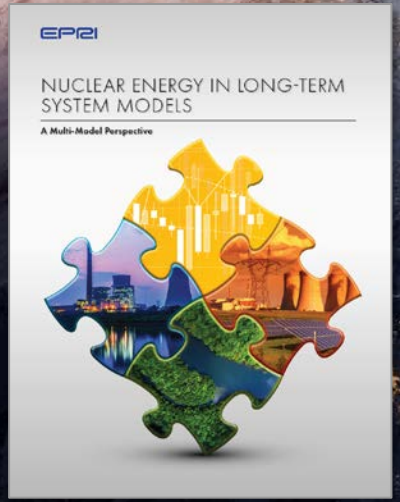


Nuclear's Role in the U.S. Electricity System: A Multi-Model Inter-Comparison Analysis

Jonathan Ho, Caitlin Murphy, and Wesley Cole

ANS Annual Meeting – Anaheim, CA
June 13, 2022

Photo from iStock-627281636

Nuclear and Energy Models

- Long term energy system models are valuable tools for planning and analysis
- Current nuclear represents 20% of generation and 50% of carbon free mix
- Purpose of this project is to understand how issues key to nuclear power are reflected in models of the US power system
- Project builds upon success of past model collaborations
  - 2017: Variable Renewable Energy in Long-Term Planning Models
  - 2020: Energy storage in long-term system models

IPM
EPA

NEMS
EIA

ReEDS
NREL

REGEN
EPRI

Scenario Matrix

Technology Sensitivities

Policy Sensitivities	Native	Harmonized Costs Only	Harmonized Costs and Financing		
			Reference	Low Costs	Carve-Out
Reference ("Current Policies")	R2.1.0	R2.1.1	R2.1.2	R2.1.3	R2.1.4
Deep Decarbonization: 80-by-50	R2.2.0	R2.2.1	R2.2.2	R2.2.3	R2.2.4
Deep Decarbonization: 100-by-50	R2.3.0	R2.3.1	R2.3.2	R2.3.3	R2.3.4

- 100-by-50 scenarios (row) completed by REGEN and ReEDS only (due to challenges with implementing 100% decarbonization in NEMS and IPM)

Policy Sensitivities

Reference ("Current Policies") Scenarios reflect on-the-books state and federal policies and incentives. The goal of this scenario is to estimate how existing and advanced nuclear technologies compete on an economic basis under existing policies.

Deep Decarbonization Scenarios reflect interest in reducing CO_2 emissions:

(a) 80% CO_2 reductions by 2050 (relative to 2005 levels); or

(b) 100% CO_2 reductions by 2050 (relative to 2005 levels)

Technology Sensitivities: Layers on Top of Policy

- **Native:** All modeling teams adopting their current assumptions for technology cost and performance
- **Harmonized Costs Only:** Use NREL's *2020 Annual Technology Baseline*. All costs are exogenous over time
- **Harmonized Costs and Financing:** In addition to the harmonized cost assumptions (above)…
  - **Fixed O&M costs for existing nuclear:** FERC Form 1 plus EUCG for O&M.
  - **Financing:** Discount rate (WACC, real dollar terms) of 3% and capital recovery period (economic lifetime) of 30 years for all investments
  - **Construction time:** Construction time for SMRs is assumed to be five years, while other new nuclear capacity is assumed to be ten years

Technology Sensitivities: Nuclear Power Plant Representation

Reference: Harmonized technology assumptions (previous slide)

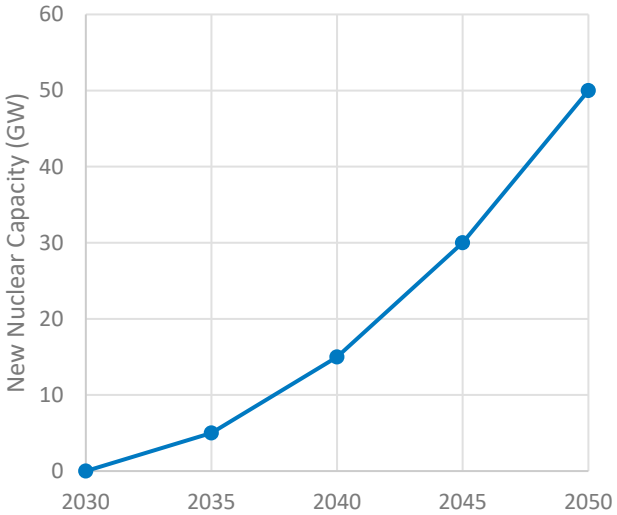
Low-Cost Nuclear: This scenario considers lower cost assumptions for new nuclear SMR capital costs and existing nuclear fixed O&M costs.

Sensitivity	2020	2035	2050
Reference (Harmonized)	$6,200/kW	$5,600/kW	$5,000/kW
Low-Cost Nuclear	$6,200/kW	$2,000/kW	$2,000/kW

Technology Sensitivities: Nuclear Power Plant Representation

Nuclear Carve-Out: This scenario harmonizes model outputs for new nuclear additions over time

- Scenario enforces additions for new nuclear capacity starting in 2035

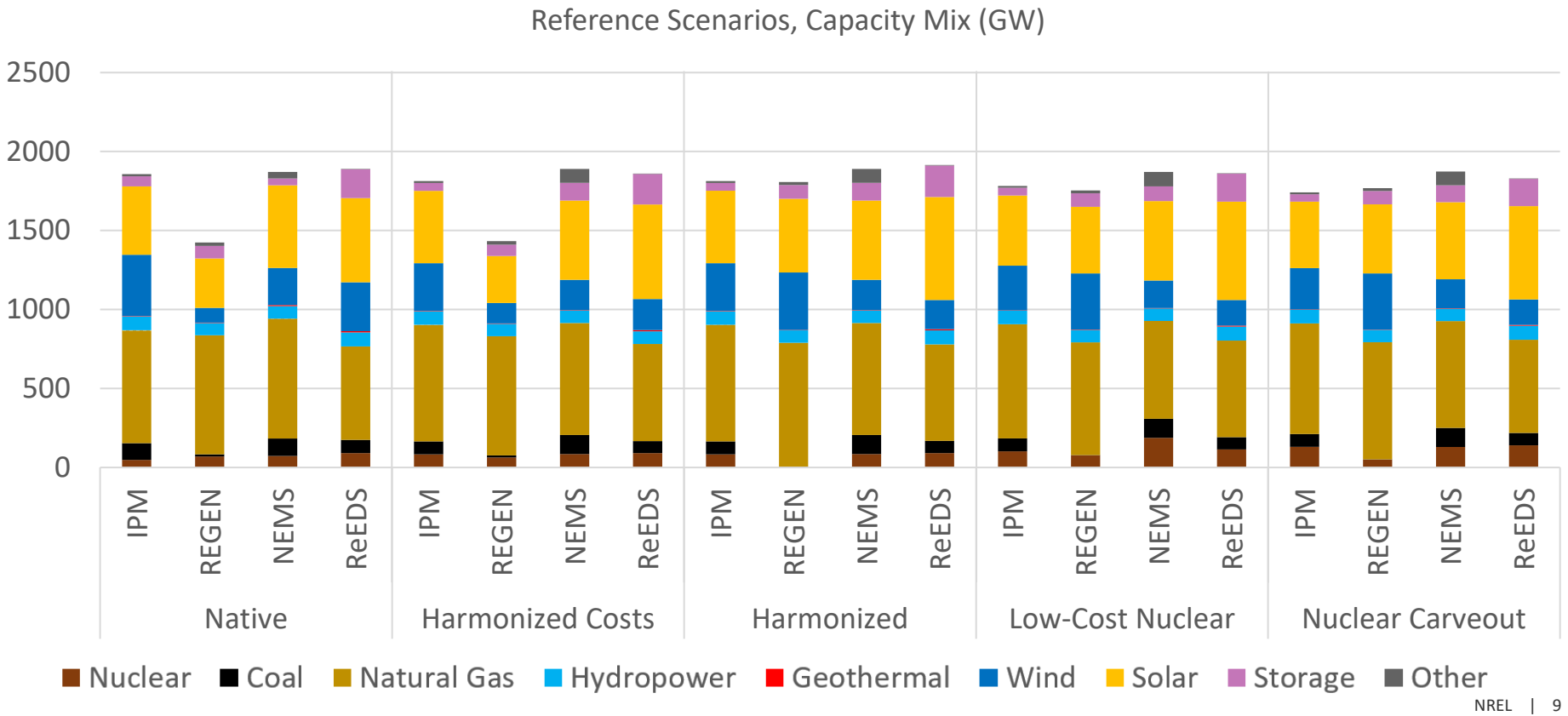


Not all harmonized assumptions are intended to be realistic

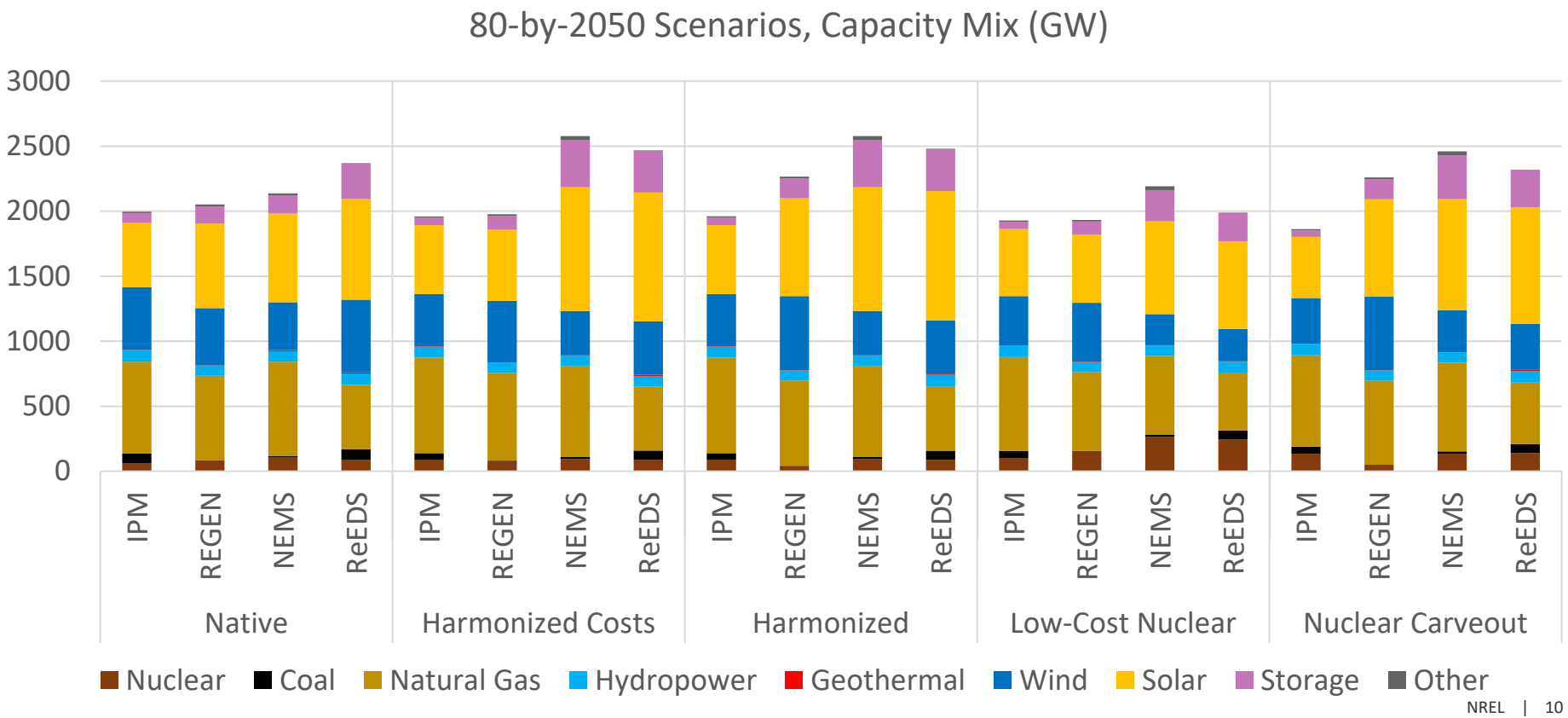
- Purpose is to understand model responses to common assumptions
- Optimistic assumptions drive significant changes

Results

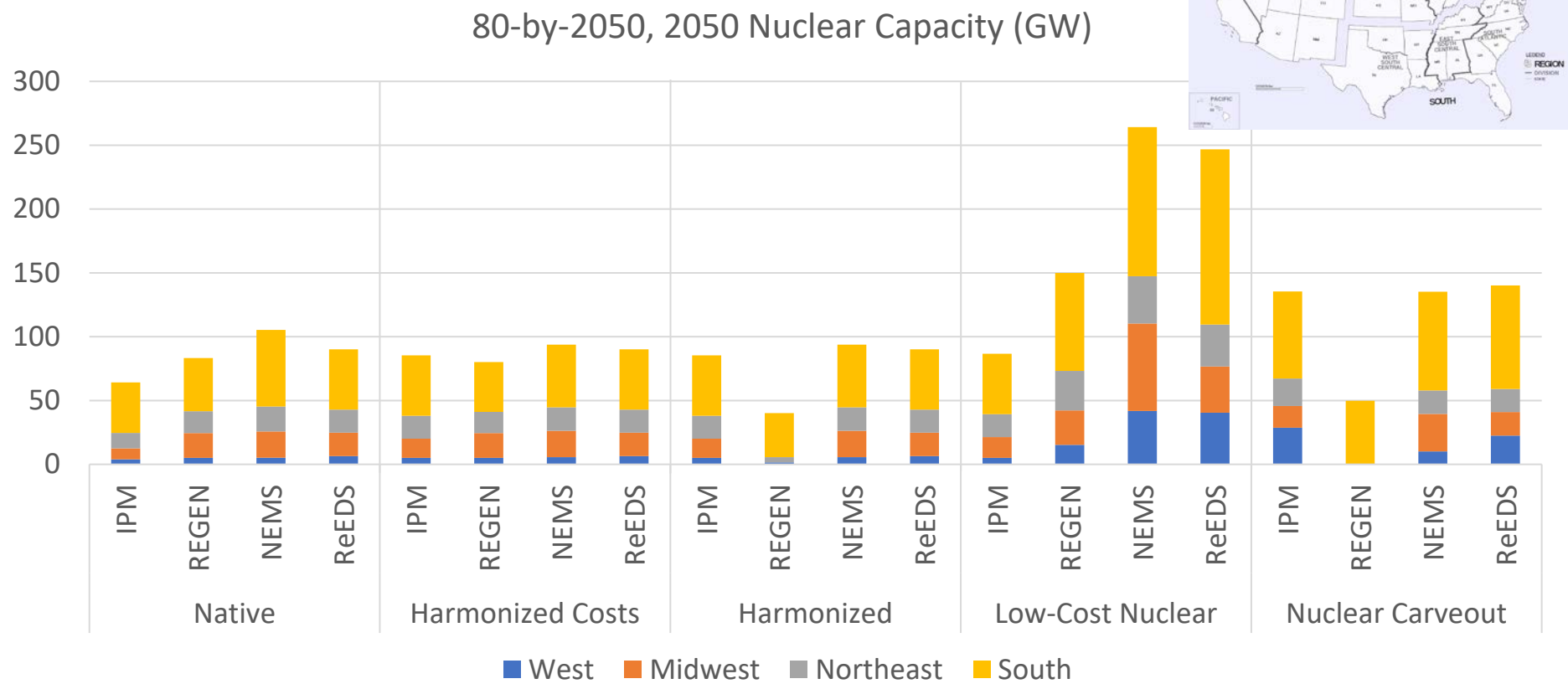
Reference : Capacity Mix Results (2050)



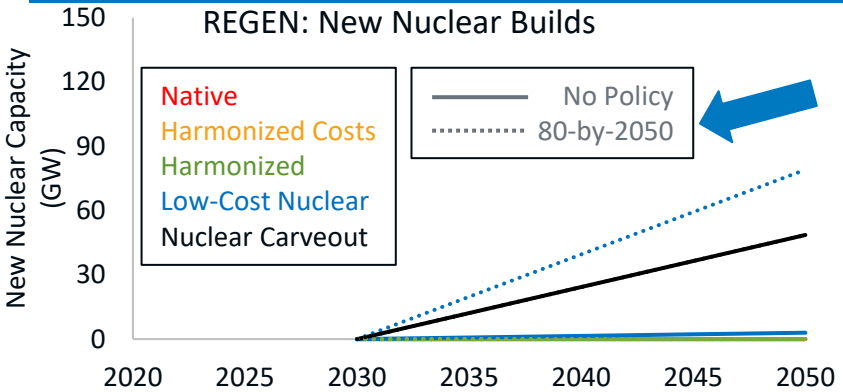
80-by-2050 Scenarios: Capacity Mix Results (2050)

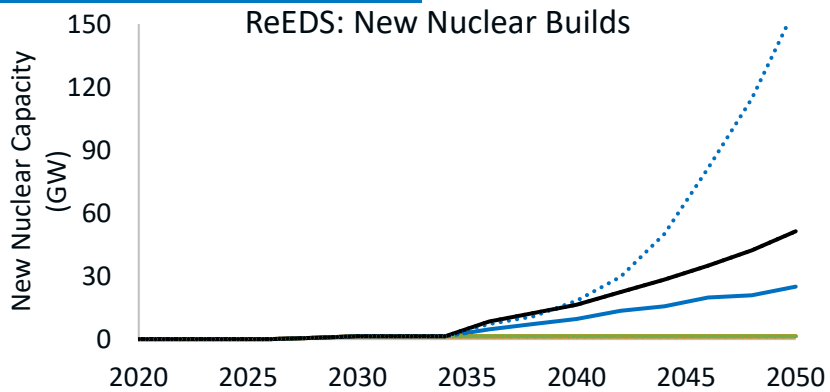


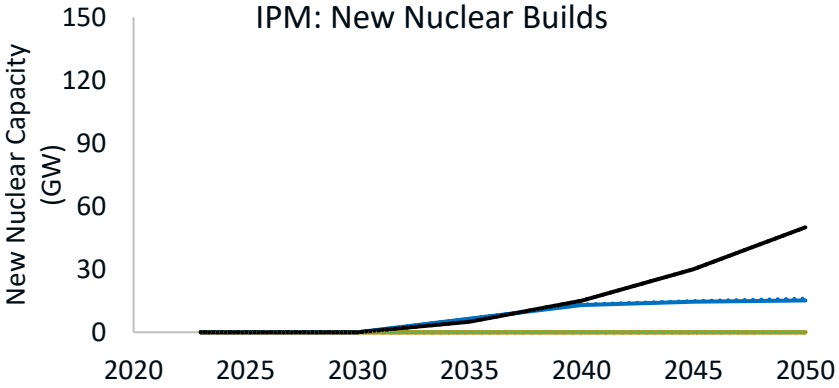
80-by-2050 Scenarios: Regional Nuclear Capacity

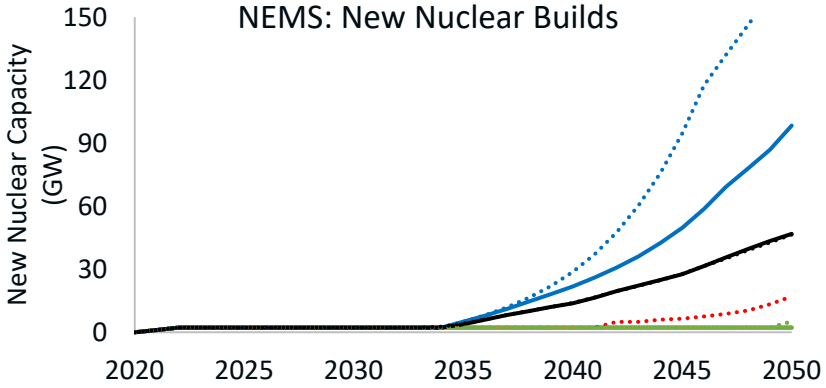


80-by-2050 Scenarios: New Nuclear

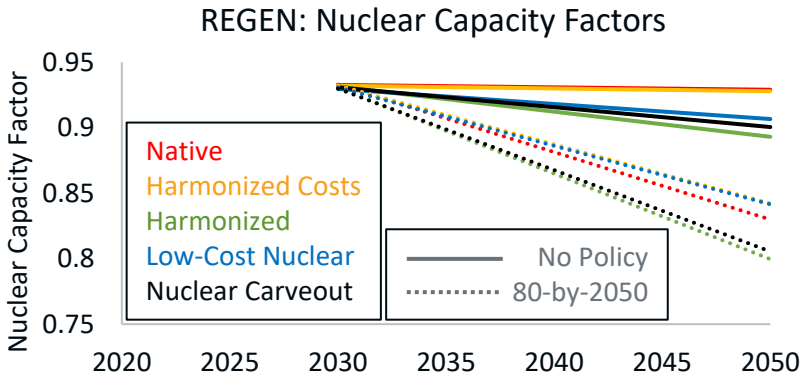


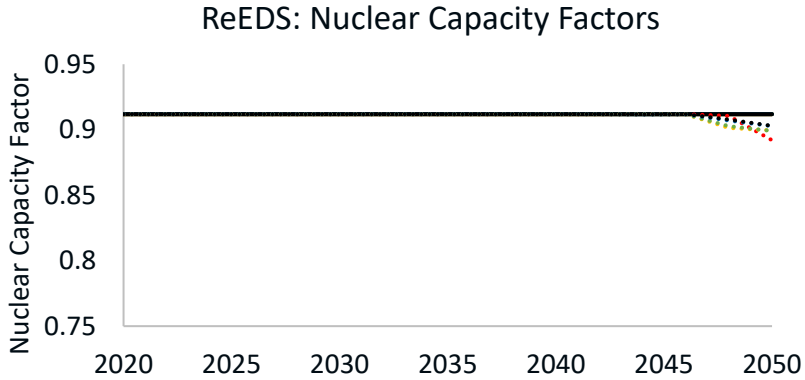


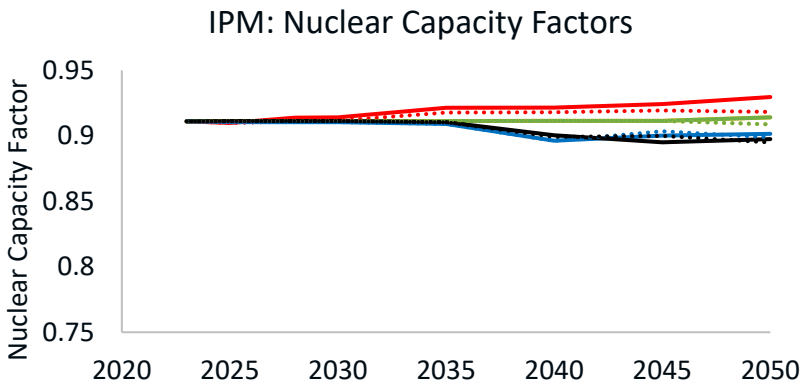


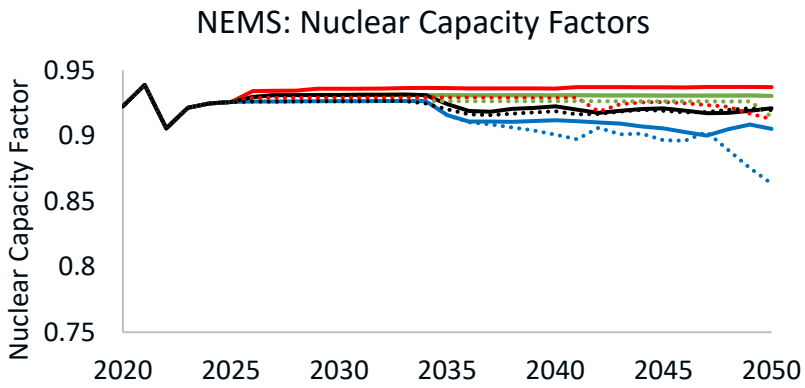


80-by-2050 Scenarios: Capacity Factors (Fleet-Wide)

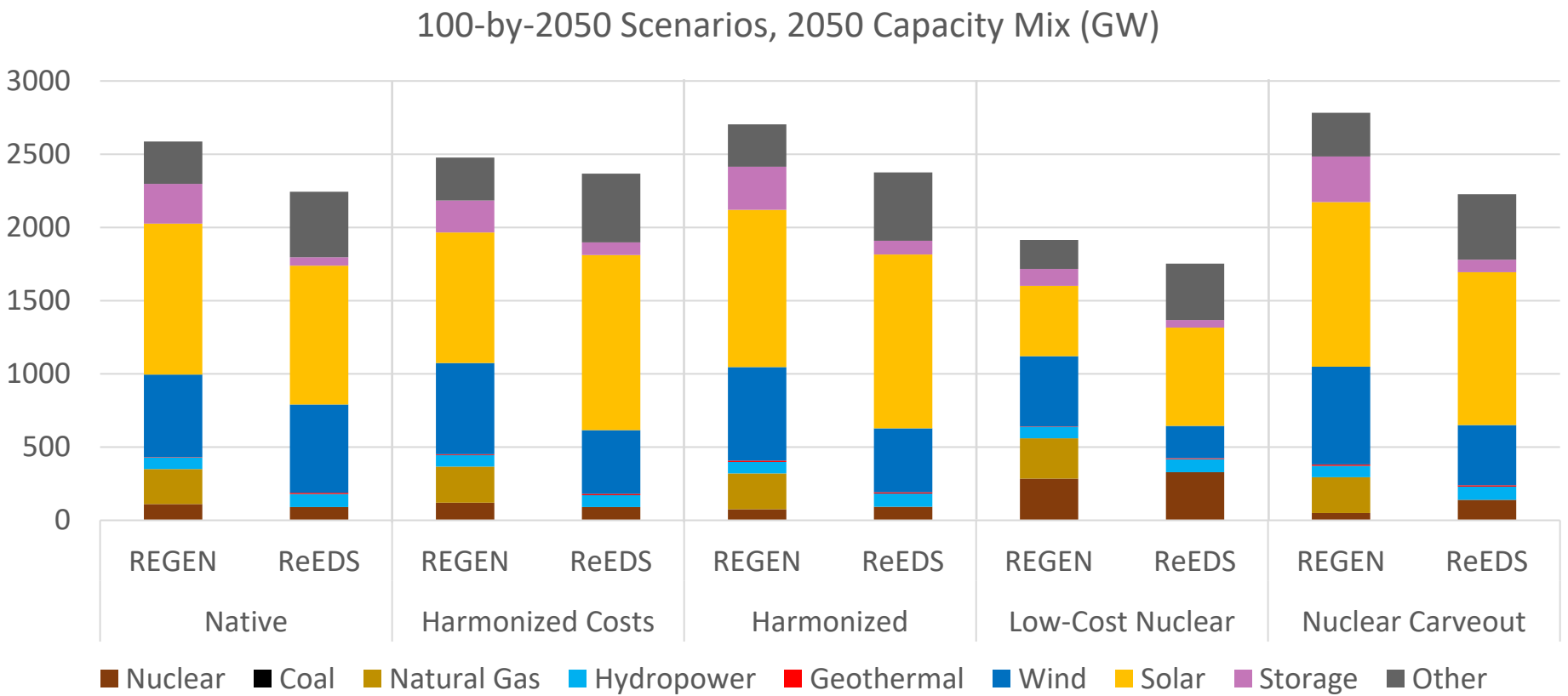




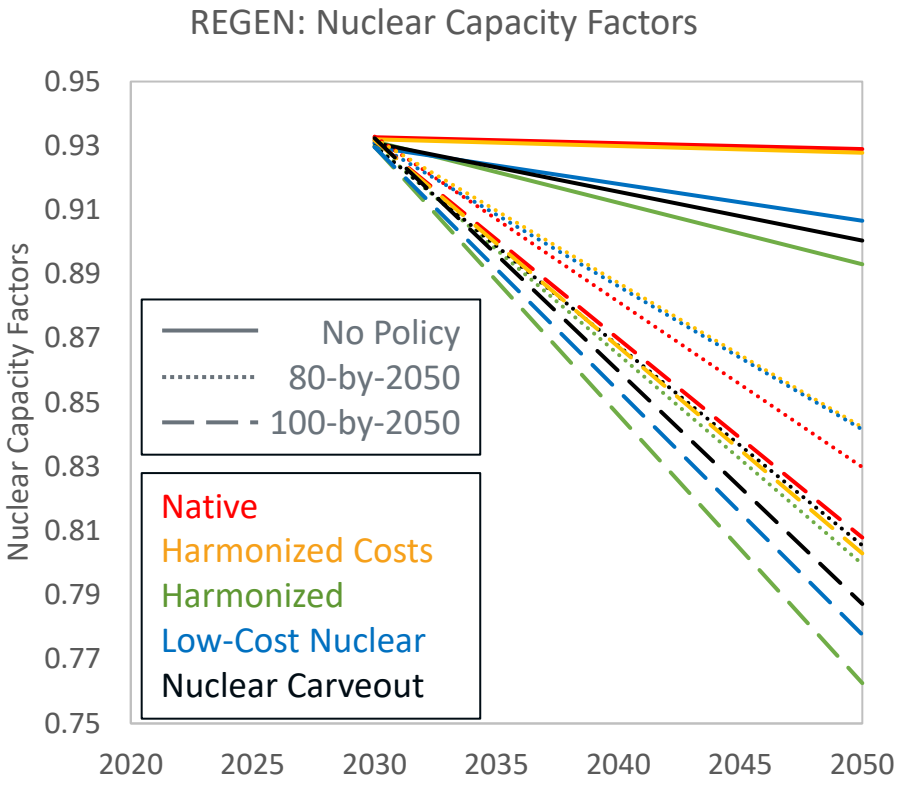


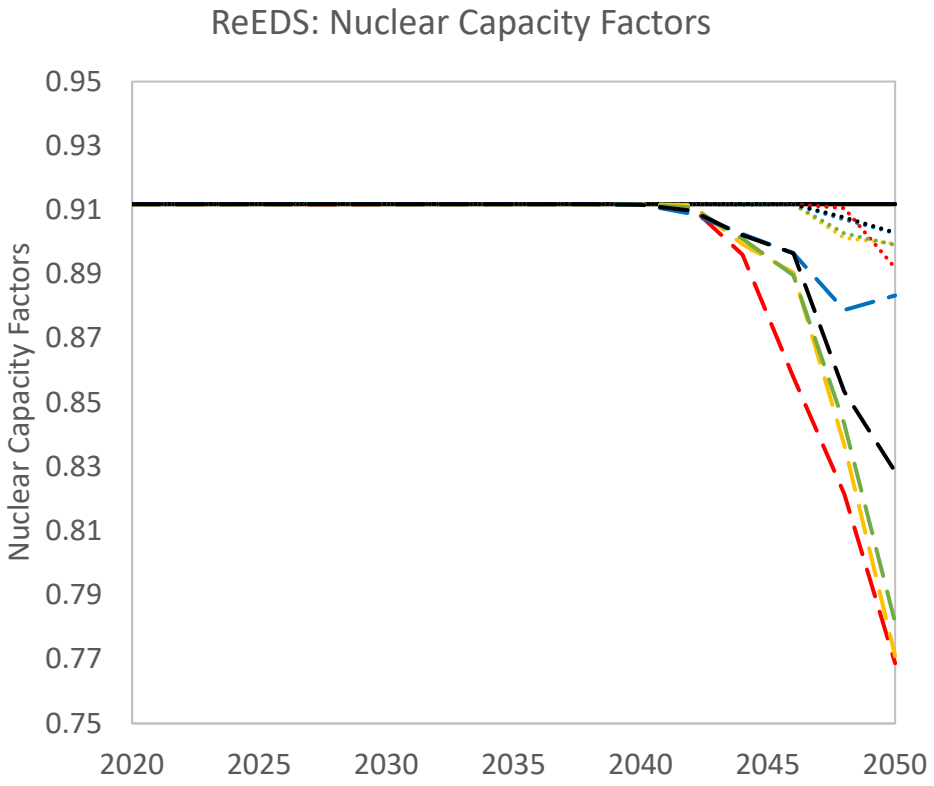


100-by-2050 Scenarios: Capacity Mix Results (2050)



100-by-2050 Scenarios: Nuclear Capacity Factors





Key Takeaways

- Role of nuclear varied with scenario, model structure, and regional representation
  - Nuclear remains an important component of the system with builds and operations responsive to scenario assumption
  - Harmonization improved alignment in models, but differences due to model structure remain
- Technology cost improvement and CO_2 policy most impactful for new nuclear capacity
- Policy, financial assumptions, and regional characteristics are key drivers of nuclear additions
- Nuclear provides firm capacity and carbon free electricity, which complements renewables and storage in low-carbon systems

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Thank You

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