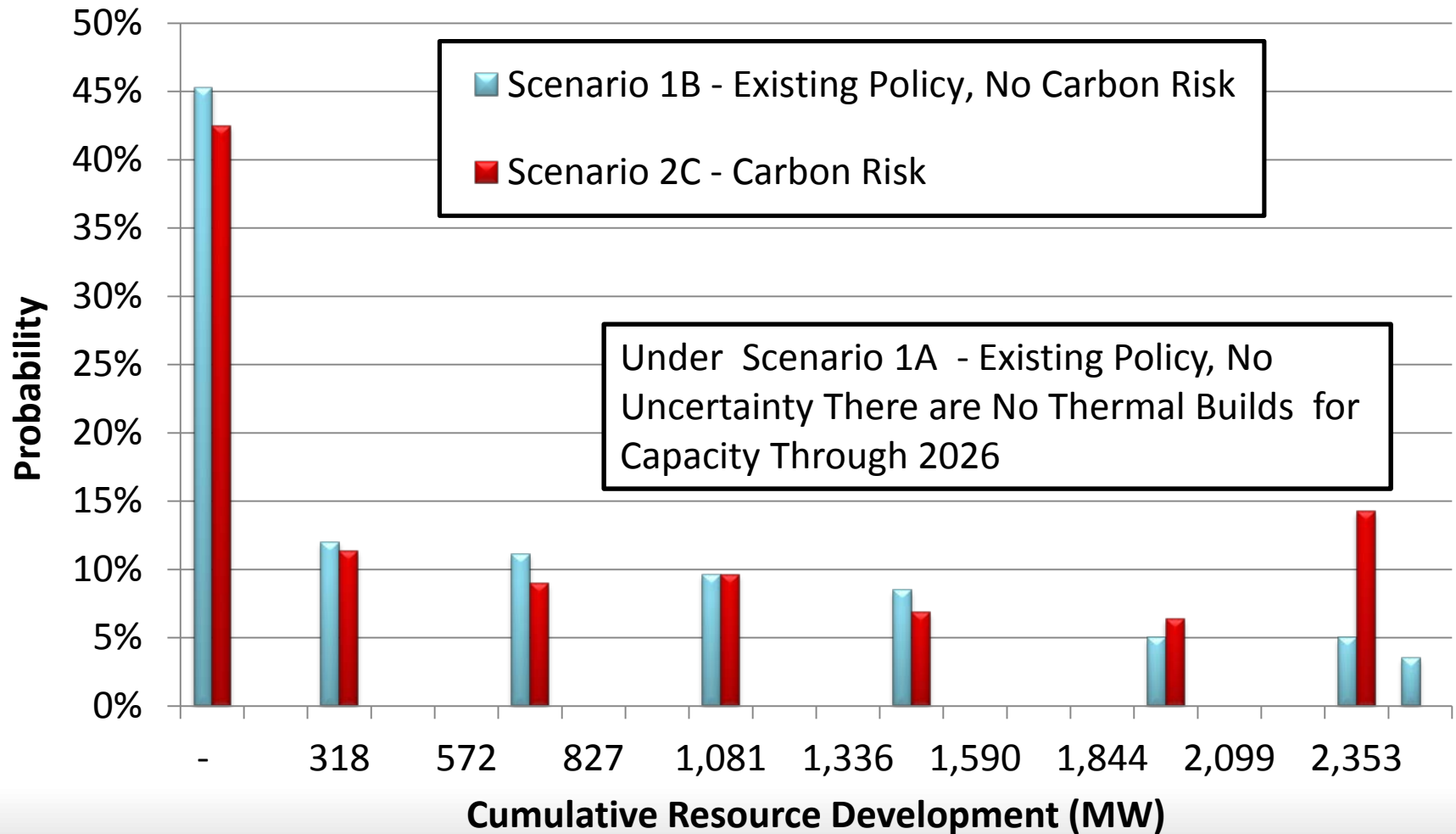
- **Least cost strategies already have low risk**
 - The planning period starts with an immediate need for capacity in most futures
 - Adequacy requirements and RPS drive resource builds, thus reducing market price risk exposure
- **Economic builds are few and far between**
 - There are no Economic builds in Scenario 1A and they occur in less than 1% of futures in the least cost resource strategy in Scenario 1B and less than 5% of the futures in other Scenario 2C
- Thermal build options selected for adequacy are related retirements of the second unit of Centralia

There Are Very Few Futures Where Economic Resource Builds Occur Across All Scenarios



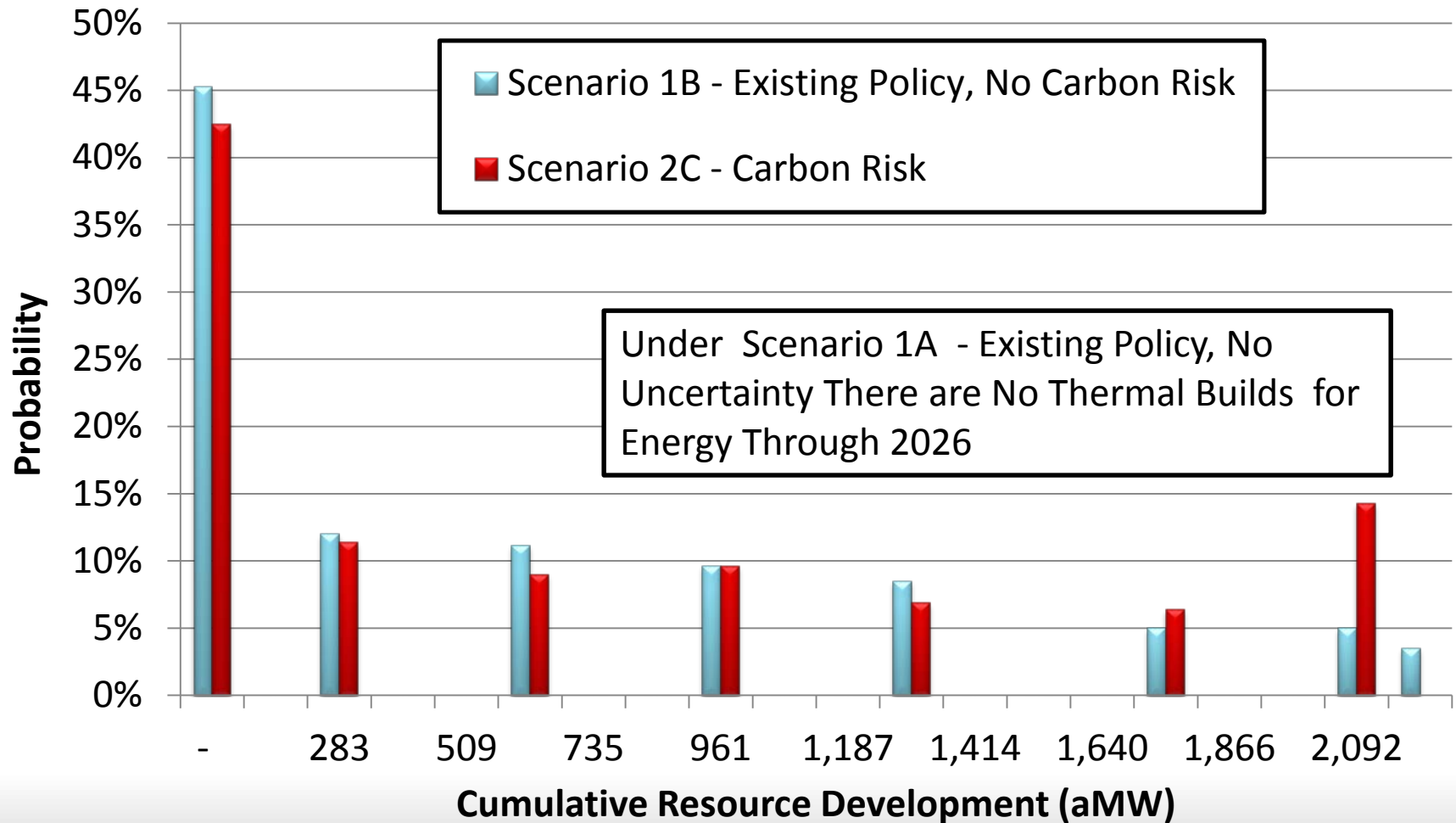
The Least Cost Strategies for Scenarios 1A, 1B and 2C

Distributions of Thermal Resource Development Through 2026 for Capacity



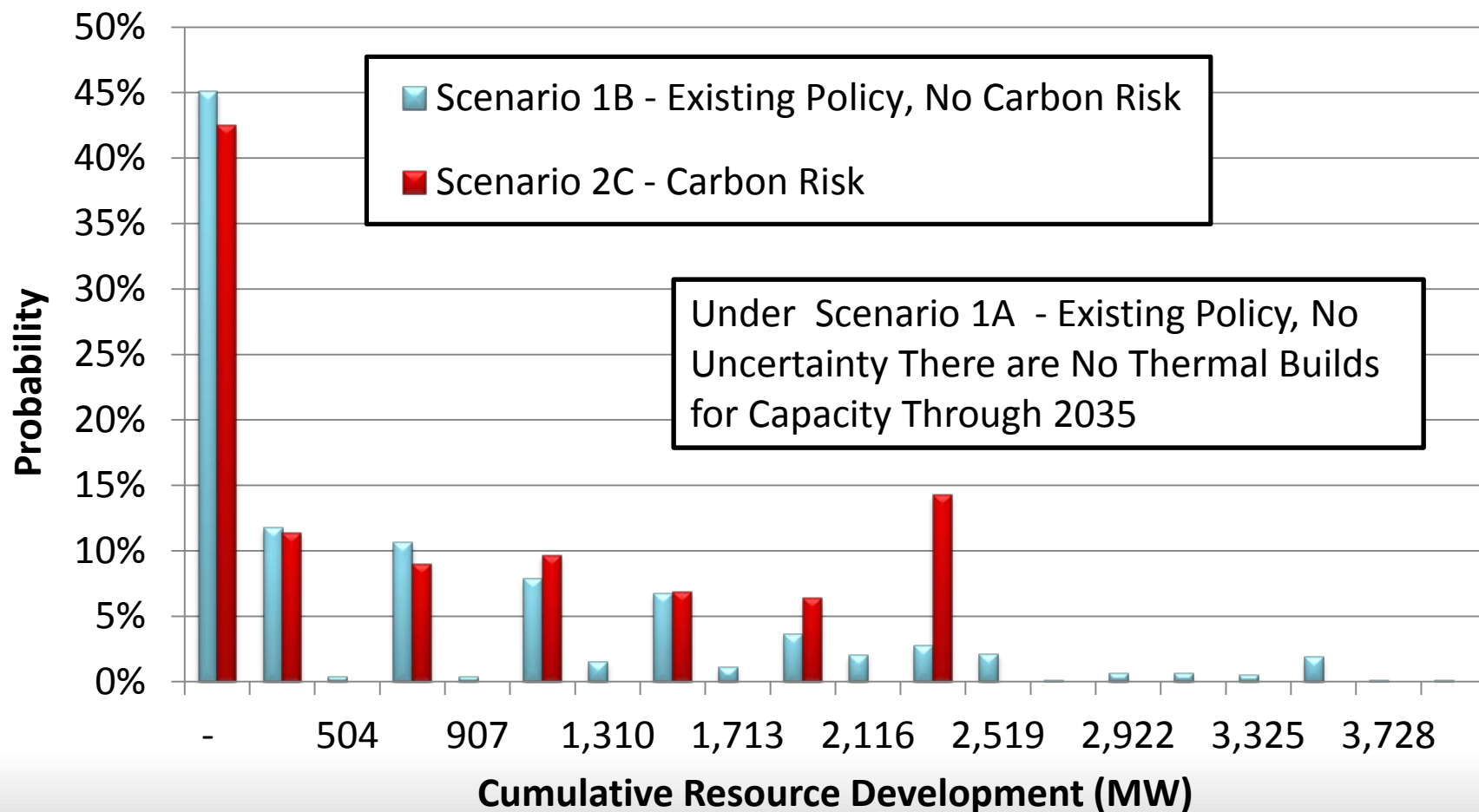
The Least Cost Strategies for Scenarios 1A, 1B and 2C

Distributions of Thermal Resource Development Through 2026 for Energy



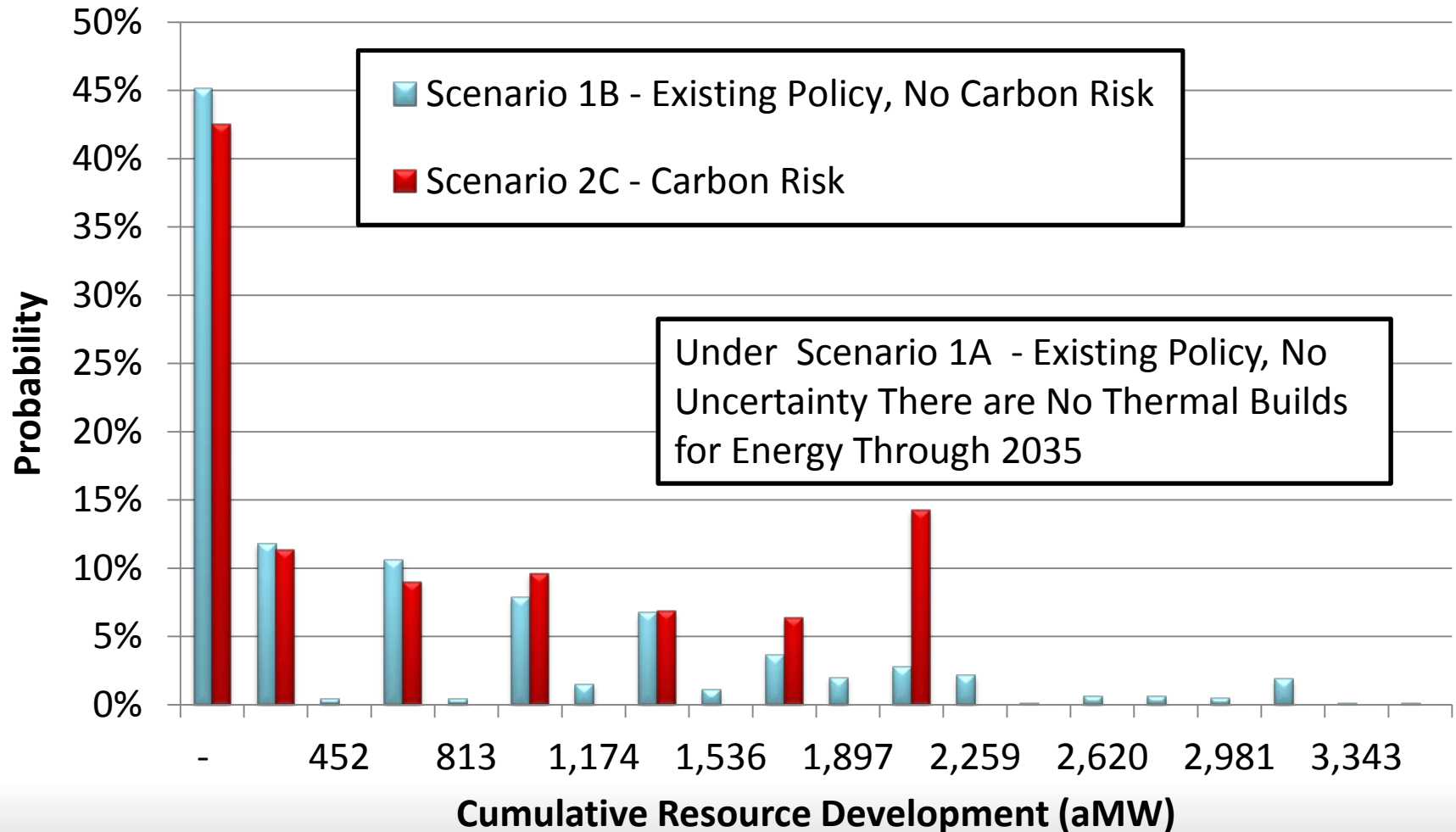
The Least Cost Strategies for Scenarios 1A, 1B and 2C Distributions of Thermal Resource Development Through 2035 for Capacity

Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



The Least Cost Strategies for Scenarios 1A, 1B and 2C

Distributions of Thermal Resource Development Through 2035 for Energy

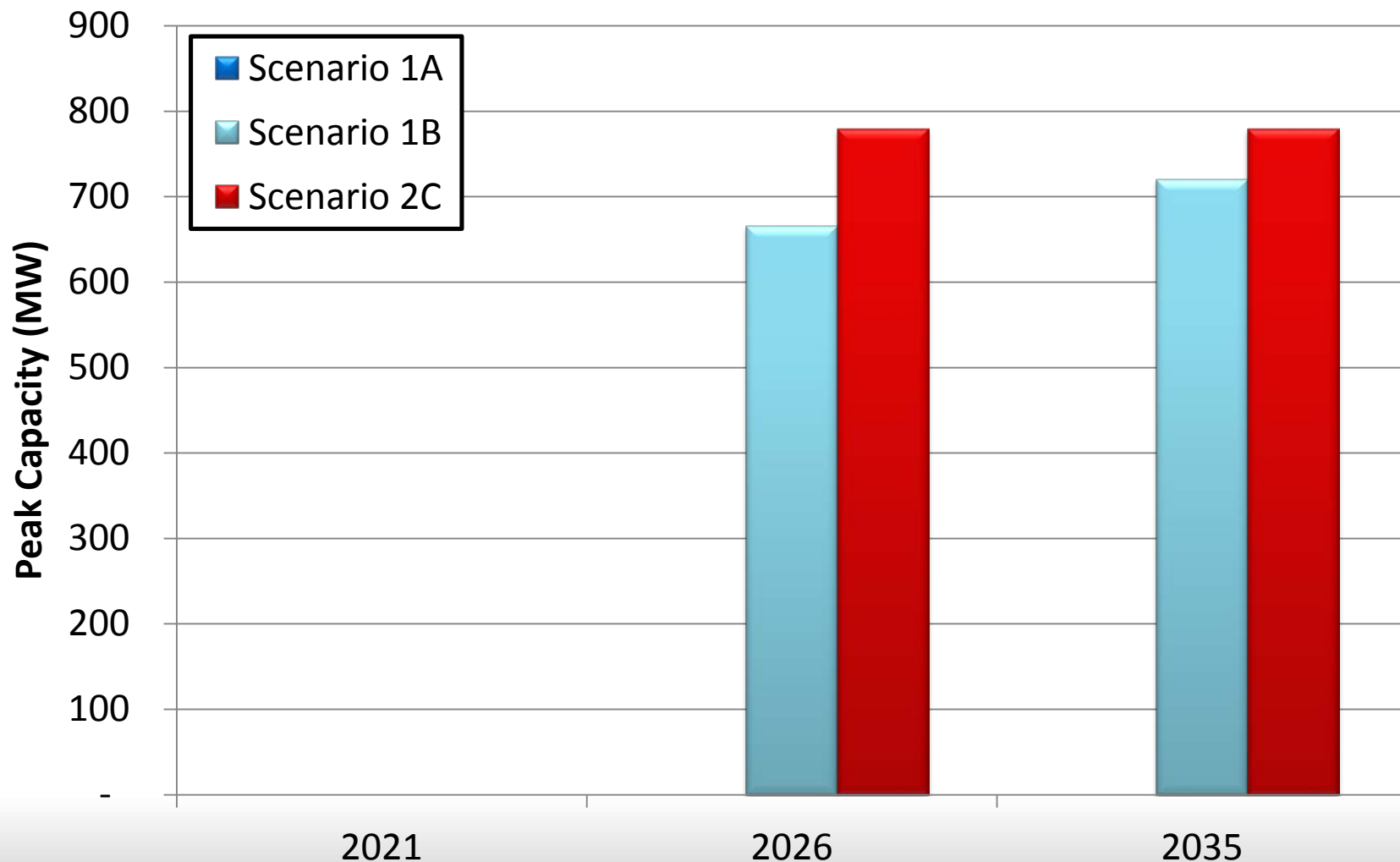


Common Elements of Least Cost Resource Strategies Across Scenarios Analyzed To Date (cont)

- Least cost strategies already have low risk
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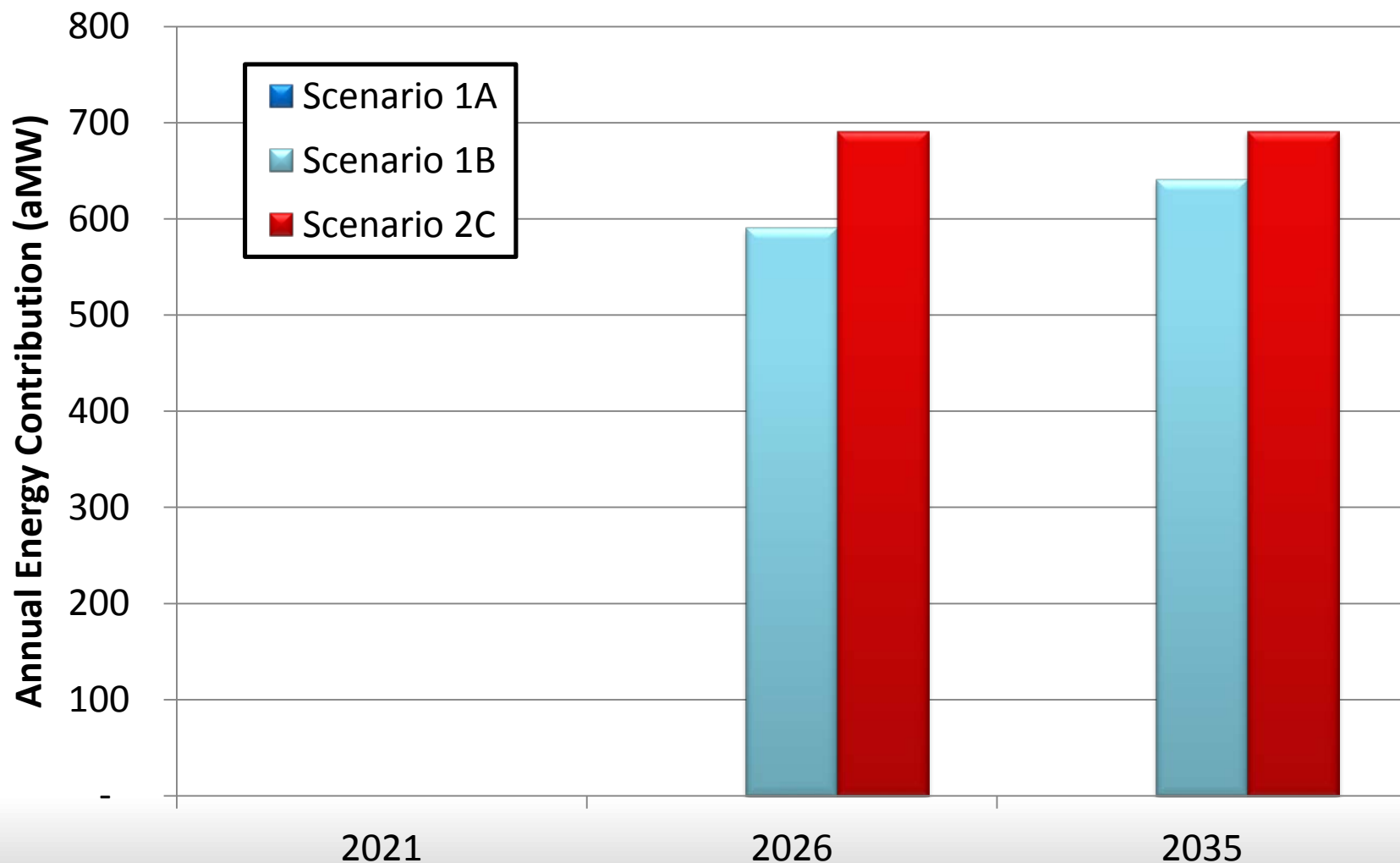
Least Cost Resource Strategy for Scenarios 1A, 1B and 2C

Average Energy Thermal Resource Development for Capacity

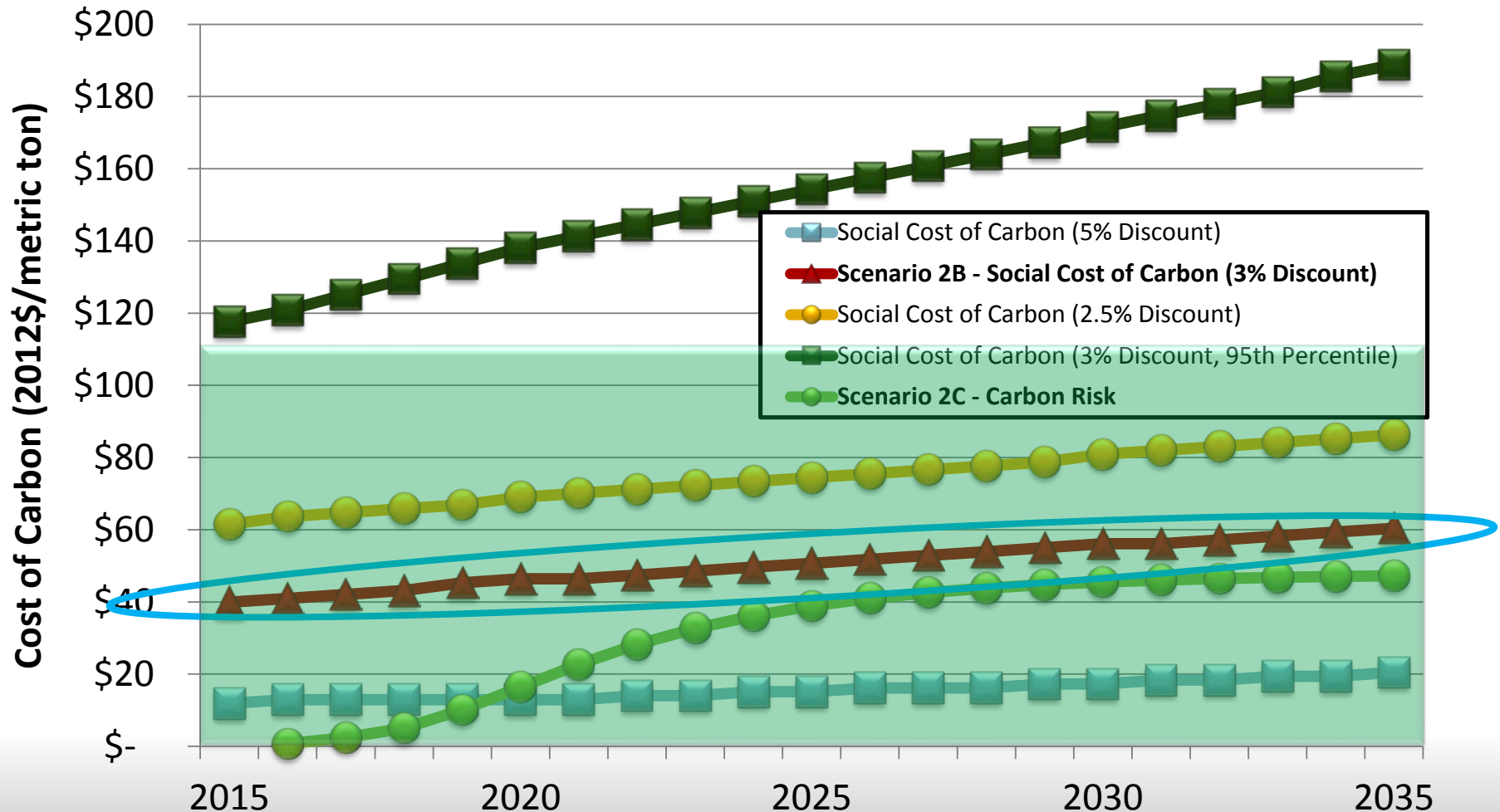


Least Cost Resource Strategy for Scenarios 1A, 1B and 2C

Average Energy Thermal Resource Development for Energy

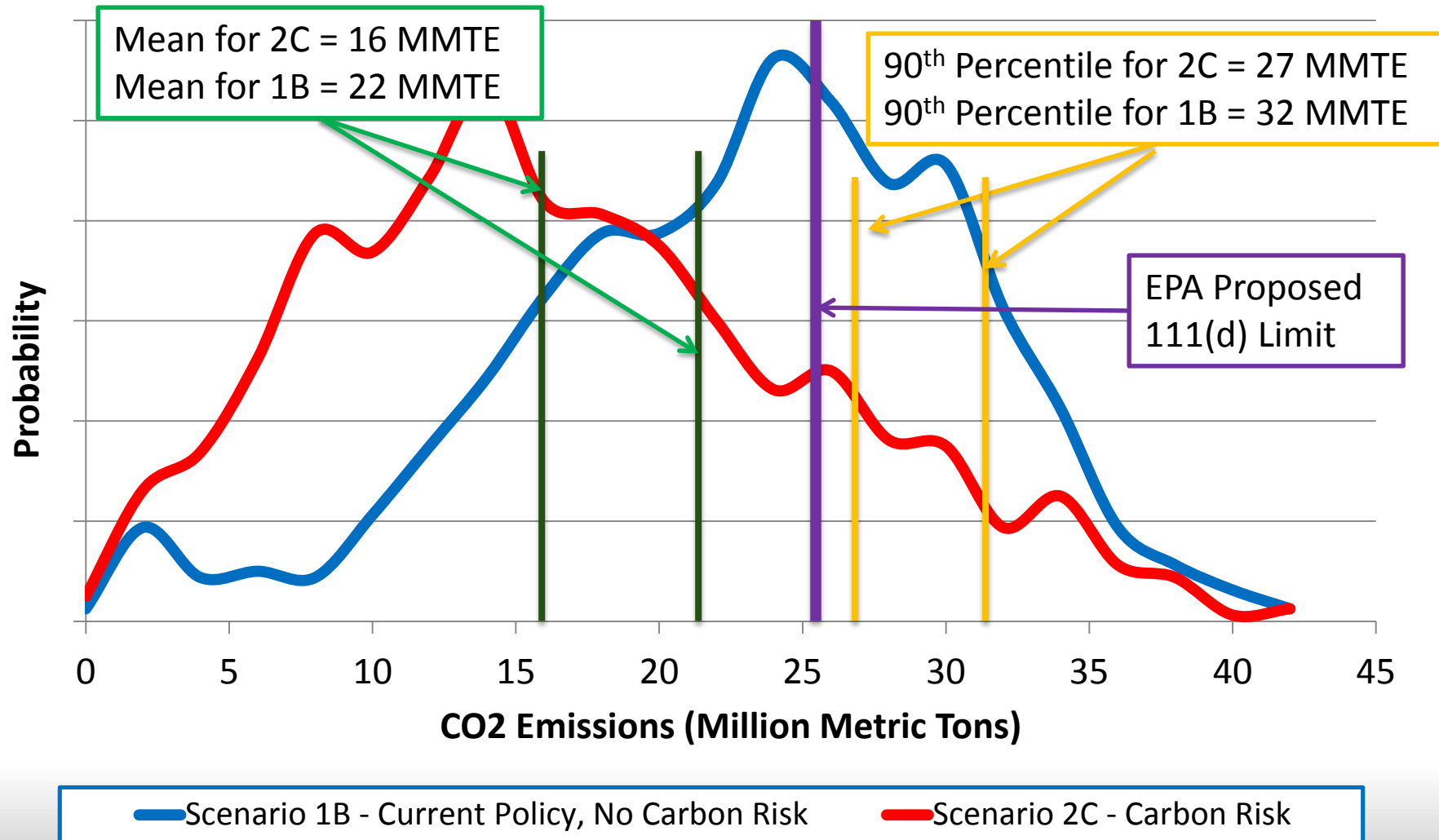


Scenario 2B and 2C Cost of Carbon Assumptions



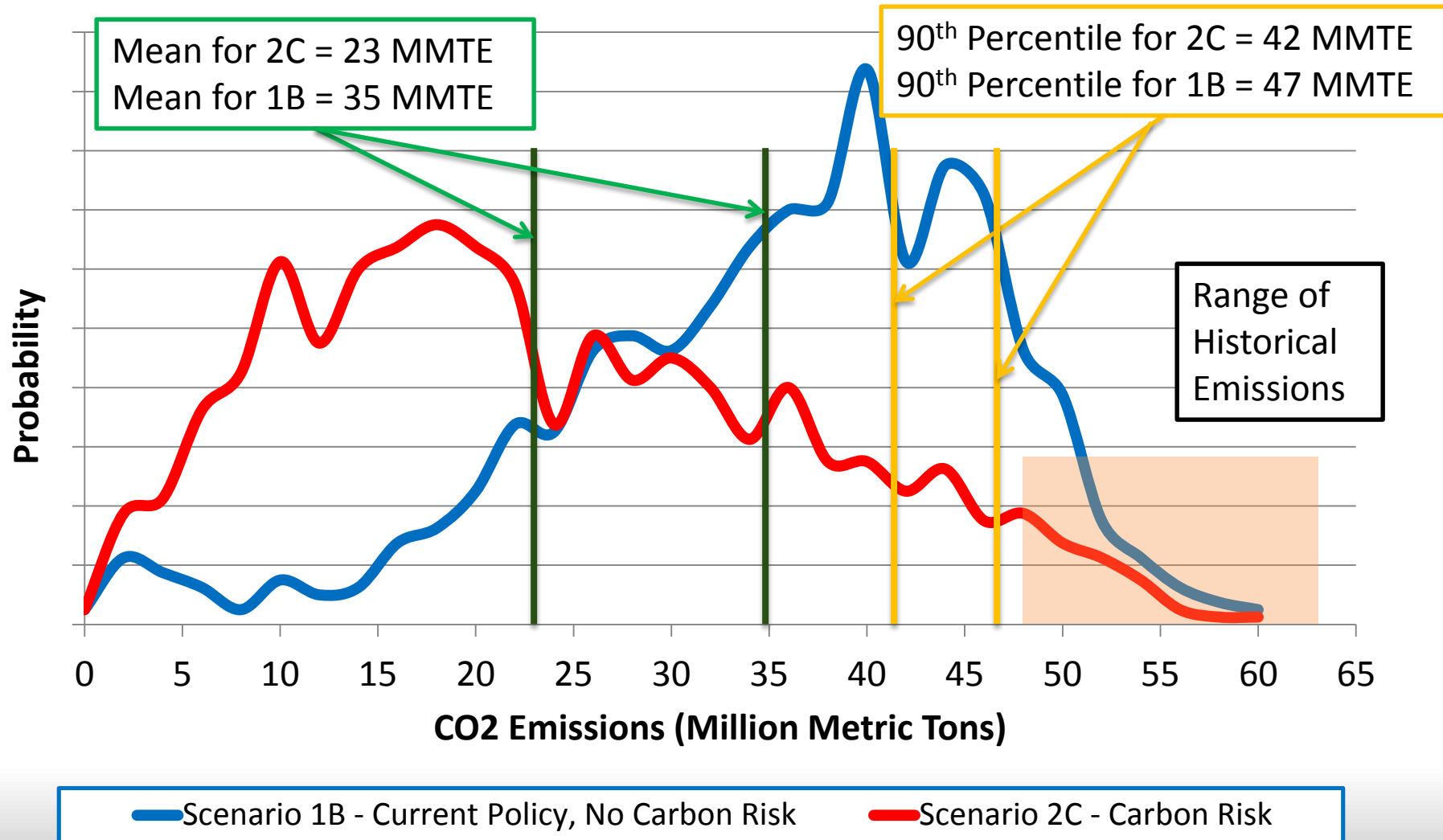
Distribution CO2 Emissions in 2030 for Resources Subject to EPA's Proposed 111(d) Regulations

Scenarios 1B and 2C – Least Cost Resource Strategies

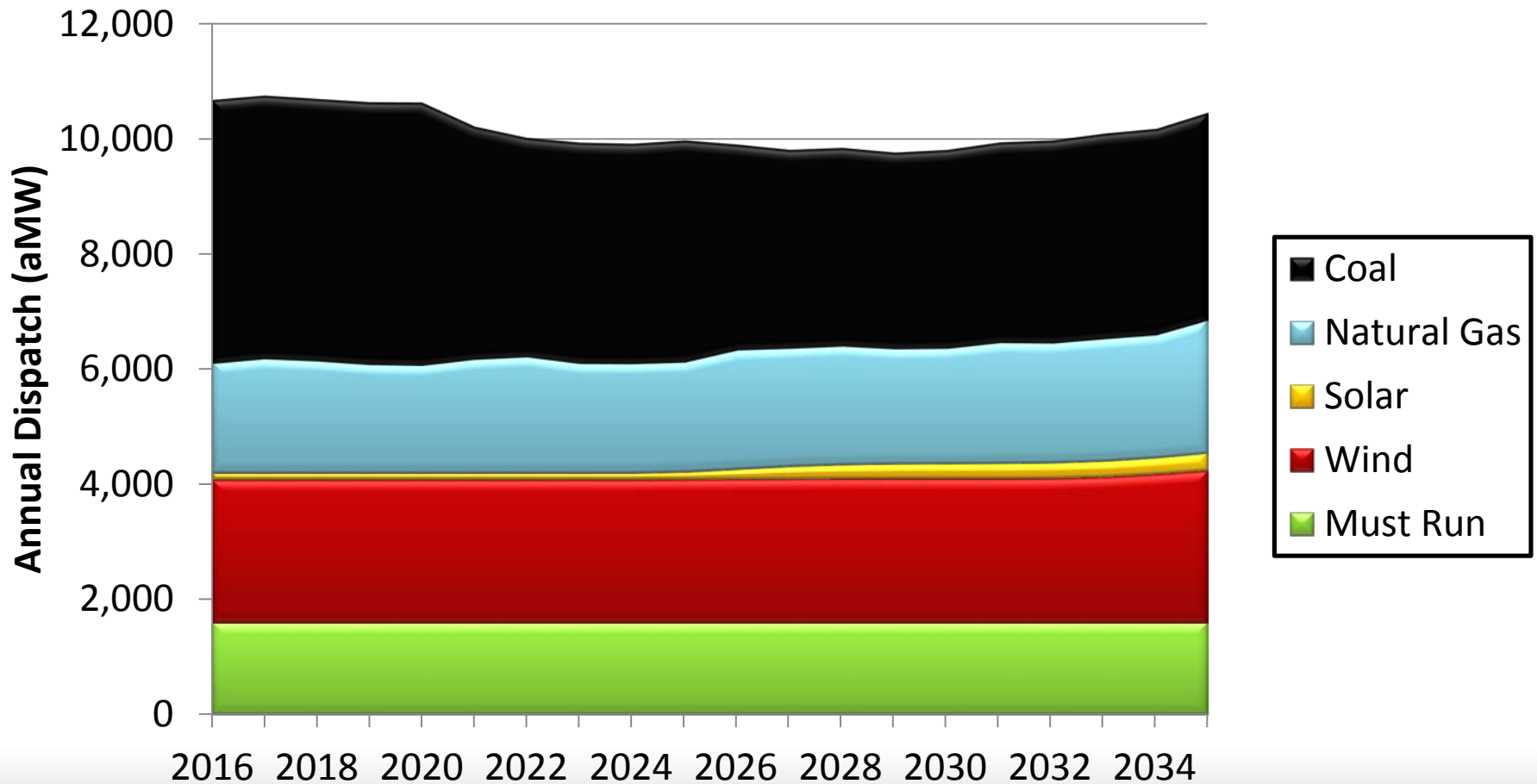


Distribution CO2 Emissions in 2030 for PNW Power System

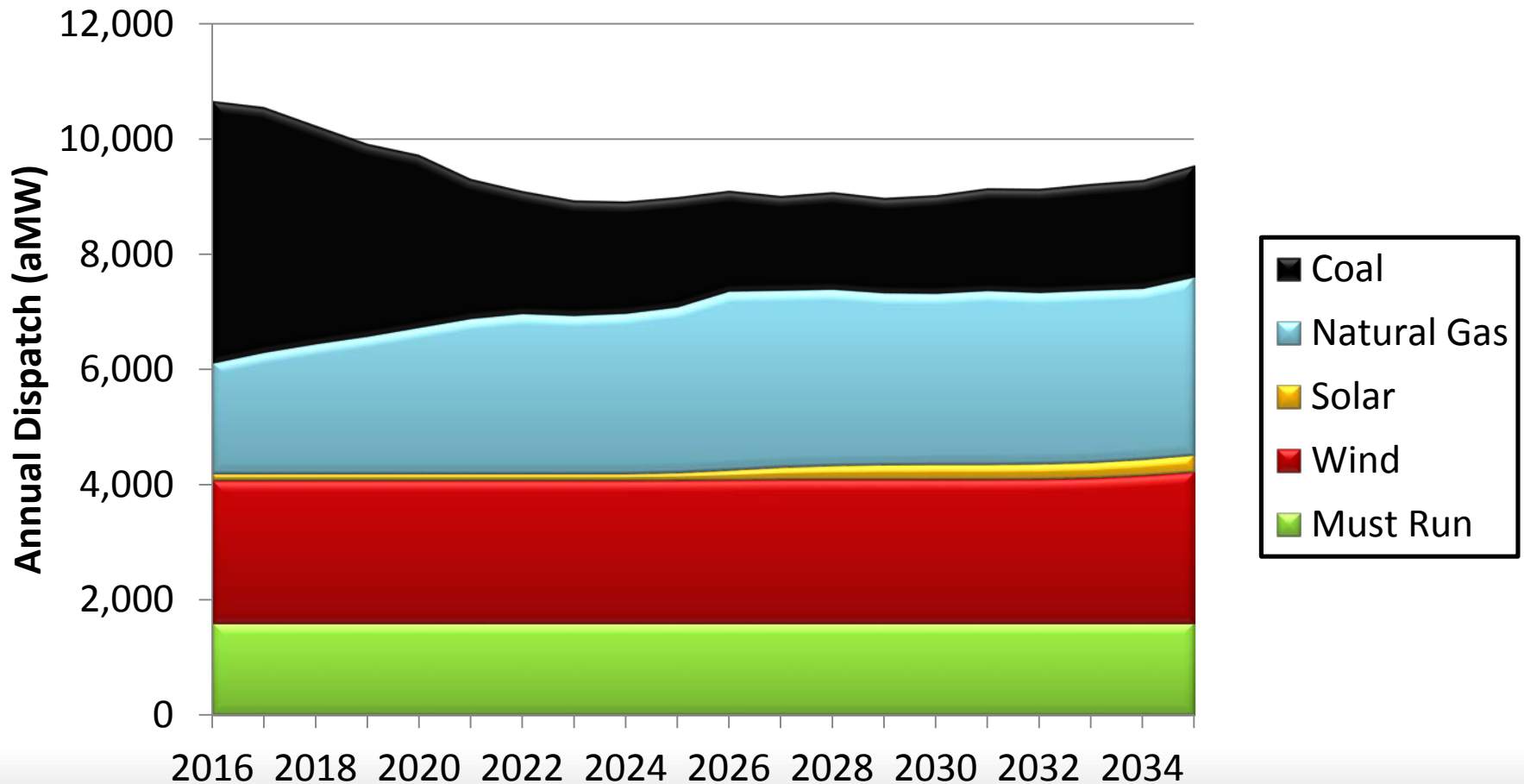
Scenarios 1B and 2C – Least Cost Resource Strategies



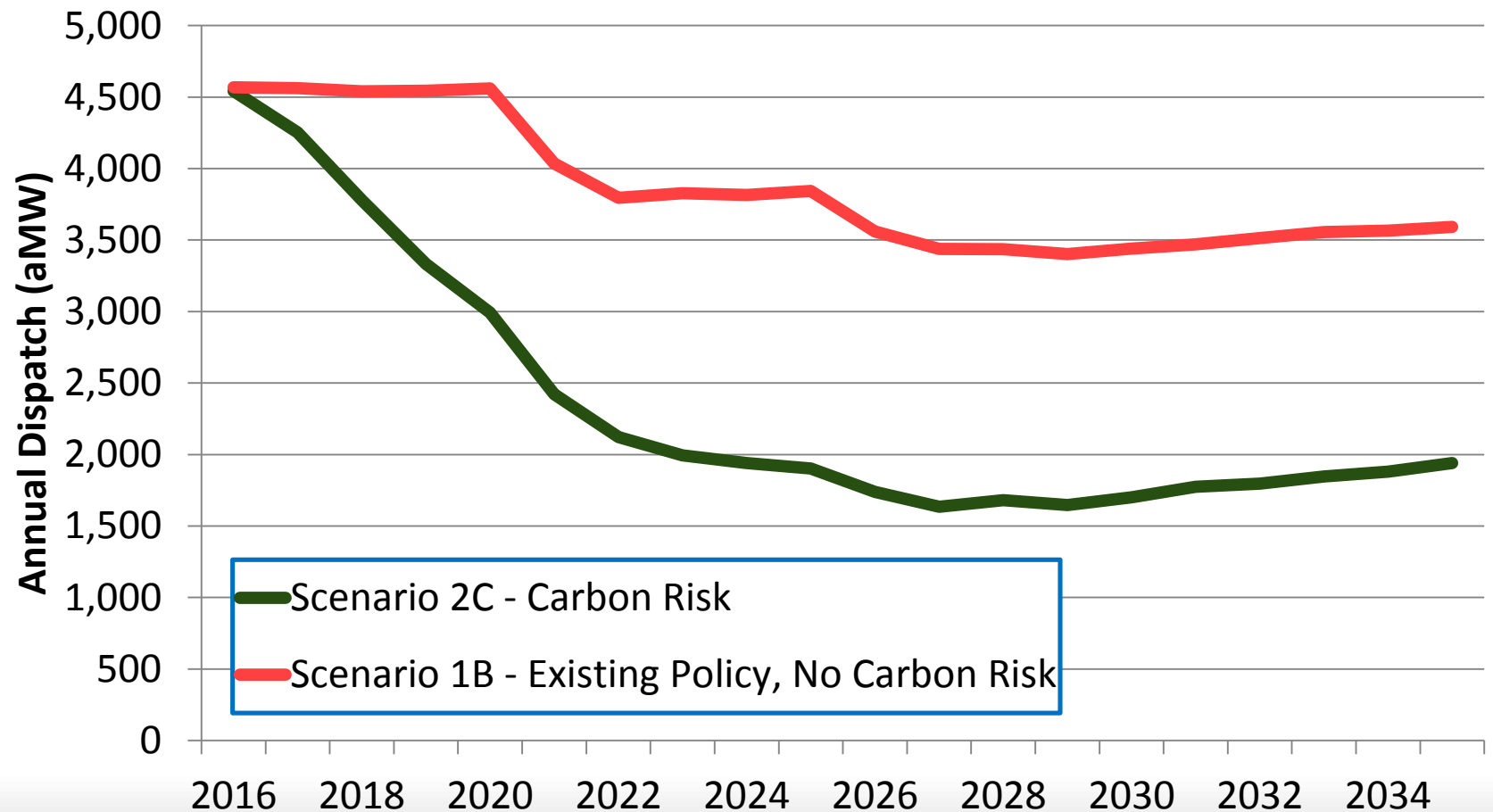
Thermal Resource Dispatch without Carbon Risk



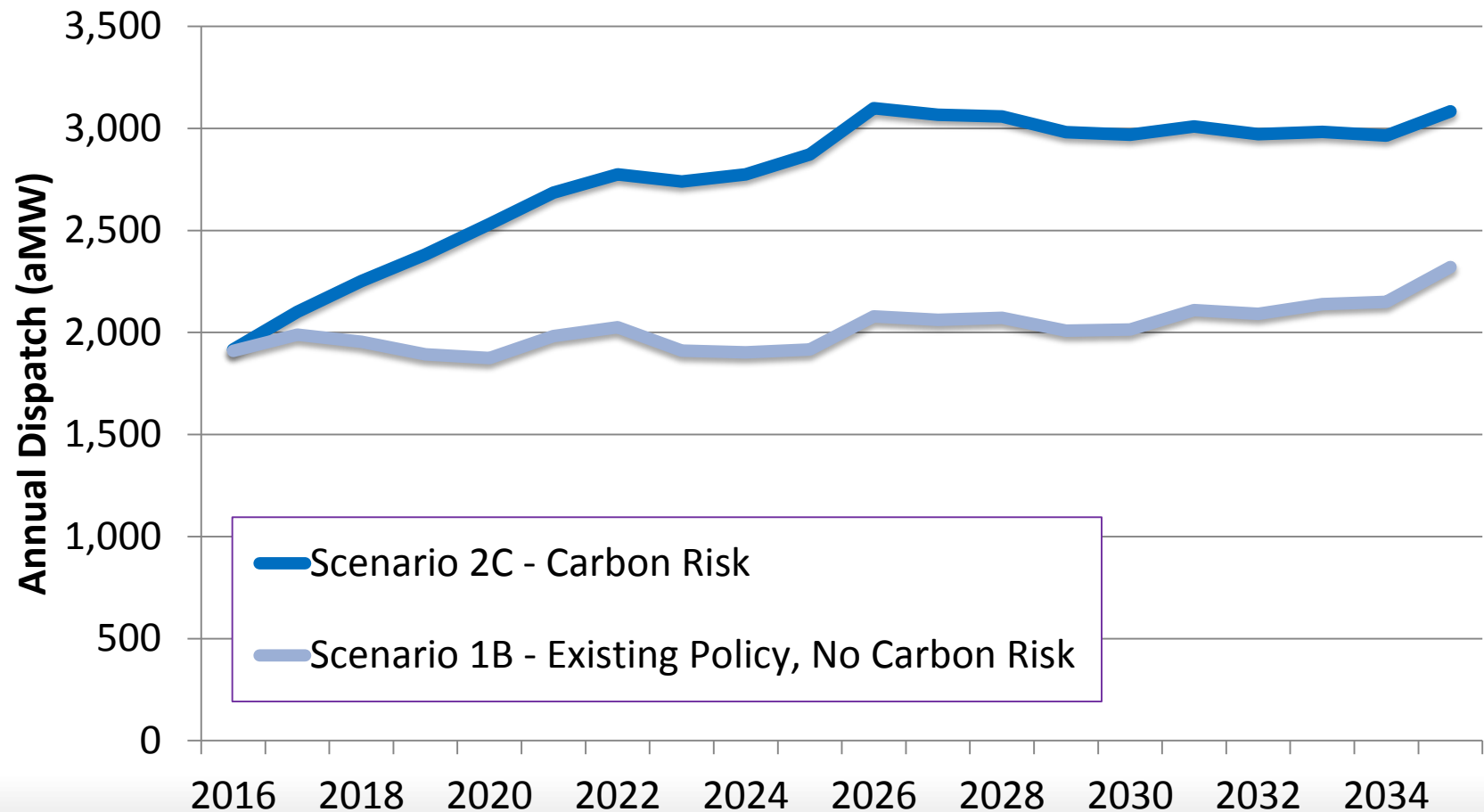
Thermal Resource Dispatch with Carbon Risk



Change in Coal Dispatch Scenario 1B vs. Scenario 2C



Change in Existing Gas Dispatch Scenario 1B vs. Scenario 2C



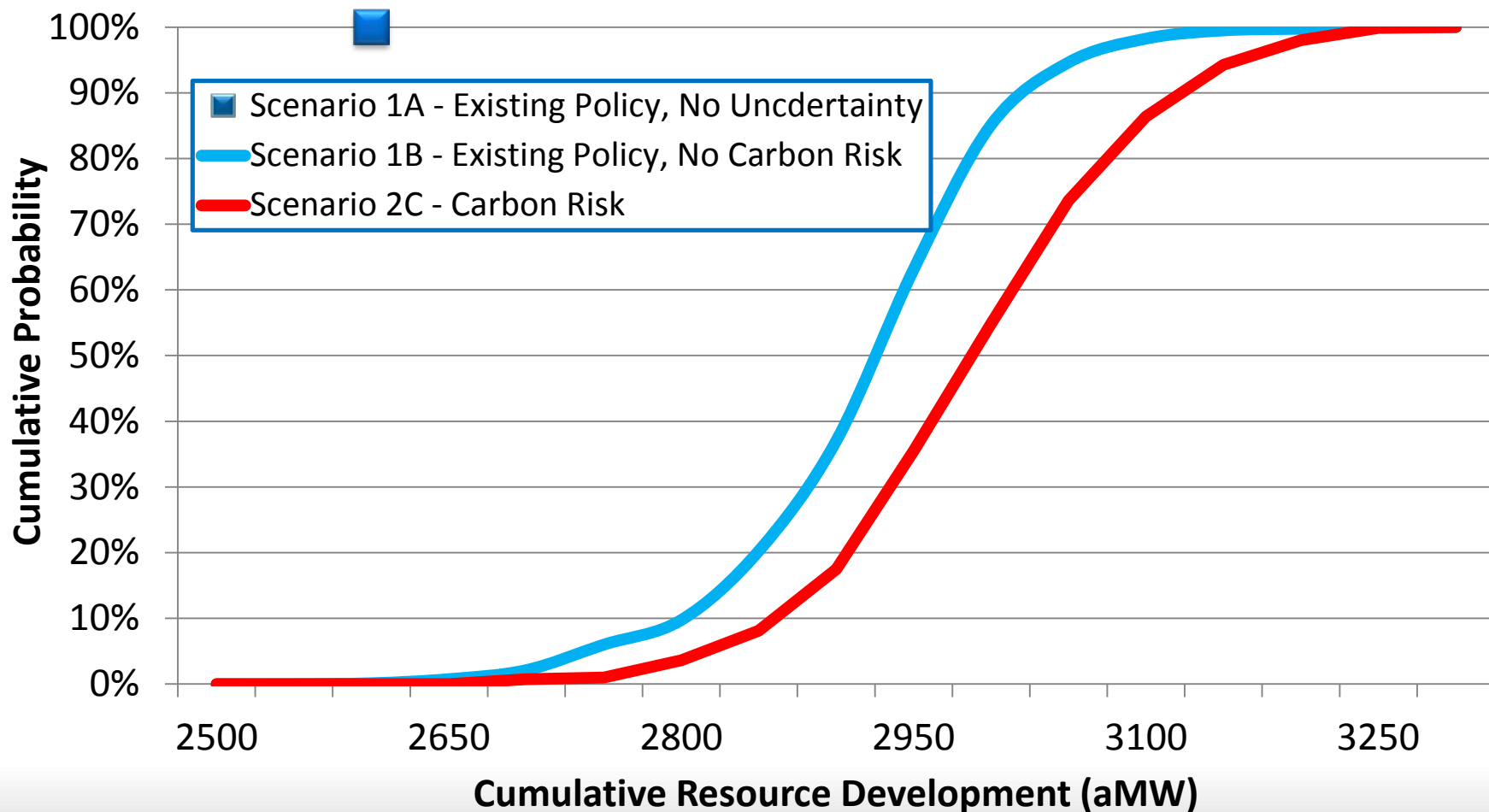
Sensitivity Studies

- The following sensitivity studies have been suggested:
 - Remove transmission credit for “west side” resources (DR, EE and gas turbines)
 - Remove DR as resource option
 - Test alternative (i.e., lower) EE winter capacity contribution
 - Test sensitivity to natural gas price assumptions
 - Assume Boardman and Centralia are not retired
- Others?

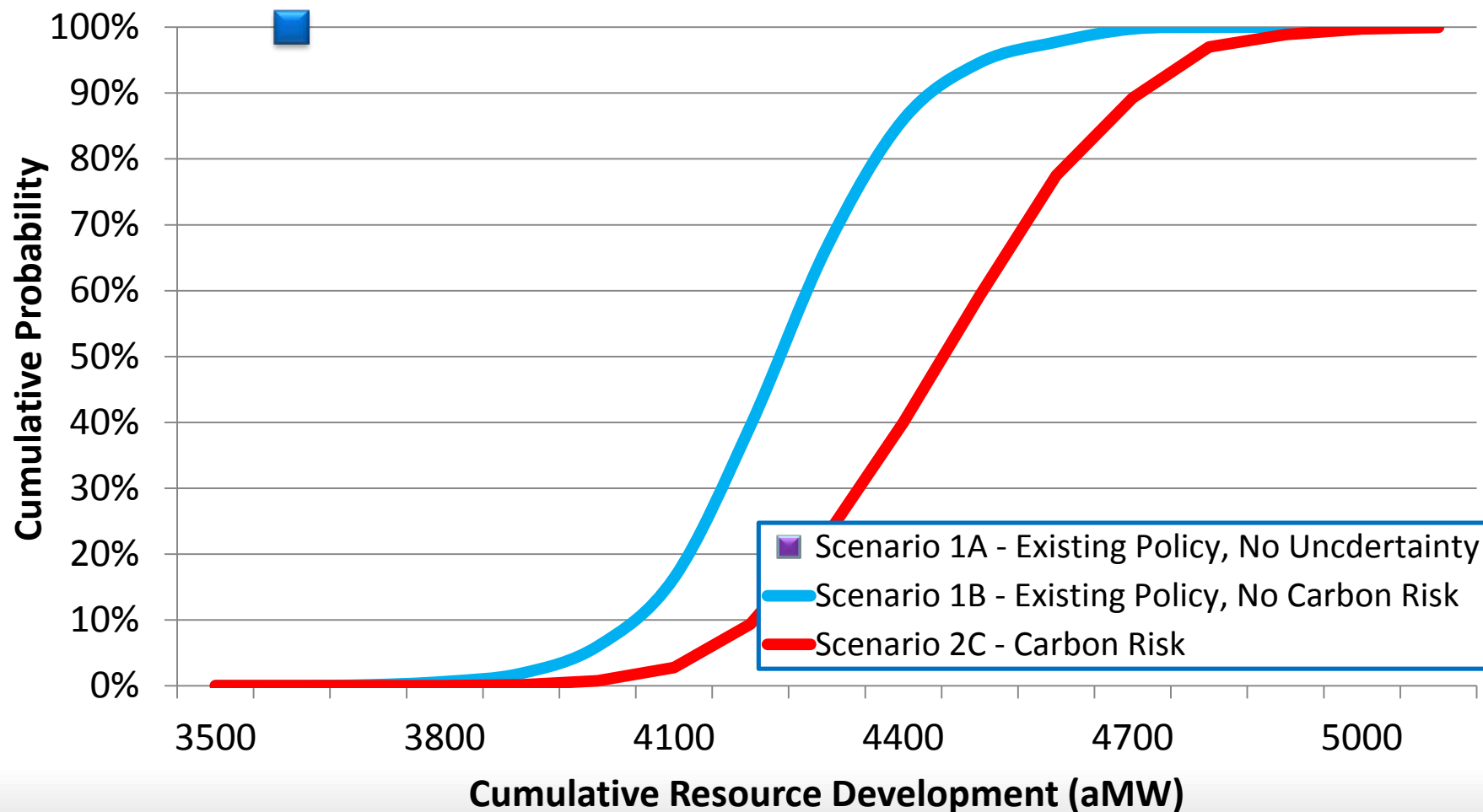
Scenario	Scenario Name	Priority	Modeling Effort	Revised Schedule
1B	Existing Policy with Uncertainty, w/o GHG reduction risk	1	Med	Early May
1A	Existing Policy without Uncertainty, w/o GHG reduction risk	2	Med	Early May
2C	Existing Policy with Uncertainty and with uncertain GHG reduction risk/target.	3	Low	Early May
4C	Major Resource Uncertainty – Faster Pace of Conservation Deployment	4	Low	Late May
4D	Major Resource Uncertainty – Slower Pace of Conservation Deployment	5	Low	Late May
2A	Existing Policy with Uncertainty and with certain GHG reduction risk/target. Example Policy Target = Clean Power Plan/Clean Air Act 111(d) goal (e.g., 30% below 2005 level by 2030)	6	Med	May not need to model
2B	Existing Policy with Uncertainty and with certain GHG reduction risk/target. Example Policy Target = Mitigate to Estimated GHG Damage Cost	7	Low	Early June
6A	Climate Change Load Impacts Resulting from Direct Effects of Climate Change	8	Low	Mid-June
4B	Major Resource Uncertainty - Anticipated Loss of Major Non-GHG Emitting Resource	9	Low	Mid- June
5B	Southwest Market Liquidity Variability	11	Low	Late June
3A	Lowering carbon emissions with current technology	12	Med	Late June
4A	Major Resource Uncertainty - Unexpected Loss of Major Non-GHG Emitting Resource	13	Low	Early July
3B	Lowering carbon emissions with emerging technology (e.g., storage, CO ₂ heat pumps, SSL)	14	High	Not Modeled
5A	Integration of Variable Resources (i.e., Managing the NW Impact of the "Duck Curve"/50% CA RPS)	15	Med/High	Mid-July
6B	Climate Change Hydro Impacts	16	High	Mid-July

Backup Slides

The Cumulative Probability of Conservation Development Through 2026 Under The Least Cost Strategies for Scenarios 1B and 2C Is Very Similar

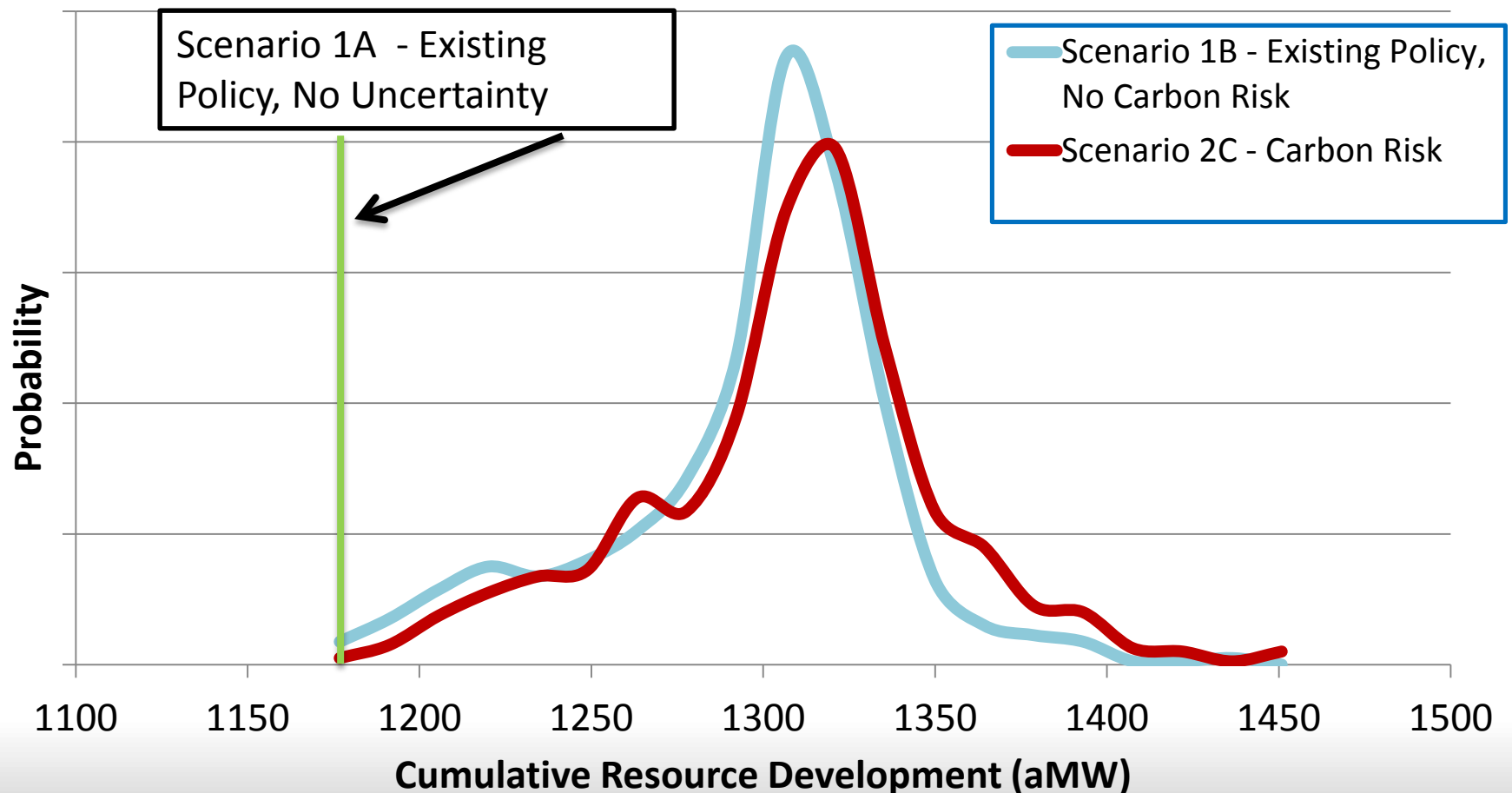


The Cumulative Probability of Conservation Development Through 2026 Under The Least Cost Strategies for Scenarios 1B and 2C Vary By Less Than 10%



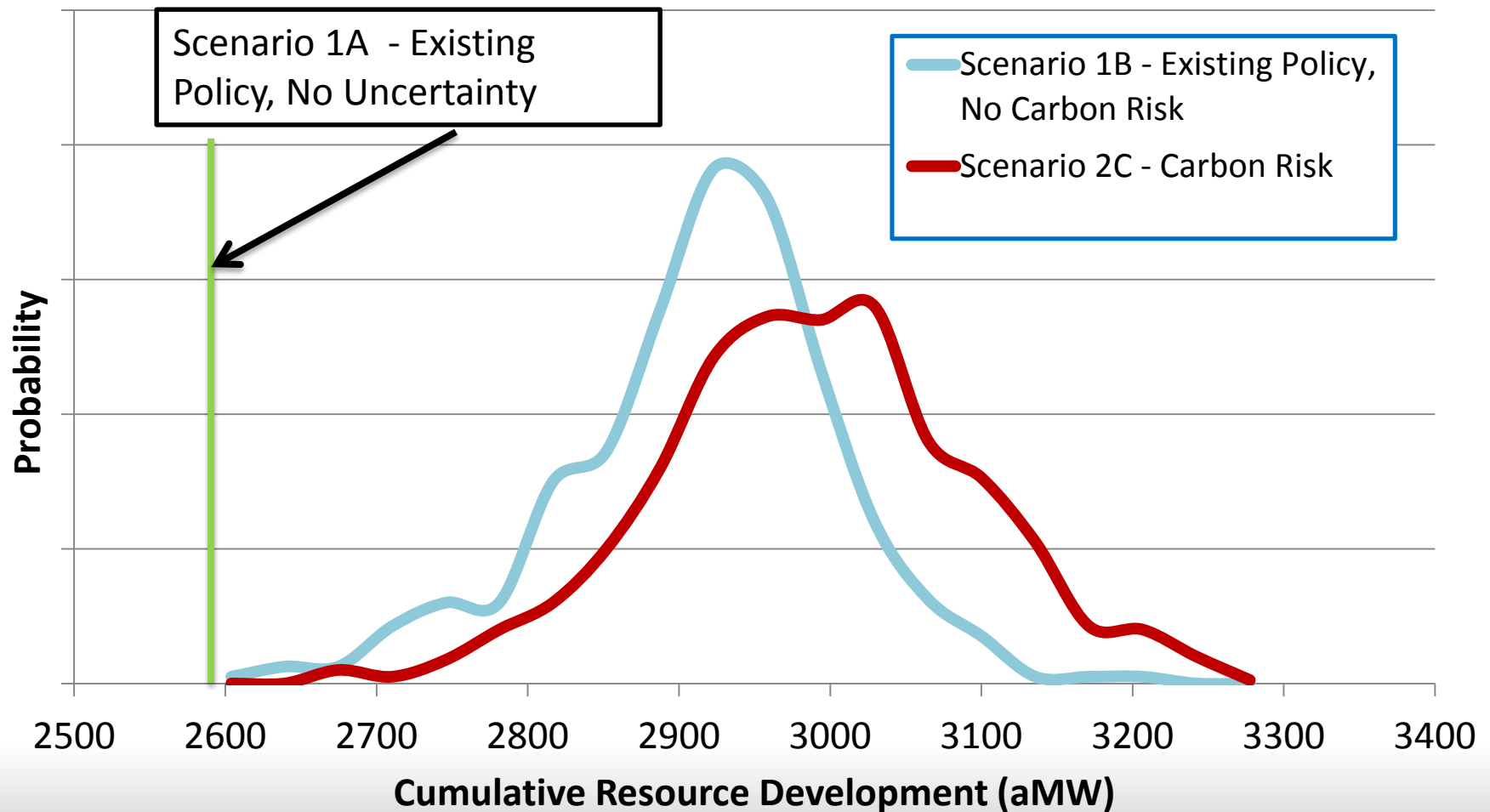
The Least Cost Strategies for Scenarios 1A, 1B and 2C Distributions of Conservation Development Through 2021

Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



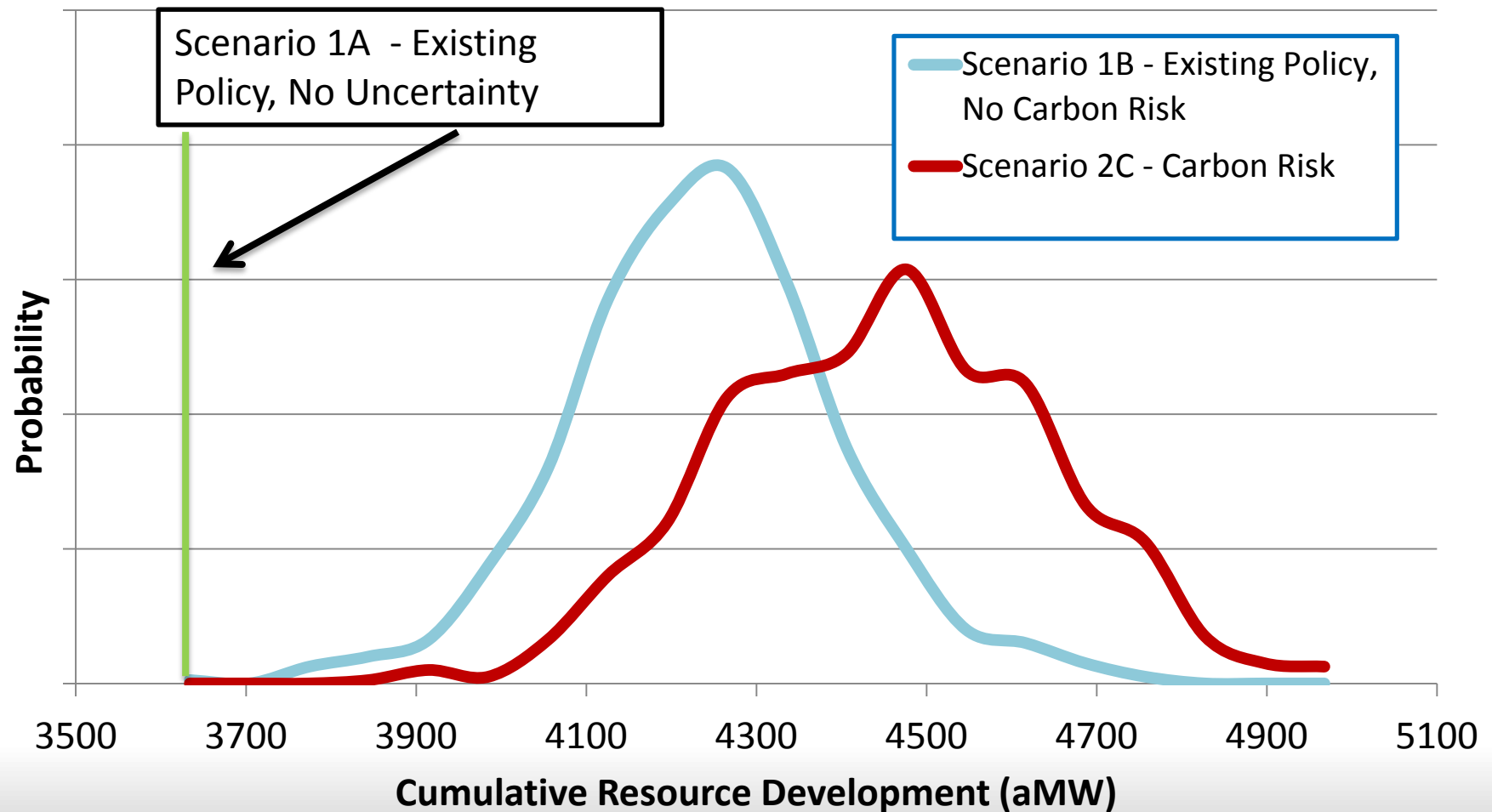
The Least Cost Strategies for Scenarios 1A, 1B and 2C Distributions of Conservation Development Through 2026

Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



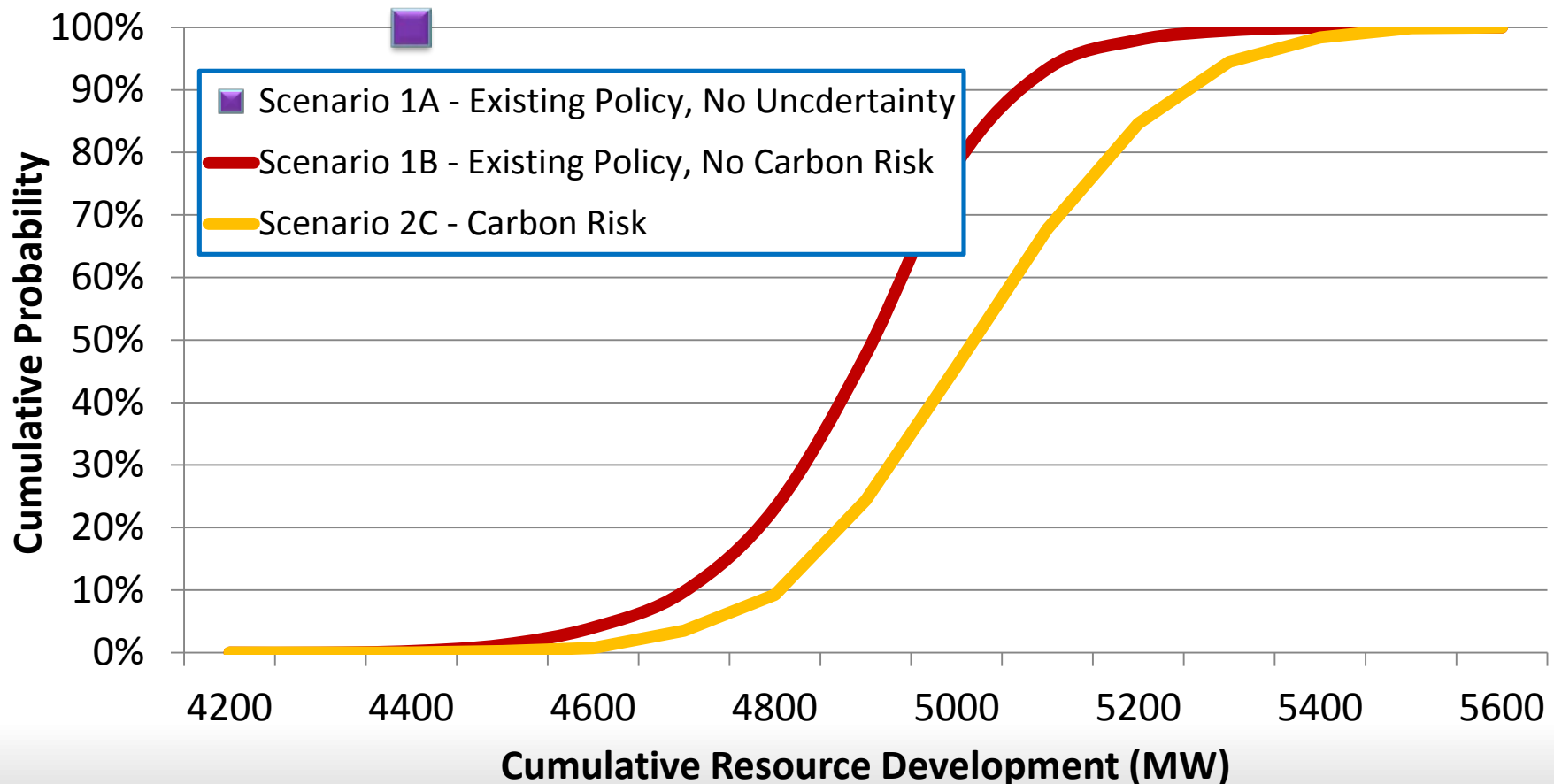
The Least Cost Strategies for Scenarios 1A, 1B and 2C Distributions of Conservation Development Through 2035

Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



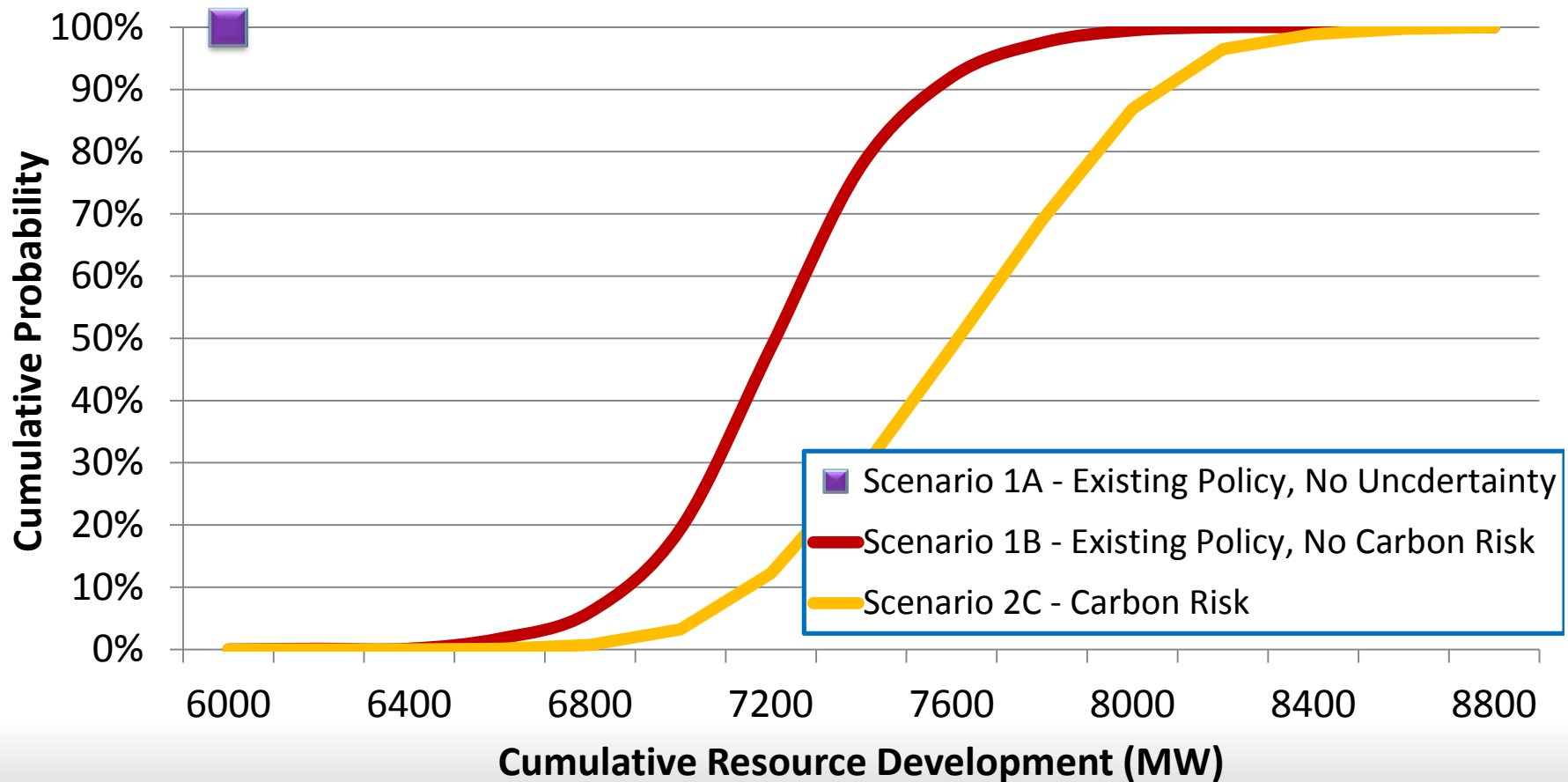
The Least Cost Strategies for Scenarios 1A, 1B and 2C Cumulative Probability of Conservation Development Through 2026

Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



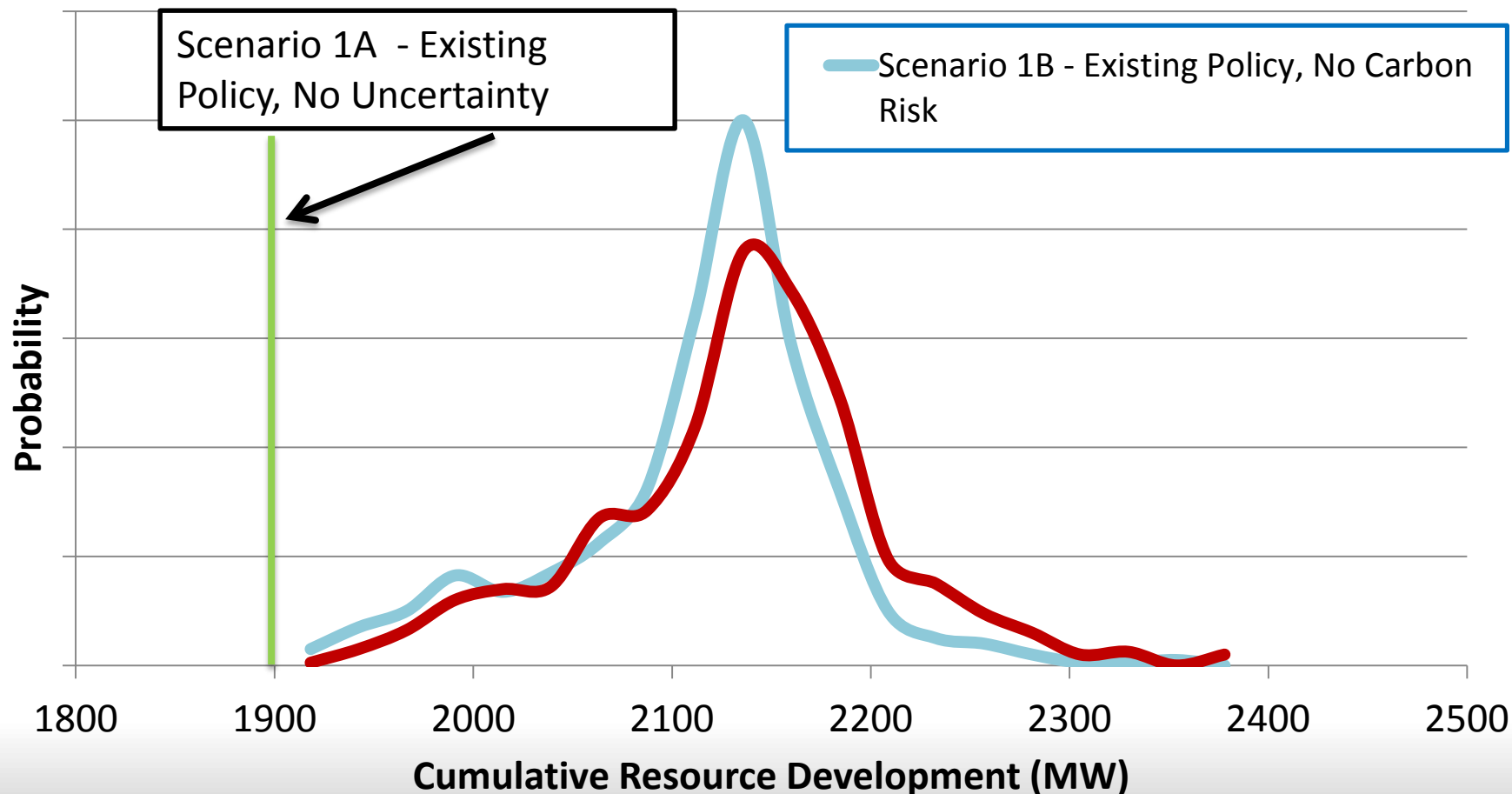
The Least Cost Strategies for Scenarios 1A, 1B and 2C Cumulative Probability of Conservation Development Through 2035

Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



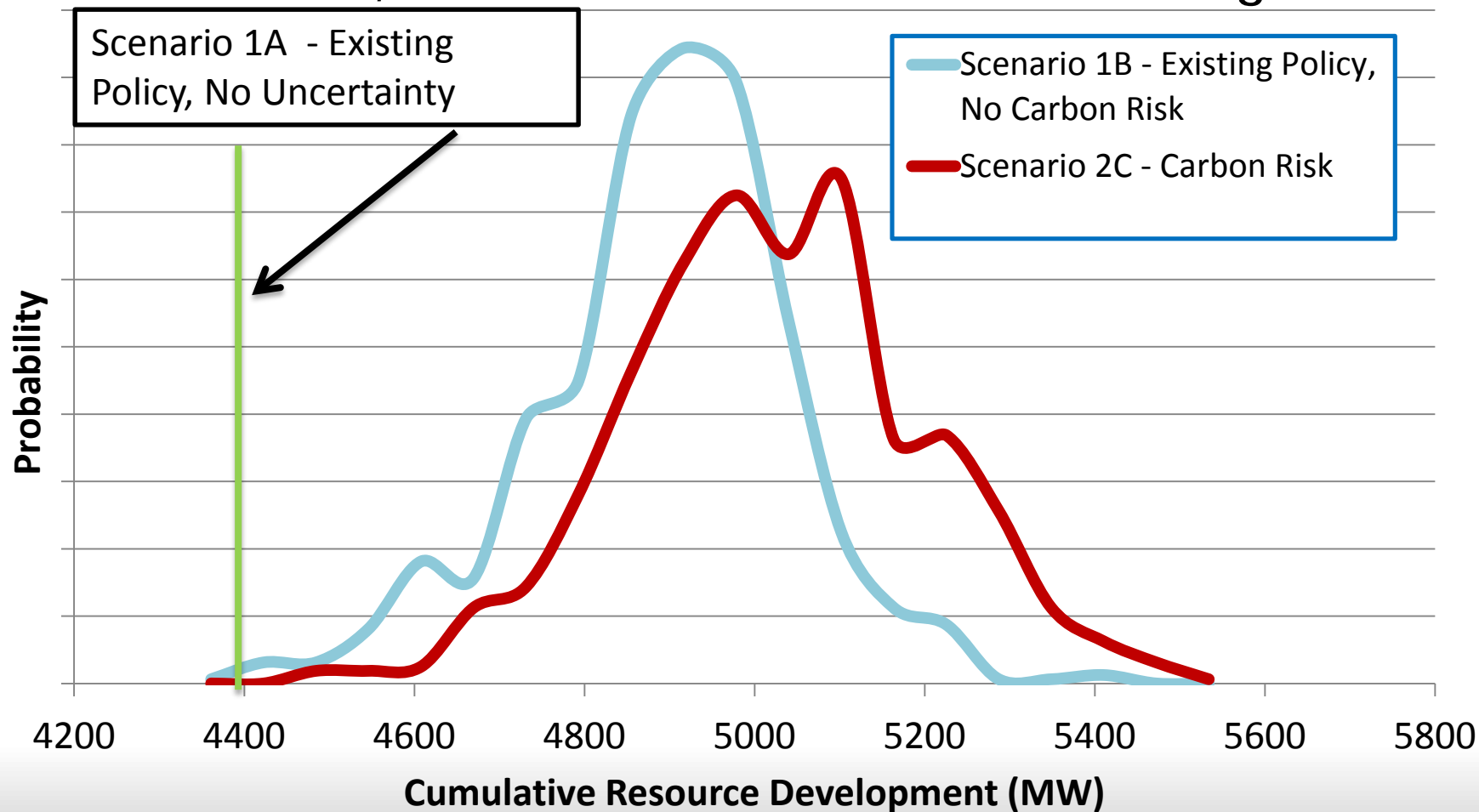
The Least Cost Strategies for Scenarios 1A, 1B and 2C Distributions of Conservation Development Through 2021 for Winter Capacity

Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



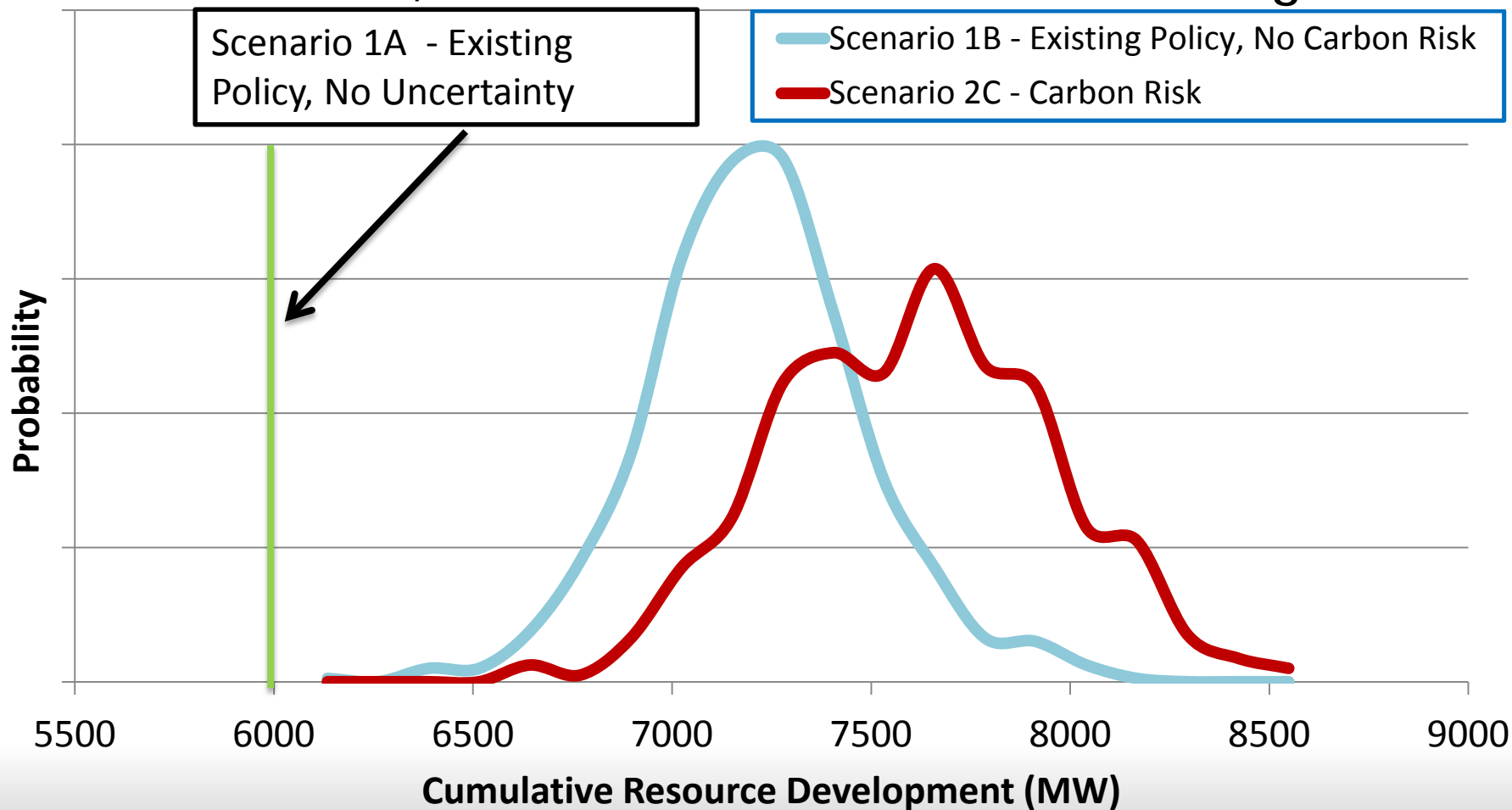
The Least Cost Strategies for Scenarios 1A, 1B and 2C Distributions of Conservation Development Through 2026 for Winter Capacity

Scenarios 1A, 1B and 2C – Least Cost Resource Strategies

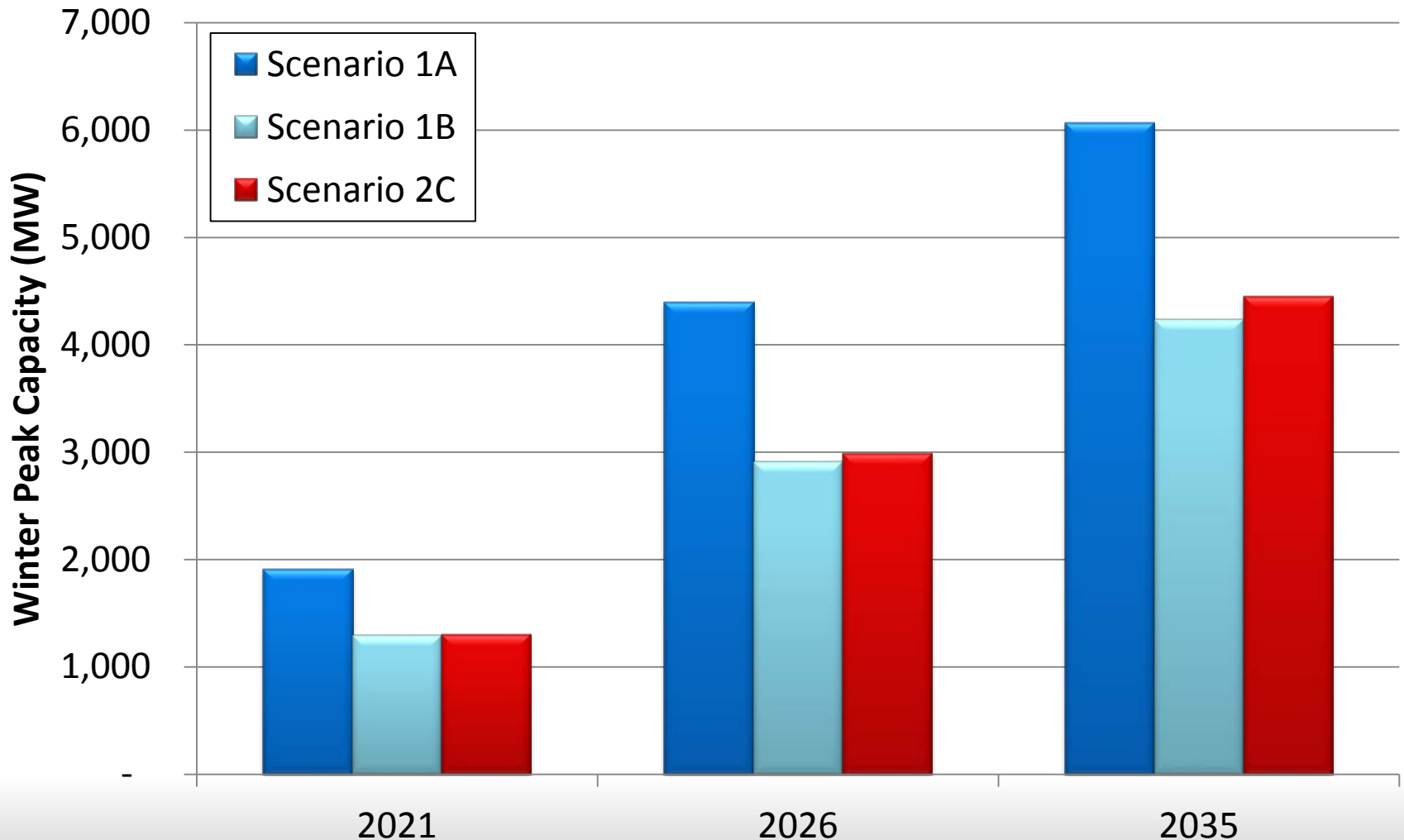


The Least Cost Strategies for Scenarios 1A, 1B and 2C Distributions of Conservation Through 2035 Development for Winter Capacity

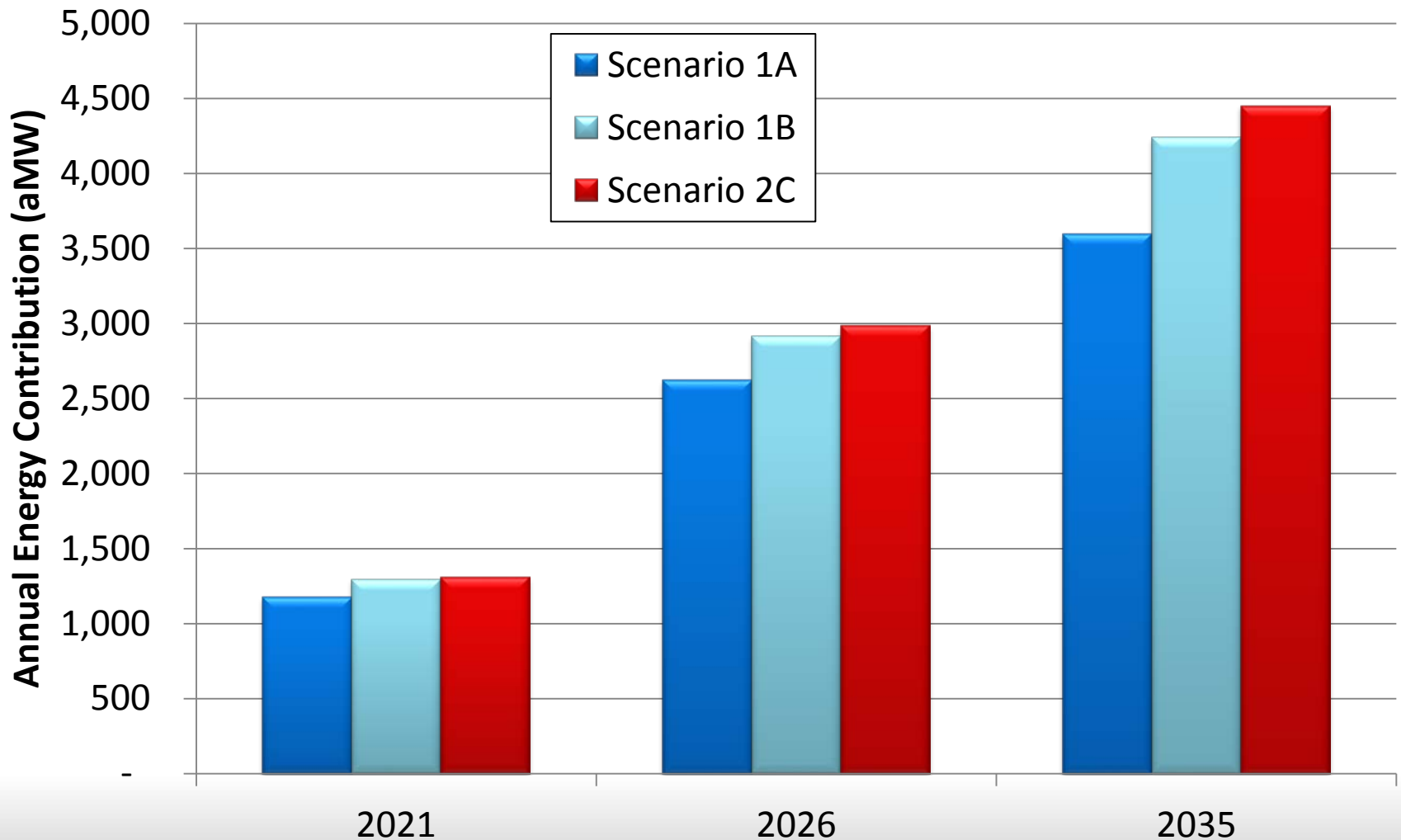
Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



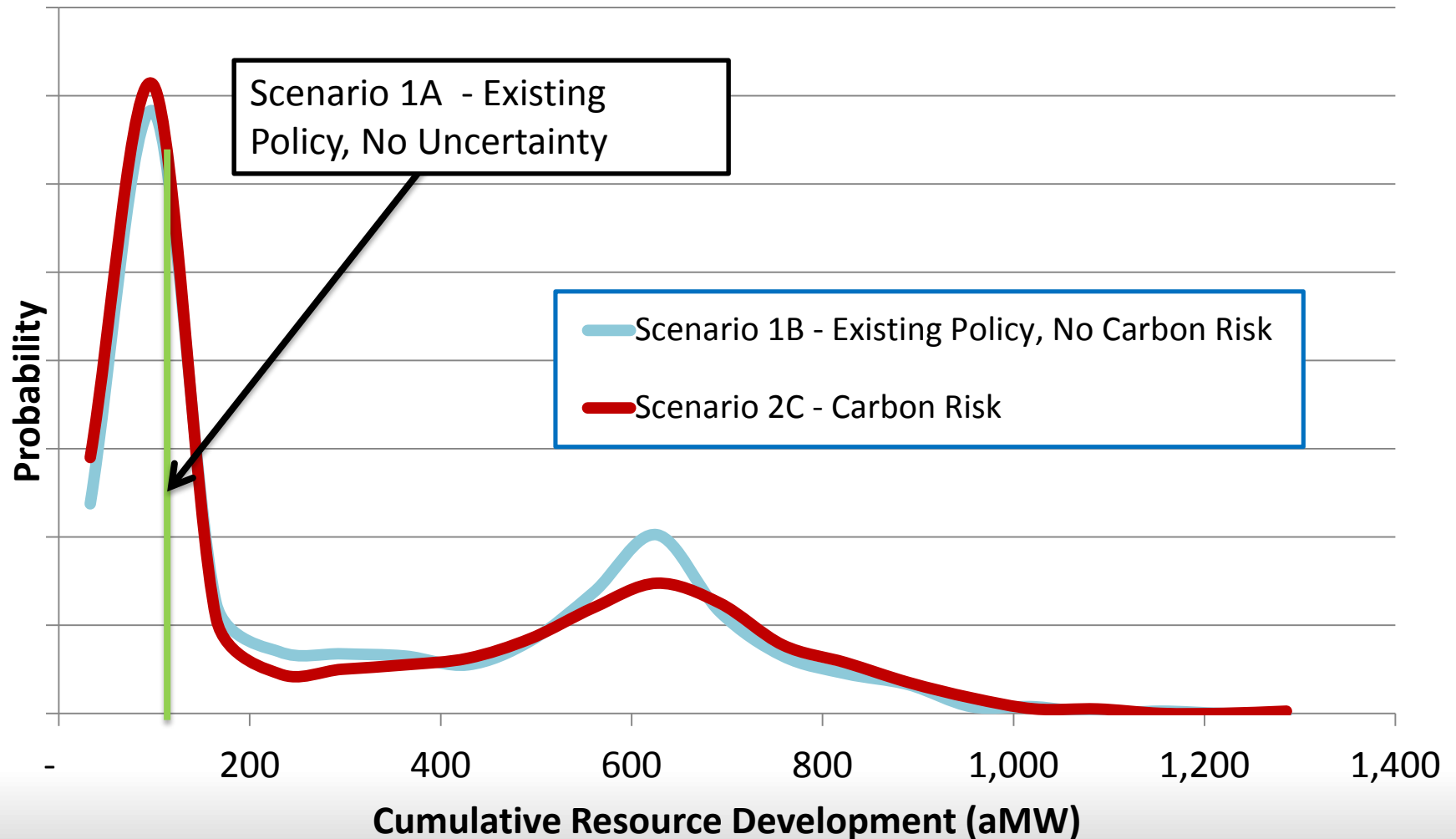
Average Conservation Winter Peak Development in Least Cost Resource Strategies for Scenarios 1A, 1B and 2C



Average Energy Conservation Development in Least Cost Resource Strategy for Scenarios 1A, 1B and 2C



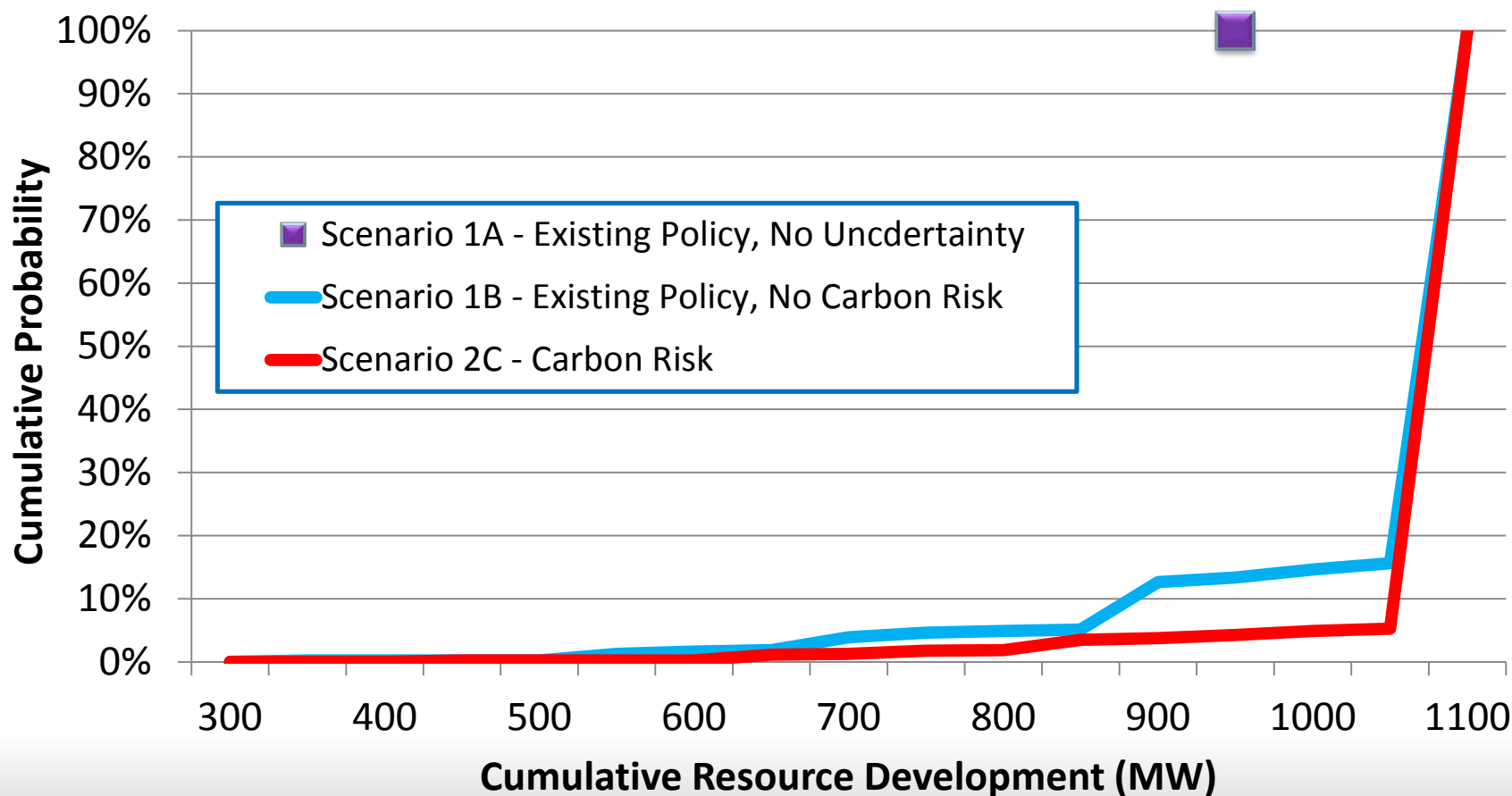
The Distribution of RPS Resource Development Through 2035 Is Affected By Conservation Development Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



The Least Cost Strategies for Scenarios 1A, 1B and 2C

Cumulative Probability of Demand Response Development Through 2021

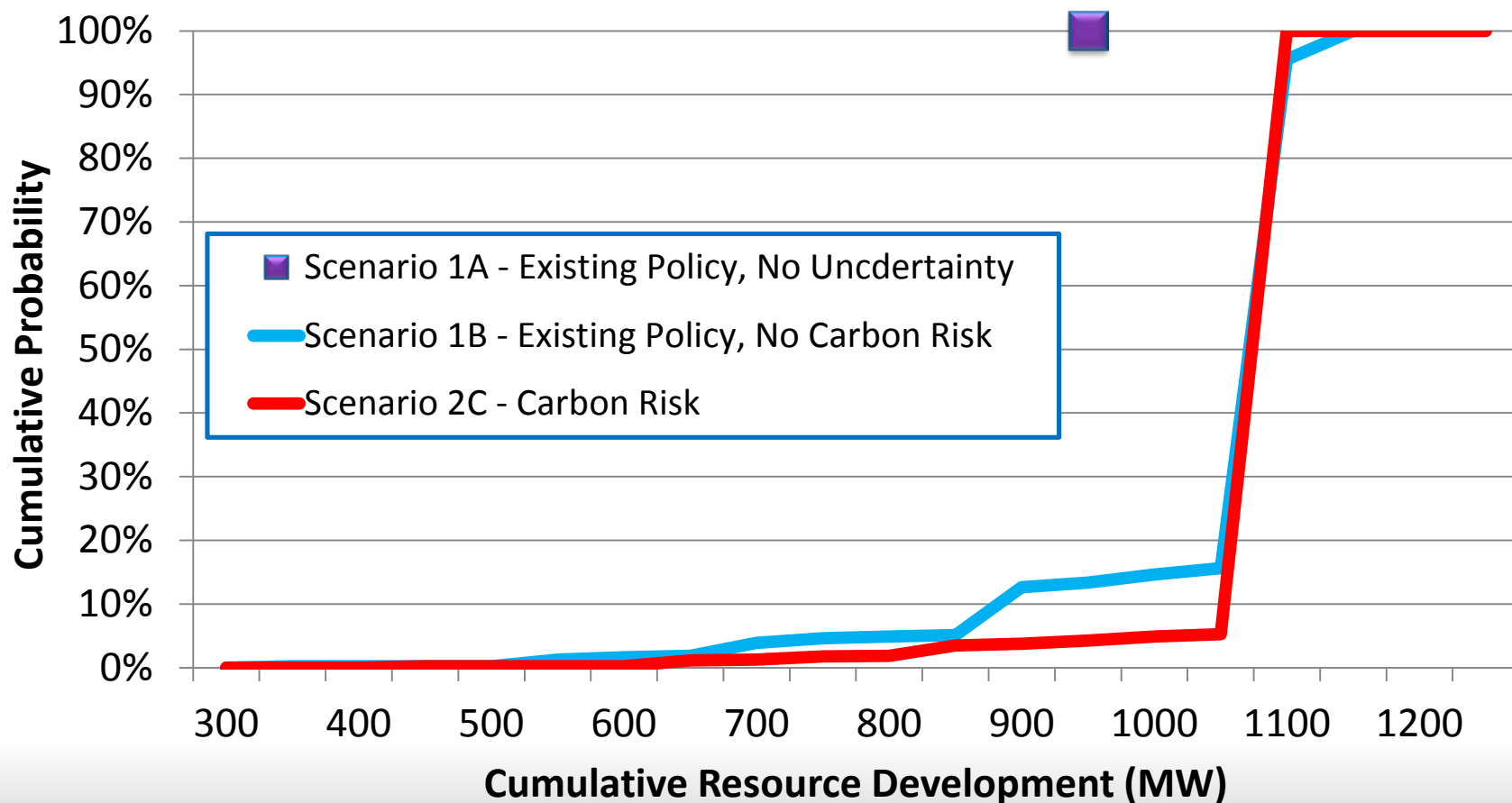
Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



The Least Cost Strategies for Scenarios 1A, 1B and 2C

Cumulative Probability of Demand Response Development Through 2026

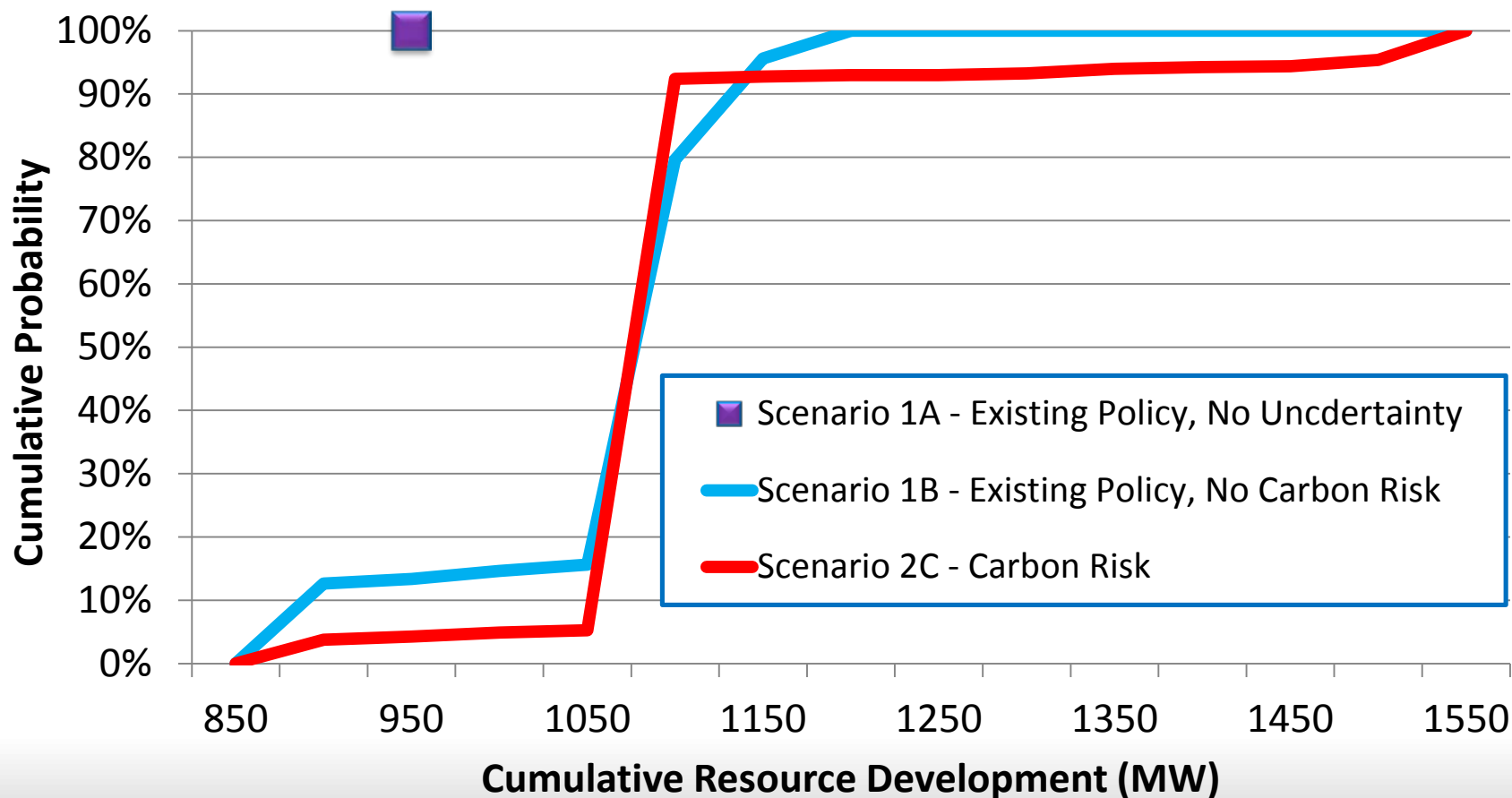
Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



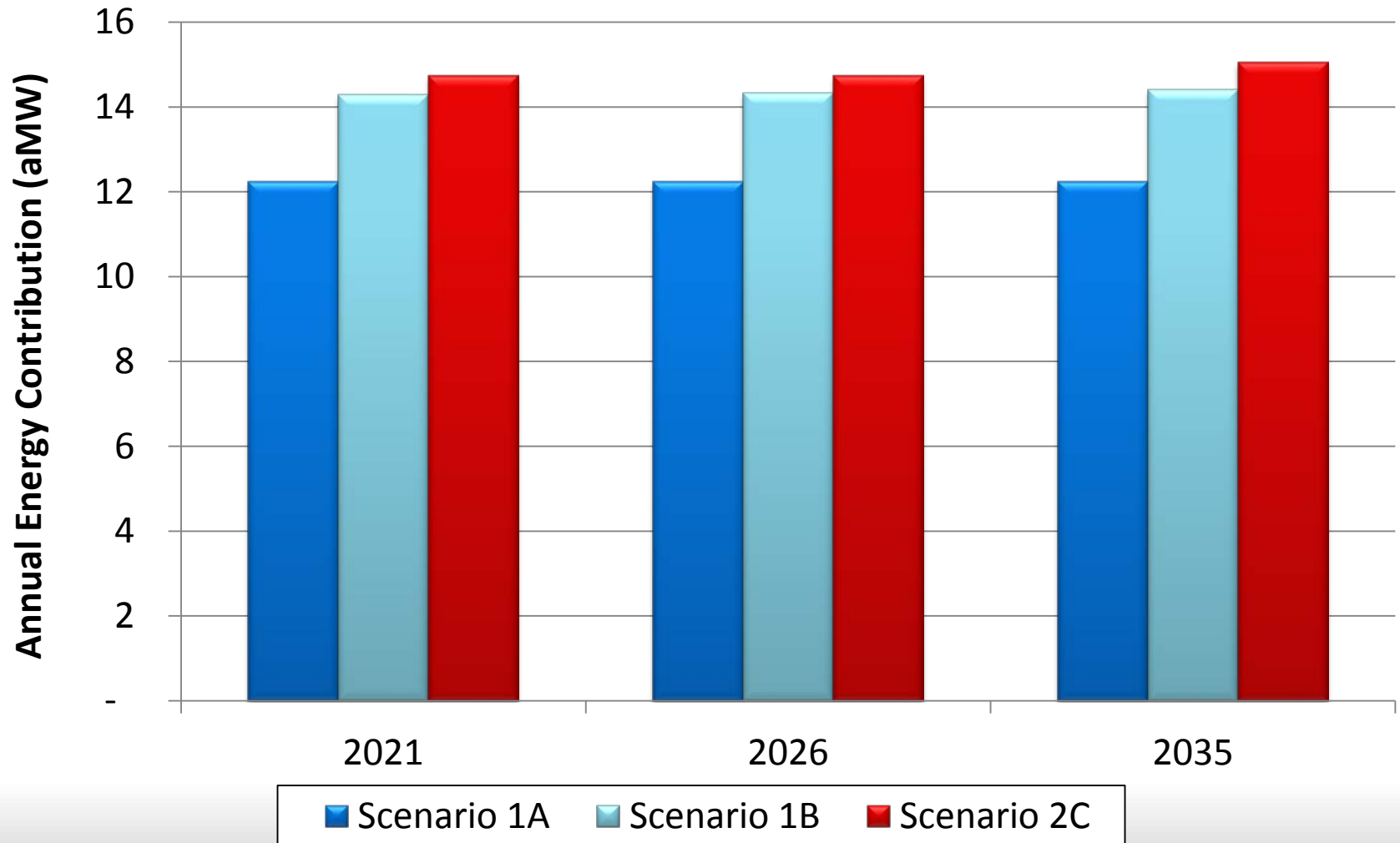
The Least Cost Strategies for Scenarios 1A, 1B and 2C

Cumulative Probability of Demand Response Development Through 2035

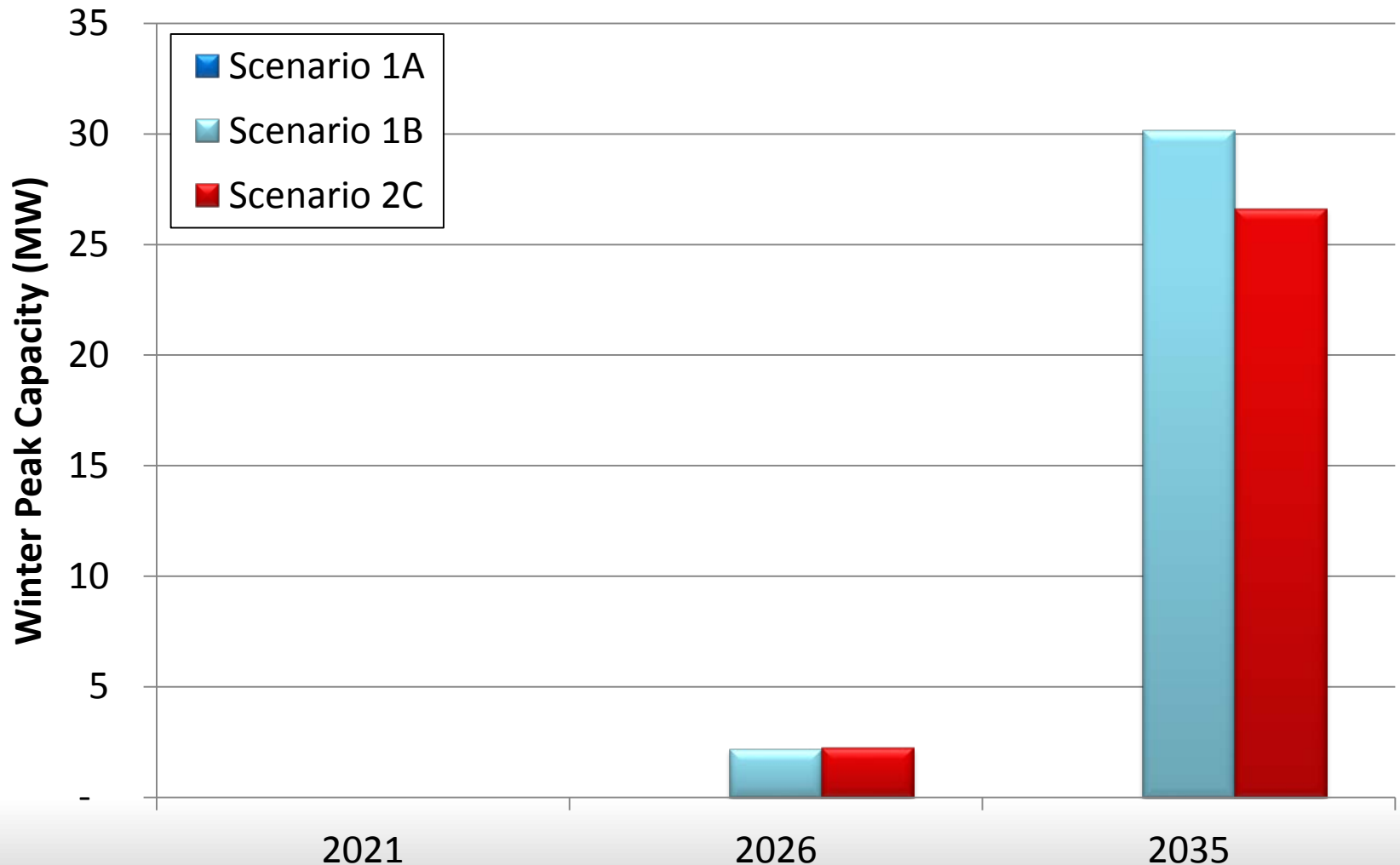
Scenarios 1A, 1B and 2C – Least Cost Resource Strategies



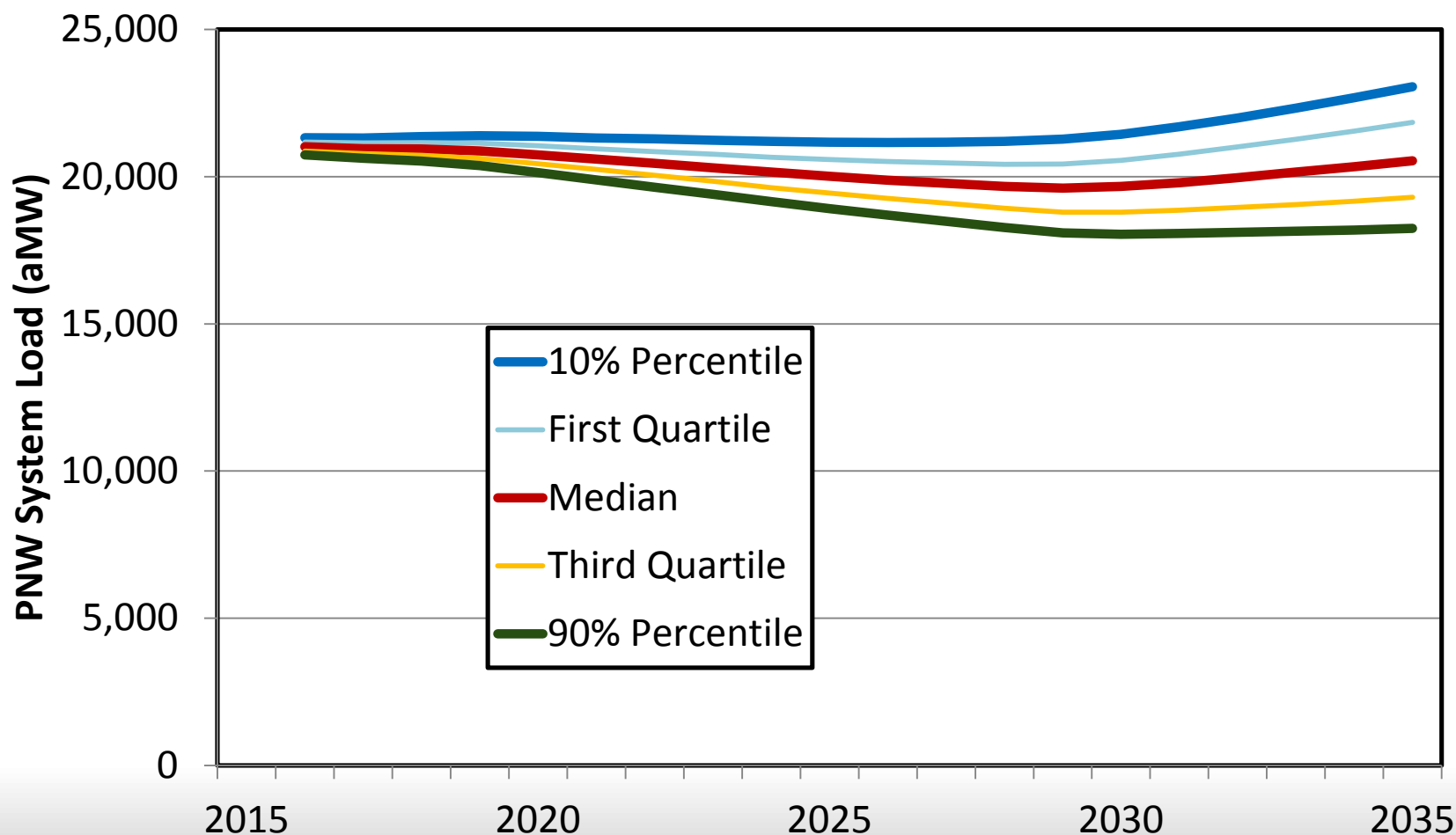
Average Demand Response Development in Least Cost Resource Strategy for Scenarios 1A, 1B and 2C



Average Renewable Resource Winter Peak Development in Least Cost Resource Strategies for Scenarios 1A, 1B and 2C



Regional Net Load After Conservation Remains “Flat On Average” Through 2035 Under the Least Cost Strategy in Scenario 1B, Existing Policy, No Carbon Risk



Regional Net Load After Conservation Also Remains “Flat On Average” Through 2035 Under the Least Cost Strategy in Scenario 2C – Carbon Risk

