

EPRI

ELECTRIC POWER
RESEARCH INSTITUTE

Prism 2.0:
Preliminary Insights from
EPRI's Regional Model

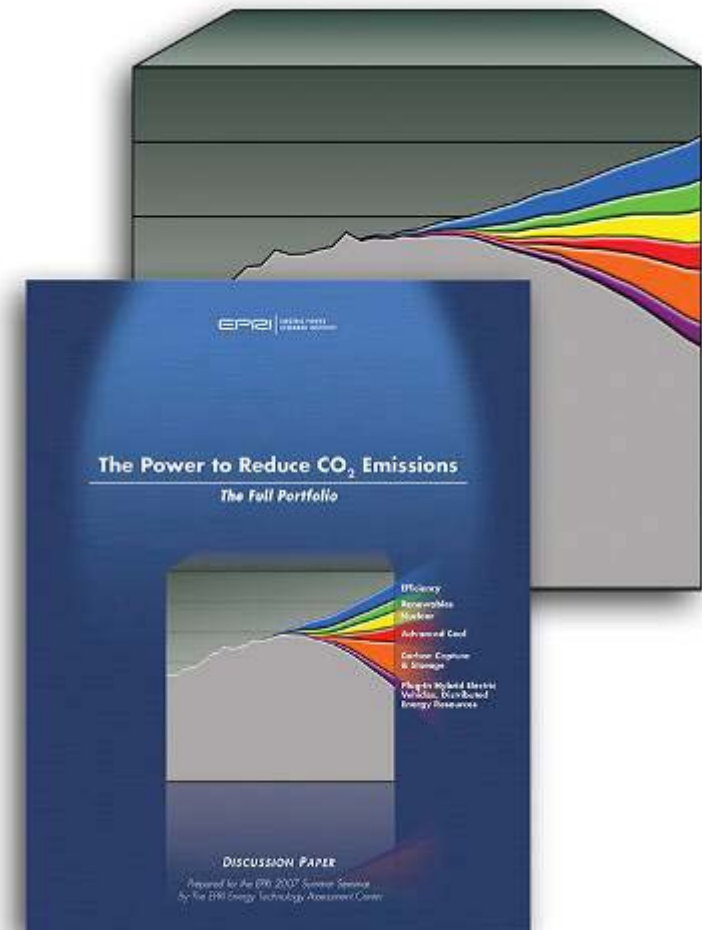
Victor Niemeyer, Ph.D.
Technical Executive, Environment

South Carolina PURCEAC Meeting
February 25, 2011

EPRI's Prism / MERGE Analysis

Roadmap for a low-carbon future...

- Detailed analysis of the pathway to reducing CO₂ emissions across the electricity sector
- Provided guidance on the needed generation mix to slow, stop and reverse CO₂ emissions
- Cited in numerous national and international publications
- Basis for new EPRI programs and demonstration projects



Electric Sector CO₂ Reductions: What is **possible**?

Context

The EPRI Prism **IS** ...

- A bottom-up estimate of GHG reduction potential (if we accomplish X , we can reduce emissions by Y)

The EPRI Prism is **NOT** ...

- A rigorous unit-by-unit assessment
- A detailed economic analysis
- A climate policy recommendation

Intended to start conversations about technology, not end them!

Options to Reduce Electric Sector Emissions

- Efficiency
 - End-Use Efficiency
 - T&D Loss Reduction
- Renewables
 - Central Station (Wind, Solar CSP, Biomass, Geothermal)
 - Distributed (Solar PV)
- Nuclear
 - Existing Plant Life Extension
 - New Advanced Reactors
- Fossil Plant Efficiency
 - Heat Rate Improvements for Existing Coal
 - High Efficiency New Coal and New Gas
- Carbon Capture and Storage
 - Existing Coal Retrofits
 - All New Coal + NGCC Post-2020
- Expanded Use
 - PHEVs
 - Electrotechnologies

EPRI Analysis and Initiatives

EPRI RPS Analysis

EPRI – INL Roadmap

EPRI – CURC Roadmap

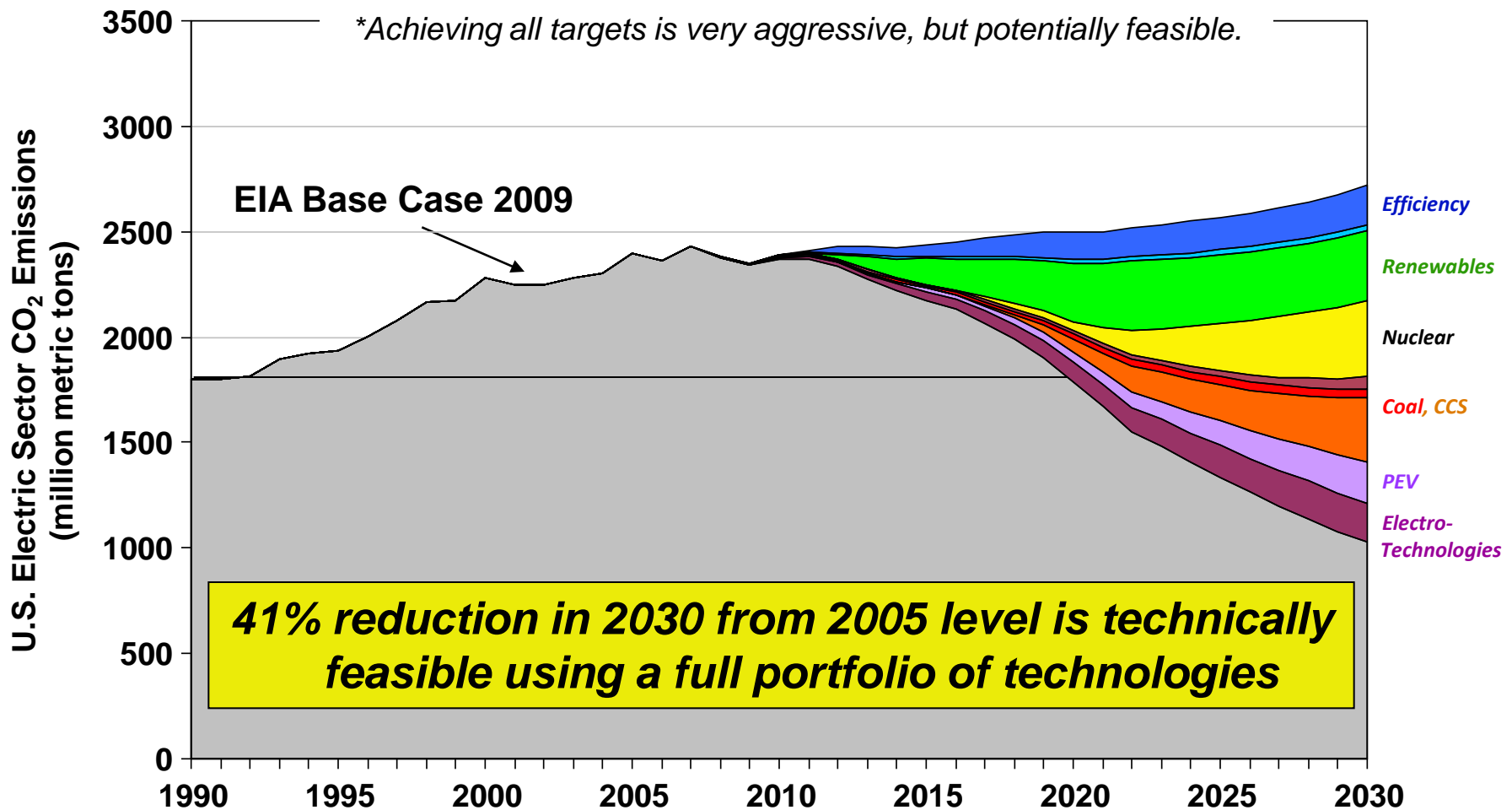
EPRI CoalFleet; CCS Demos

EPRI Analysis

2009 Prism Technology Targets

	<i>Technology</i>	<i>EIA AEO Base Case</i>	<i>EPRI Prism Target</i>
	Efficiency	Load Growth ~ +0.95%/yr	Load Growth ~ +0.47%/yr
	T&D Efficiency	None	20% Reduction in T&D Losses by 2030
	Renewables	60 GWe by 2030	135 GWe by 2030
	Nuclear	12.5 GWe New Build by 2030	No Retirements; 64 GWe New Build by 2030
	Fossil Efficiency	40% New Coal, 54% New NGCCs by 2030	+3% Efficiency for 75 GWe Existing Fleet 49% New Coal; 70% New NGCCs by 2030
	CCS	None	90% Capture for All New Coal + NGCC After 2020 Retrofits for 60 GWe Existing Fleet
	Electric Transportation	None	PEVs by 2010; 40% New Vehicle Share by 2025 3x Current Non-Road Use by 2030
	Electro-technologies	None	Replace ~4.5% Direct Fossil Use by 2030

CO₂ Reductions ... Technical Potential*



Key Insights from Prism/MERGE

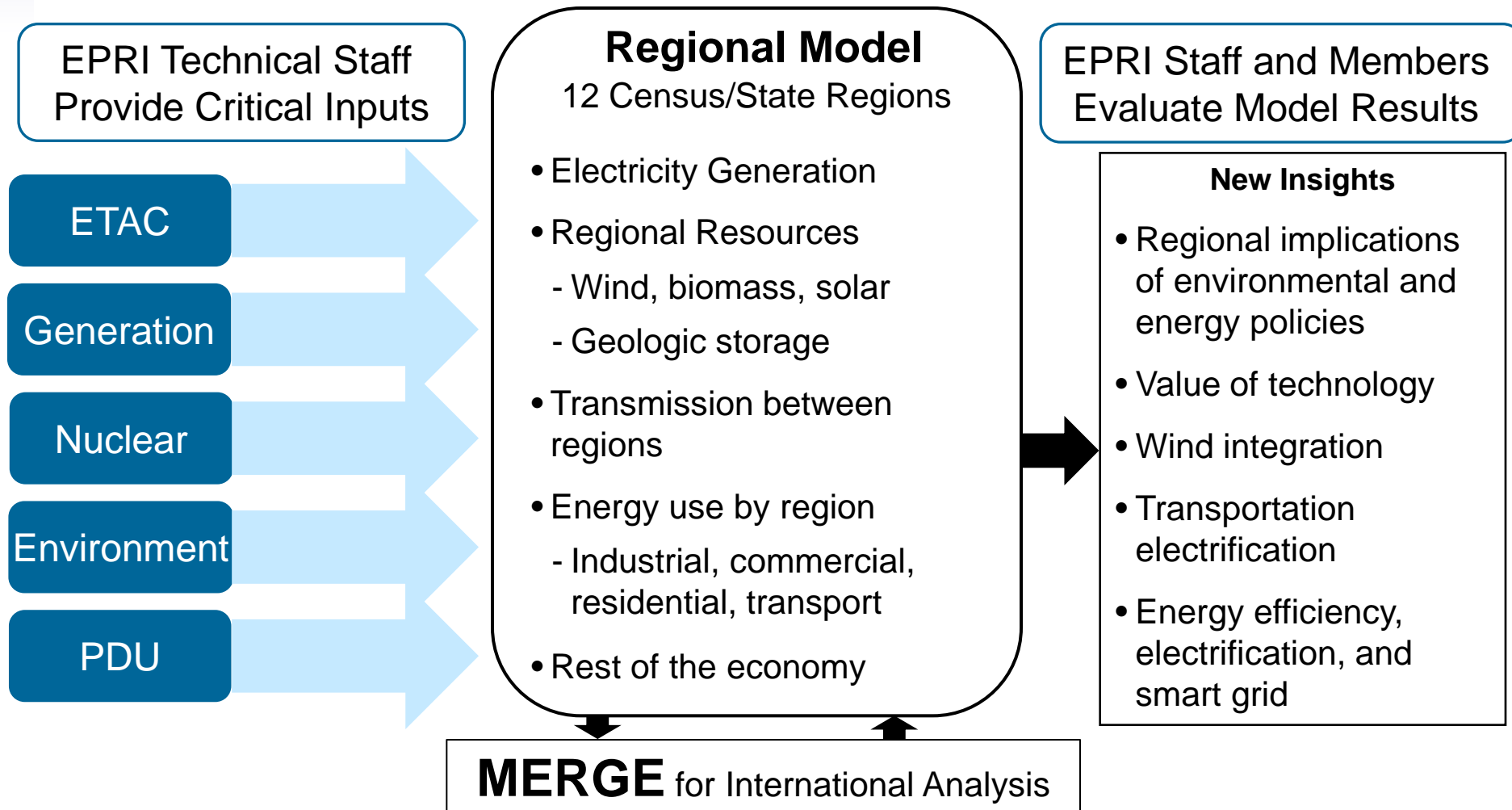
- The technical potential exists for the U.S. electricity sector to significantly reduce its CO₂ emissions over the next several decades.
- Low-carbon electricity technologies can drive growth in electricity demand even as CO₂ emissions are reduced.
- A low-cost, low-carbon portfolio of electricity technologies can significantly reduce the costs of climate policy.
- No one technology will be a silver bullet – a portfolio of technologies will be needed.
- Much of the needed technology isn't available yet – substantial R&D, demonstration is required.

Why Prism 2.0?

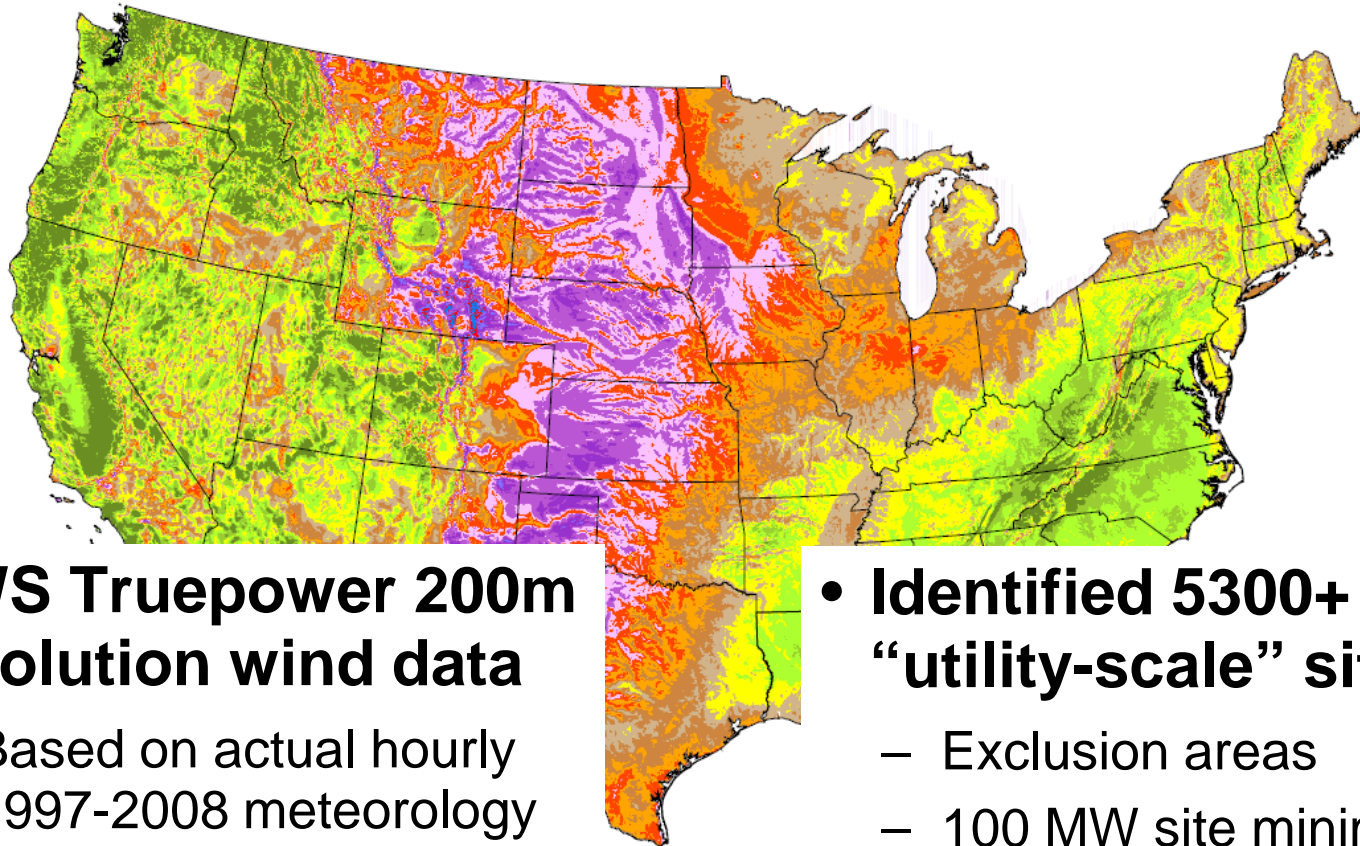
- **New Regional Economic Model**
- **Improved treatment of renewable energy**
 - *High-resolution wind and solar resource data*
 - *Full treatment of integration costs of variable generation*
 - *Integrated biomass model with resource competition*
- **Expanded demand-side detail by region and technology**
 - *Energy efficiency, demand response, and distributed resources*
 - *Electric transportation and electro-technologies*
- **Full complement of environmental regulations**

The Next Generation of EPRI Analysis

Leveraging EPRI Technology and Expertise



New Wind Resource Data: Capturing the Variability of Wind



- **AWS Truepower 200m resolution wind data**

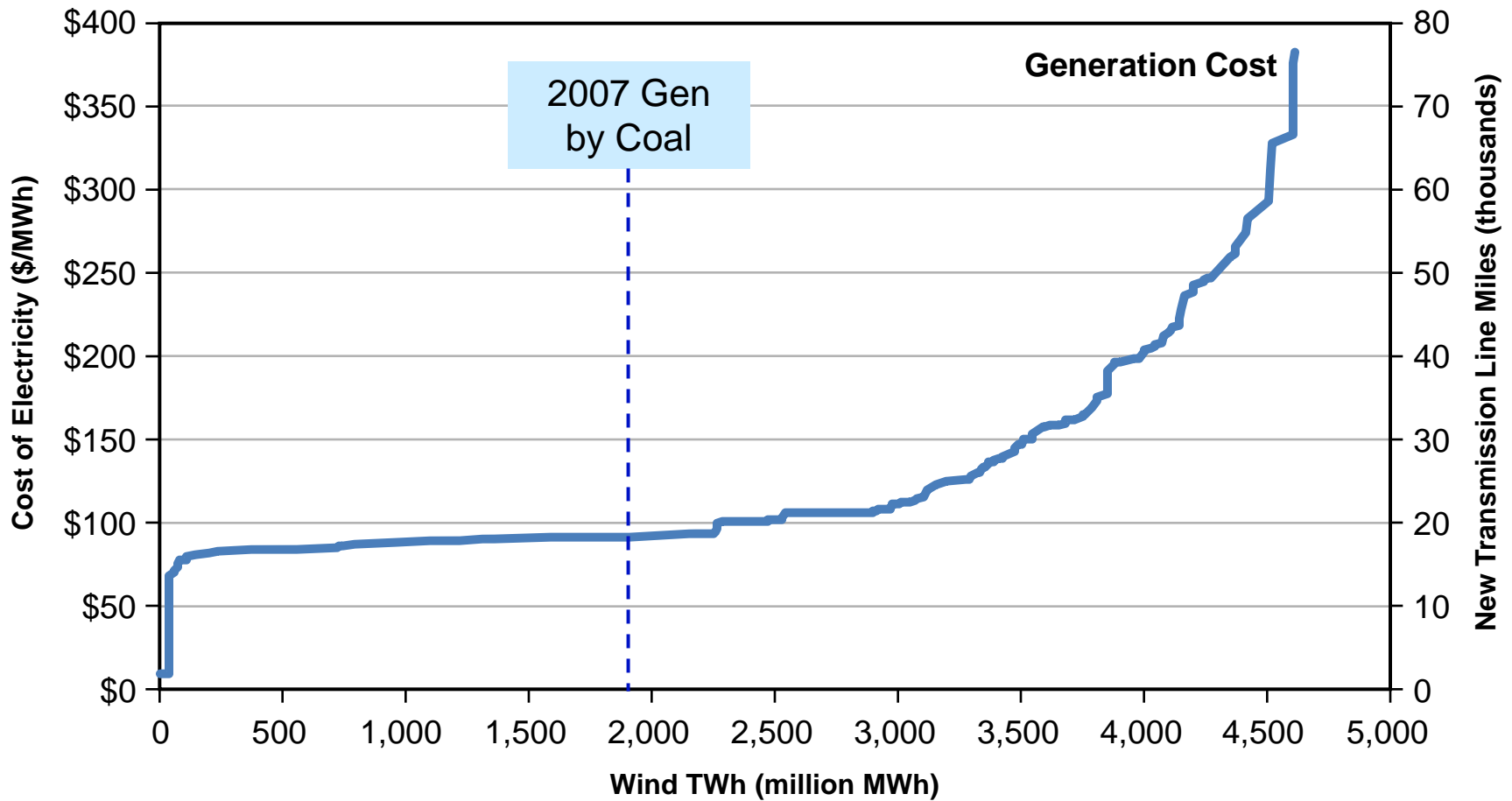
- Based on actual hourly 1997-2008 meteorology
- Provides simulated output for typical turbine (80m height, 1.5 MW)

- **Identified 5300+ “utility-scale” sites**

- Exclusion areas
- 100 MW site minimum
- Distance to grid
- Terrain/wake effects

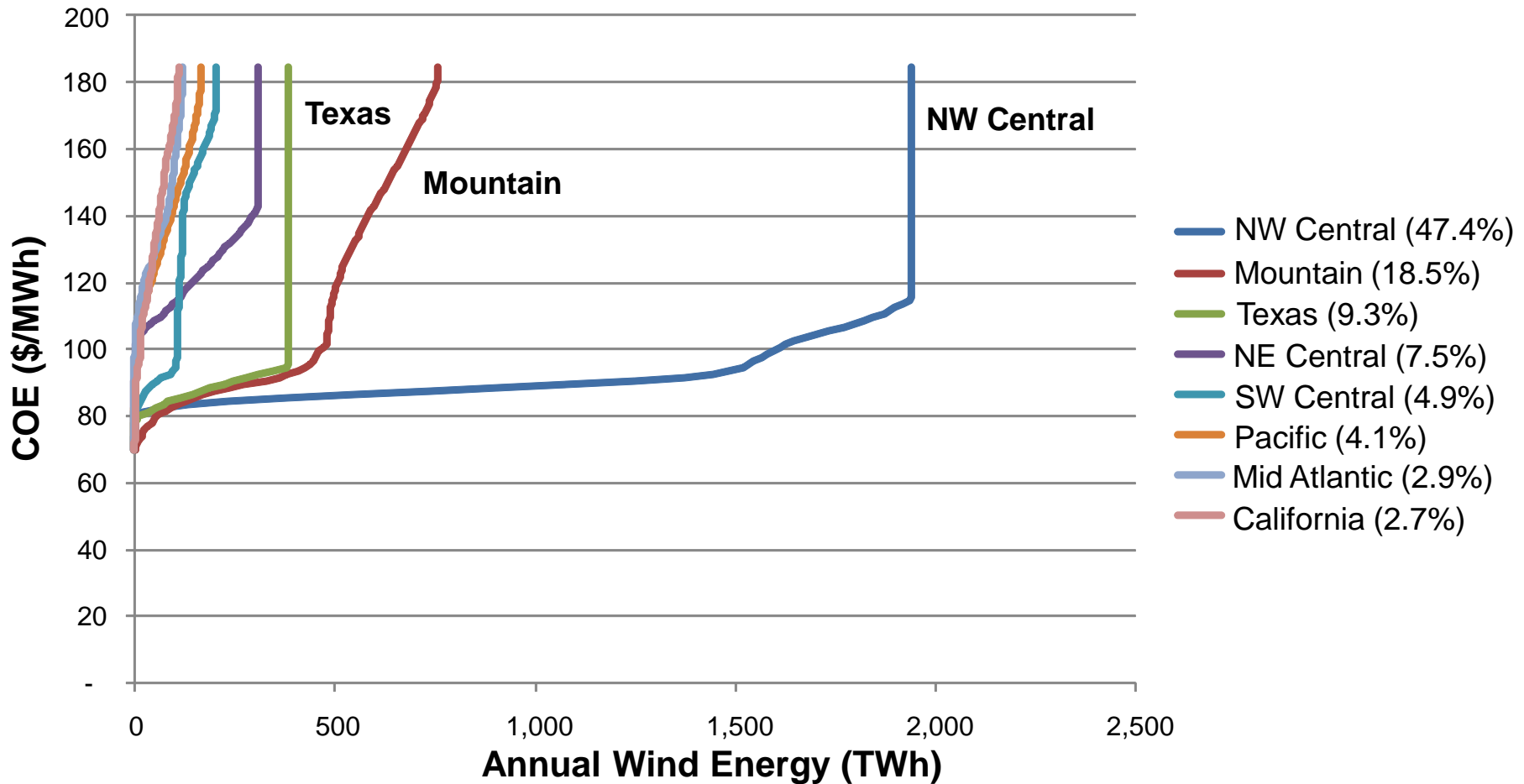
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National Wind Energy Potential* (excluding delivery costs)



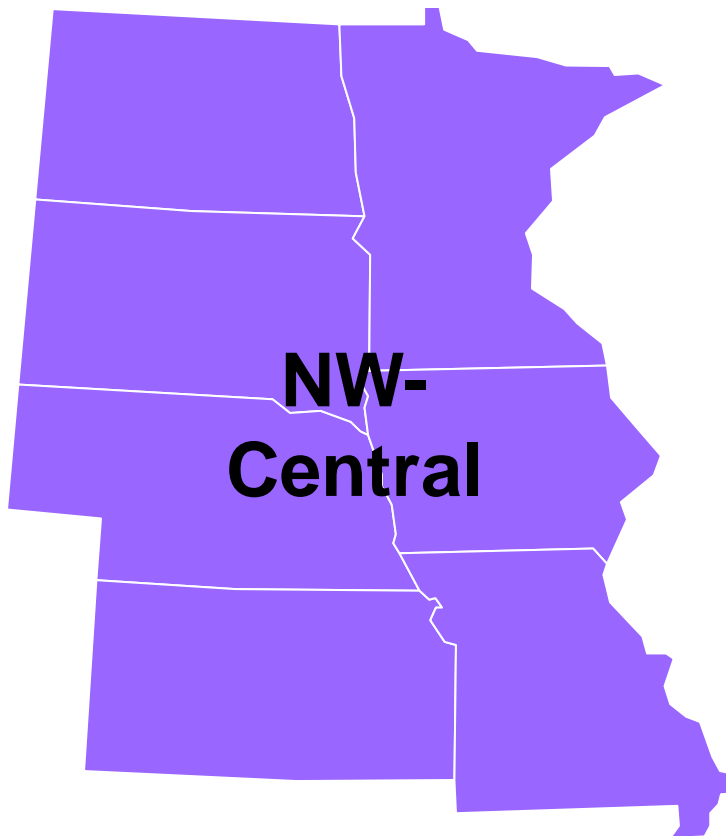
*EPRI – AWS TruePower National Wind Energy Supply Curve

Wind Energy Potential by Region (excluding delivery costs)



Uneven Regional Distribution.... ~50% of Economic Resource in NW Central

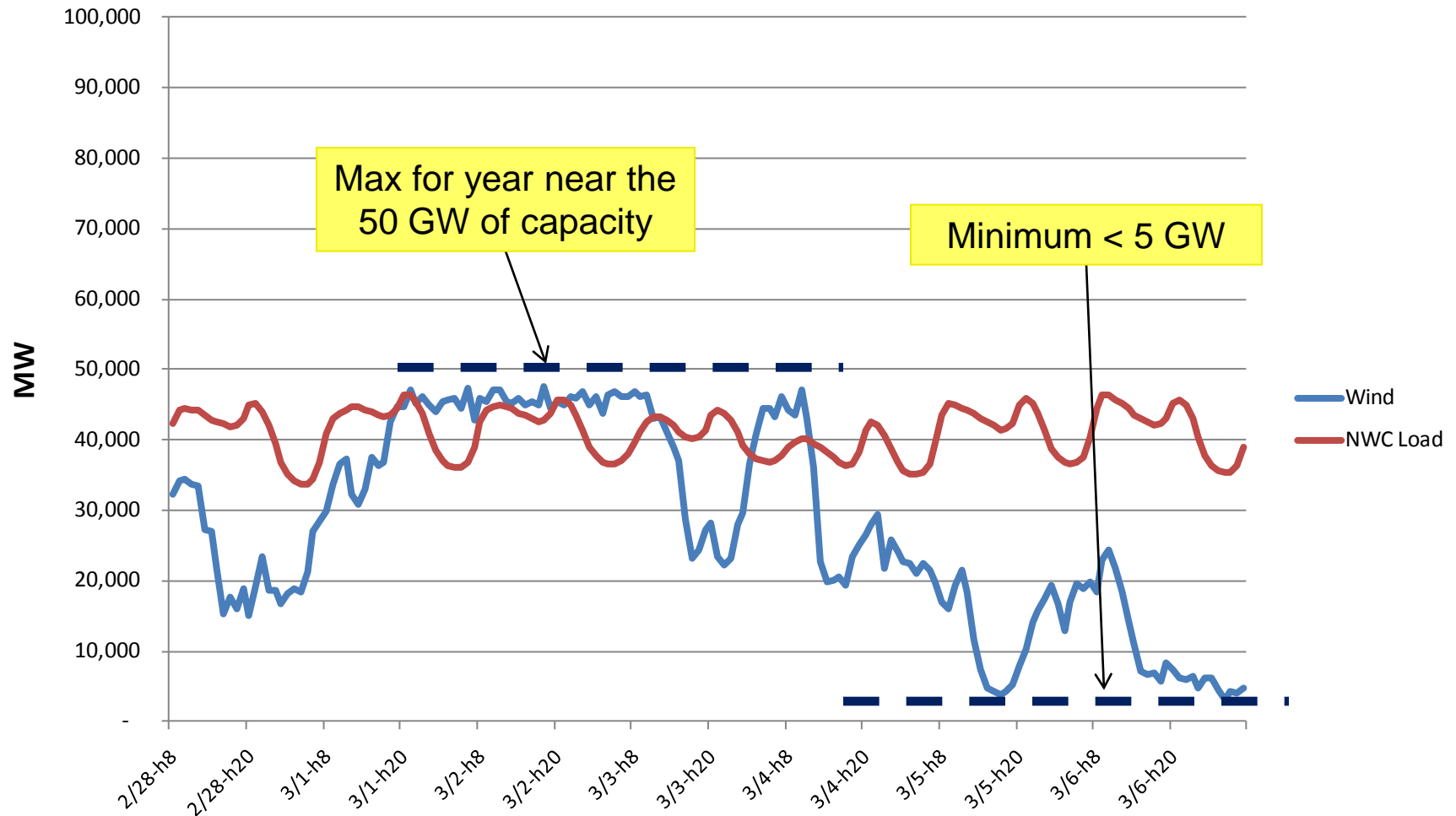
Focus on NW-Central Region



- State hourly load data for 2007 from Energy Velocity
- Hourly loads and wind output synchronized so driven by same 2007 meteorology
- Add 50 GW new installed wind capacity within region
- Rank sites by capacity factor, build best sites first

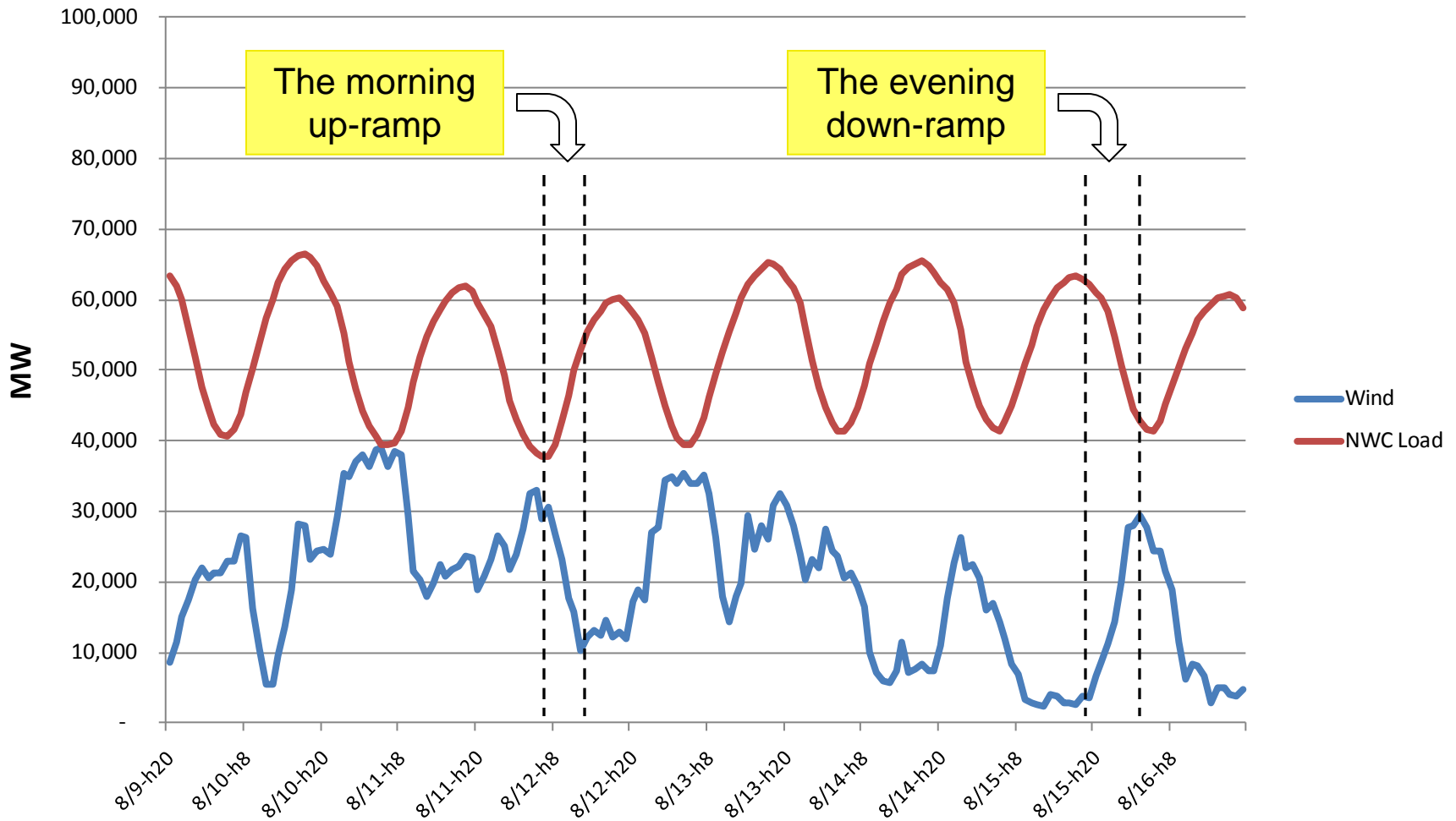
New Model Approach Captures Wind Variability

NWC Time Series from 2/28/07 to 3/7/07 w 50 GW Added

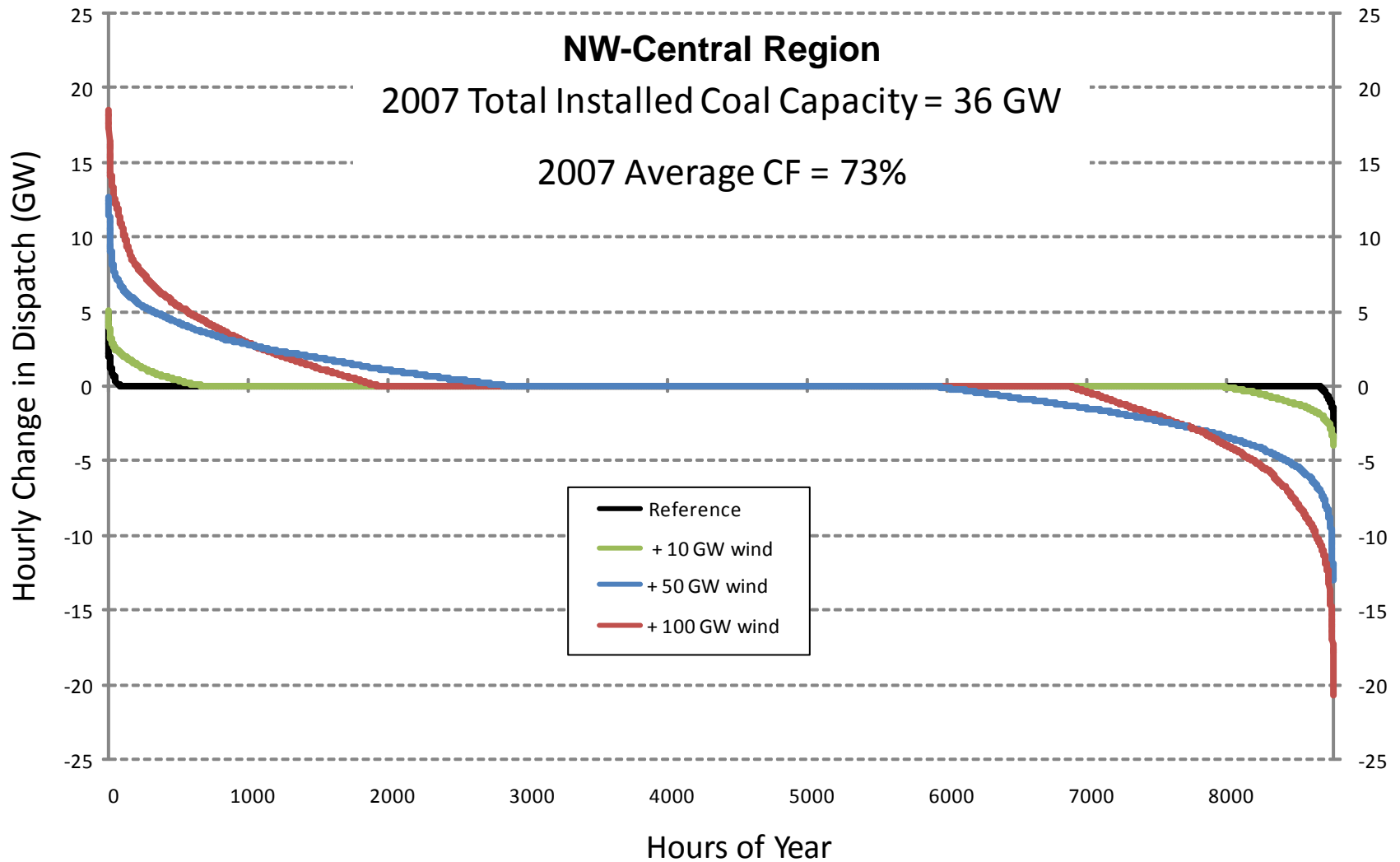


Anti-correlation of Wind with Load Creates Ramping Issues

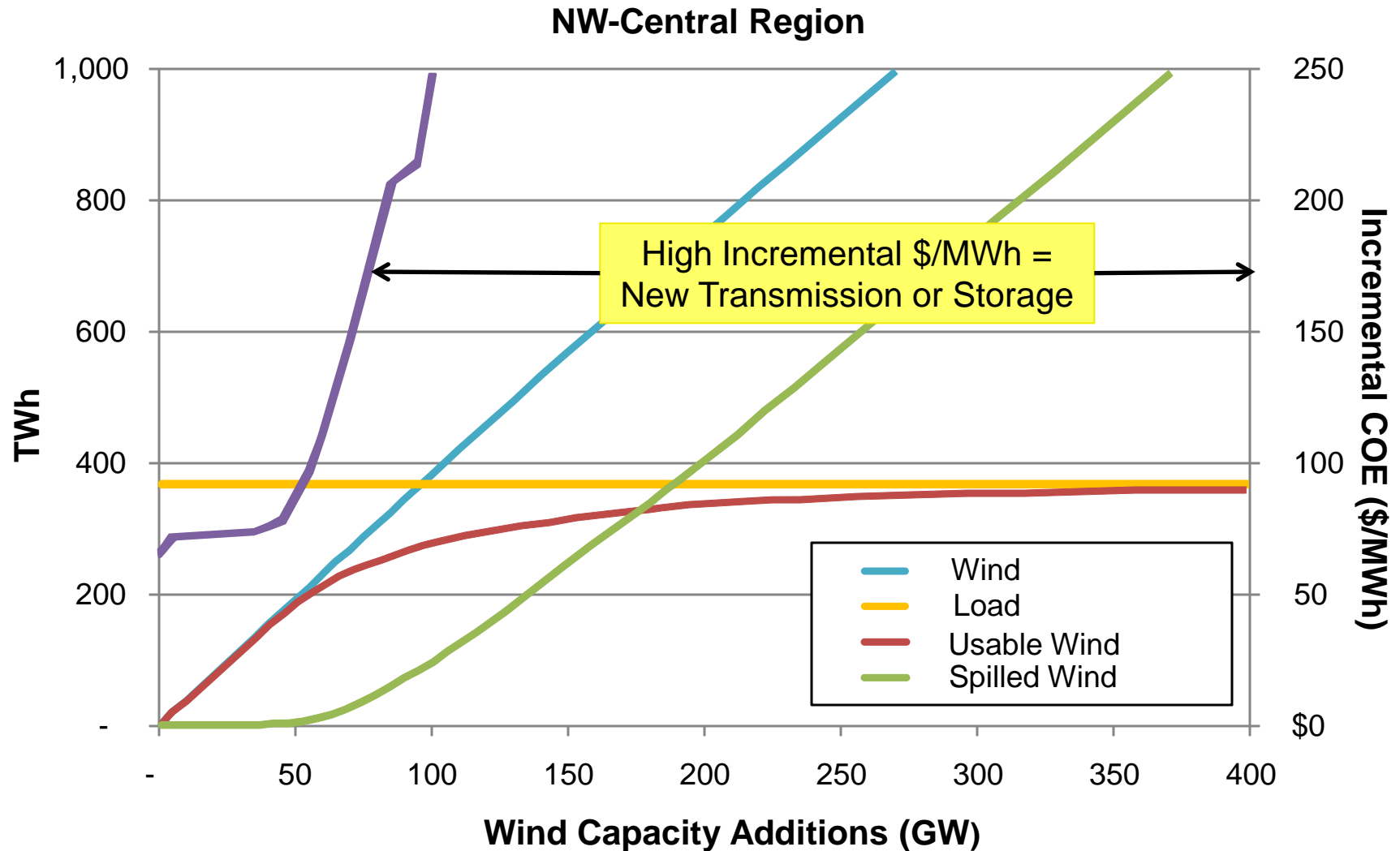
NWC Time Series from 8/9/07 to 8/16/07 w 50 GW Added



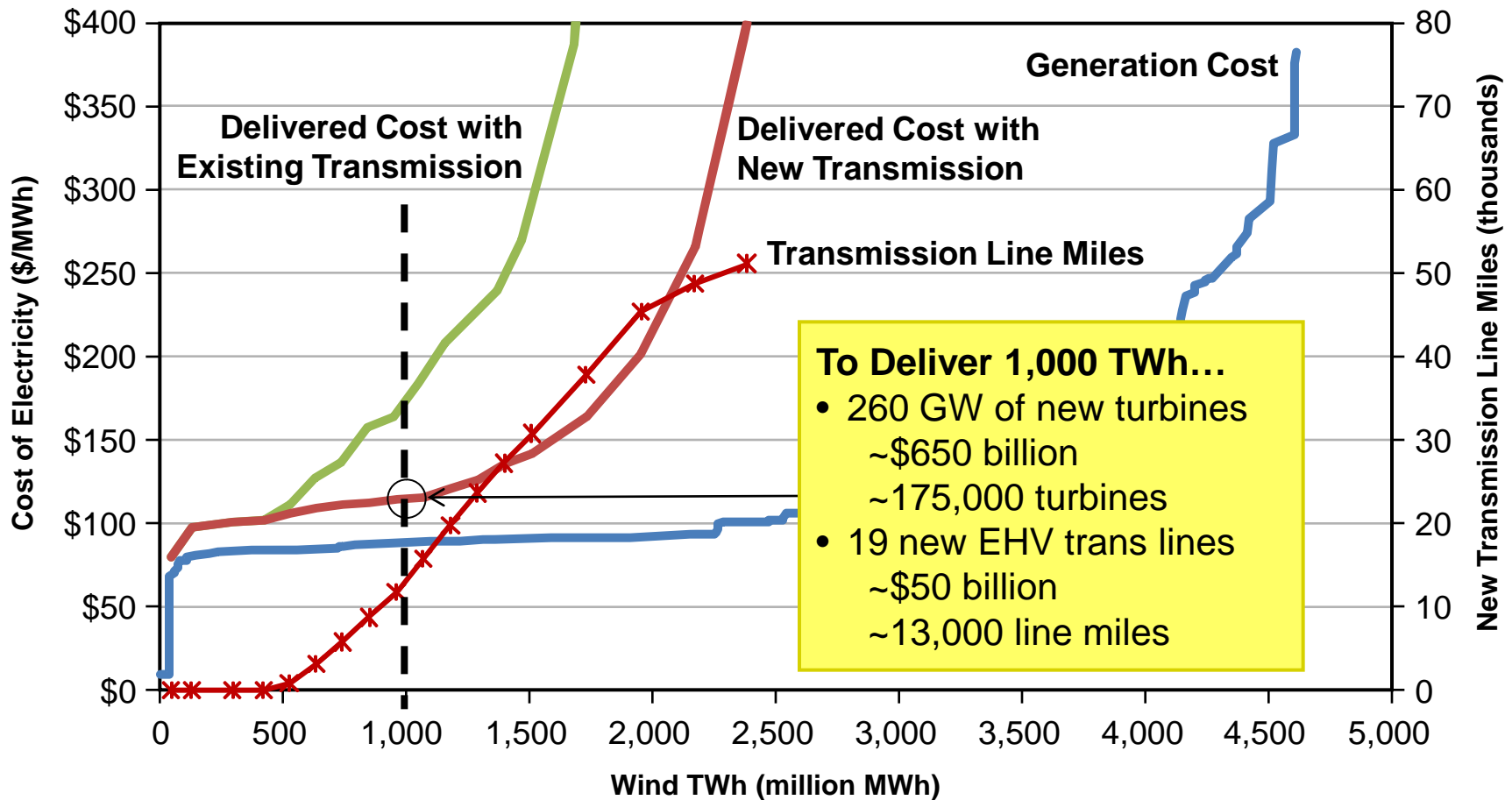
Wind Variability Impacts Thermal Fleet



What Happens When Wind Exceeds Load?



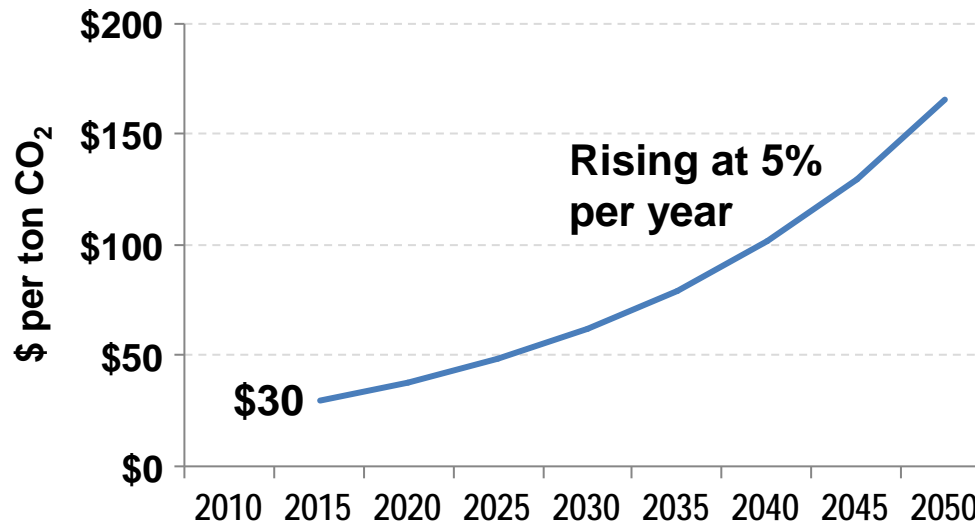
National Wind Energy Potential* (including delivery costs)



*EPRI – AWS TruePower National Wind Energy Supply Curves

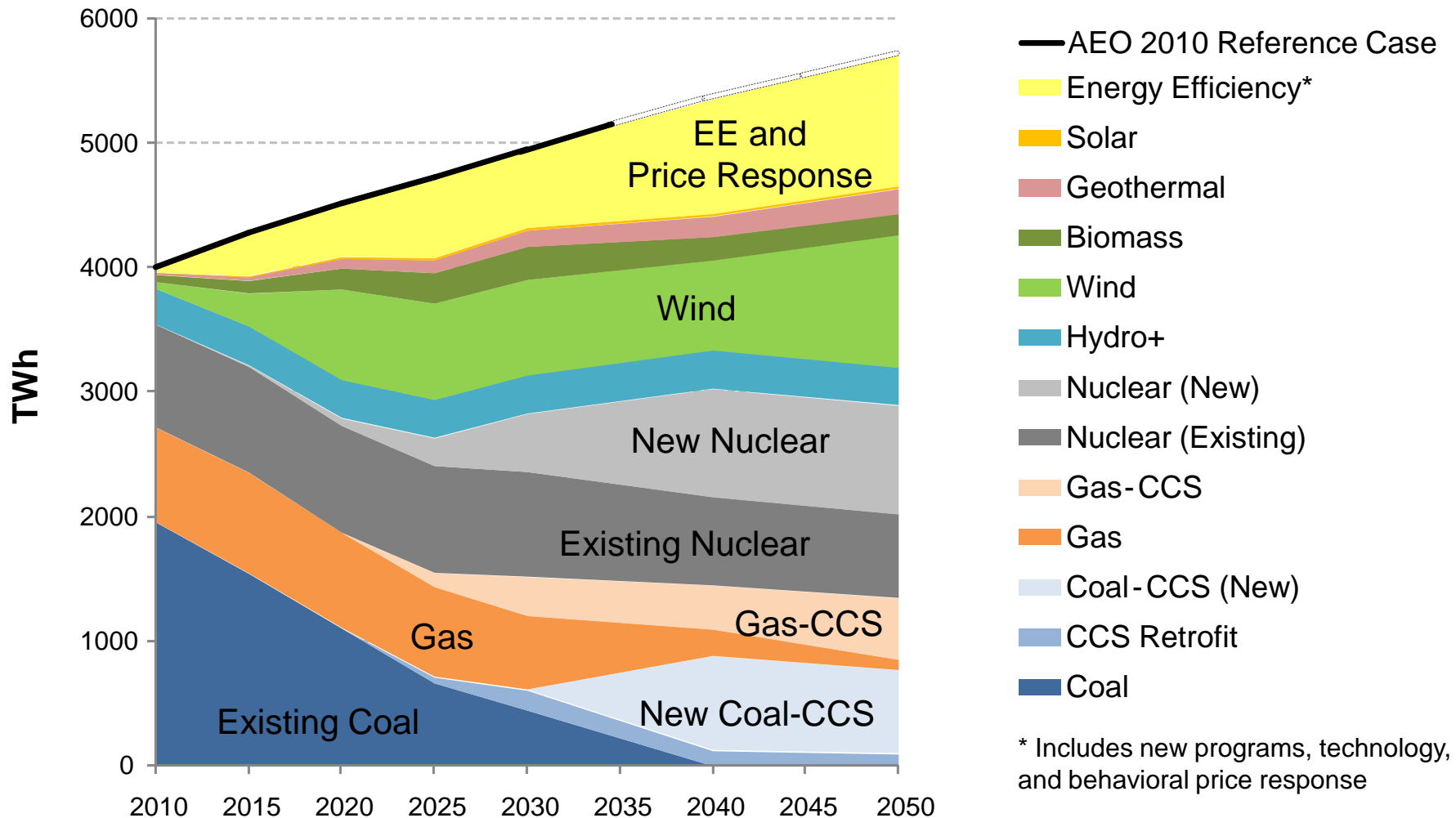
Taking Prism 2.0 for a “Test Drive”

- Details and timing of potential federal limits on GHG emissions remain unclear
- Without specifying a particular proposal or cap, we can simulate an aggressive policy with a rising CO₂ price:



Results are illustrative, not polished scenarios!!!

Prism 2.0 “Test Drive” Generation Mix

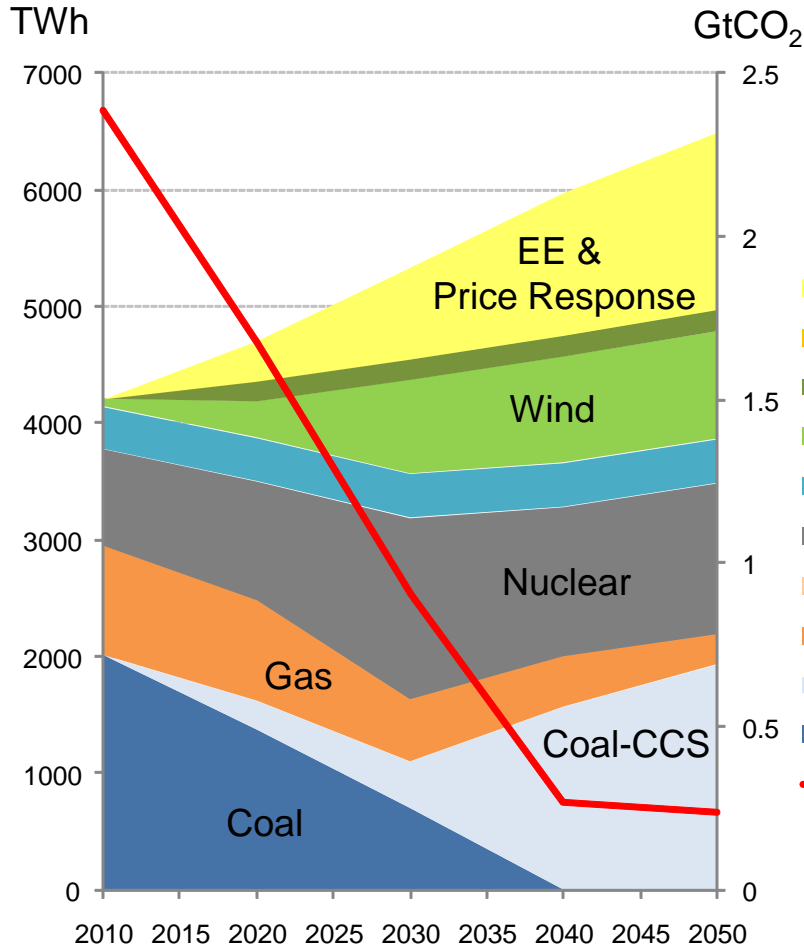


* Includes new programs, technology, and behavioral price response

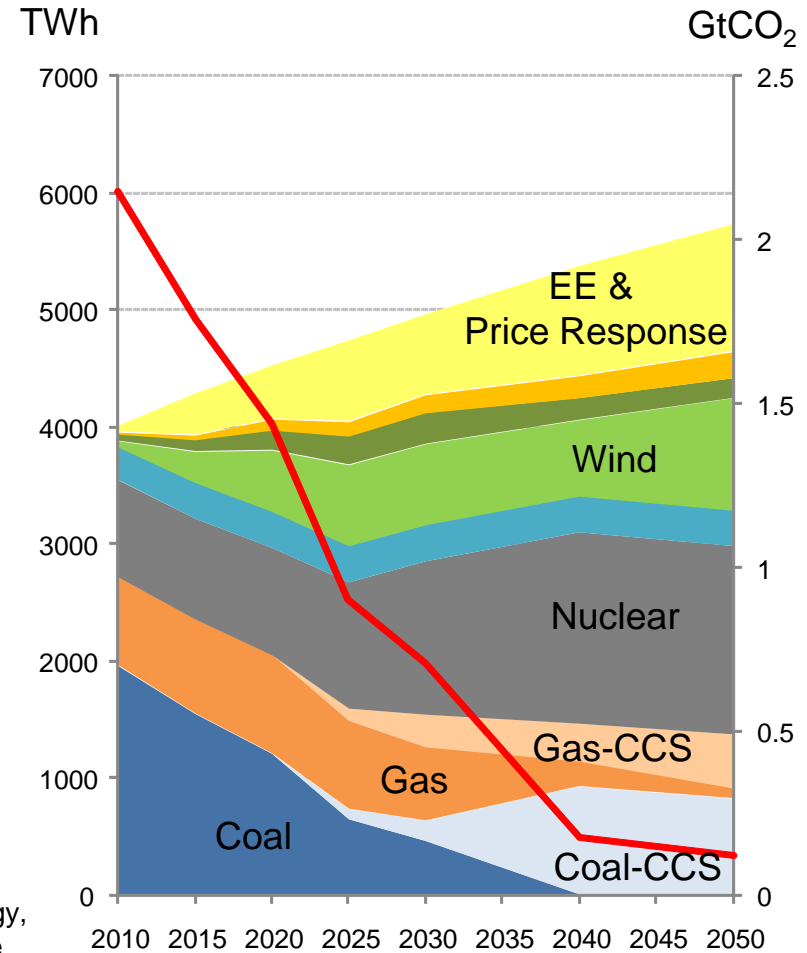
MERGE vs. Prism 2.0 “Test Drive”

Electric sector module only

MERGE with 80% by 2050 Cap

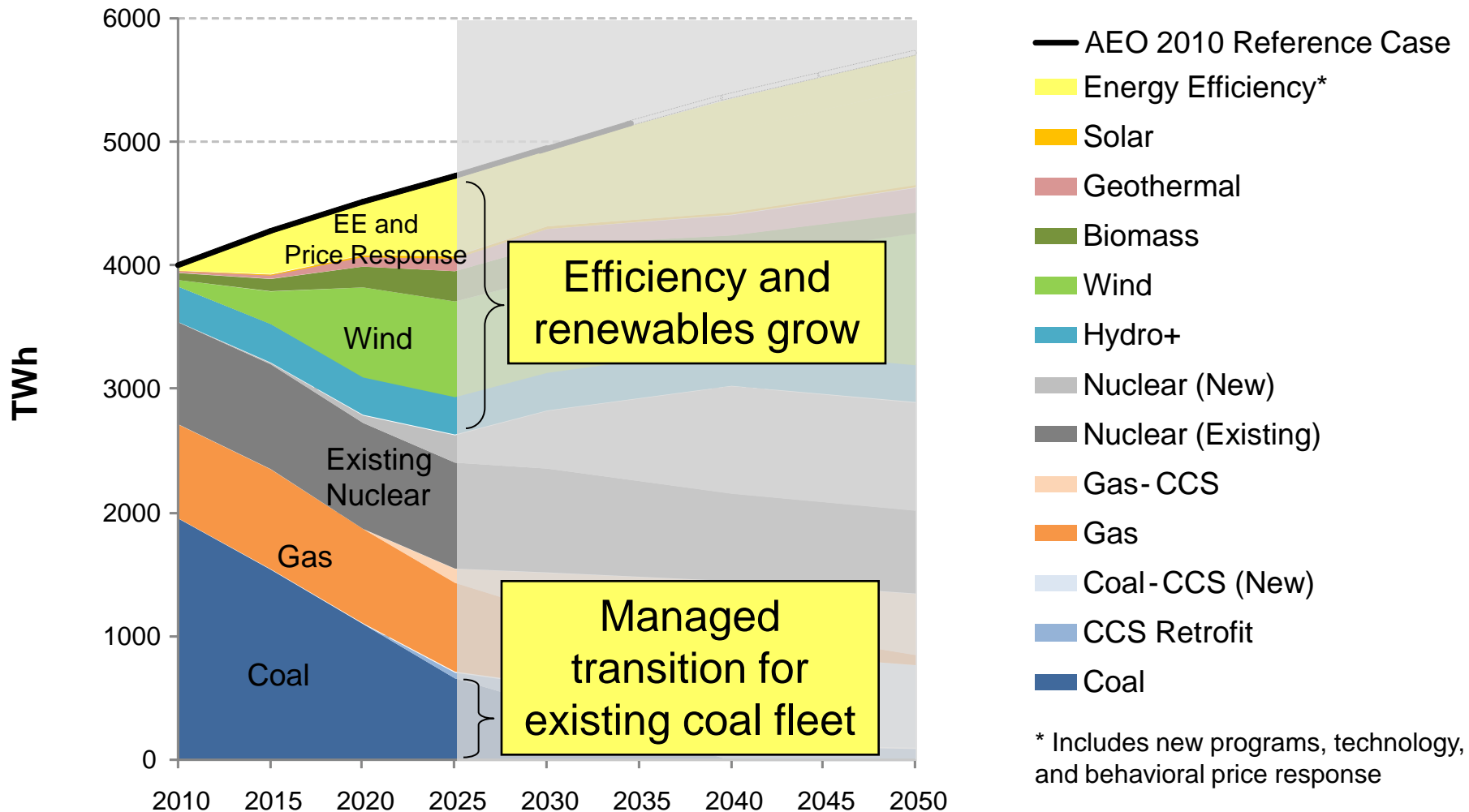


Prism 2.0 “Test Drive”

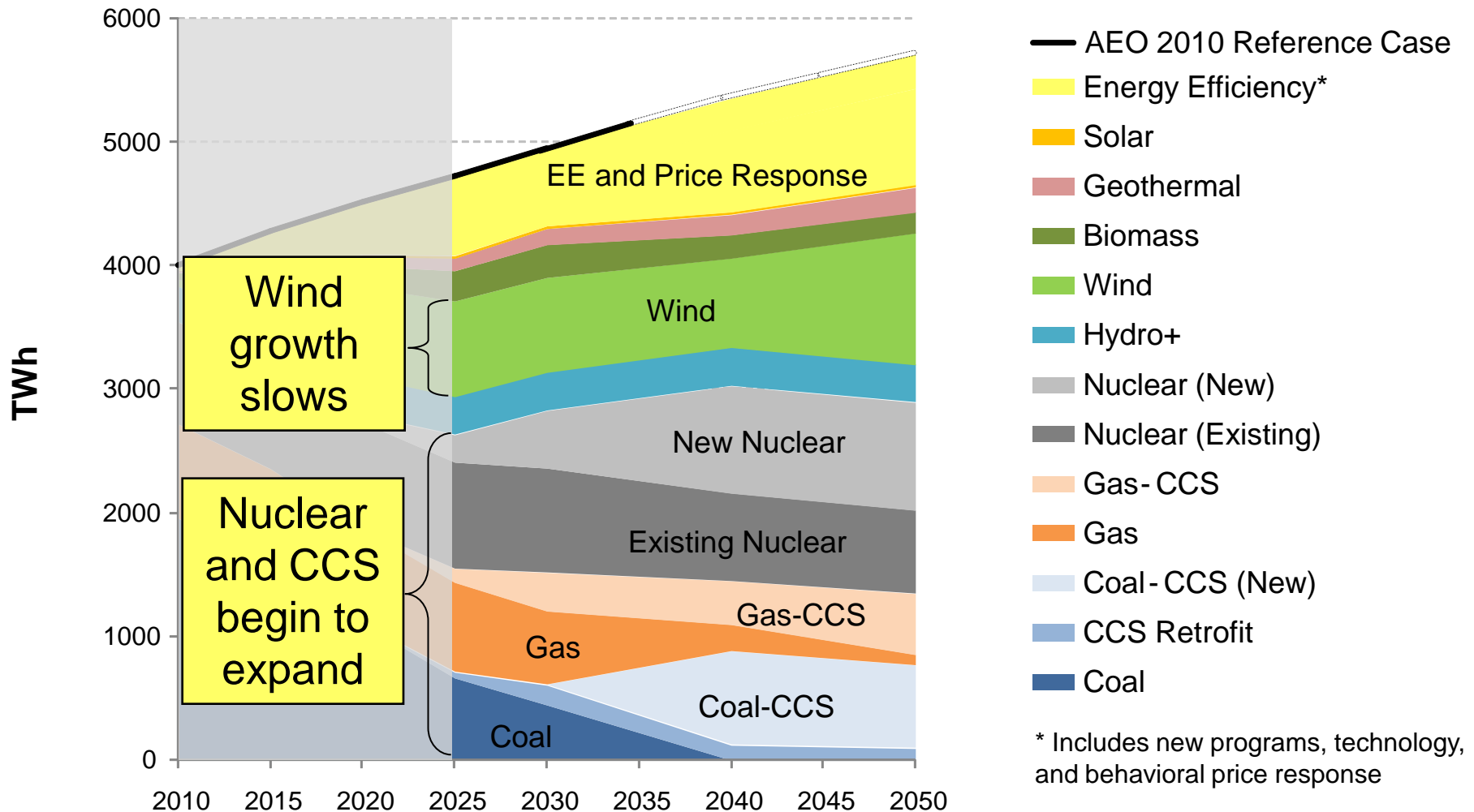


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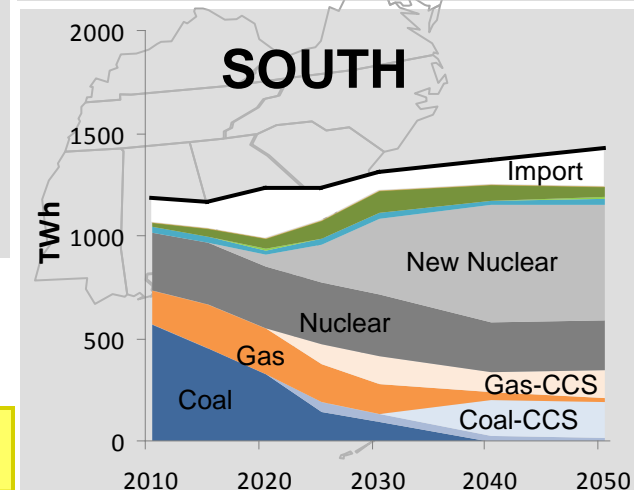
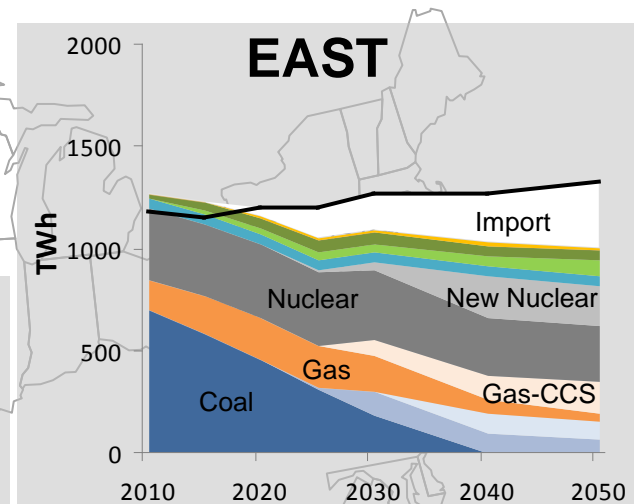
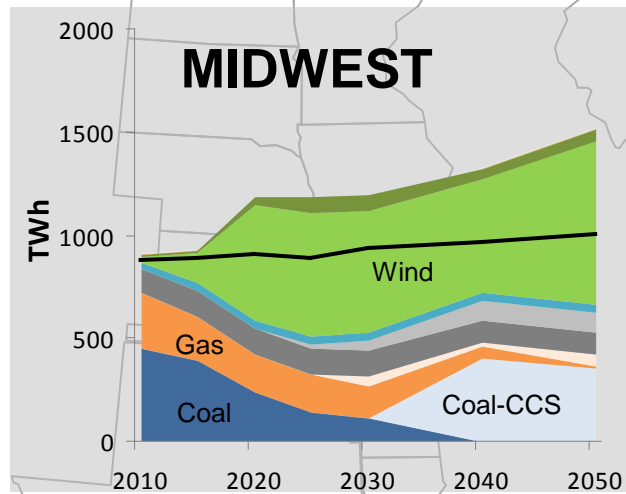
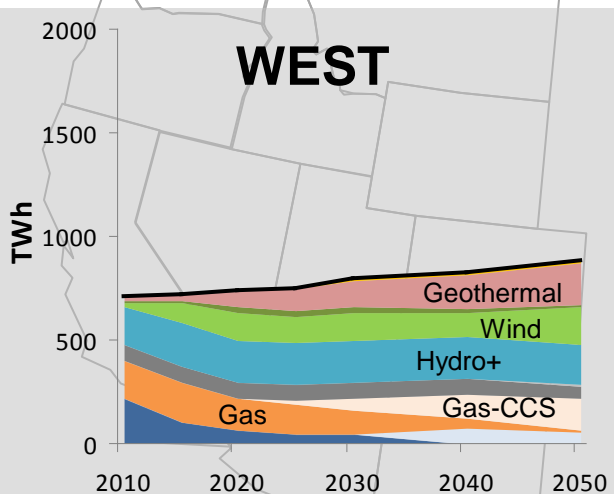
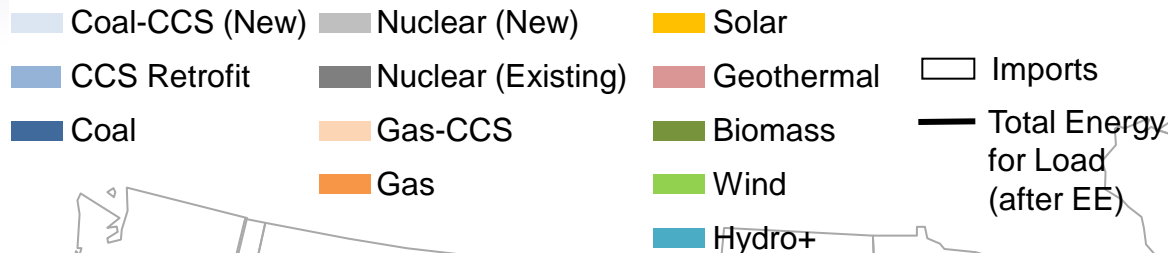
Prism 2.0 “Test Drive” Insights... 2010-2025



Prism 2.0 “Test Drive” Insights... Post-2025



Prism 2.0 “Test Drive” Insights... Regional Generation Mix

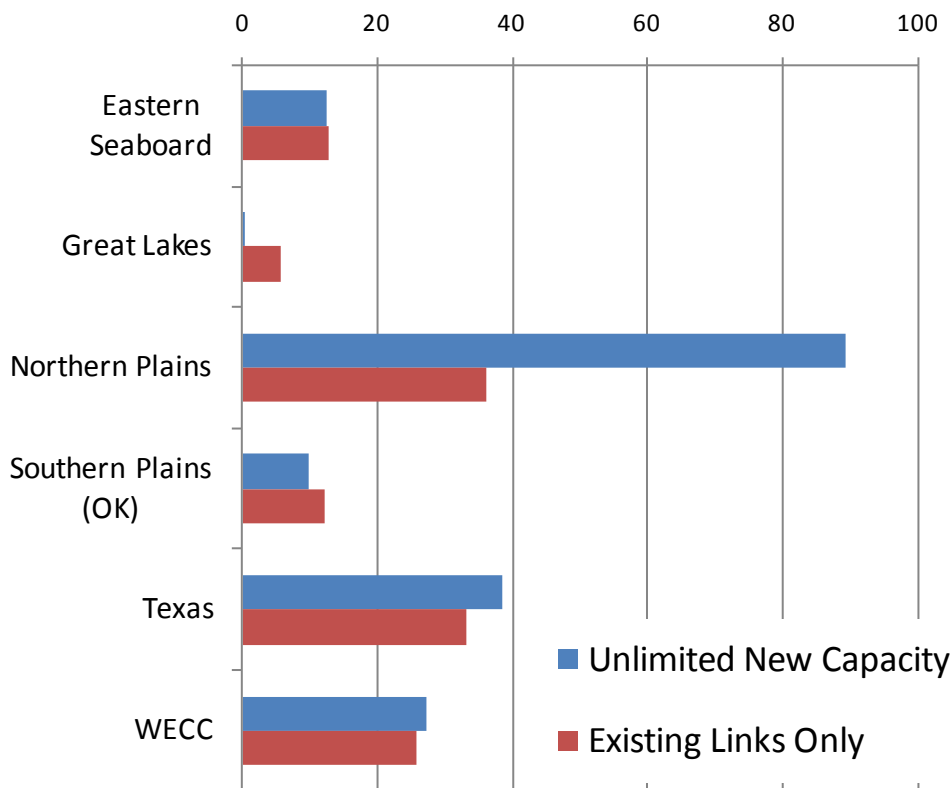


Responses to CO₂ policy differ greatly by region

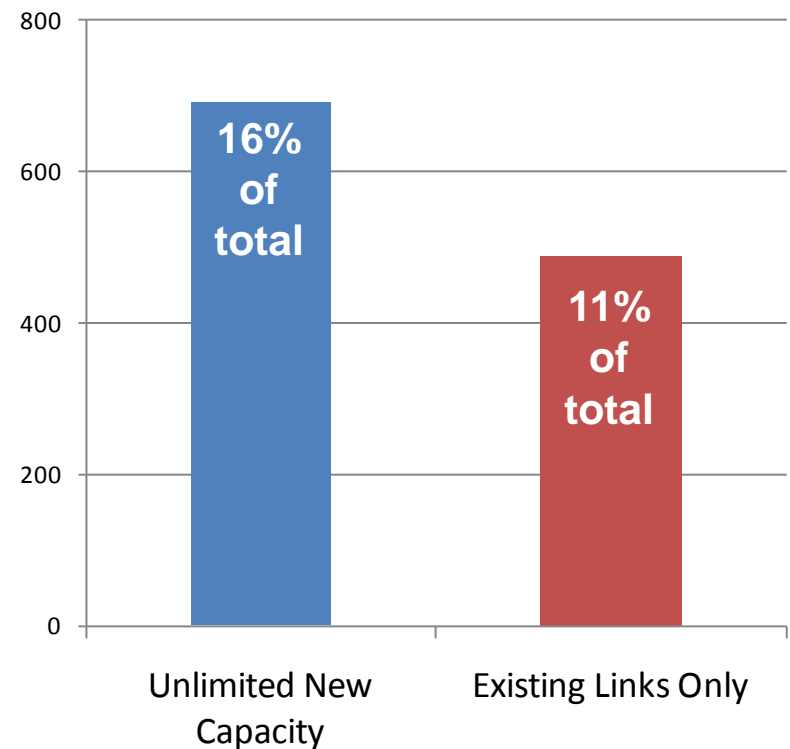
Prism 2.0 “Test Drive” Insights...

What if no new inter-region transmission?

New Wind Additions through 2030 (GW)

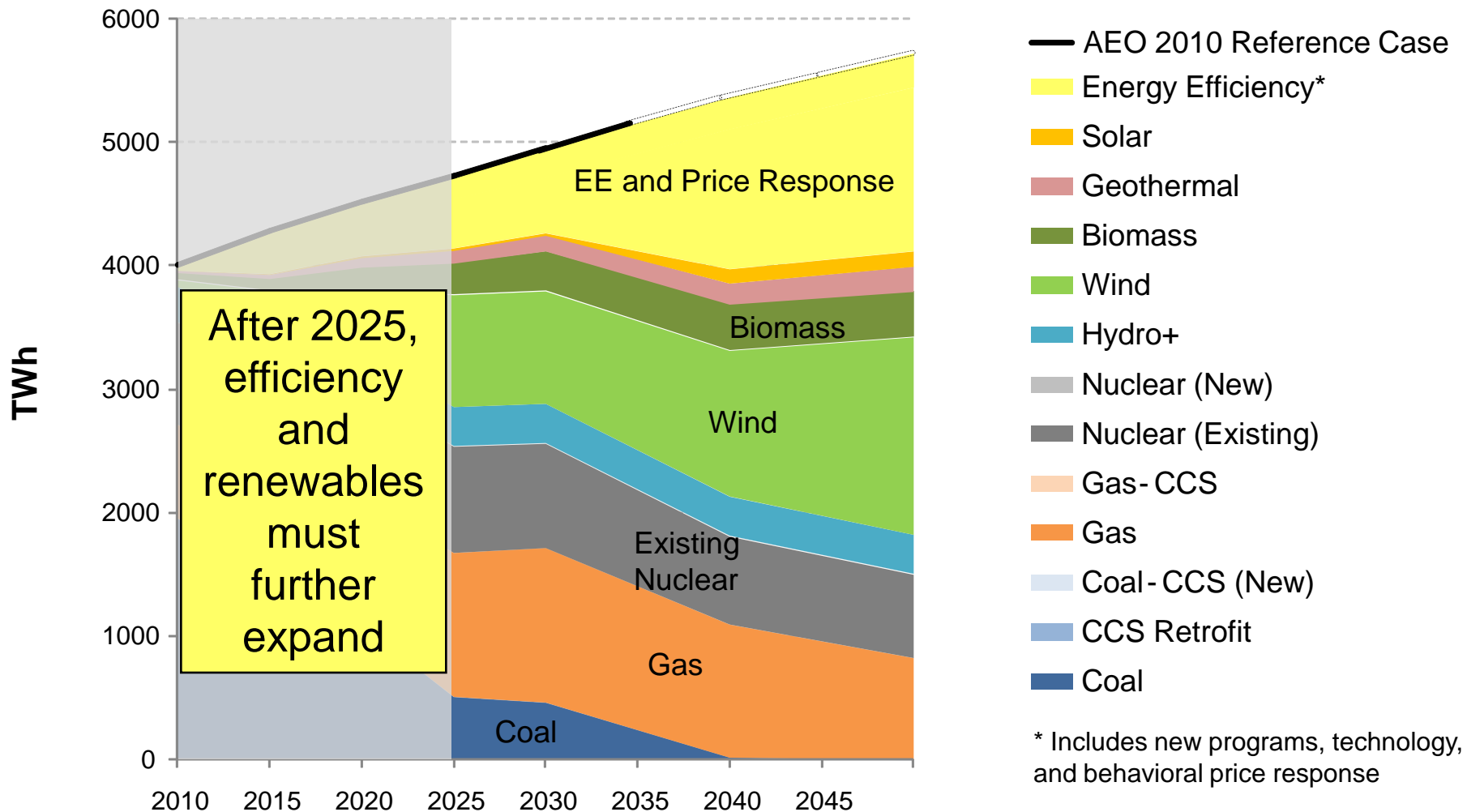


Total US Wind Generation in 2030 (TWh)



Less wind, more regionally distributed

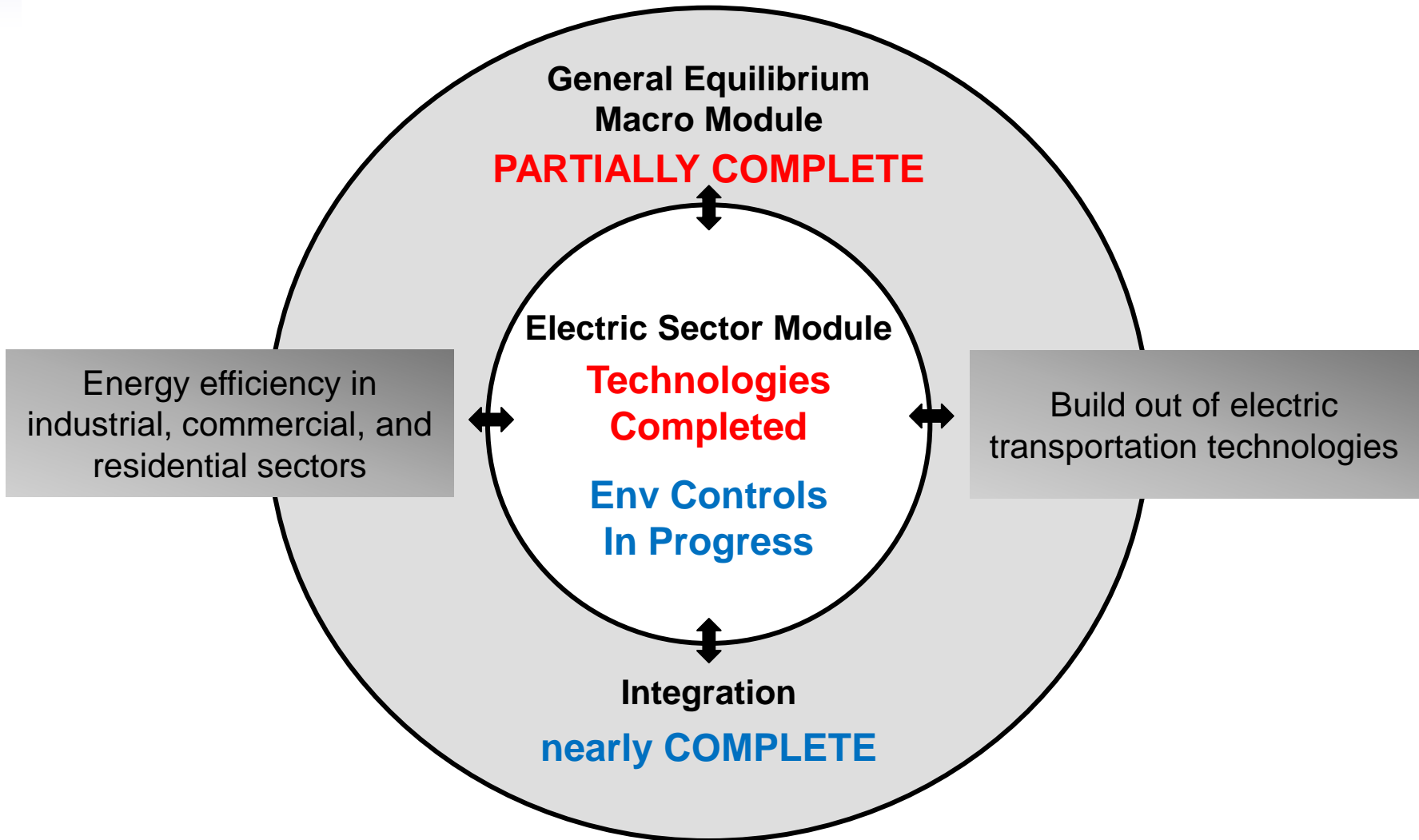
Prism 2.0 “Test Drive” Insights... What if no new nuclear or CCS?



What We Are Seeing ... *Initial Insights*

- **Near term response to high CO₂ price likely dominated by renewables, efficiency and natural gas**
 - Coal retirements offset by new renewables, efficiency
 - Natural gas fills any remaining demand
- **Wind integration costs significant at high penetration**
 - New balancing resources required (transmission, storage, smart grid, PHEVs)
 - Ramping impacts on thermal fleet → increased O&M
- **Longer term, nuclear and CCS will be important**
 - Without them, rely on more costly renewables, efficiency

Prism 2.0 Project Status



Together...Shaping the Future of Electricity