Selected Findings from Scenario Analysis Conducted To Date

Power Committee Webinar

June 26, 2014

Progress Since The June Council Meeting – Model Inputs

- RPM inputs have been updated:
  - Revised peak load forecast to reflect historical relationship between weather and other factors (e.g., day of week) a peak loads
  - Include announced retirement of Valmy coal plants in 2026
  - Resource adequacy penalty was increased
    - This guarantees that paying the penalty **every period** is more expensive than building any of the resources that are available for selection in the model

Progress Since The June Council Meeting – Model Structure

- RPM has been revised:
  - Resource expansion logic modified to reflect need for capacity resources and contract status
  - Resource adequacy penalty was changed to only apply to capacity shortfalls that can be addressed by the resources in the model, i.e. penalties are not added into the NPV unless it's possible for the model to avoid them
  - All graphs used in this presentation show NPV without any penalties added

Progress Since The June Council Meeting – Model Structure

- RPM has been revised:
  - Resource expansion logic modified to reflect need for capacity resources and contract status
    - The model was given close to “perfect foresight” so that in each future it forecast close to exact need for capacity that will be needed in that future. While this reduces the risk associated with “forecast error” it was deemed acceptable given the short lead times for new resource development.
  - Resource adequacy penalty was changed to only apply to capacity shortfalls that can be addressed by the resources in the model, i.e. penalties are not added into the NPV unless it’s possible for the model to avoid them

Progress Since The June Council Meeting – Model Structure (2)

- RPM revisions "in progress":
  - Testing of revised peak load forecast inputs and RPM model revisions revealed the need for additional modifications
  - The hourly time-step of the GENESYS model allows it to use of hydro-system for peaking and dispatch other resources to provide energy (e.g., replaces water used for "peaking" with energy generated by wind and gas turbines)
  - RPM is being revised to allow peak/energy substitution to reflect NW system operation that is more consistent with GENESYS
    - This is done by adjusting all resources to reflect their "System Capacity Contribution"

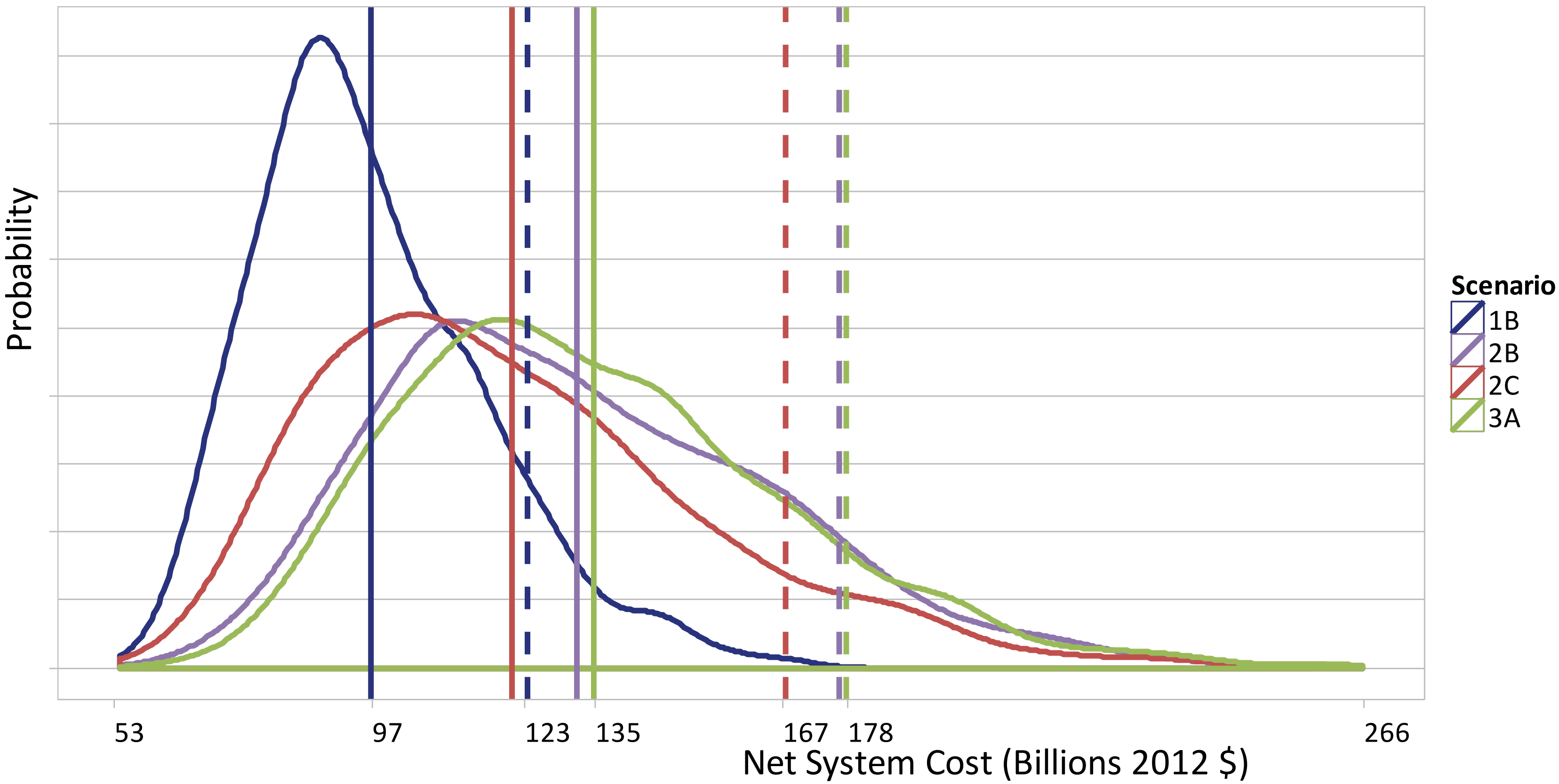
What Is "System Capacity Contribution"? (2)

- System Capacity Contribution is the capacity credit of resources (e.g. wind, solar PV, CCCT) when integrated into an existing power system.☐
- The System Capacity Contribution may exceed the nameplate capacity of a plant in power systems that have storage
  - Example:
    - A standalone battery can supply 10 MW, but without a system to charge it cannot provide either capacity or energy.
    - Coupling this battery to 100 MW thermal plant that supplies both the energy to charge the battery and 100 MW of capacity provides the system with 110 MW of capacity

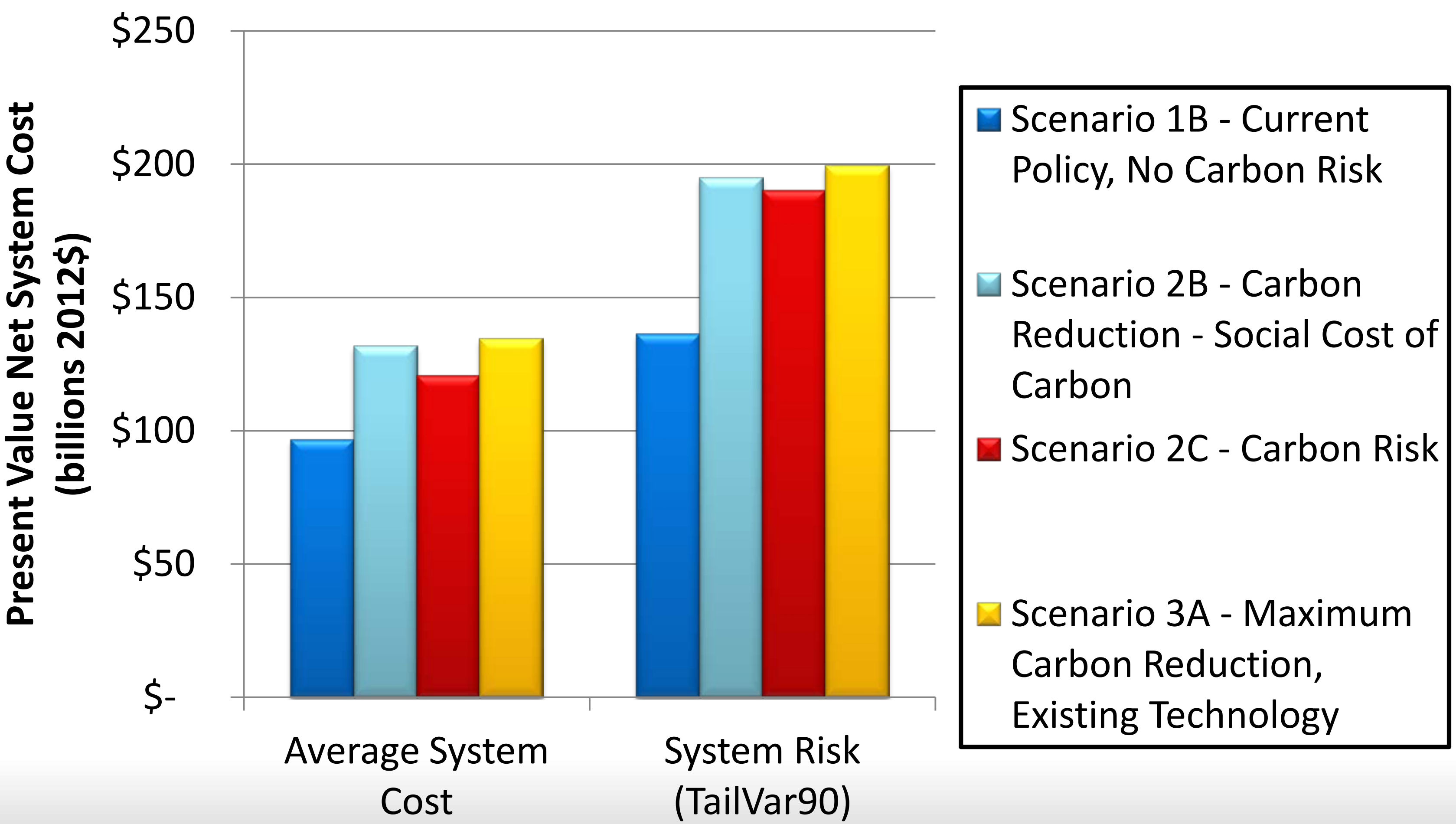
Why Does System Capacity Contribution Matter in the RPM?

- 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 resources to reflect their capacity contribution allows the RPM to recognize resource that provide *energy* to "release" hydro-generation to meet short term peaking requirements

Now, On To Scenario Comparisons and Observations
Net System Cost
Least Cost Strategies for 1B, 2B, 2C and 3 A



The Average Present Value Net System Cost and Risk for Least Cost Strategies Under All Carbon Reduction Are Similar



Observations from Scenarios To Date: Demand Response

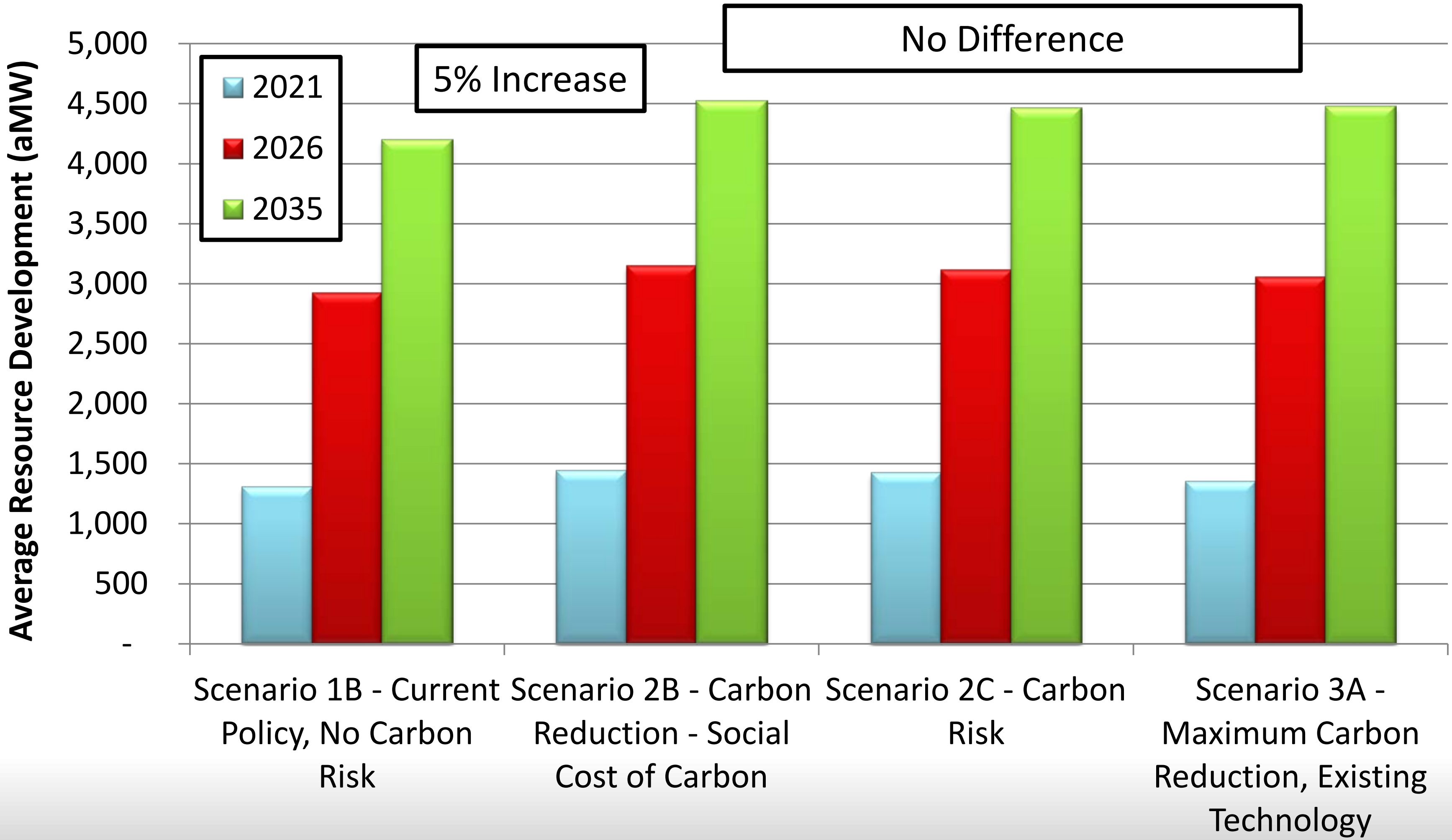
- Demand Response is the preferred resource to meet short-term peaking capacity requirements*
- Why
  - It is lowest cost option for maintaining capacity reserves
  - It has a shorter lead-time and comes in more "modular" sizes than generation
    - About 1000 MW of DR resources can be optioned and built 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 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.

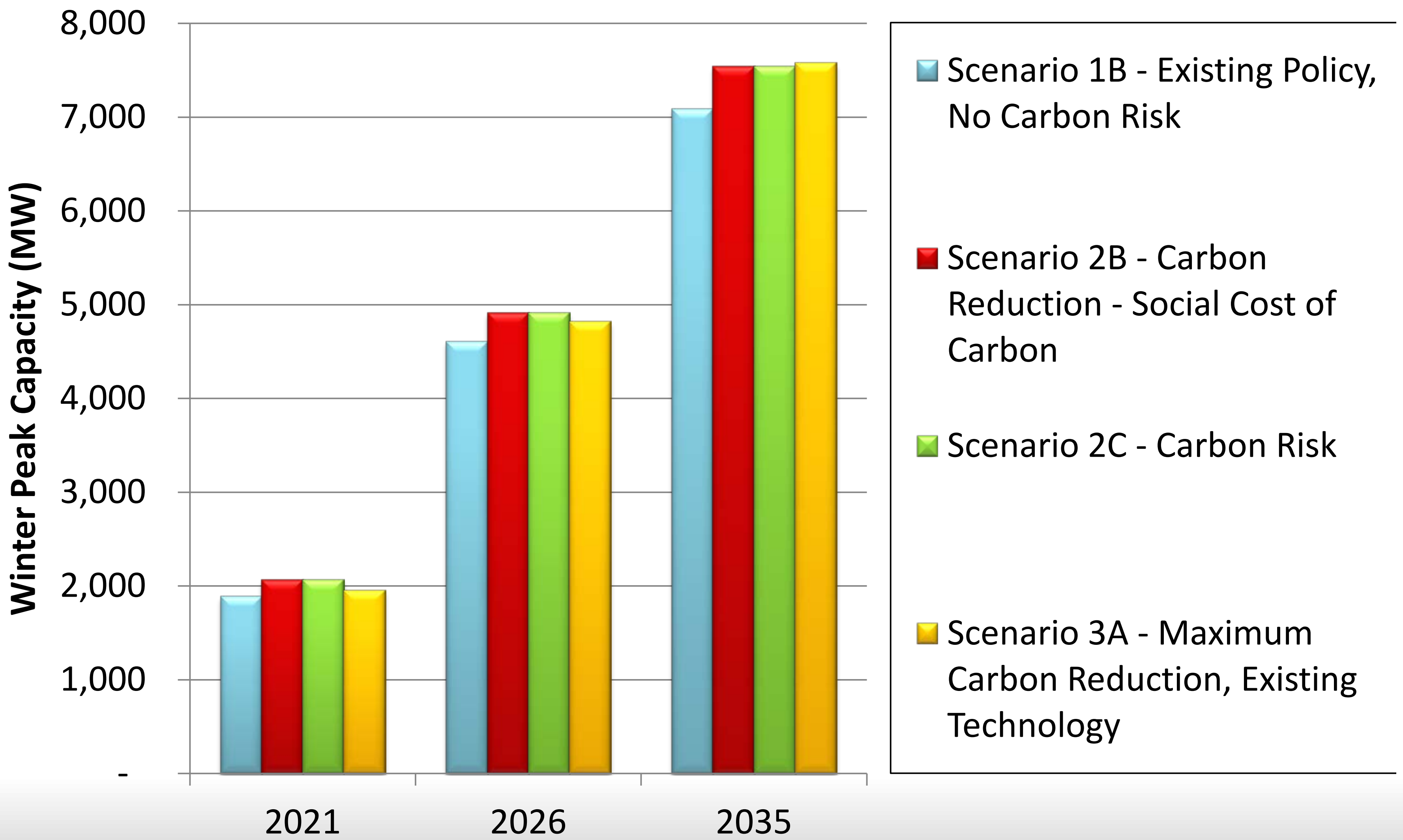
Observations from Scenarios To Date: Energy Efficiency

- 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.
- 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

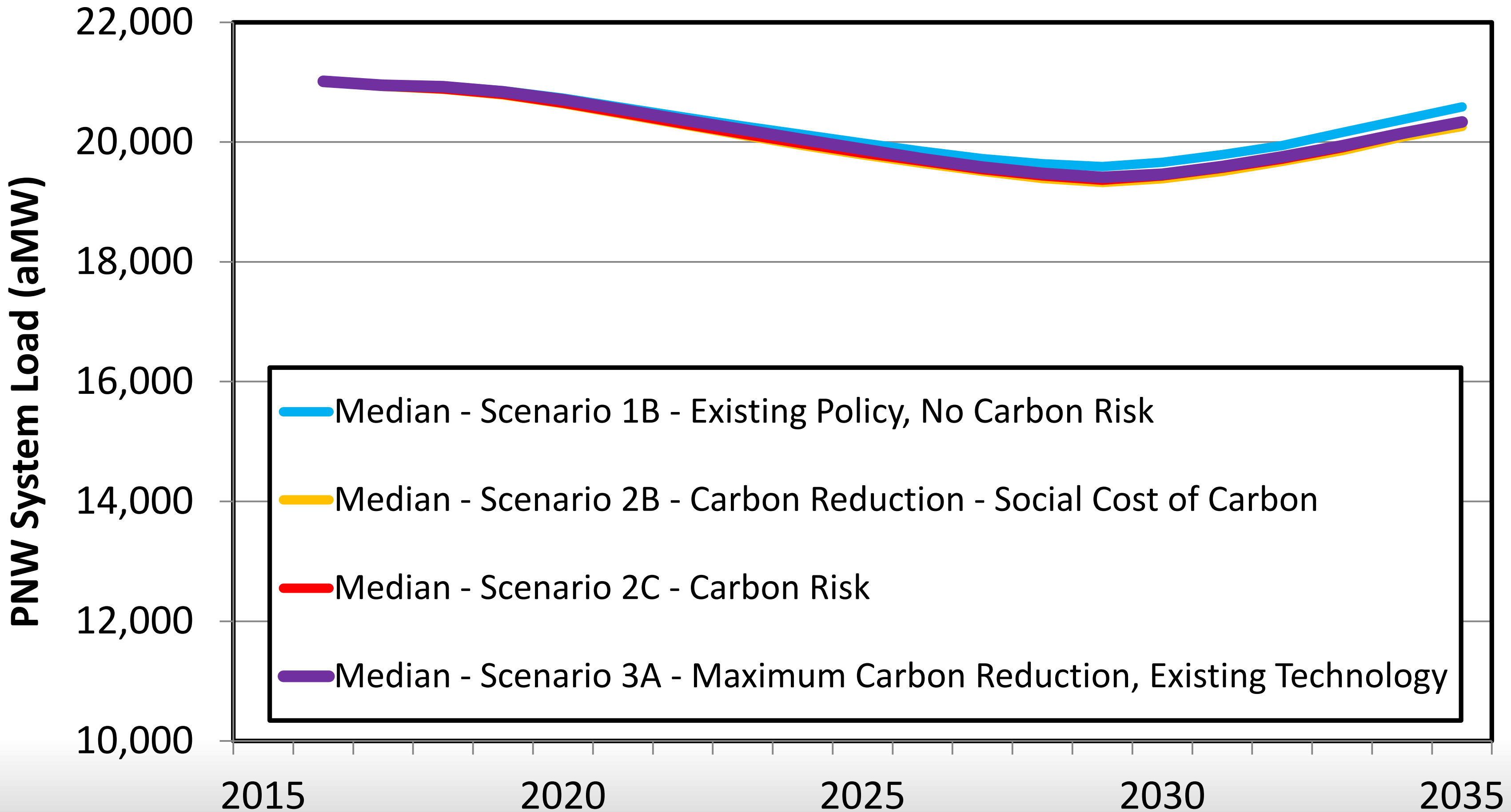
Average Conservation Development Across Scenarios Increases When Carbon Risk Are Considered But Does Not Increase With Full Coal Retirement or Consideration of the Social Cost of Carbon



Average Conservation Winter Peak Development in Least Cost Resource Strategies for Scenarios 1B, 2B, 2C and 3A

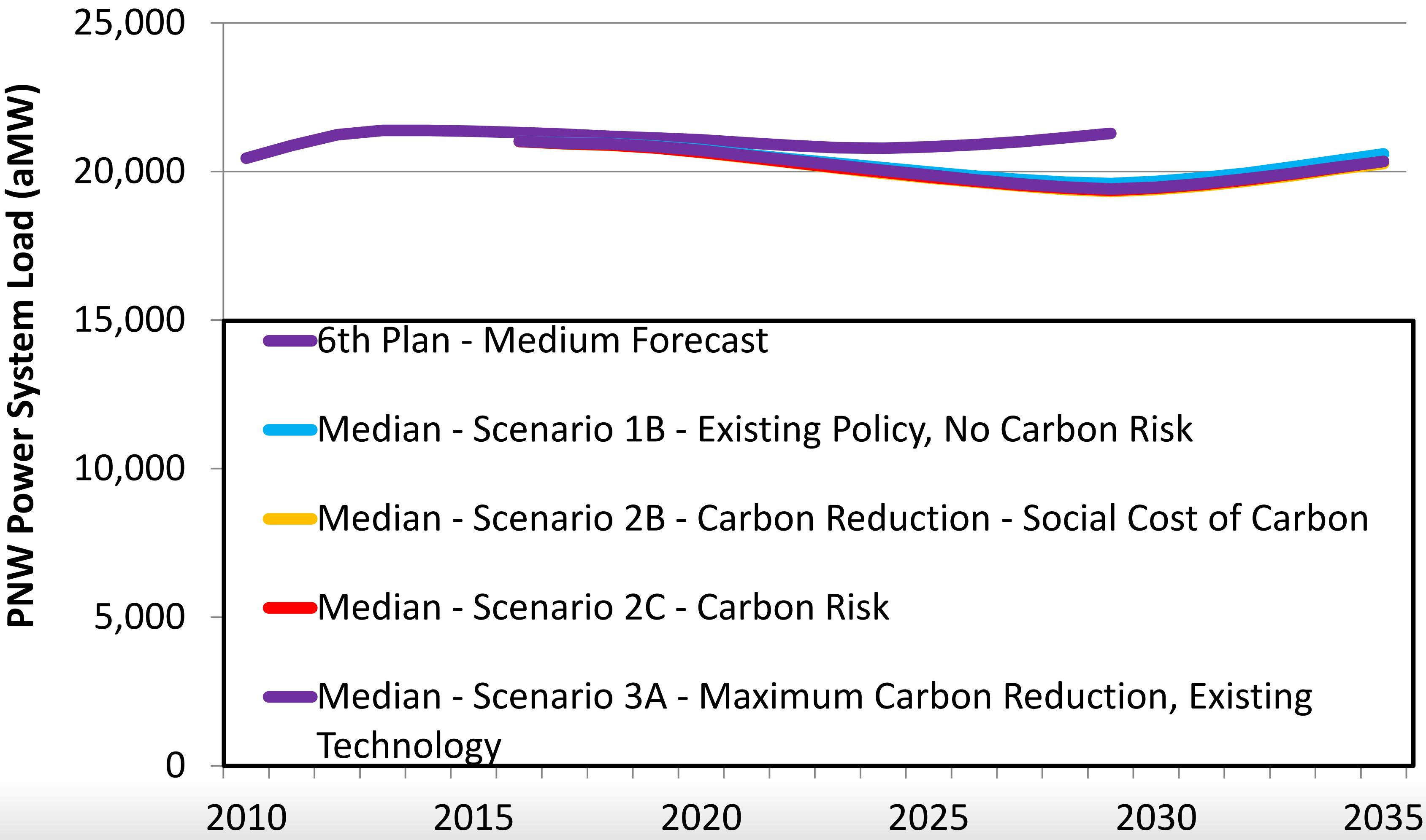


Regional Net Load After Conservation Remains "Flat On Average" Through 2035 Under the Least Cost Strategy in Scenarios 1B, 2B, 2C and 3A



This Result is Very Similar To The 6th Plan

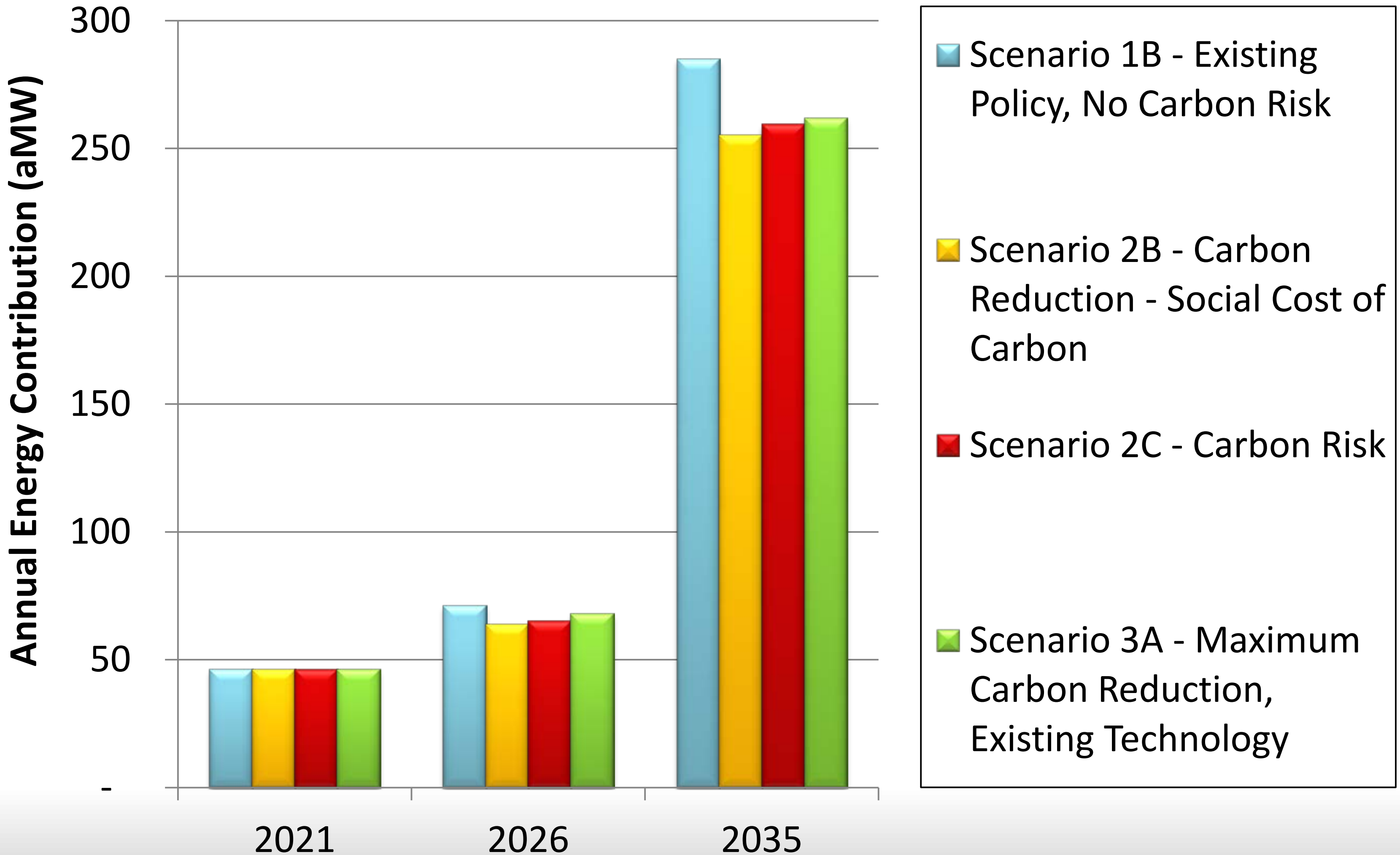
Net Load After Conservation Scenarios 1B, 2B, 2C and 3A Least Cost Strategy and 6th Plan



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 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

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



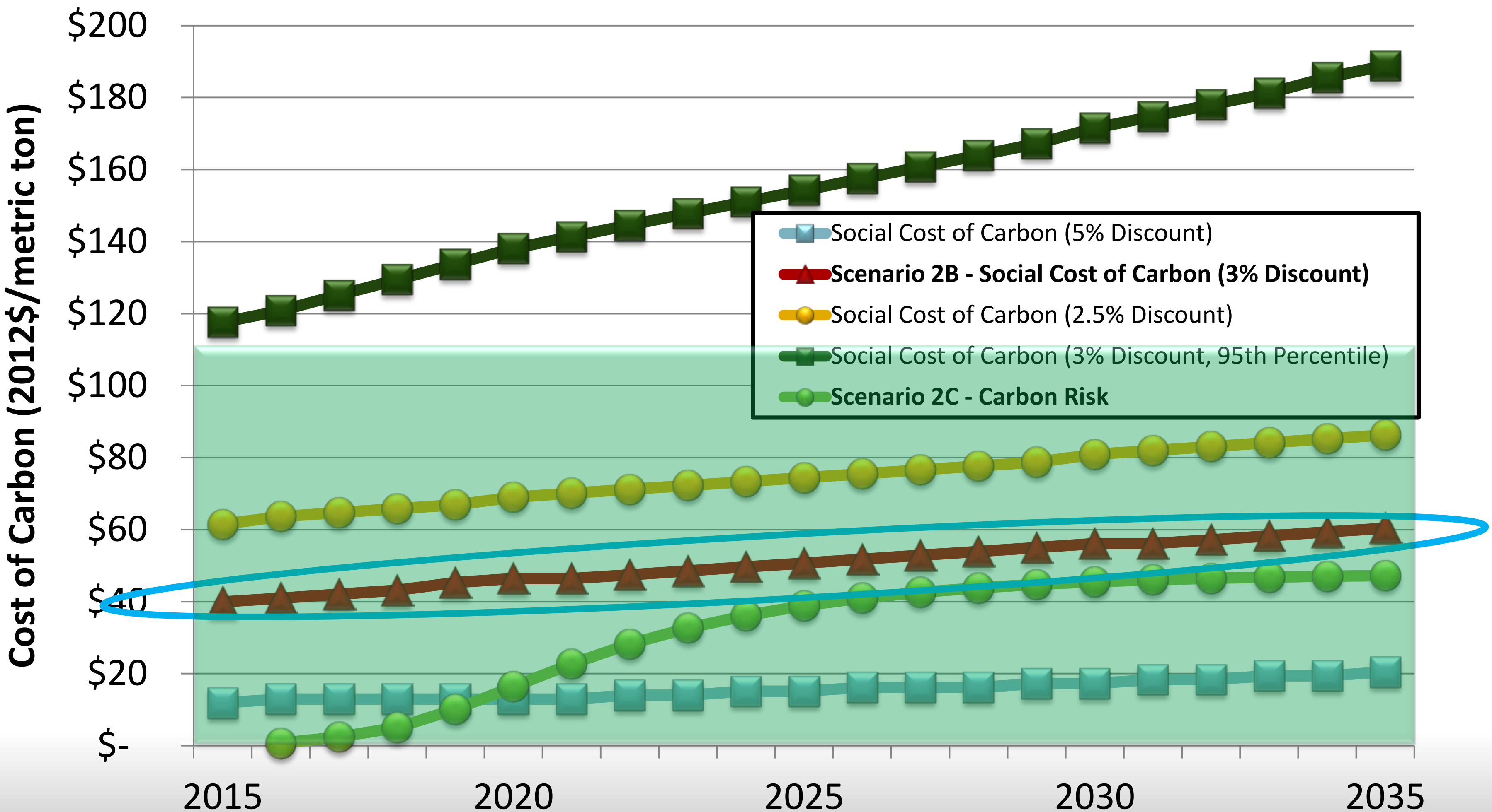
Observations from Scenarios To Date: Thermal Resources

- 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***

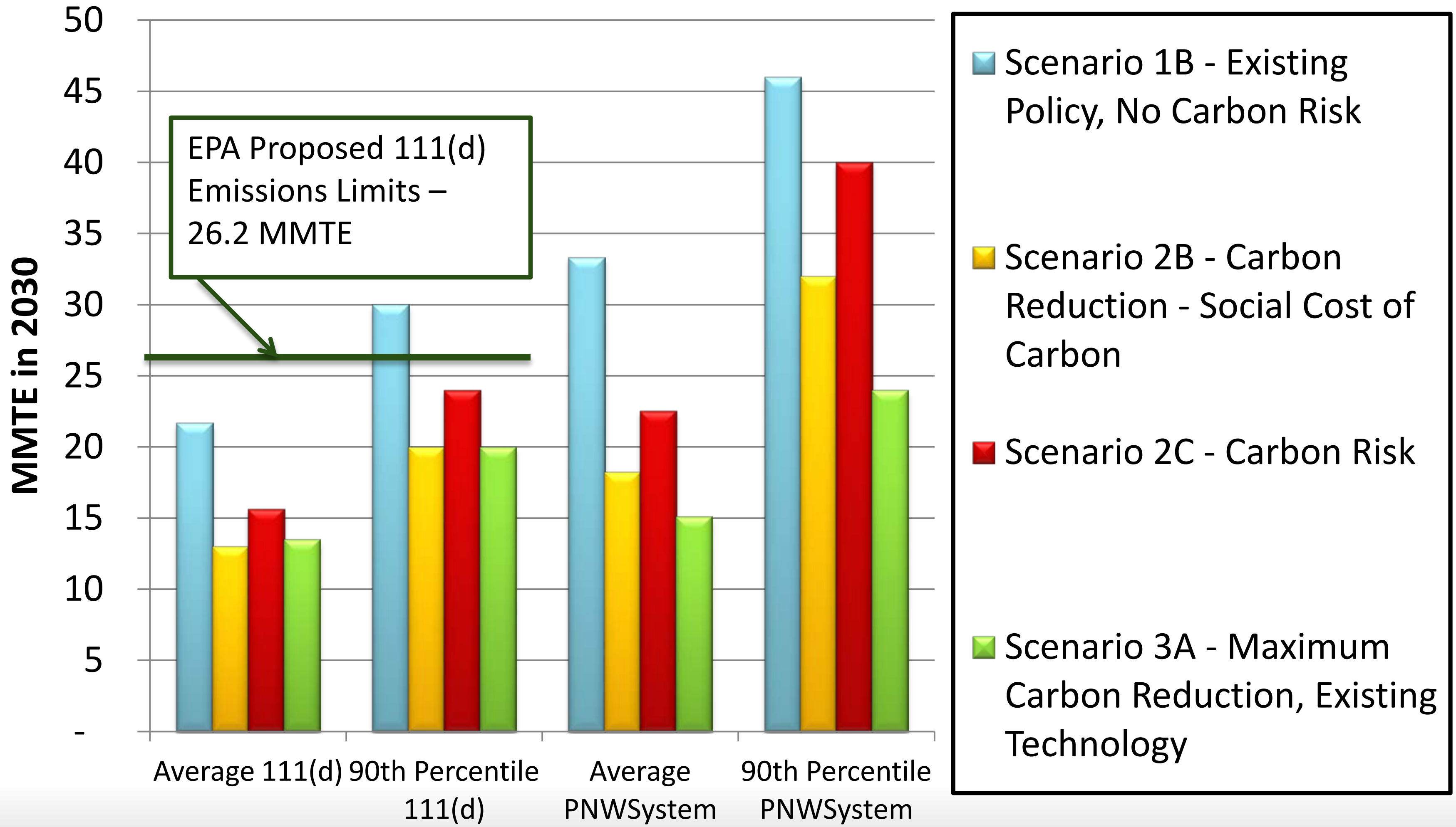
Observations from Scenarios To Date: Carbon Emissions Reduction

- 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

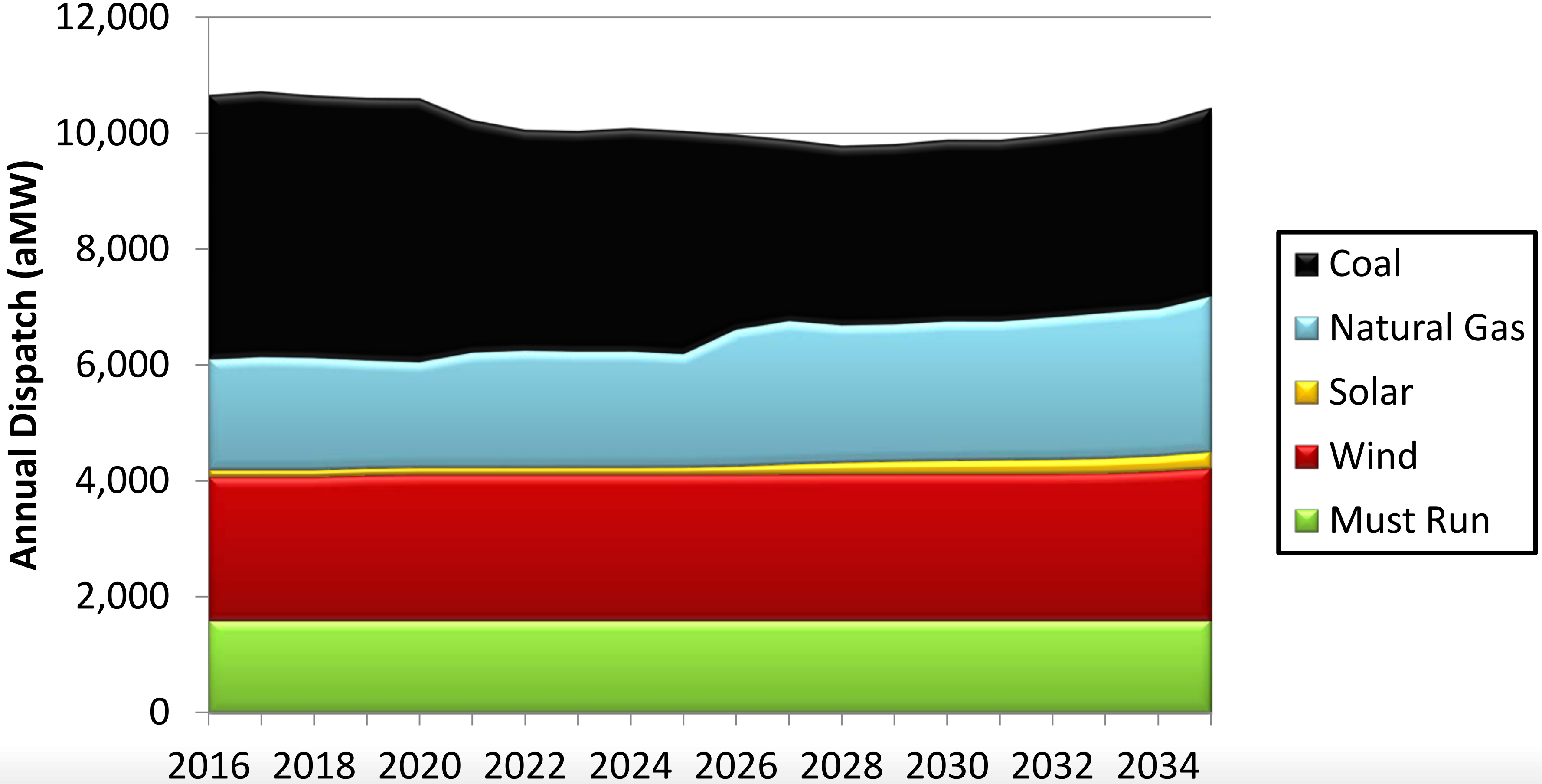
Scenario 2B and 2C Cost of Carbon Assumptions



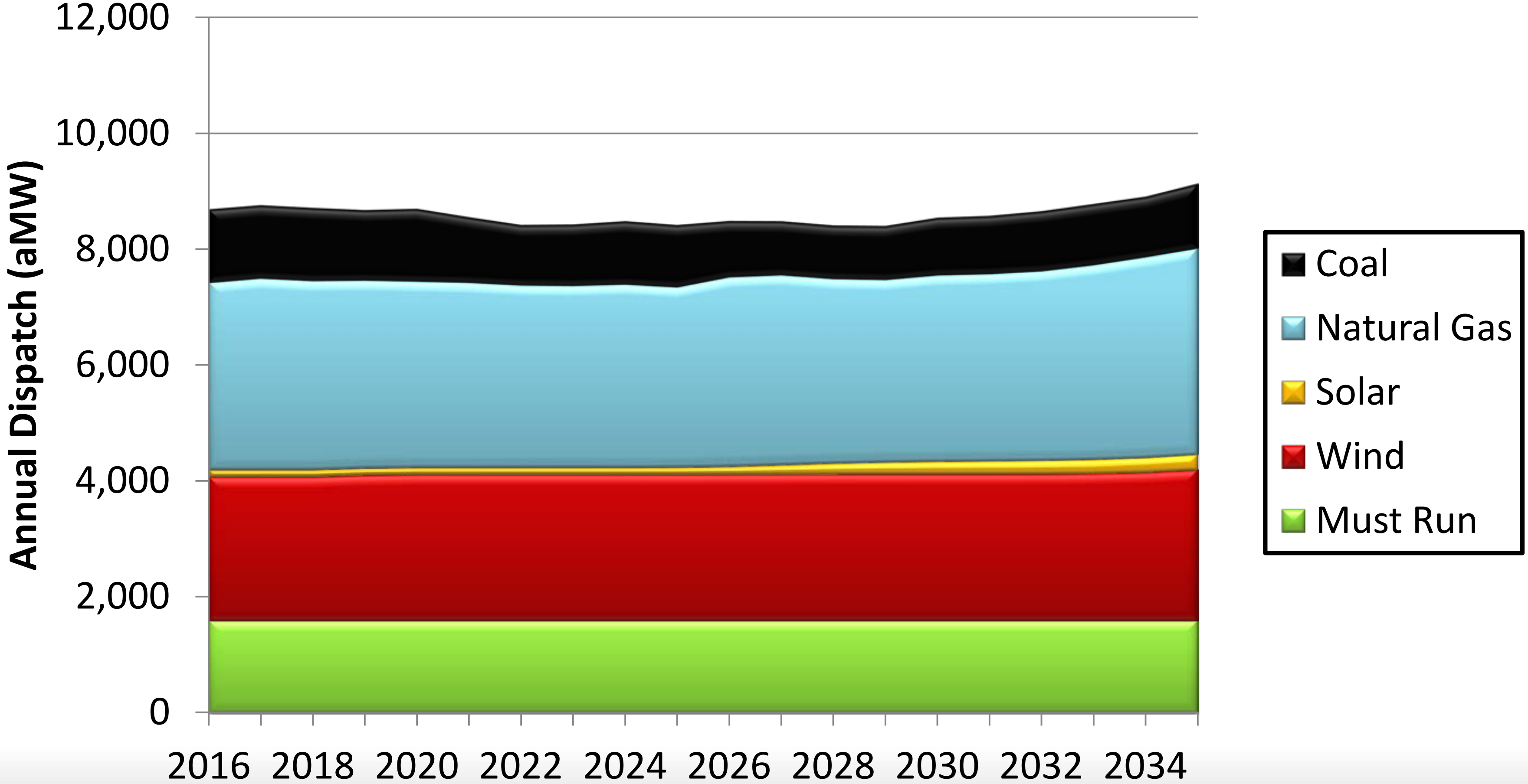
CO2 Emissions Across Least Cost Resources Strategies - 2030



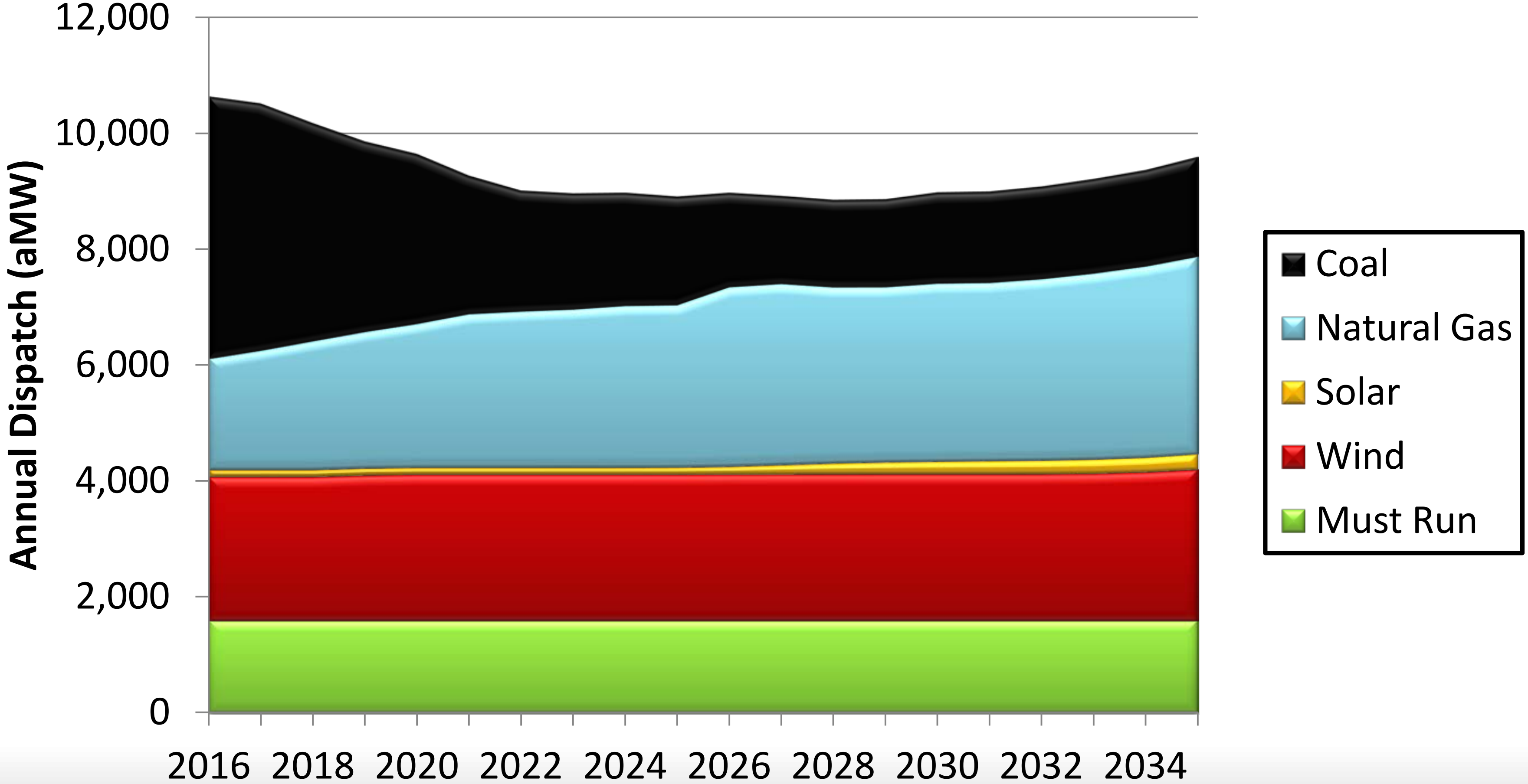
Thermal Resource Dispatch without Carbon Risk – 1B



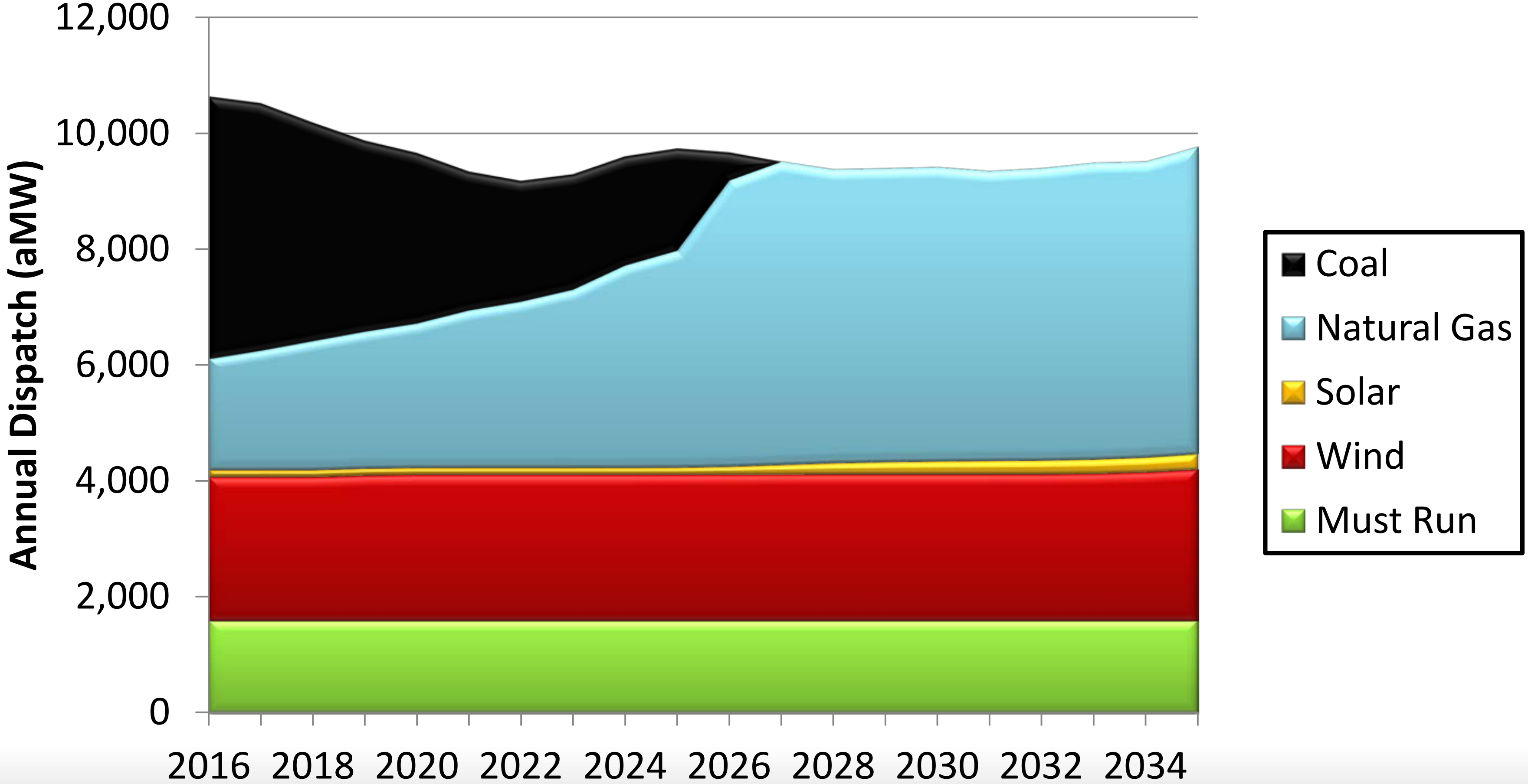
Thermal Resource Dispatch with Social Cost of Carbon – 2B



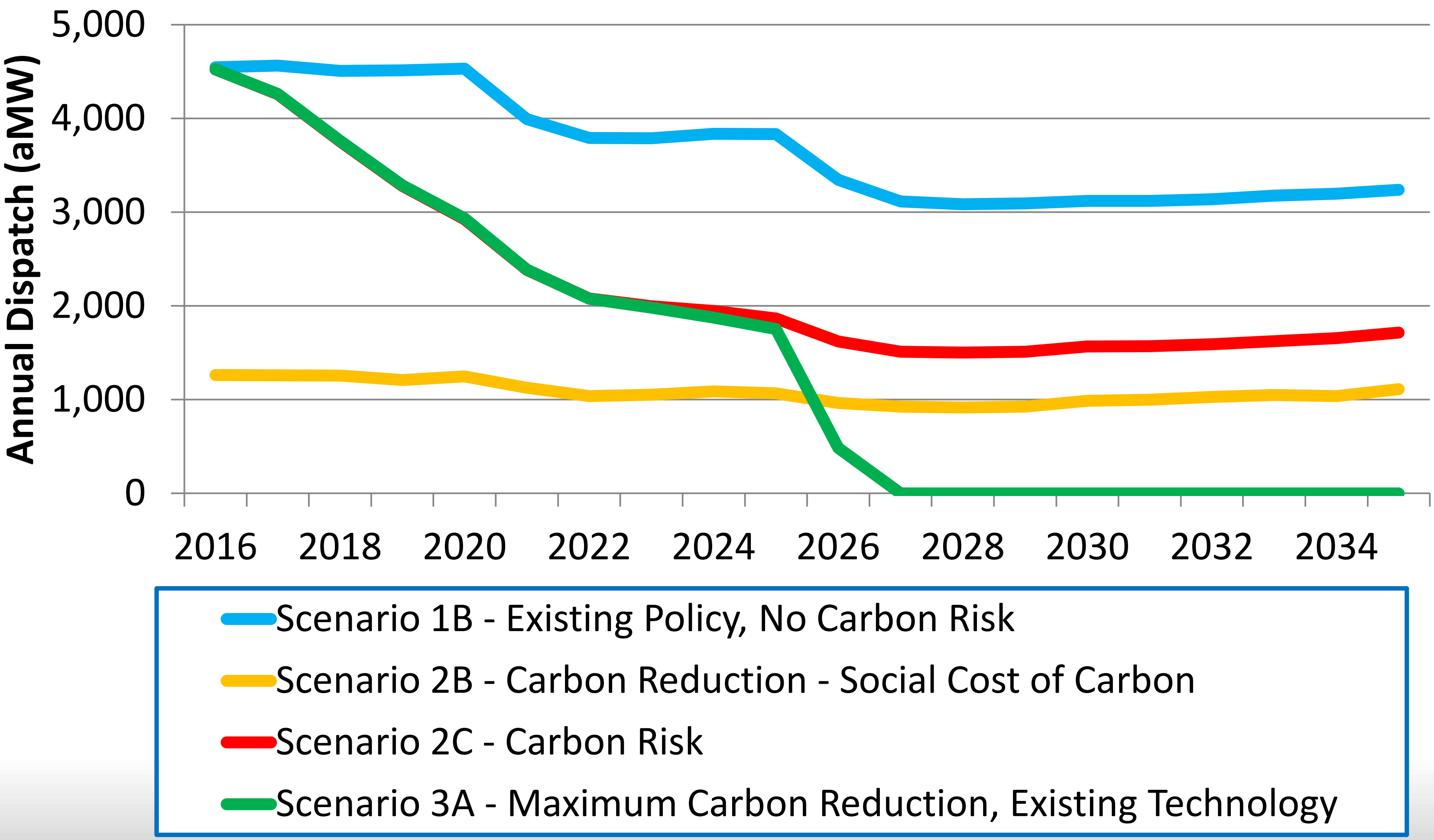
Thermal Resource Dispatch with Carbon Risk - 2C



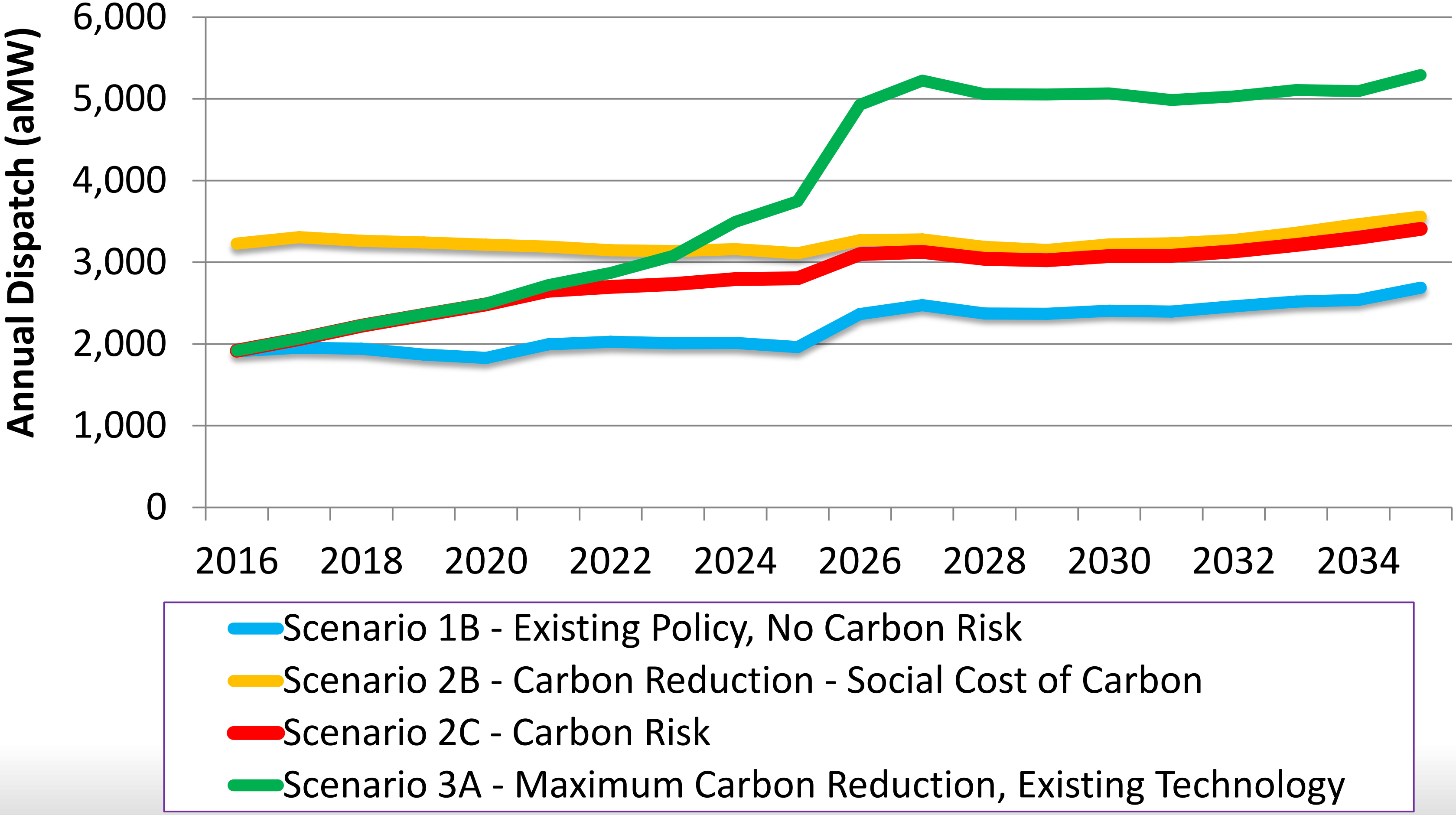
Thermal Resource Dispatch with Coal and Inefficient Gas Retirement



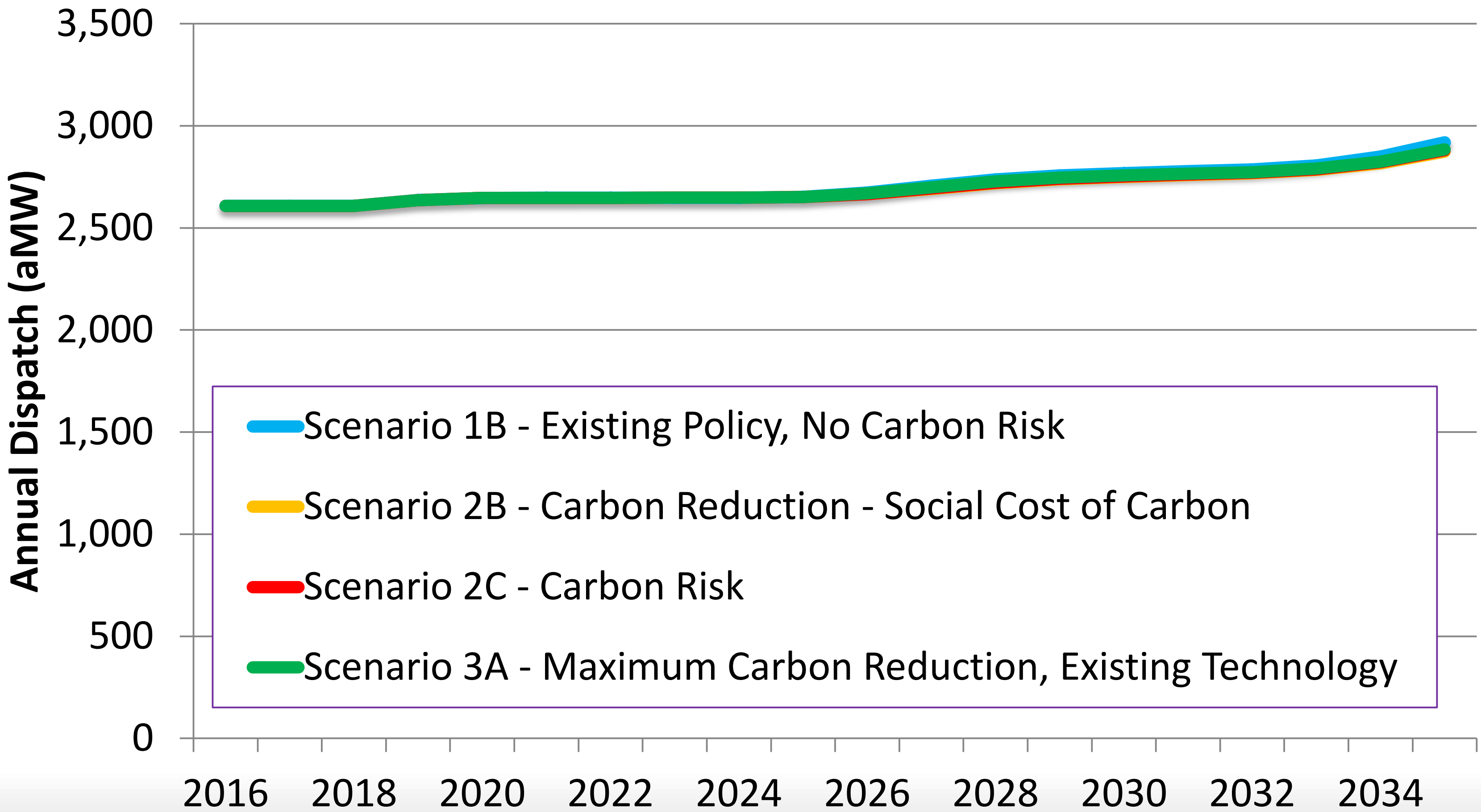
Change in Coal Dispatch
Scenarios 1B, 2B, 2C and 3A



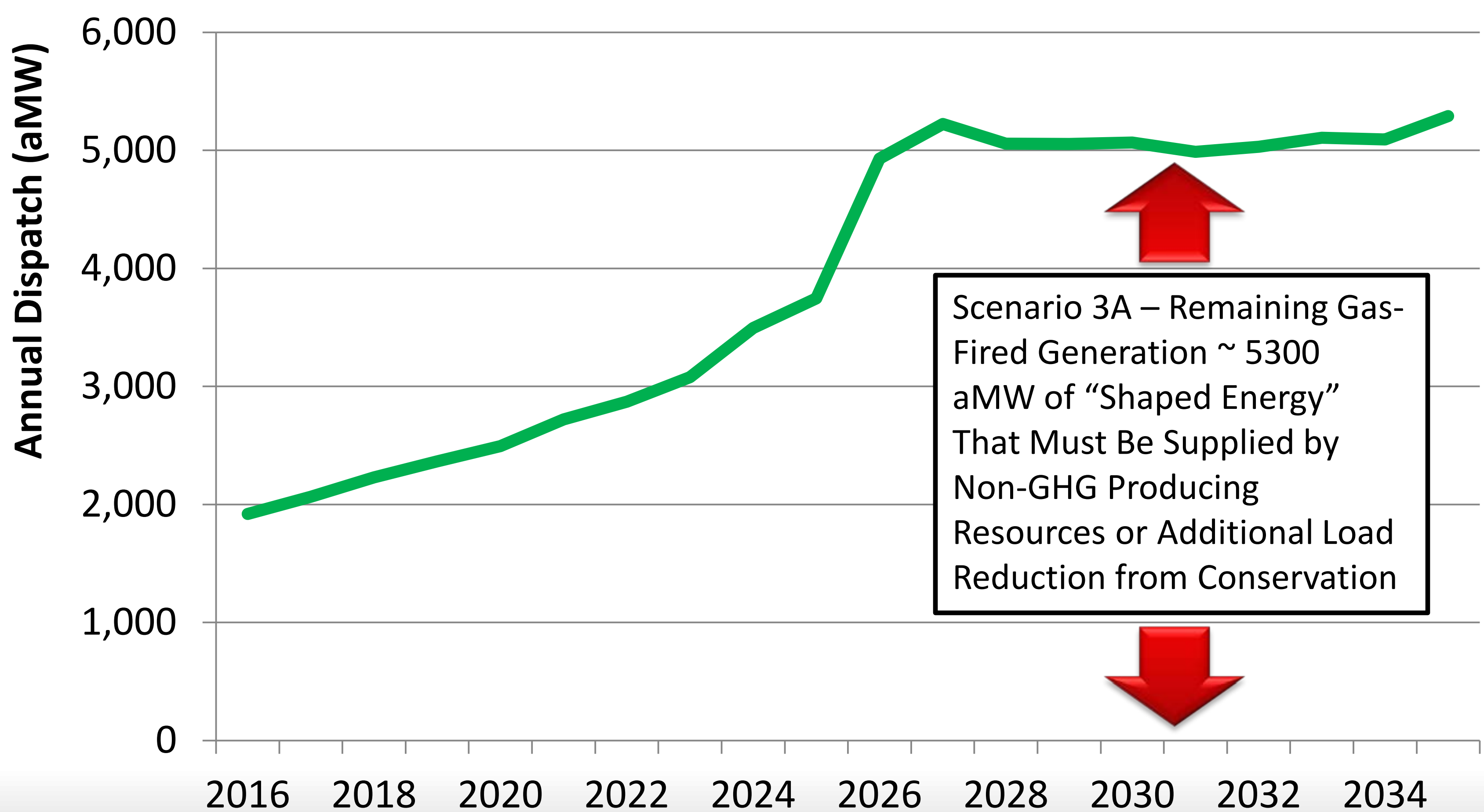
Change in Existing Gas Dispatch Scenario 1B, 2B, 2C and 3A



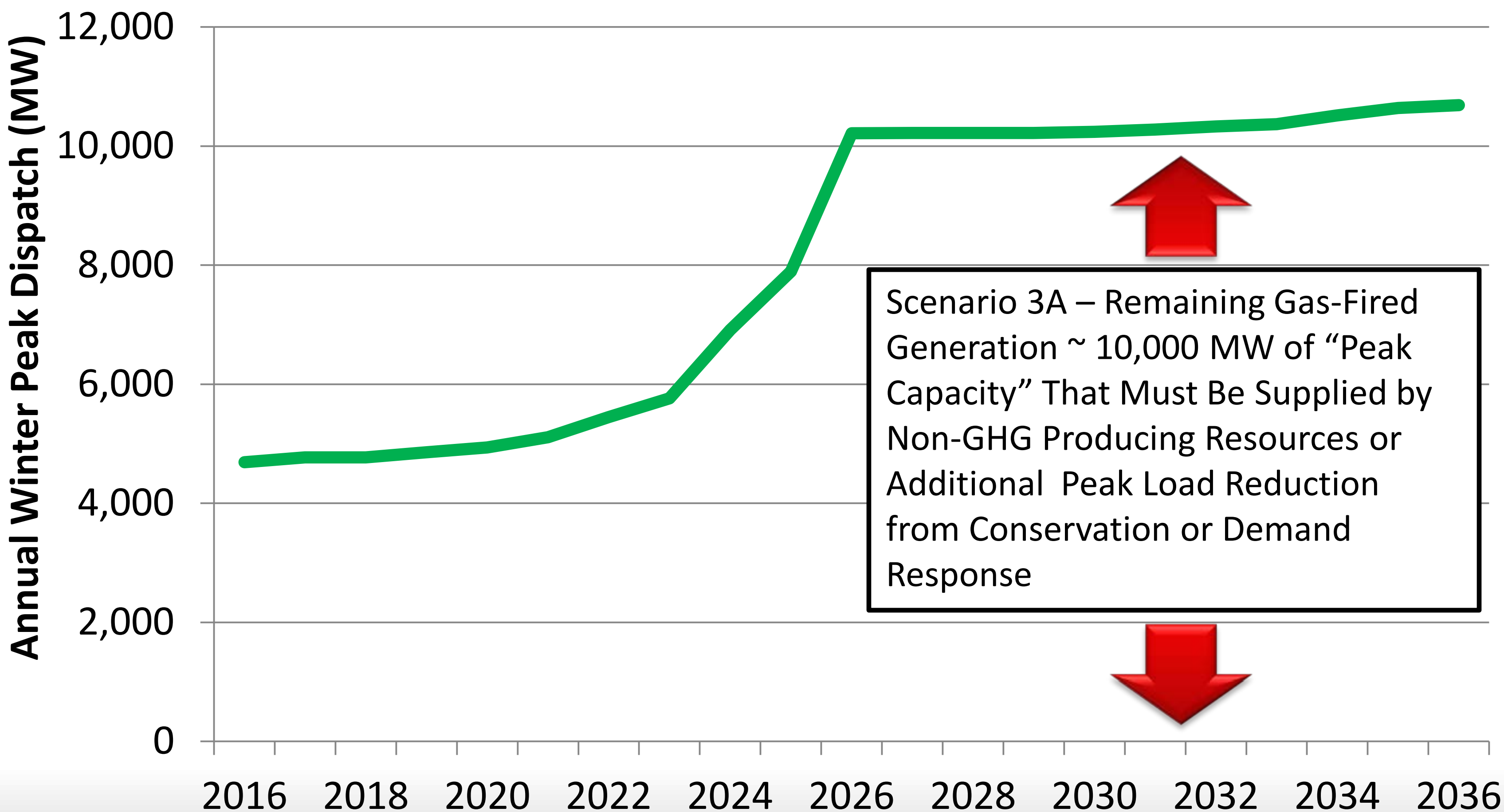
Change in Renewable Resource Dispatch
Scenarios 1B, 2B, 2C and 3A



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 Meeting
  - Revised analysis reflecting model input and model structure changes for scenarios
    - 1B, 2B, 2C, 3A – Updates
    - S3 – No Demand Response