



**EPRI** | ELECTRIC POWER  
RESEARCH INSTITUTE

# Creating a <sup>Secure</sup> Low-Carbon Future

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**North Carolina Energy Policy Council**

**December 18, 2009**

# The Electric Power Research Institute

## RD&D for the Electricity Industry

- Independent, unbiased, tax-exempt collaborative research organization
- Full spectrum industry coverage
  - *Nuclear*
  - *Generation*
  - *Environment*
  - *Power Delivery & Utilization*
- 460 participants in over 40 countries
- Major offices in Palo Alto, CA; Charlotte, NC and Knoxville, TN



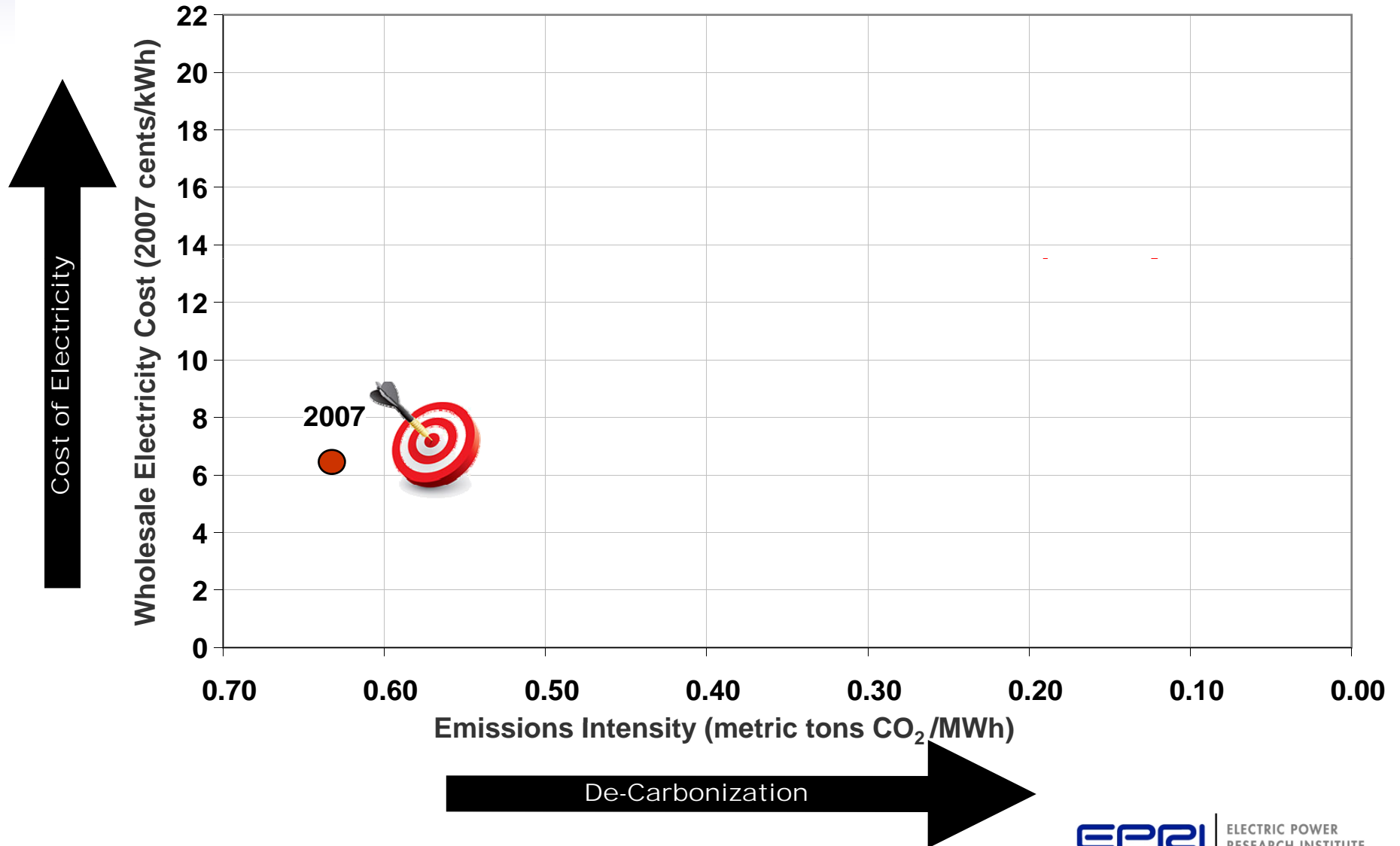
# The Electricity Technology Challenge

- Defining the Challenge
- Understanding the Challenge
- Meeting the Challenge
- Technology Costs

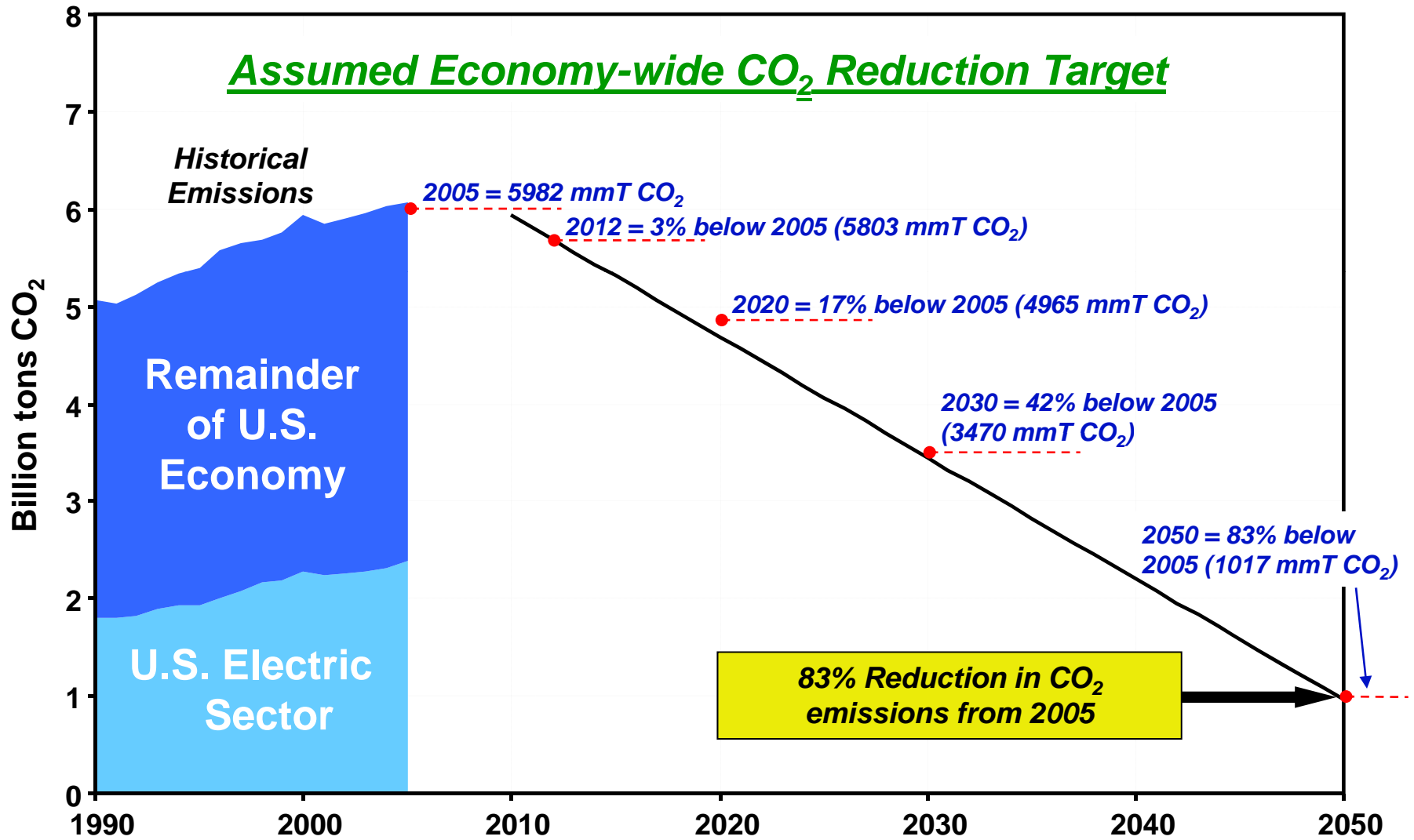
# The Technology Challenge

1. De-carbonize the electricity infrastructure and meet binding economy-wide CO<sub>2</sub> reduction targets
2. Provide reliable, affordable, and environmentally-responsible electricity as demand grows

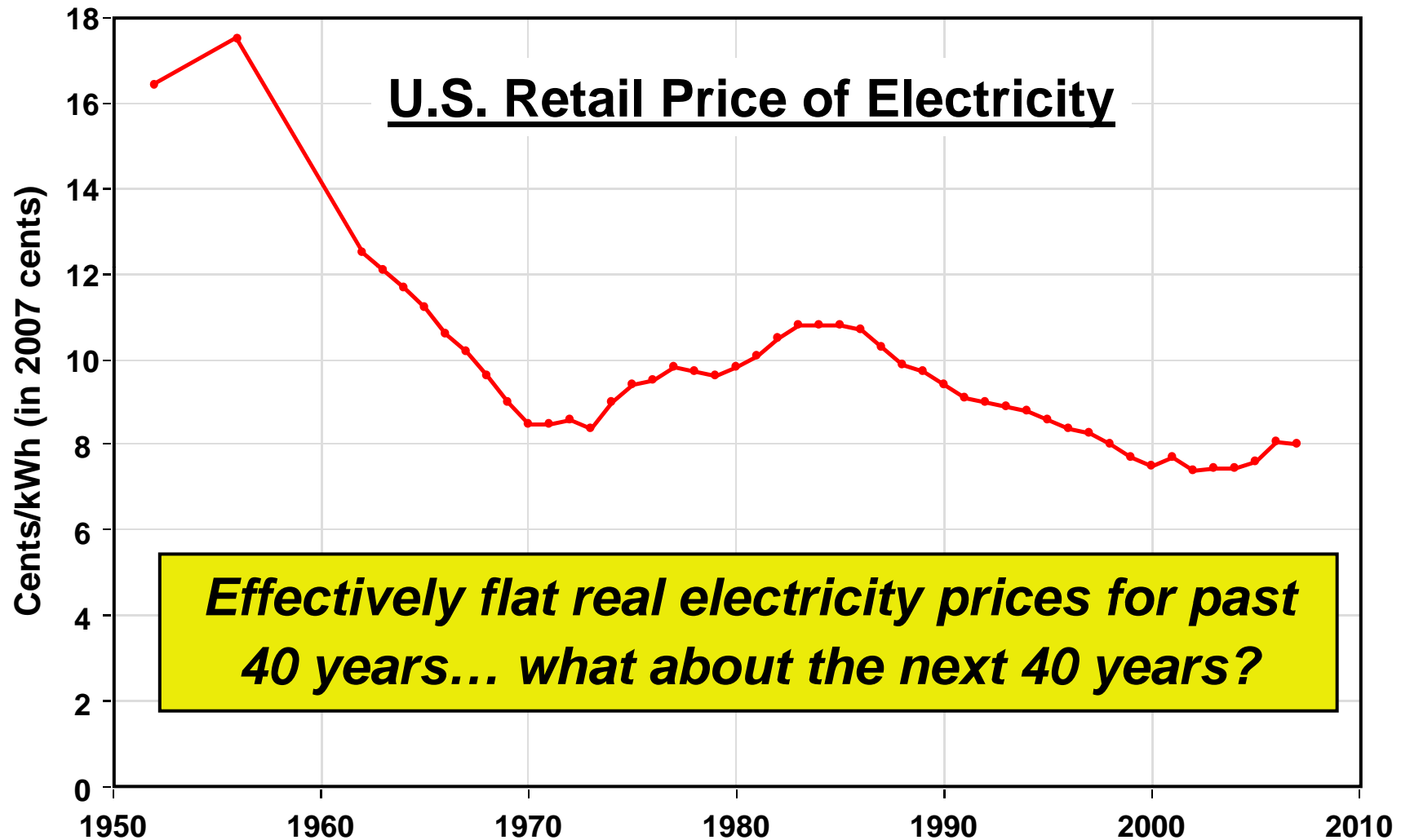
# The Technology Challenge



# The CO<sub>2</sub> Challenge



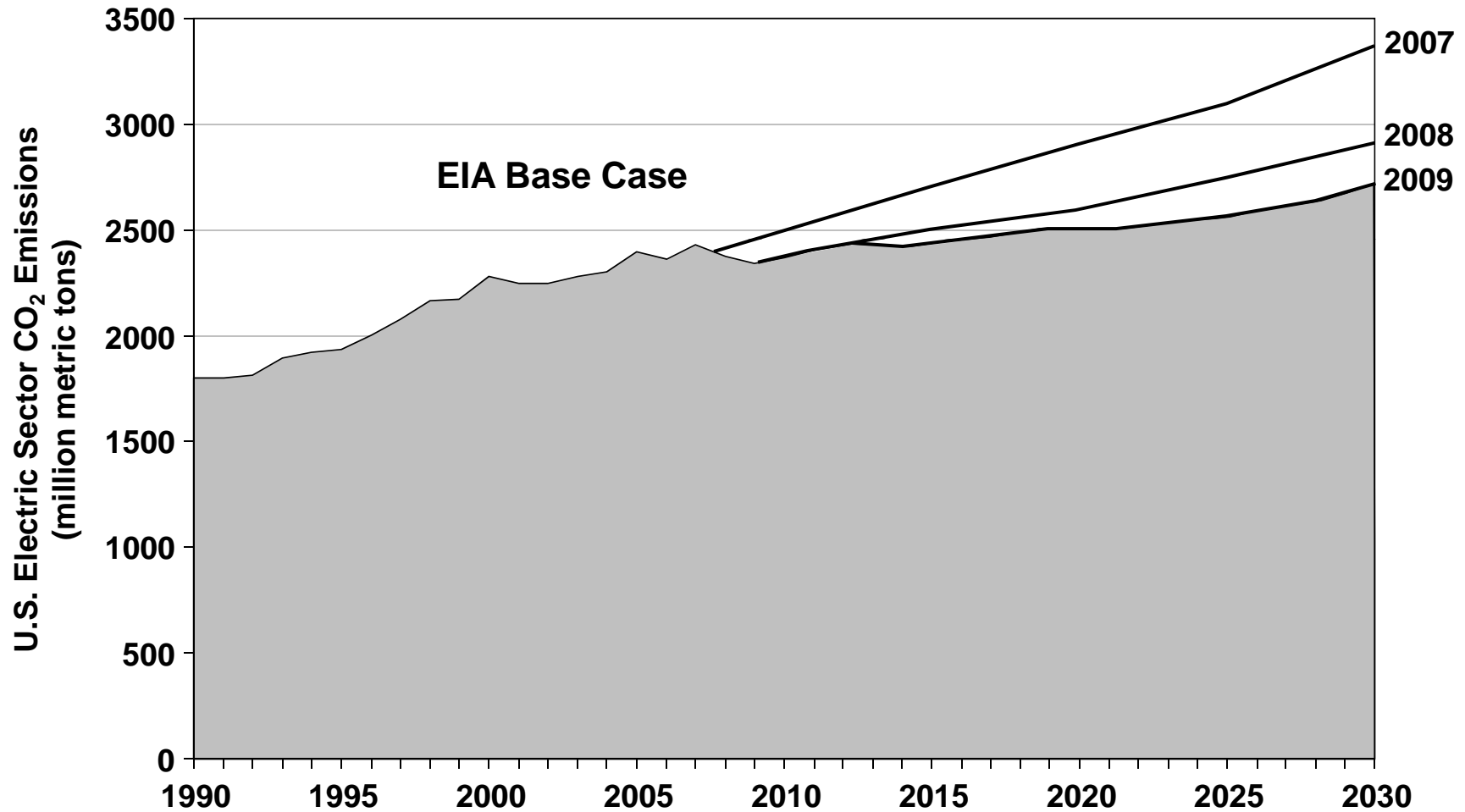
# The Cost Challenge



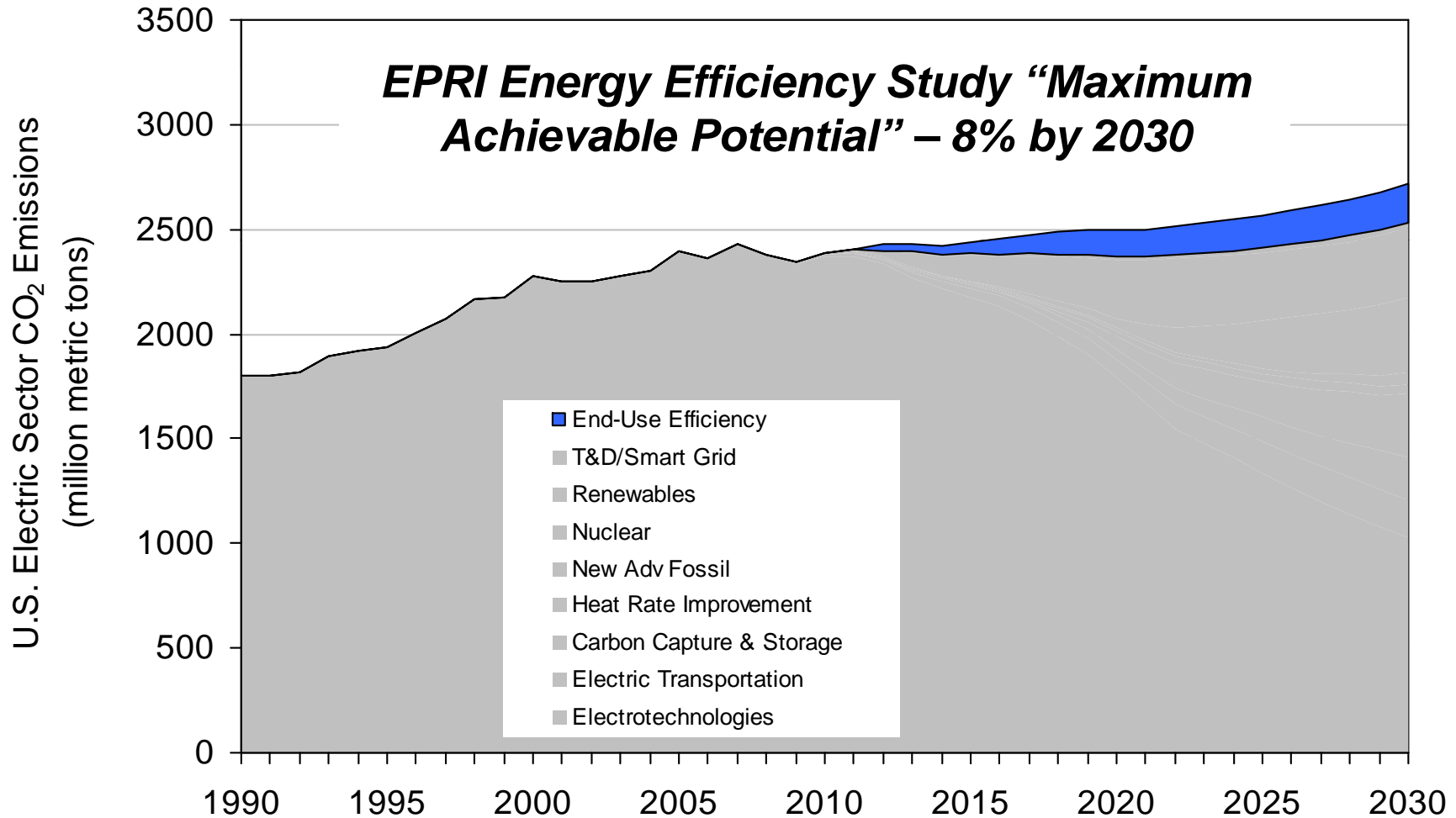
# The Electricity Technology Challenge

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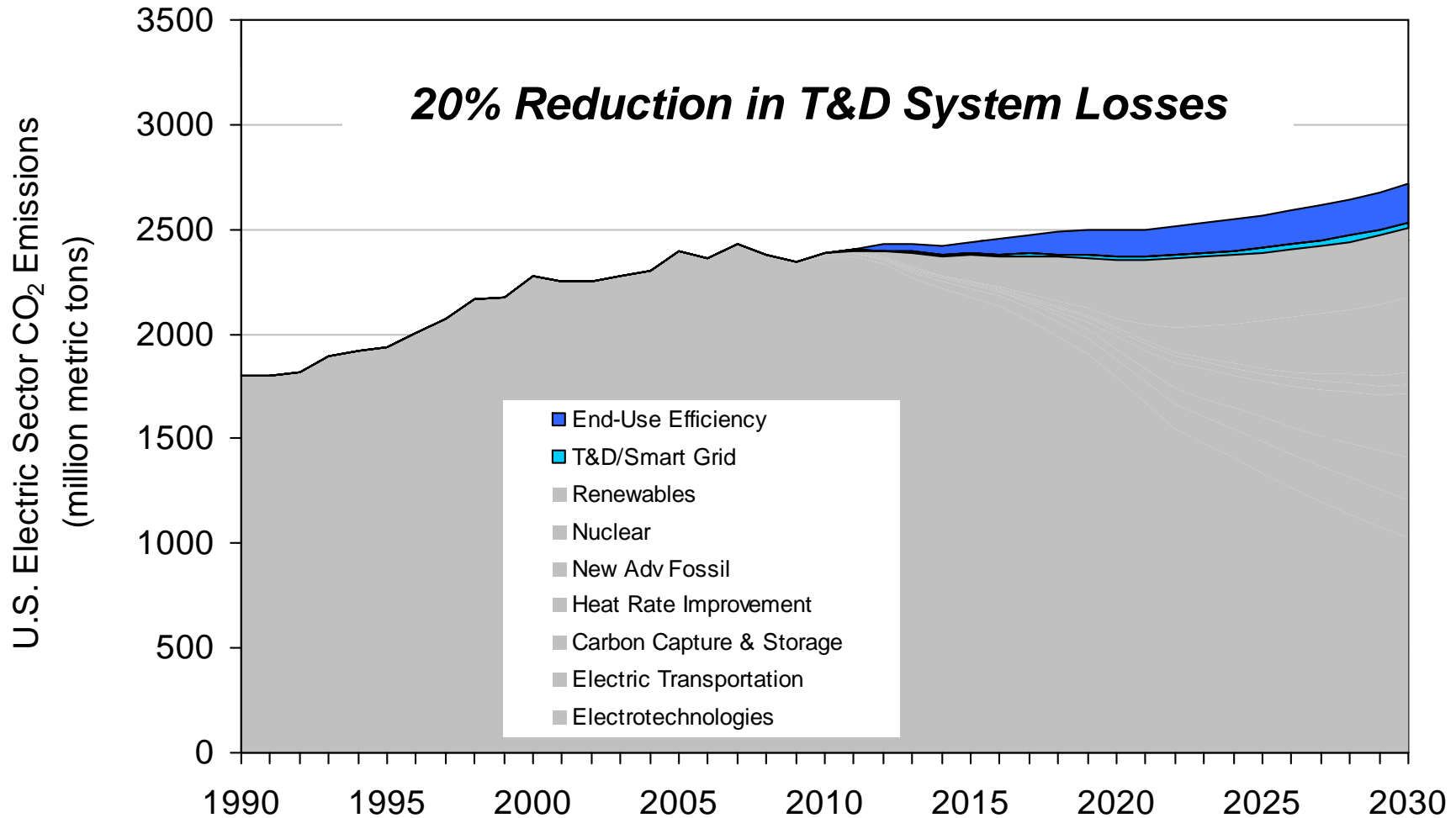
# U. S. Electric Sector CO<sub>2</sub> Emissions



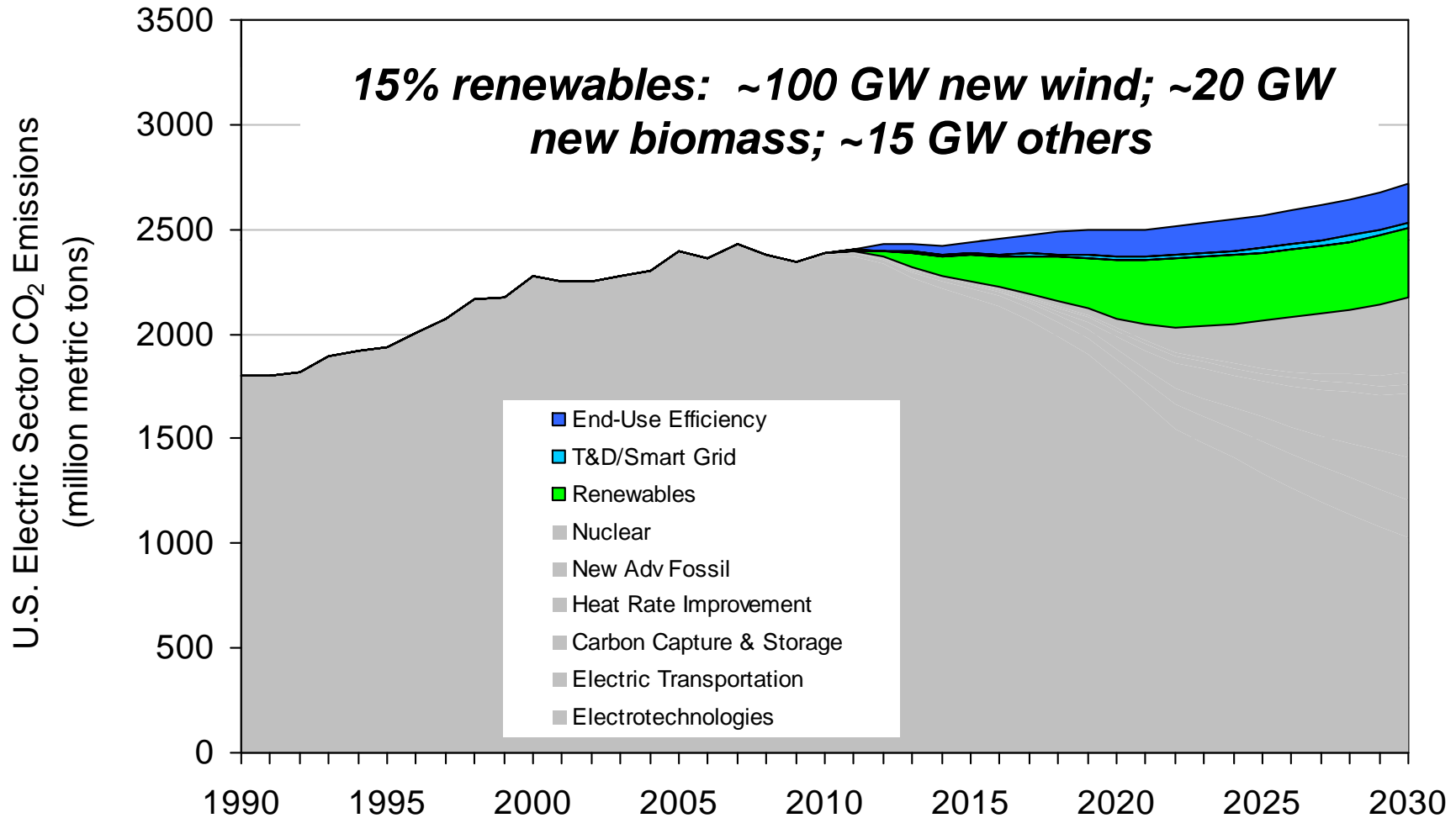
# CO<sub>2</sub> Reductions from Energy Efficiency



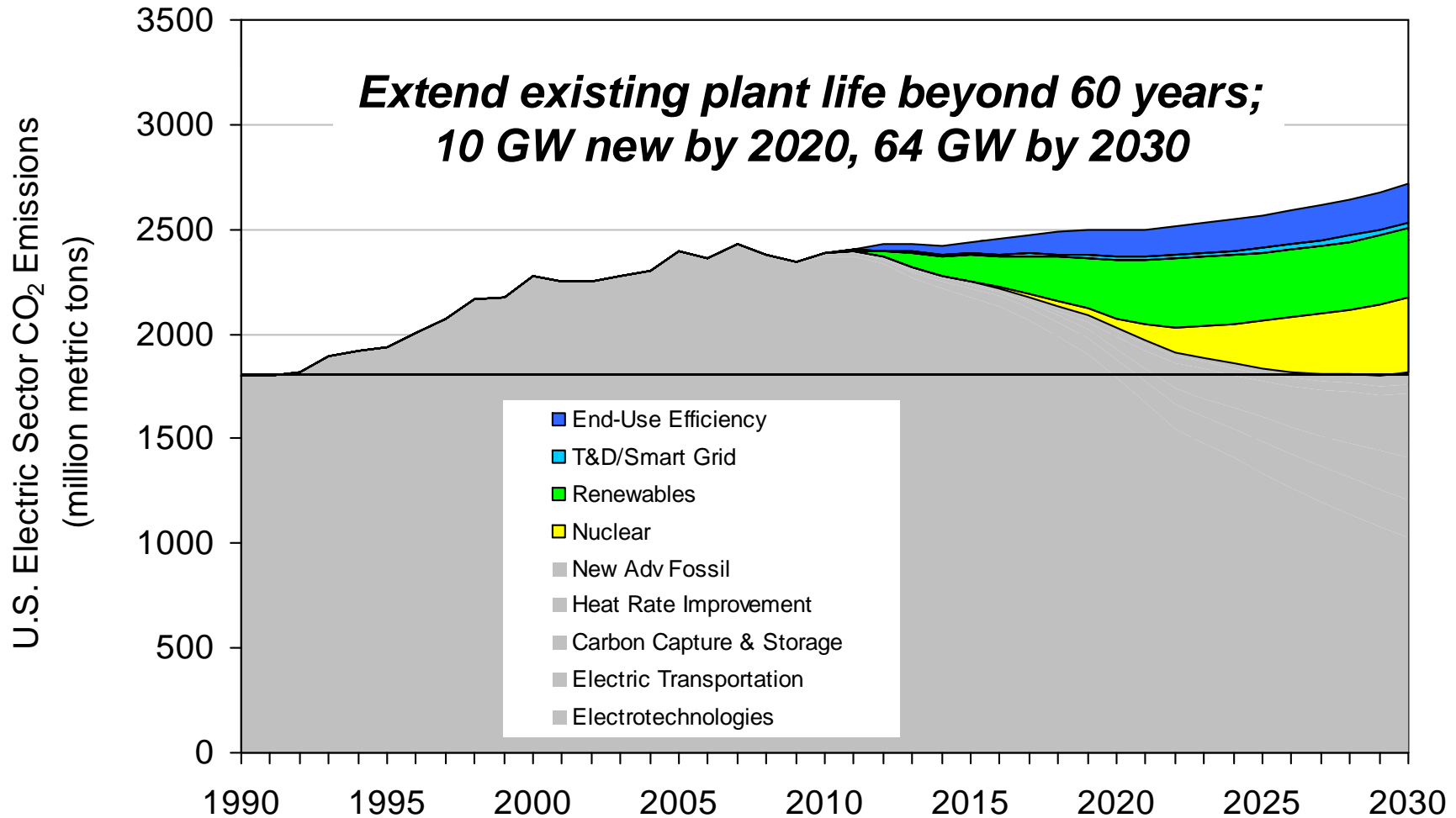
# CO<sub>2</sub> Reductions from T&D Efficiency



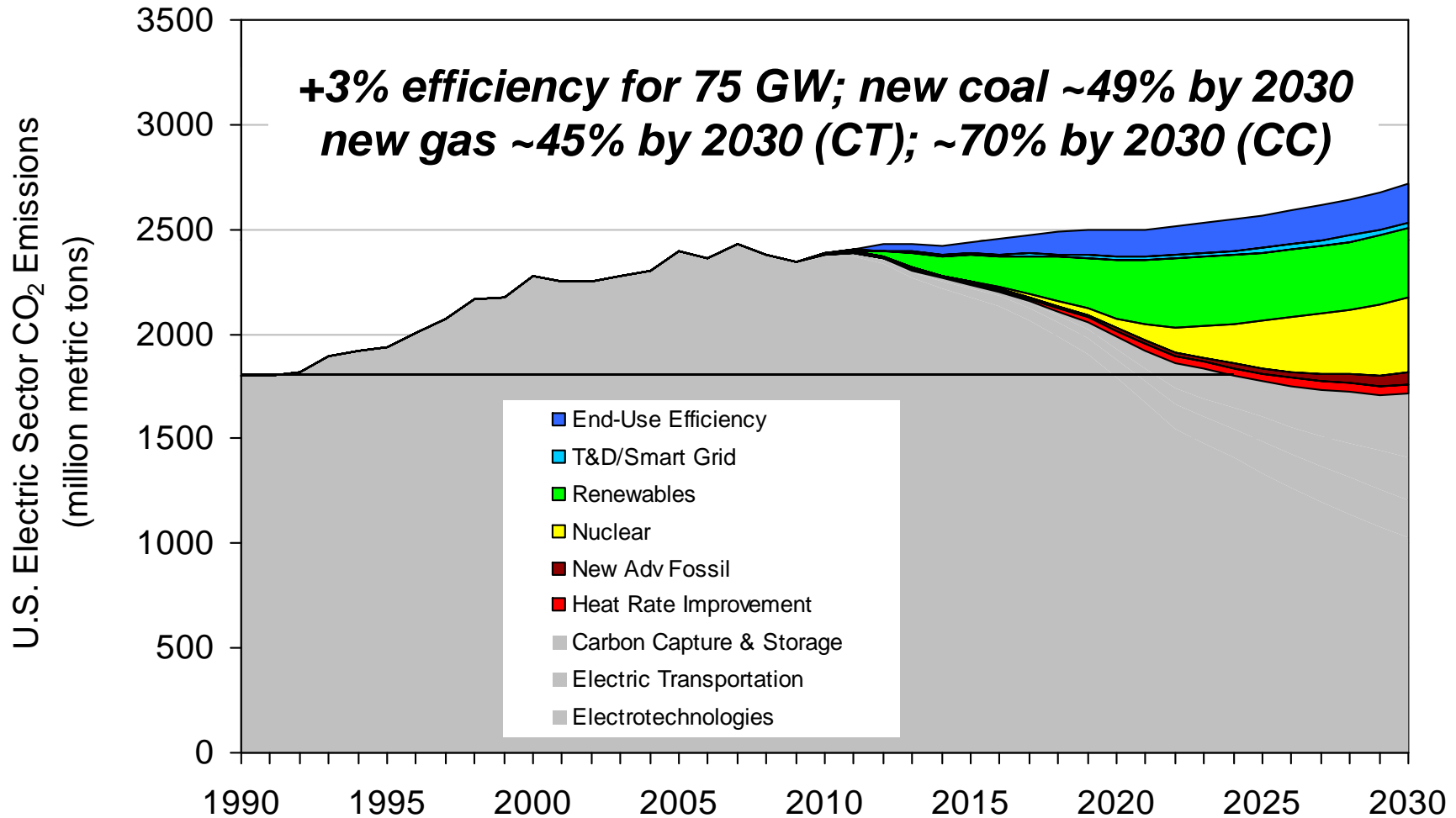
# CO<sub>2</sub> Reductions from Renewables



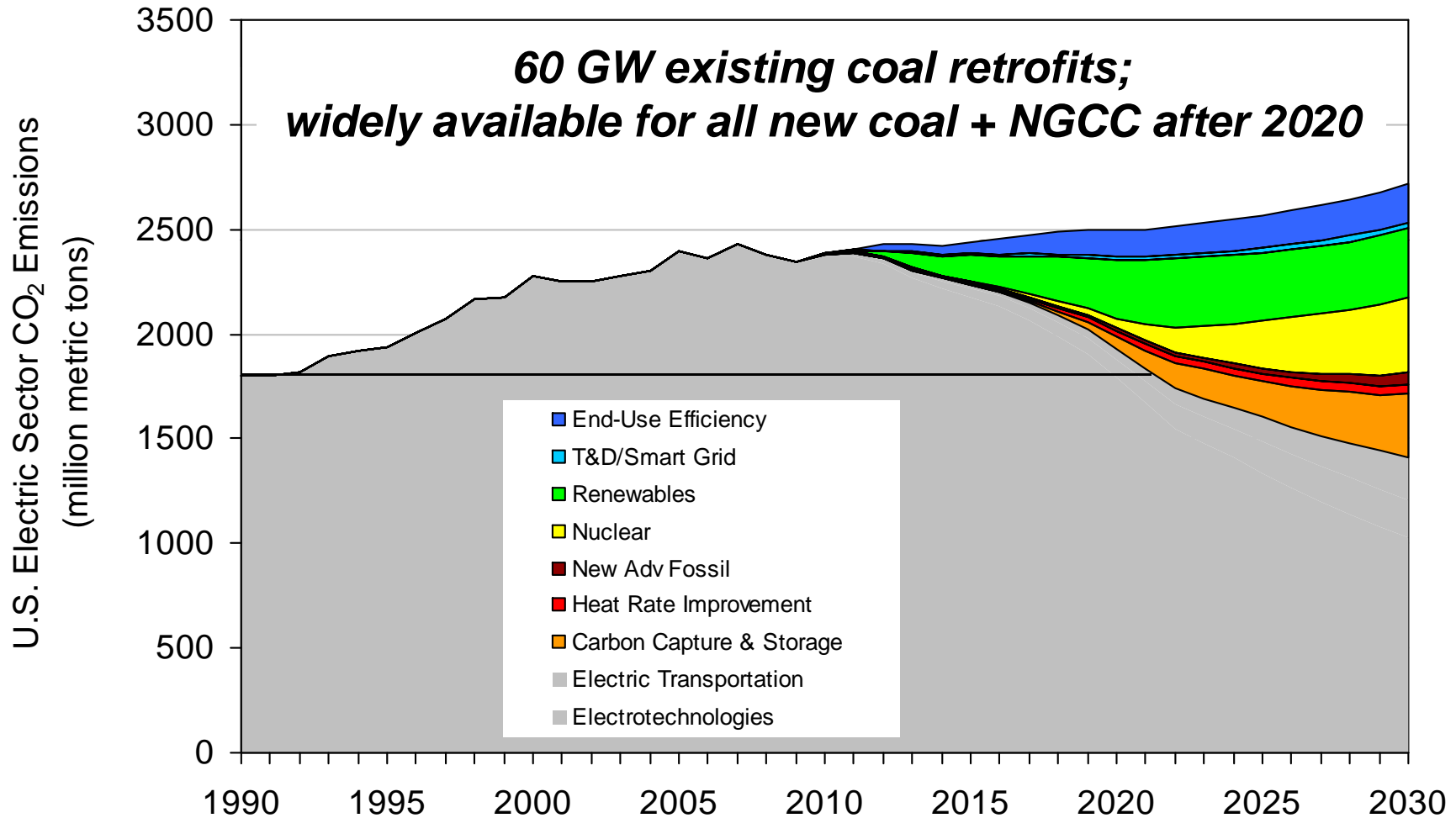
# CO<sub>2</sub> Reductions from Nuclear



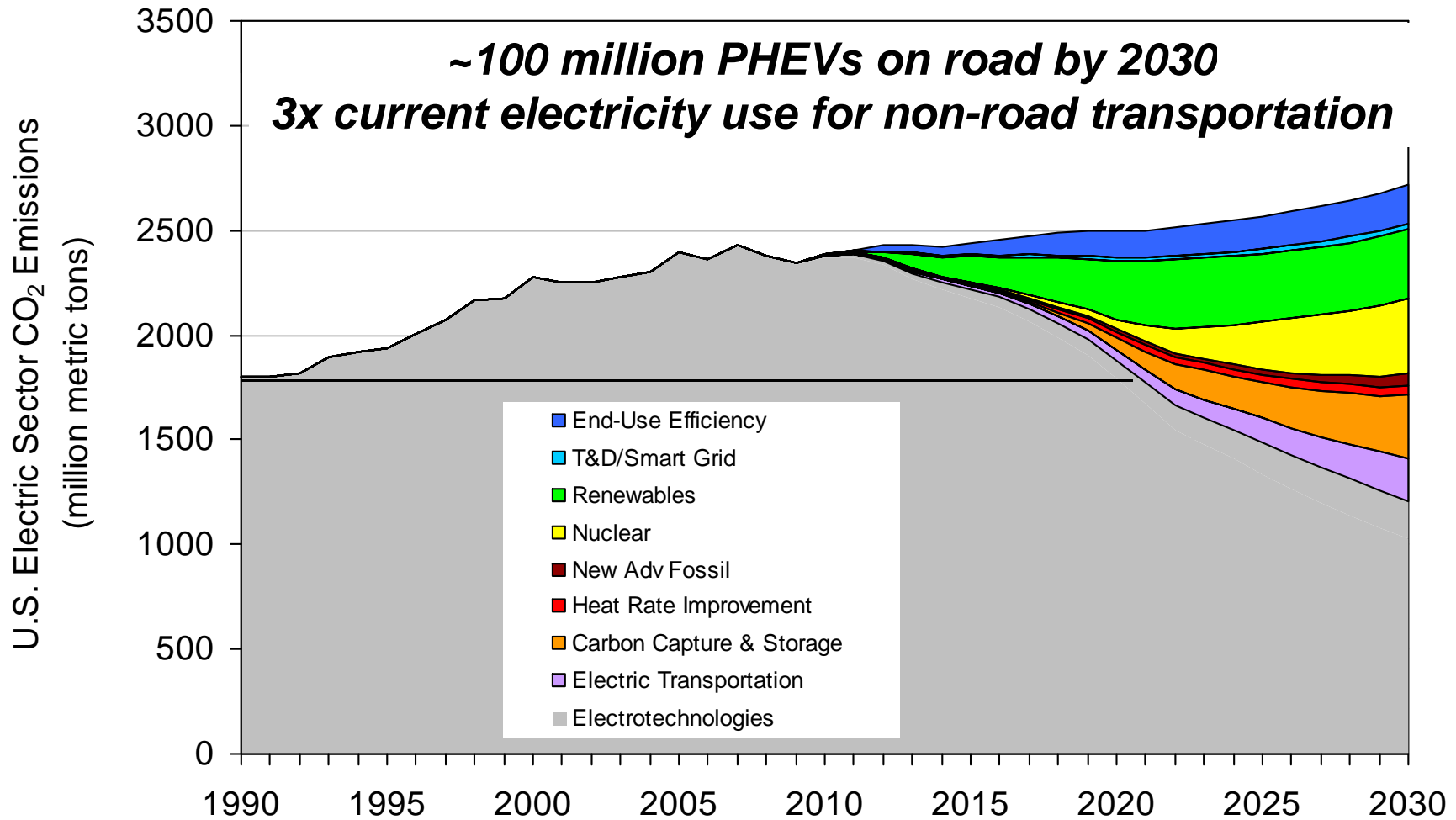
# CO<sub>2</sub> Reductions from Fossil Plant Efficiency



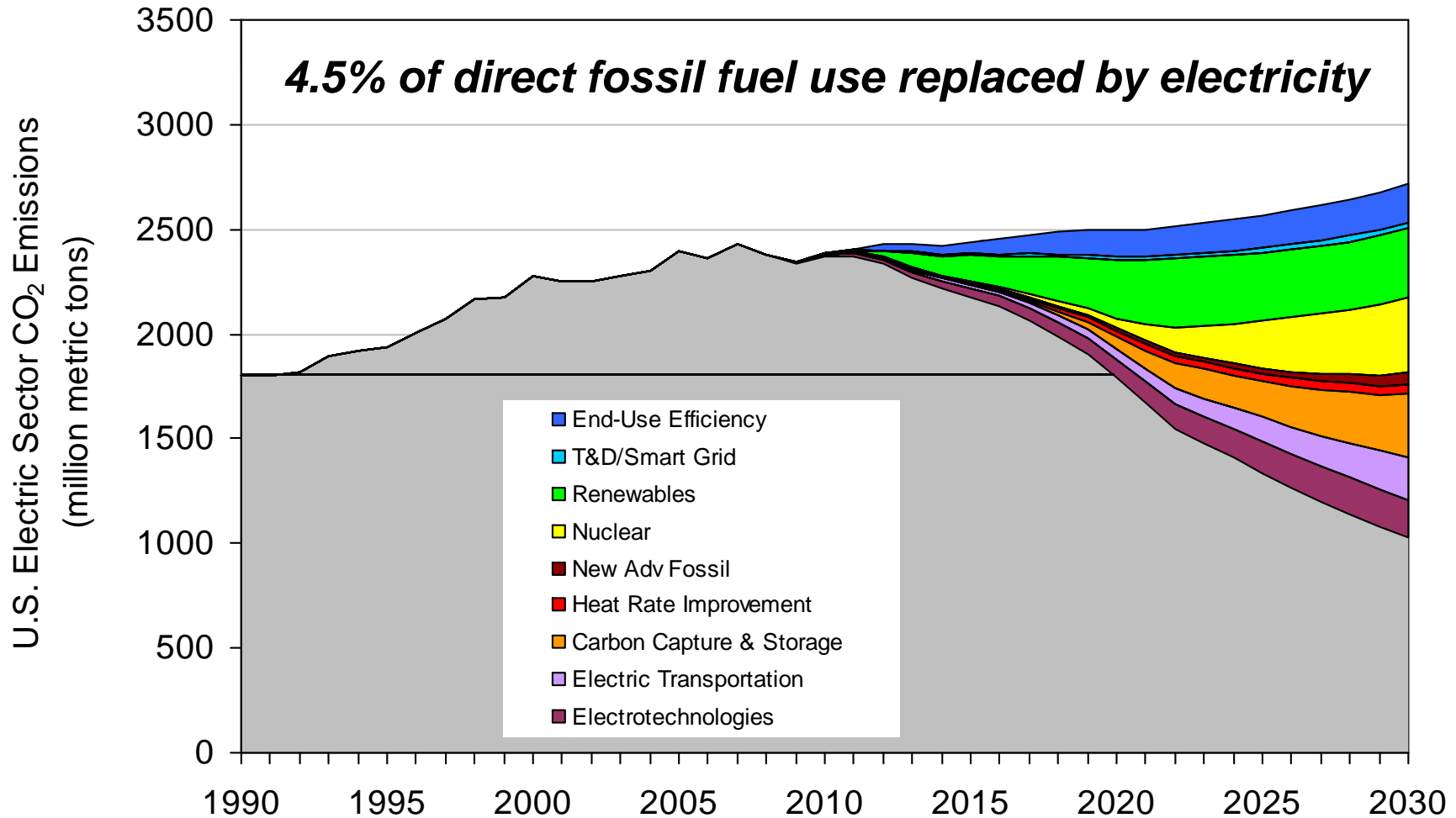
# CO<sub>2</sub> Reductions from CO<sub>2</sub> Capture and Sequestration (CCS)



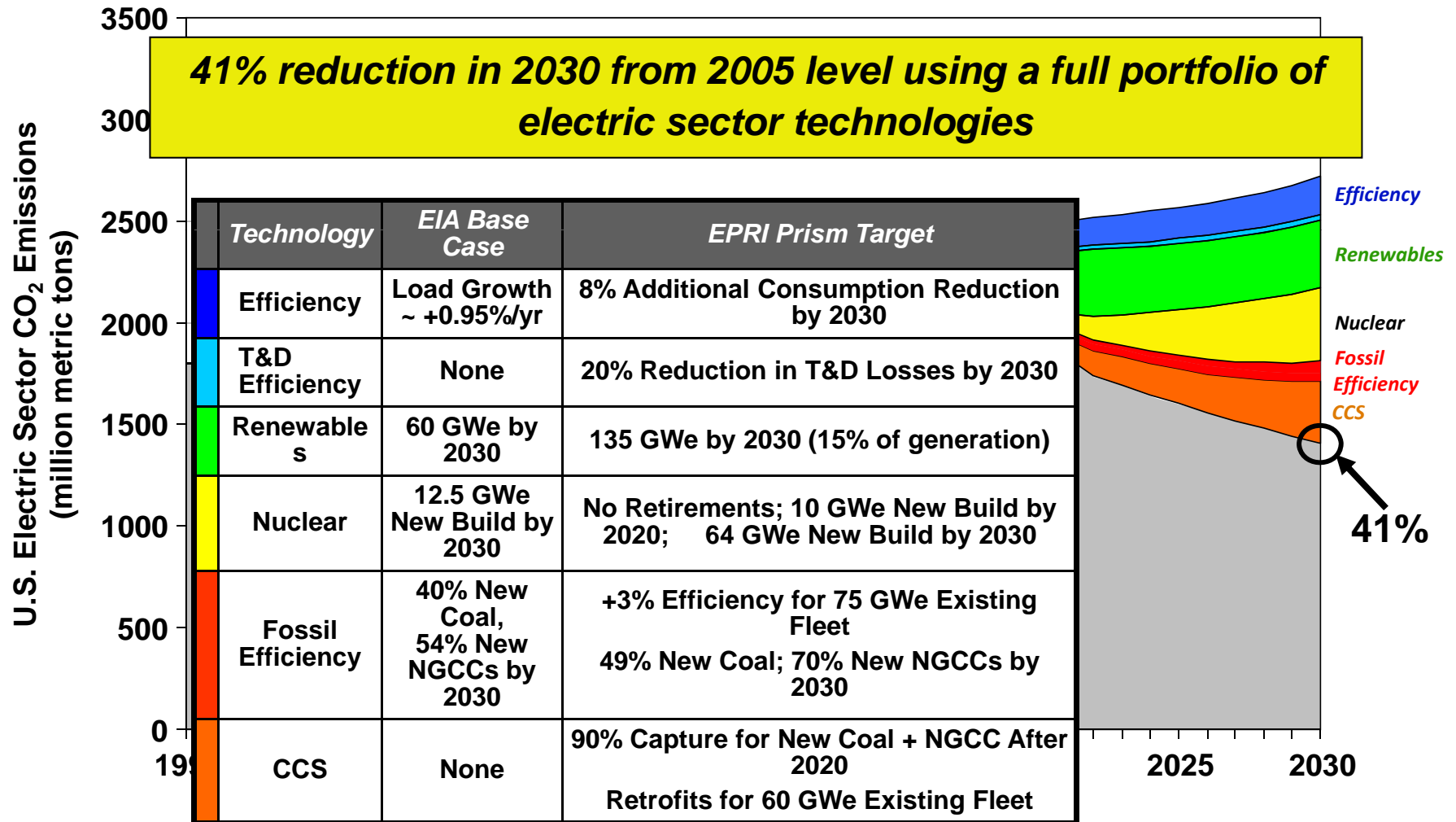
# CO<sub>2</sub> Reductions from Electric Transportation



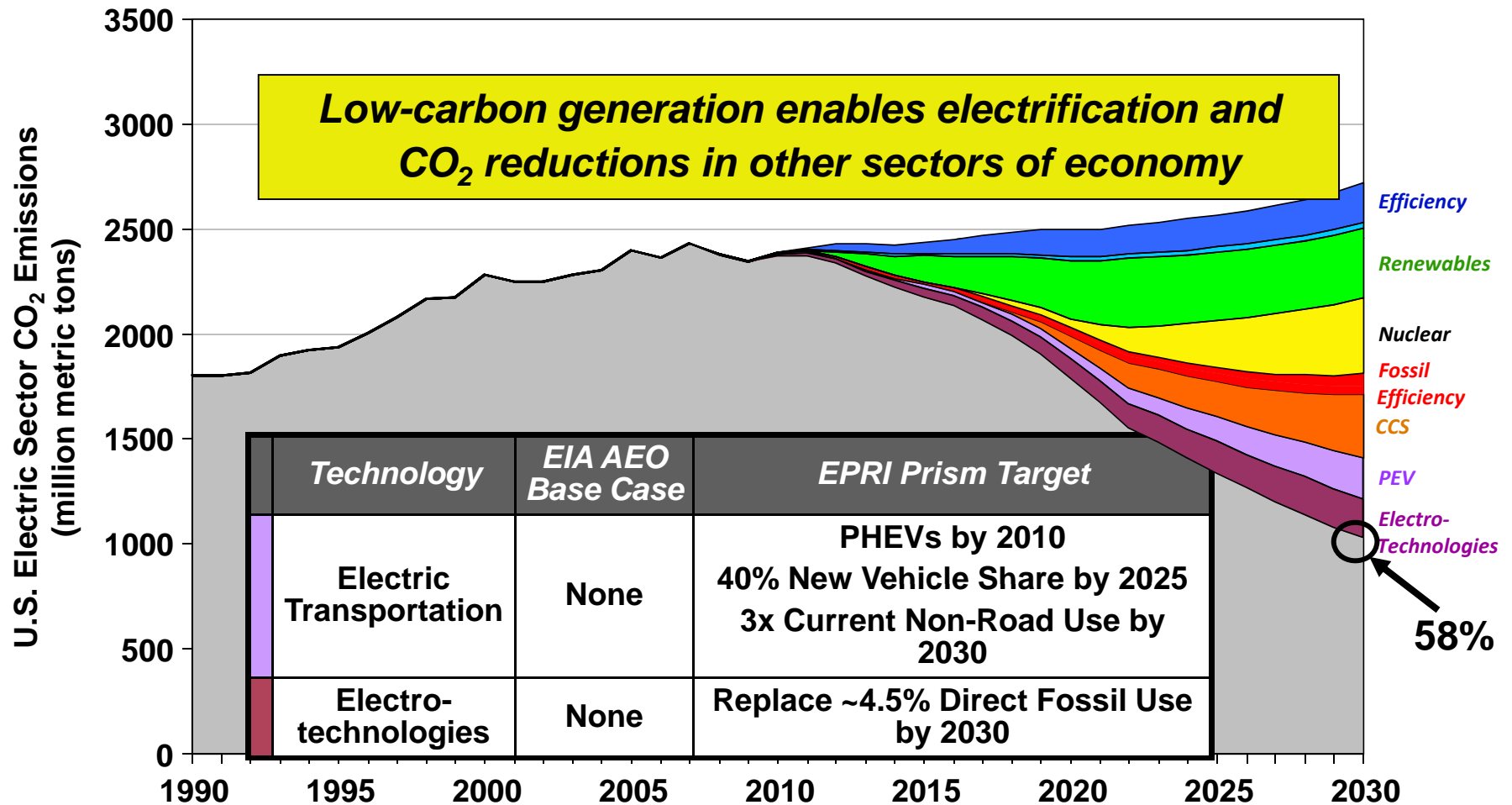
# CO<sub>2</sub> Reductions from Electrotechnologies



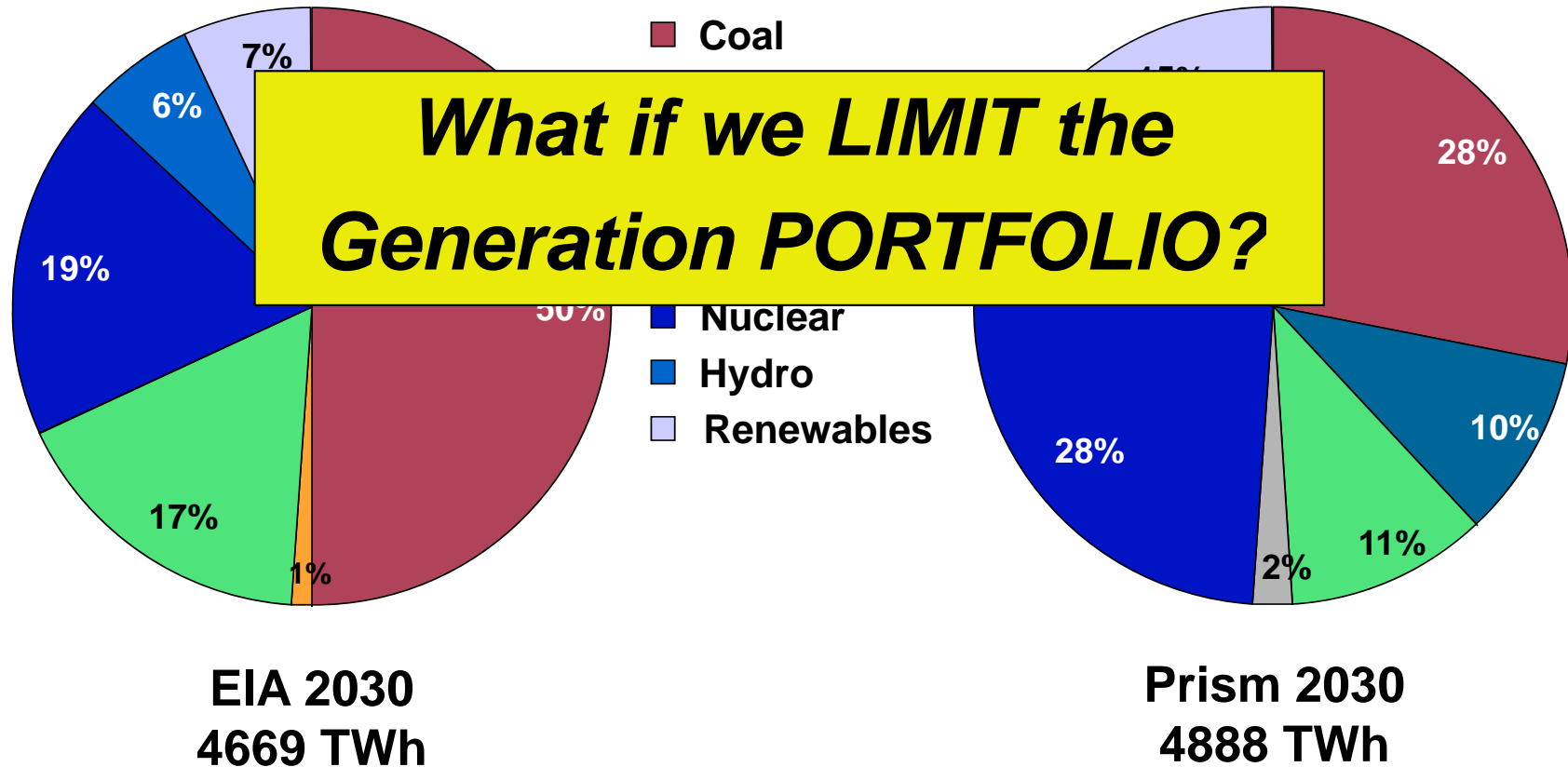
# EPRI 2009 Prism: CO<sub>2</sub> Reductions are Technically Feasible with an Aggressive Deployment Strategy



# Additional CO<sub>2</sub> Reductions through Transportation and Electro-Technologies



# Generation by Fuel Source in 2030



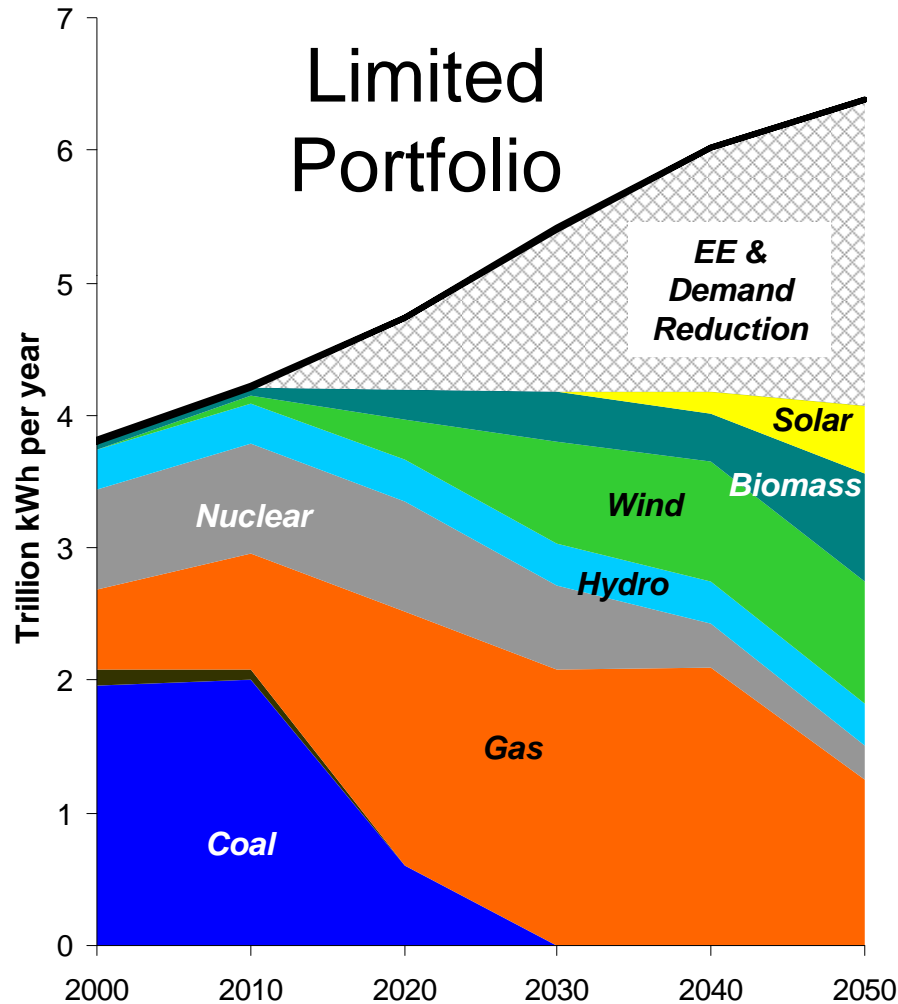
***Prism → 60% no- or low-carbon electricity by 2030***

# MERGE Economic Model

- MERGE: Model to Estimate the Regional and Global Effects of GHG Reductions
- Optimization model of economic activity and energy use through 2050
  - Maximize economic wealth
- Inputs
  - Energy supply technologies
  - Costs for electric and non-electric energy
- Constraints
  - Greenhouse gas emissions limitations
  - Energy resources
- Outputs
  - Economy-wide impact of technology and carbon constraints



# MERGE U.S. Electric Generation Mix



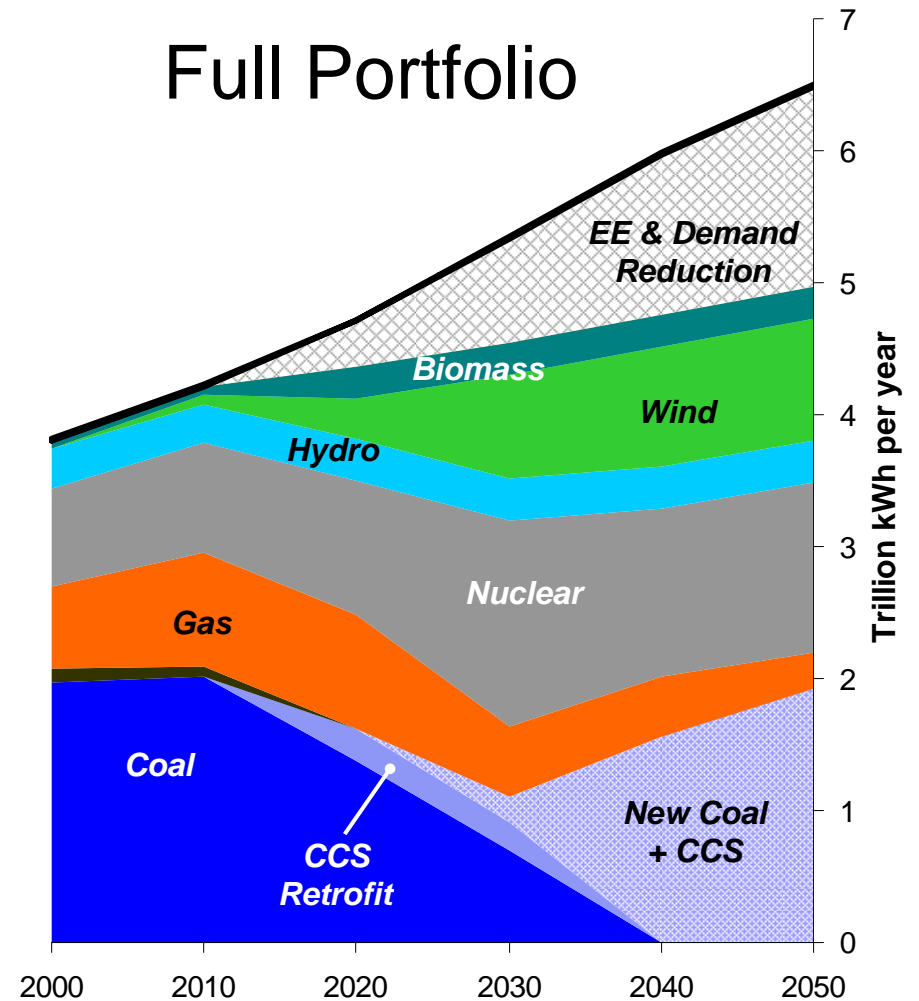
## Limited Portfolio

- No CO<sub>2</sub> capture and sequestration (CCS)
- Nuclear generation does not expand
- No plug-in electric vehicles (PEVs)

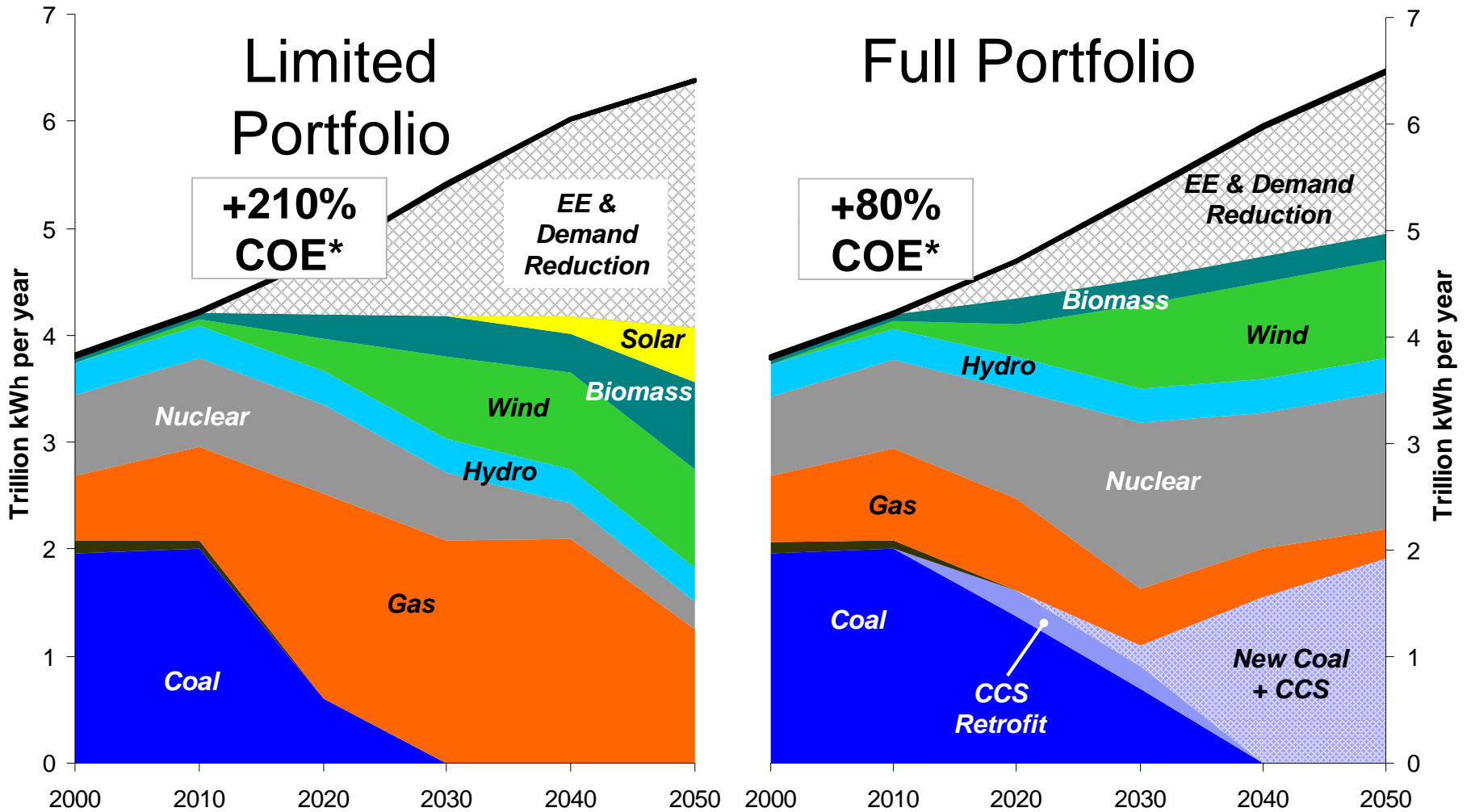
# MERGE U.S. Electric Generation Mix

## Full Portfolio

- Coal and gas CCS available
- Nuclear production can expand
- Accelerated end-use efficiency
- PEVs can expand



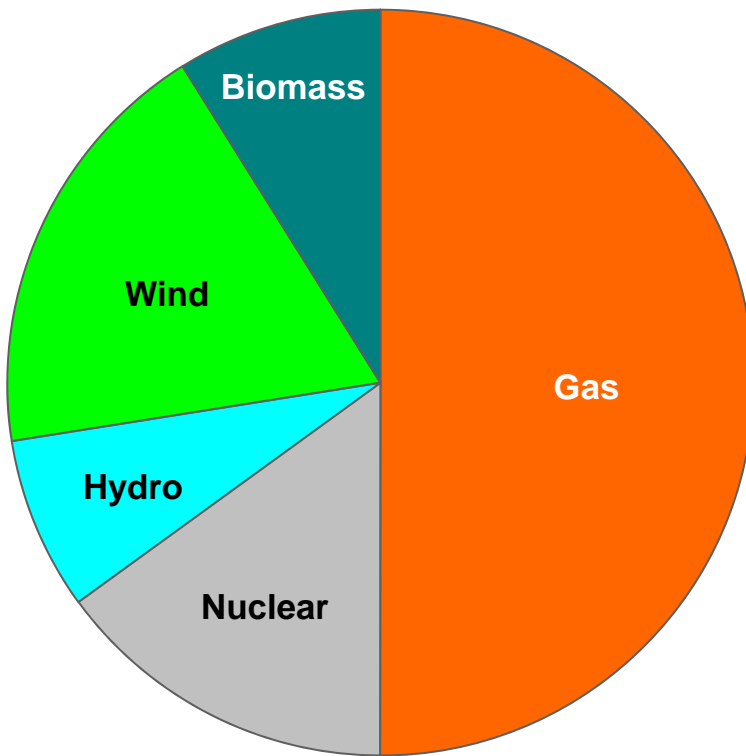
# MERGE: Full Portfolio Assures Lower Cost Low Carbon Future



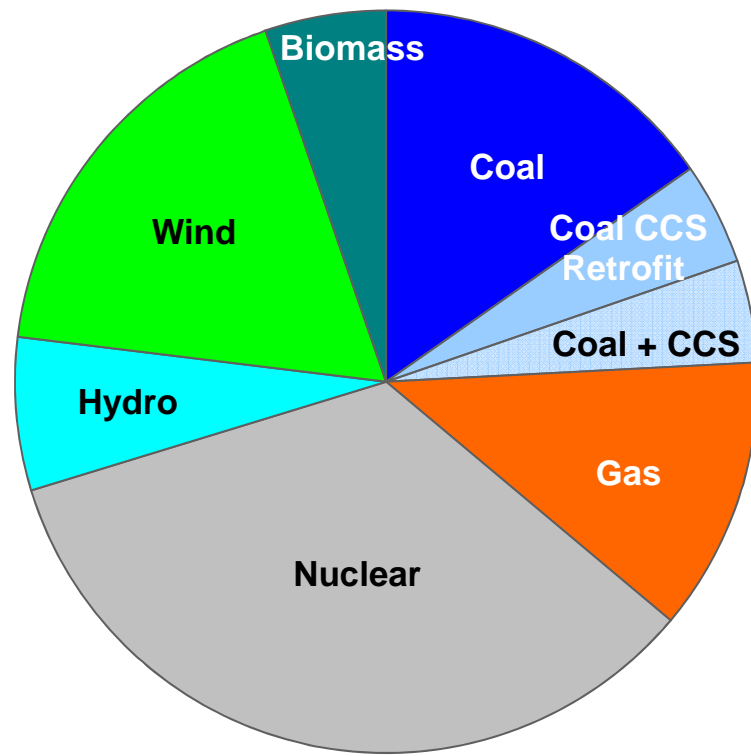
\* Cost of wholesale electricity increase relative to 2007

# 2030 Generation Mix

*Remarkably different futures...and only 20 years away!*



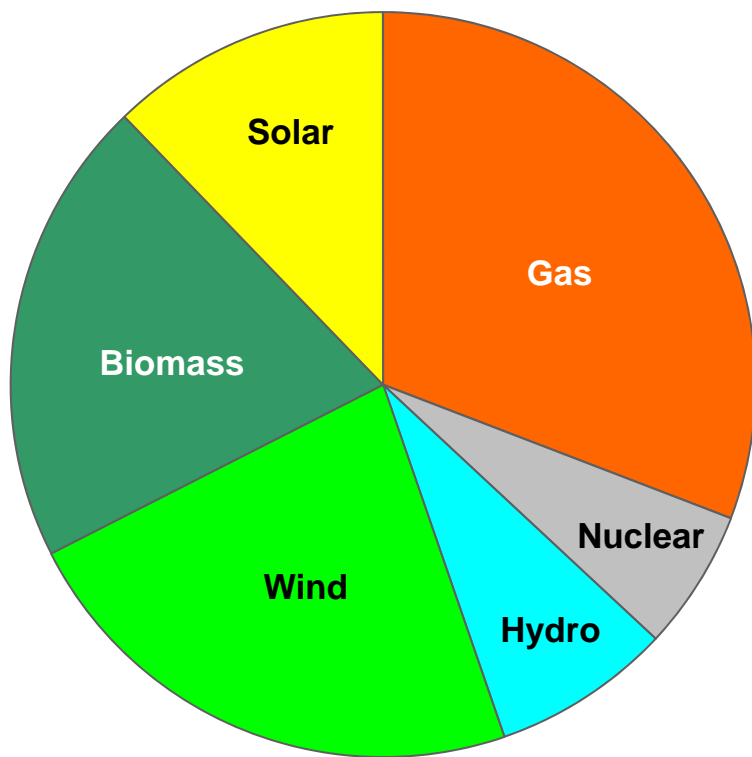
**Limited Portfolio**



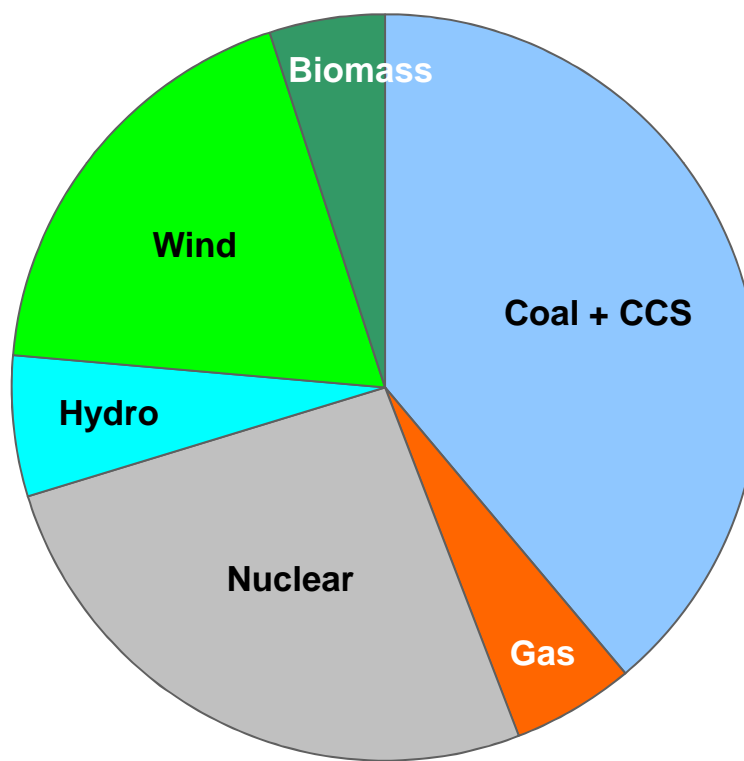
**Full Portfolio**

# 2050 Generation Mix

*Totally different futures in 2050*

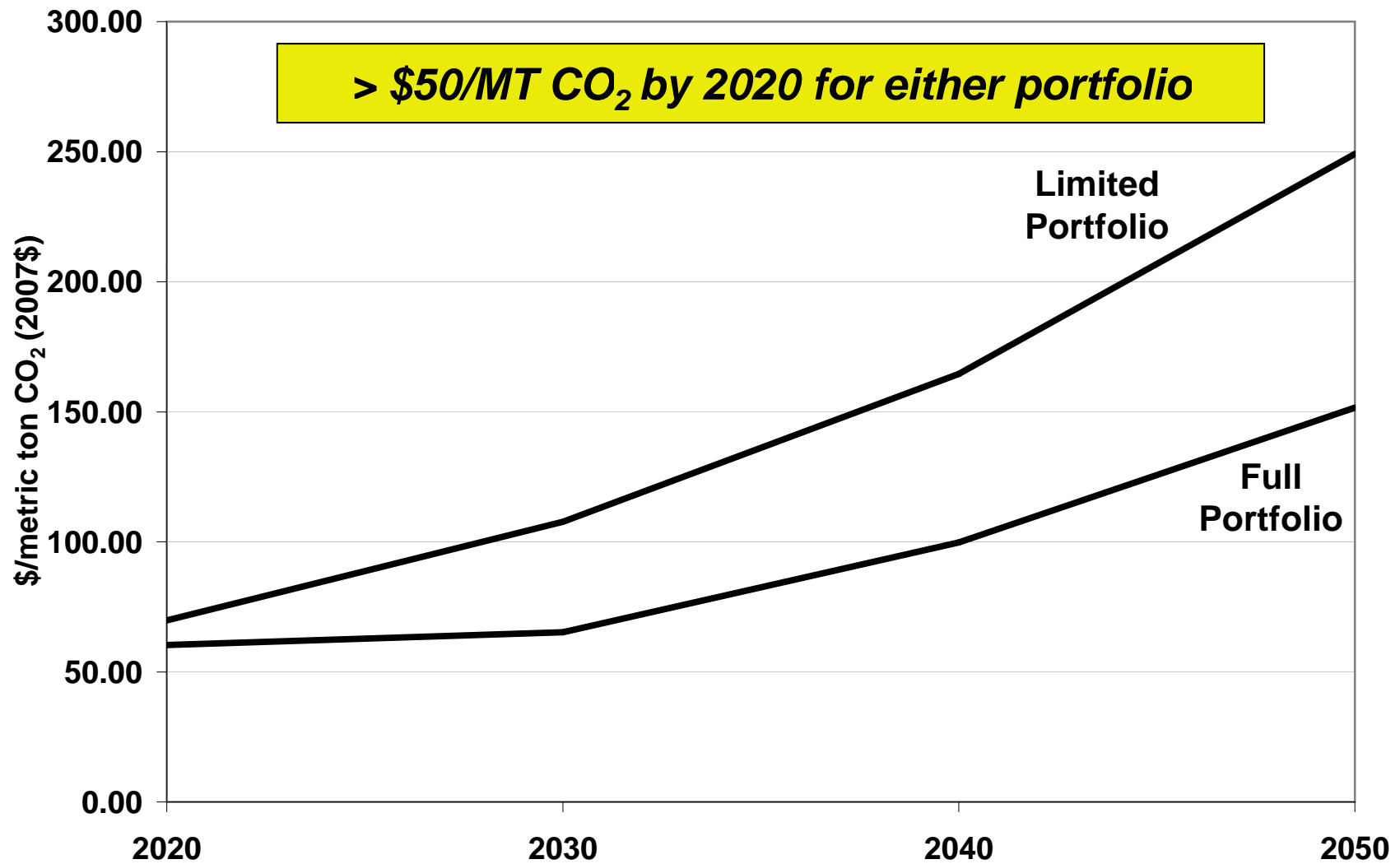


**Limited Portfolio**

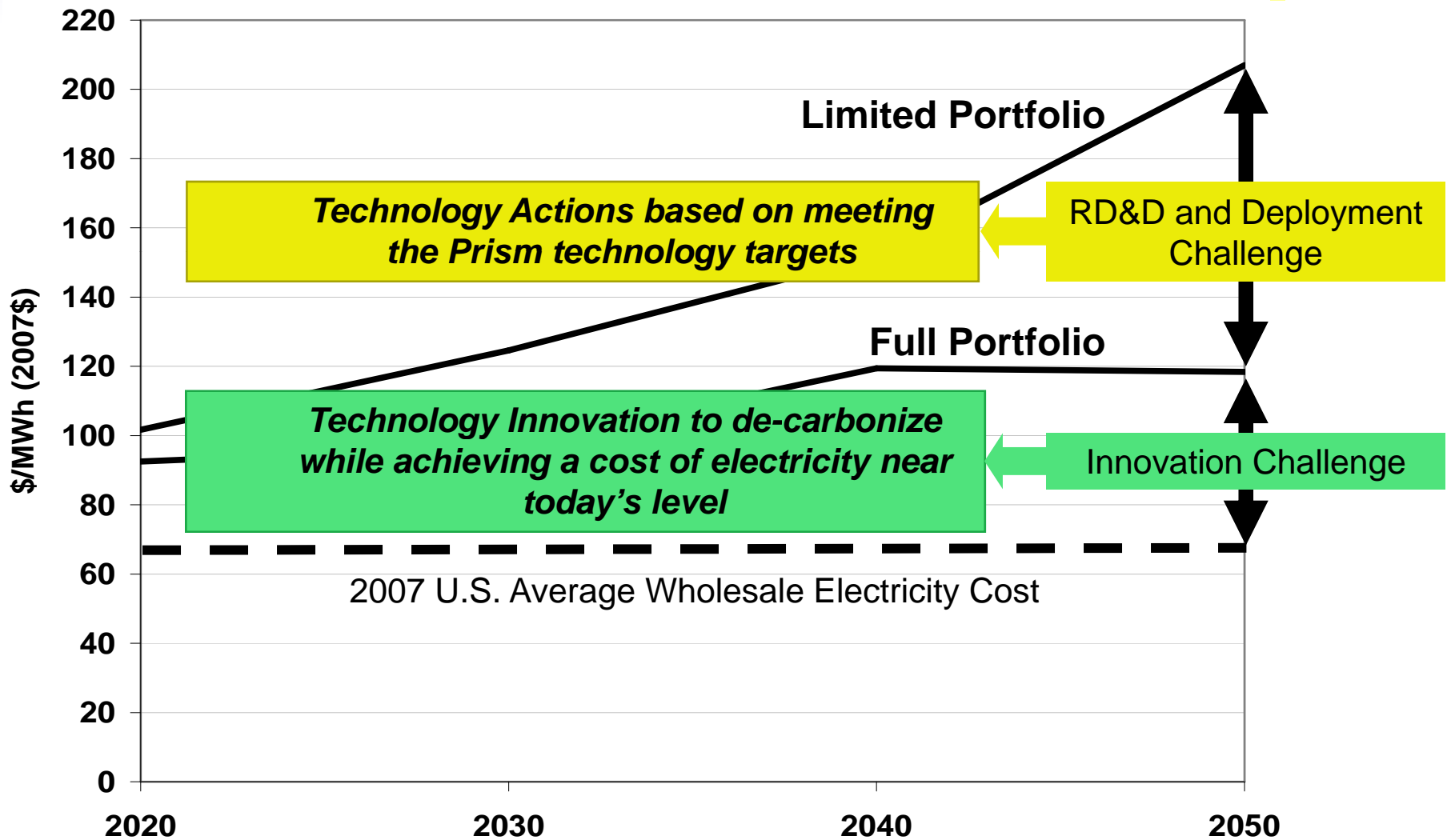


**Full Portfolio**

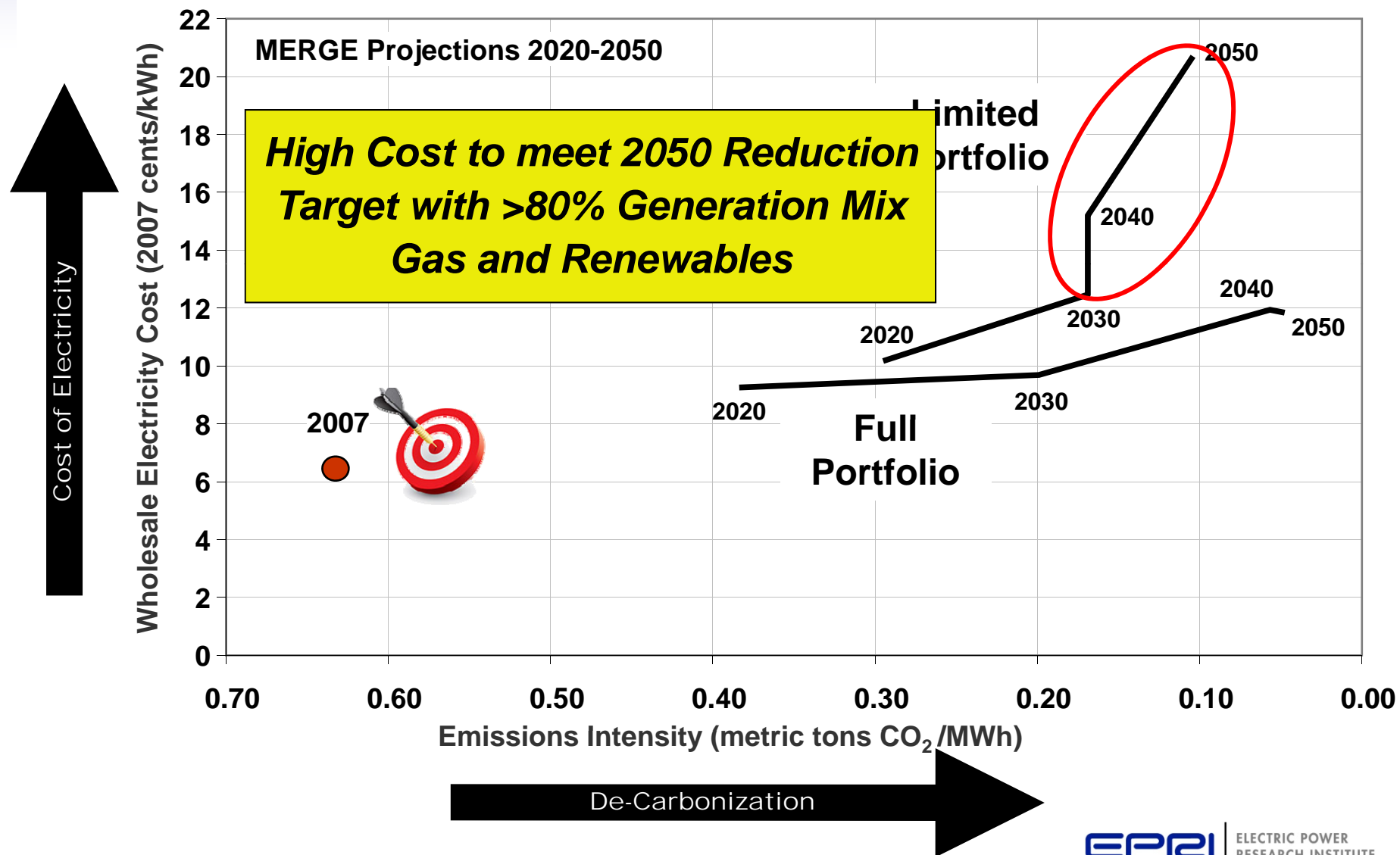
# MERGE CO<sub>2</sub> Price = Highest Cost Abatement



# Innovation is Needed for an *Affordable* Low Carbon Future



# MERGE De-carbonization Results



# Meeting the Challenge

- ✓ ***De-carbonize the electricity infrastructure***
- ✓ ***Meet binding economy-wide CO<sub>2</sub> reduction targets***
  - ***Provide reliable, affordable, and environmentally responsible electricity to consumers***

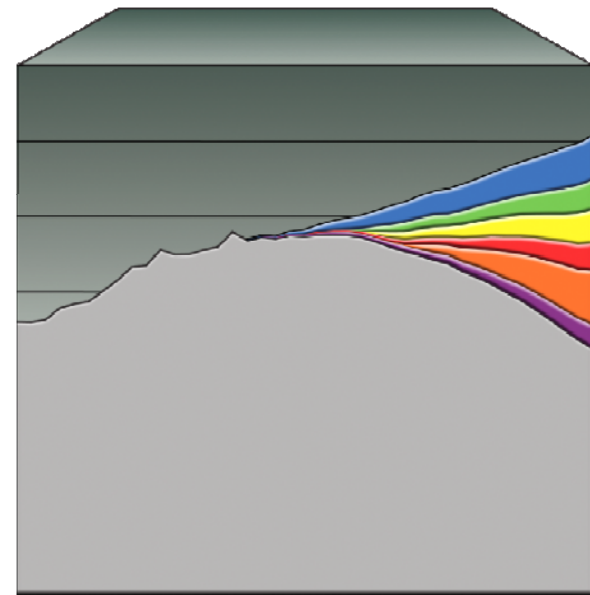
***CO<sub>2</sub> Reduction Targets Can be Met ...  
The Challenge is Affordability***

# The Electricity Technology Challenge

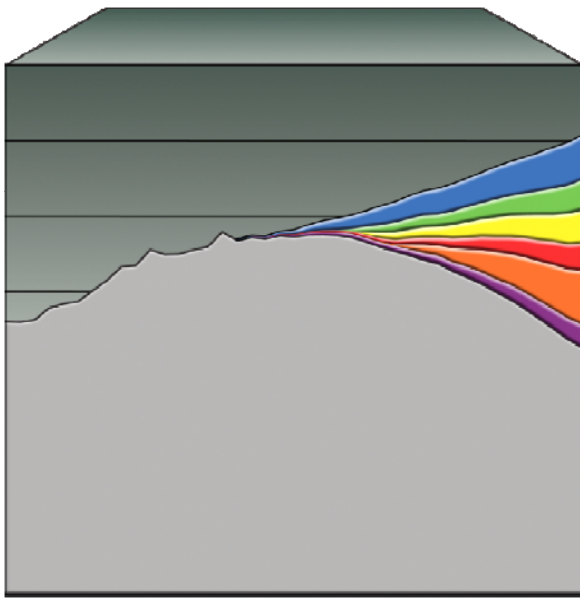
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# Technology Challenges: Assuring the Full Portfolio

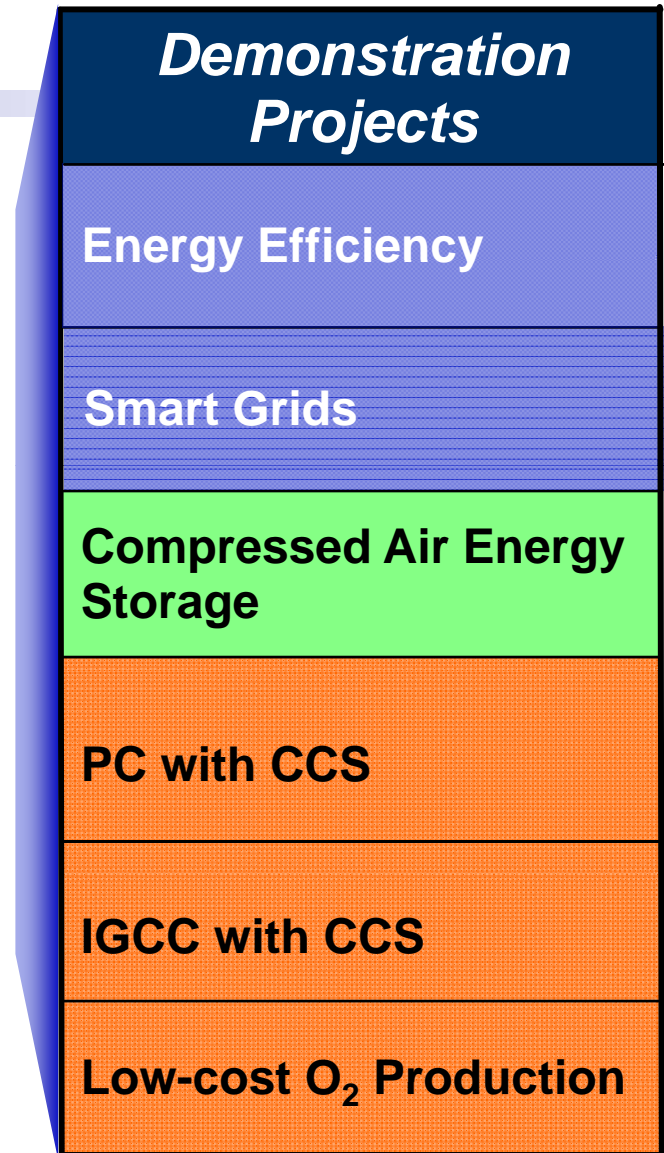
- Efficient end-use technologies
- Smart grids
  - To enable electric transportation, distributed resources, demand response
  - To enable intermittent renewable resources
- Advanced nuclear
- Advanced coal with CO<sub>2</sub> capture and sequestration



# Industry Demonstration Projects... From Analysis to Action



**EPRI's Prism Analysis**



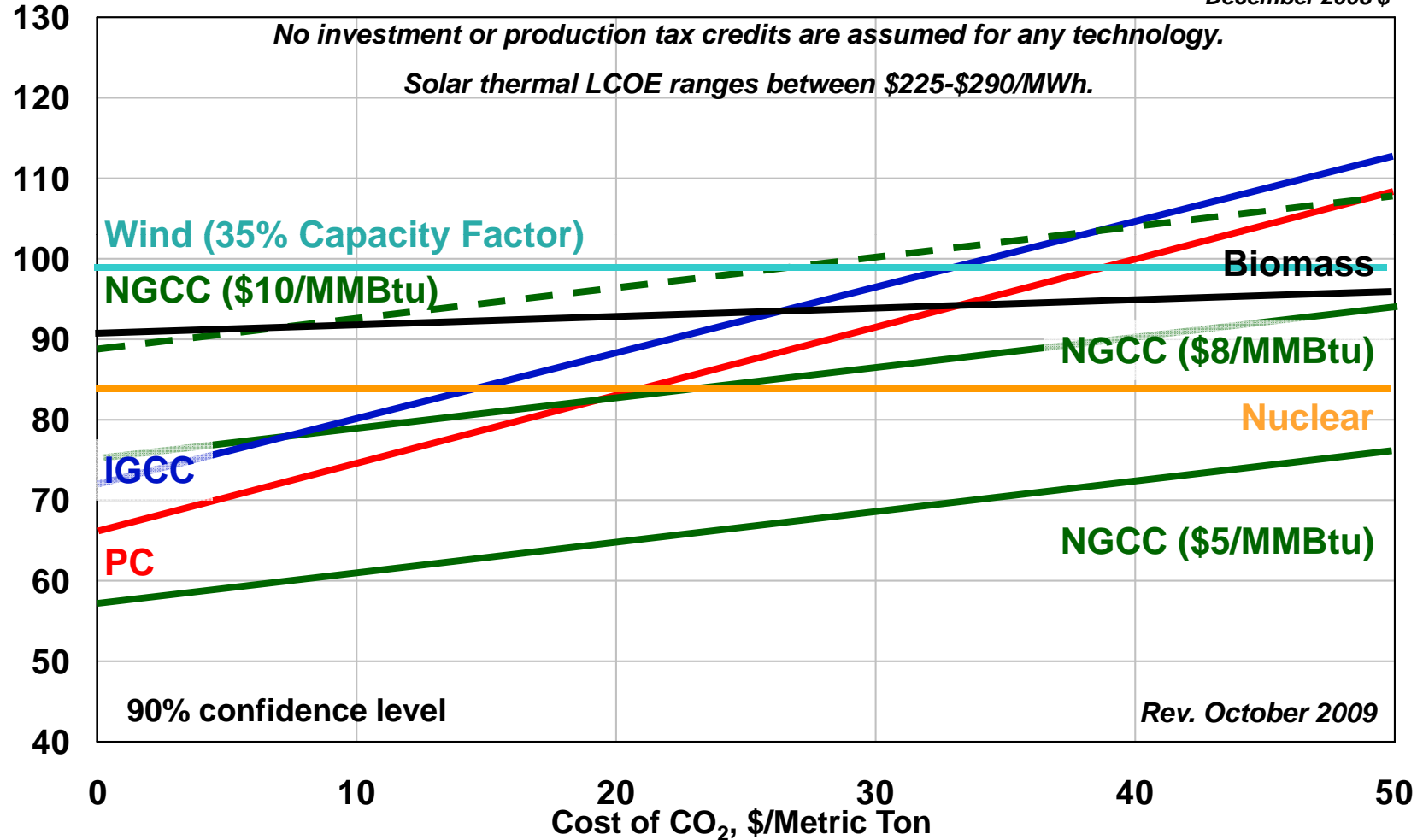
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# Comparative Levelized Costs of Electricity – 2015

Levelized Cost of Electricity, \$/MWh

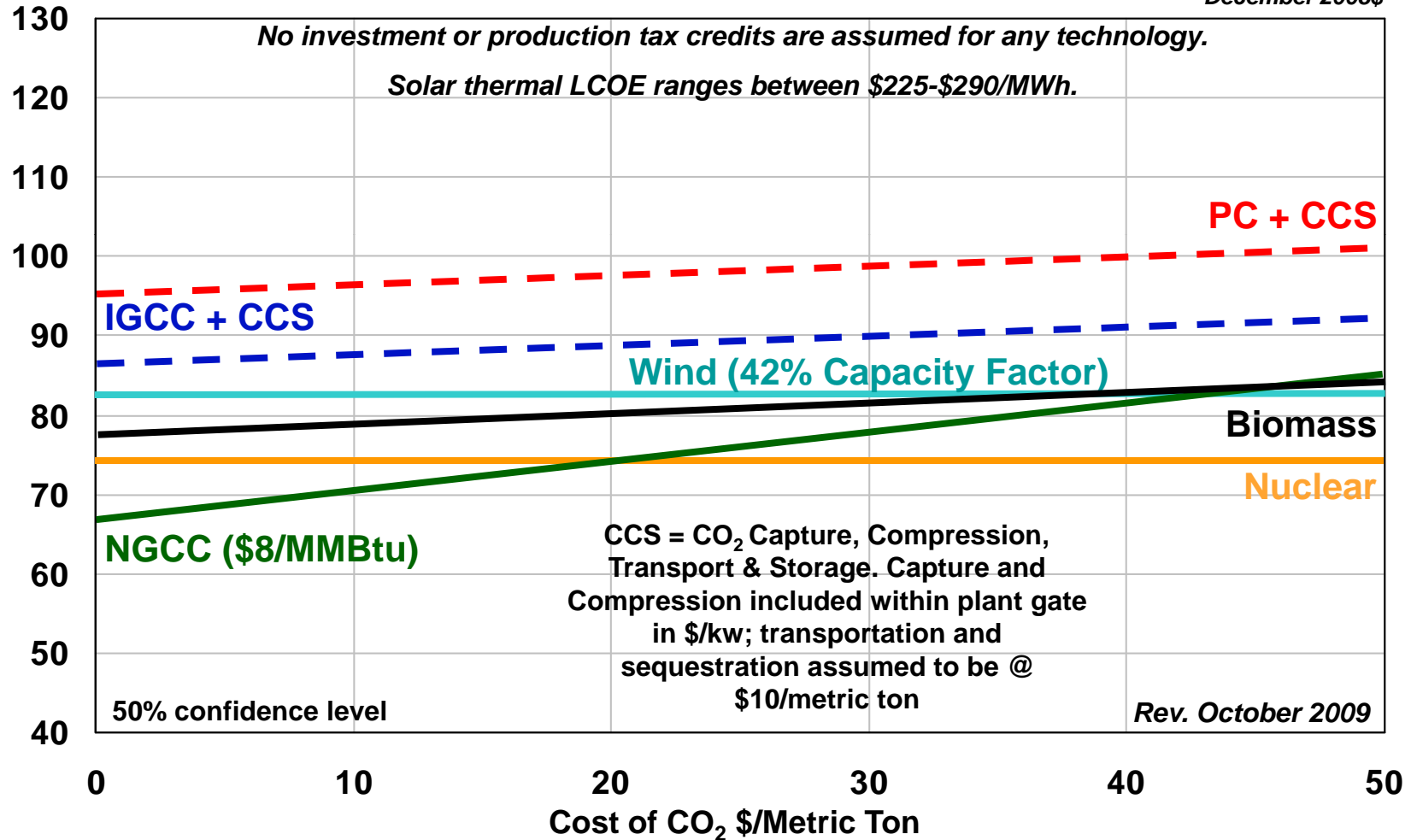
All costs are in December 2008 \$



# Comparative Levelized Costs of Electricity – 2025

Levelized Cost of Electricity, \$/MWh

All costs are in December 2008\$



# Additional Information

[www.epri.com](http://www.epri.com)

- EPRI Prism/MERGE 2009 1019563
- EPRI Report on Integrated Generation Technology Options 2009 Update 1019539
- Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010–2030) 1016987
- Advanced Coal Power Systems with CO2 Capture: EPRI's CoalFleet For Tomorrow Vision 1016877

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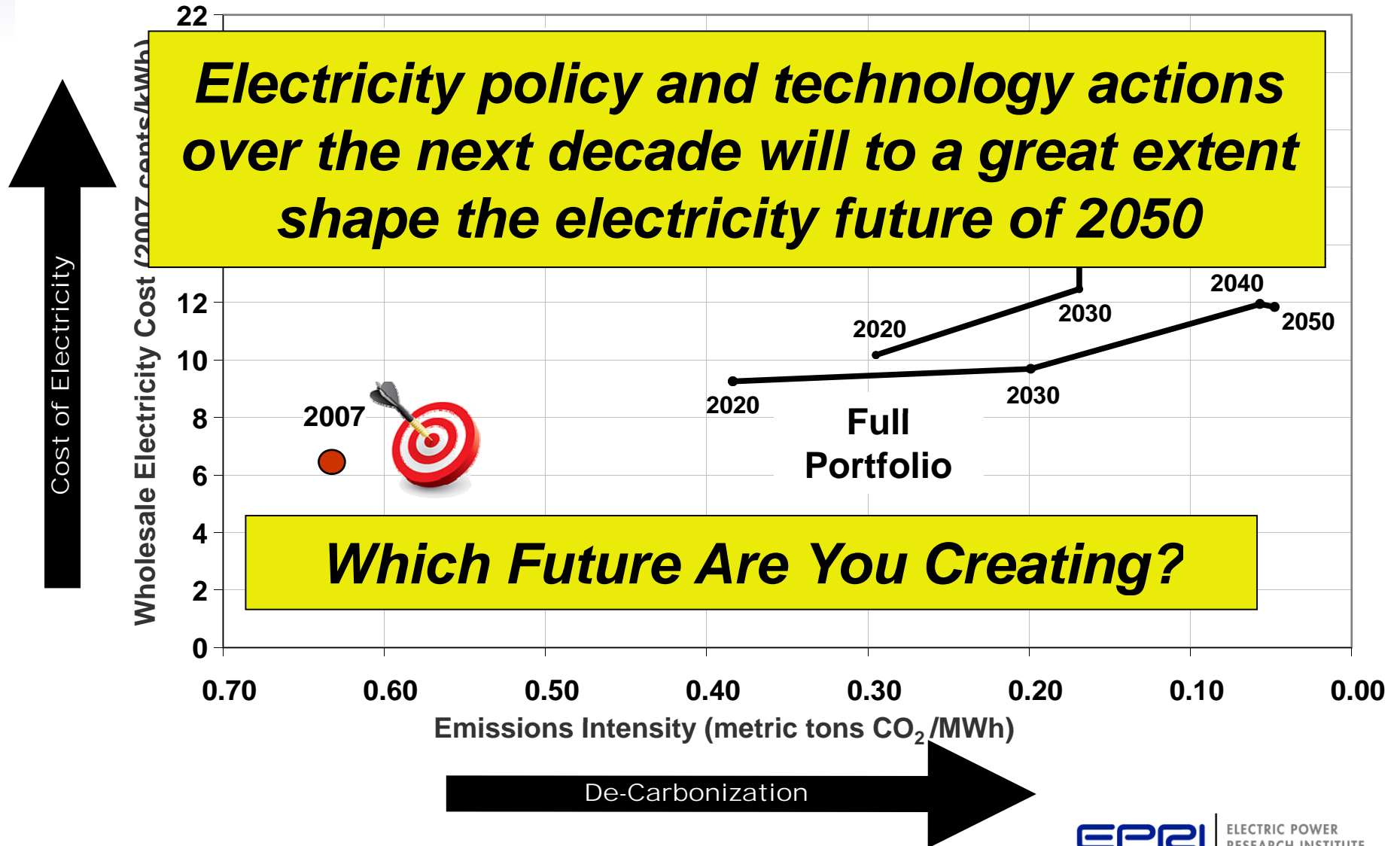


# Summary

- The **full portfolio** is essential to meeting the CO<sub>2</sub> and cost challenges
- Continuing research is critical
- Demonstration projects are needed to validate and accelerate technologies
- EPRI's role:
  - Collaborative research
  - Coordinate and facilitate demonstrations
  - Goal - accelerate technology introduction



# Conclusion



Together...Shaping the Future of Electricity



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