

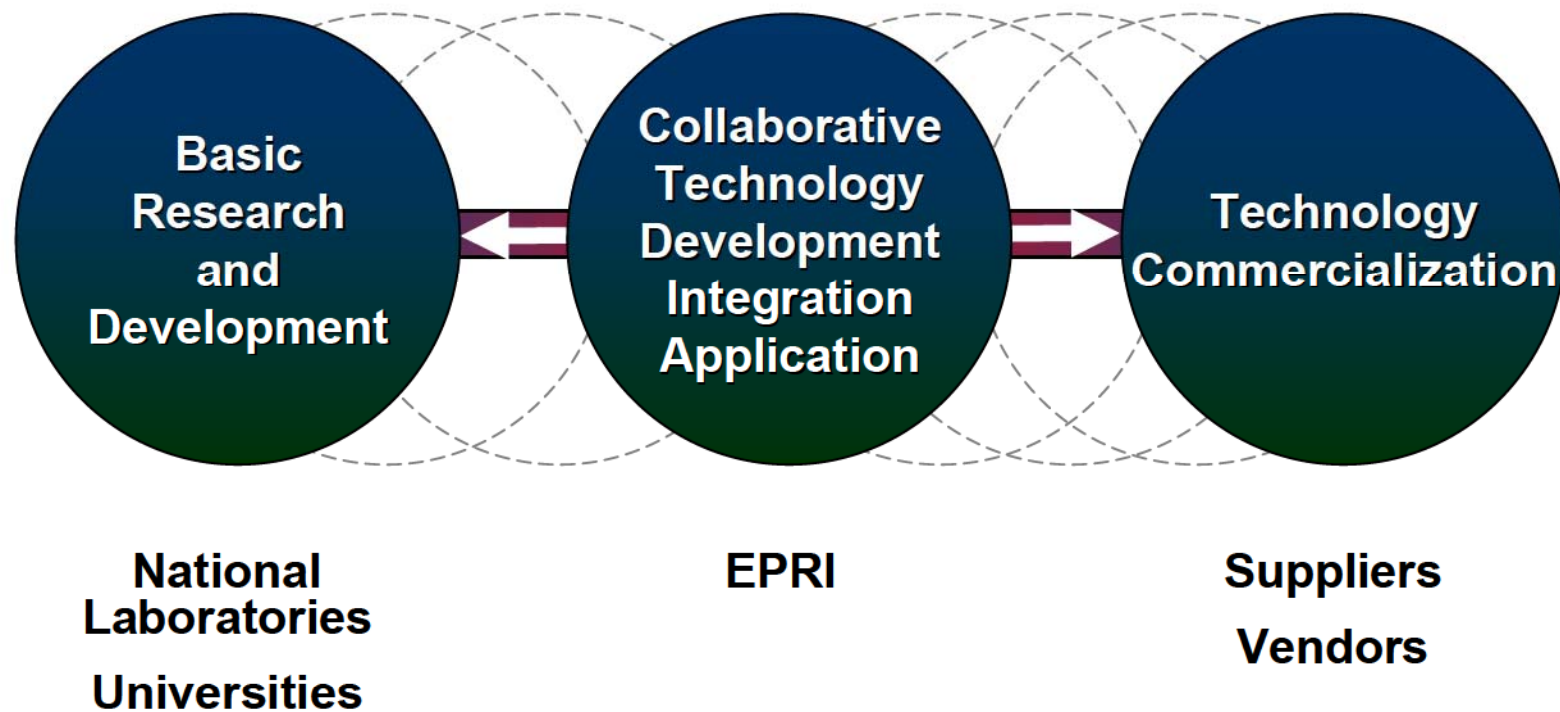


Electricity Technology in a Carbon-Constrained Future

March 15, 2007
PacifiCorp Climate Working Group

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Vice President - Environment

EPRI Role



Global Climate Area Overview

Value

- Helps inform policy deliberations
- Helps guide technology decisions
- Helps companies understand risks and opportunities; create strategies
- Plays a role that companies cannot play themselves

Why EPRI?

- World class, in-house analytical and technology capabilities
- Cutting-edge research
- Strong role for industry collaboration
- Viewed as independent, credible, neutral

**Inform
Public
Policy**

**Inform
Utility
Decisions**

Program 102:

Identify components of least-cost strategies.
Analyze costs and benefits of major proposals.

Programs 102/103:

Examine role of technologies.
Identify ways to spur innovation.

Program 103:

Support utility analysis of emissions, reduction options, strategies and communication.

Presentation Objective

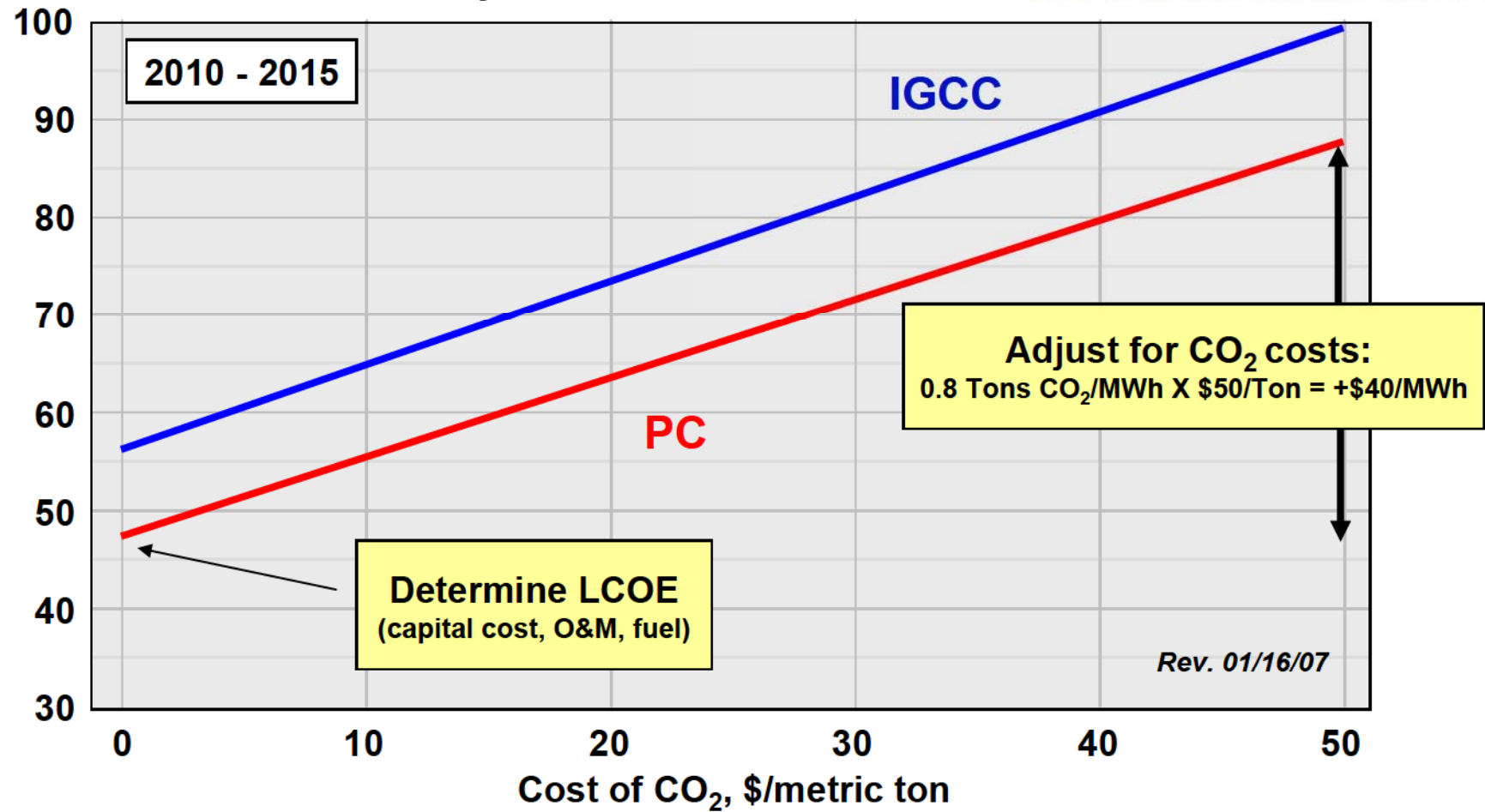
Provide a factual framework for discussing:

- I. Generation technologies and investment decisions in a carbon-constrained world
- II. The technical feasibility of reducing U.S. electric sector CO₂ emissions

Example: Coal Generation

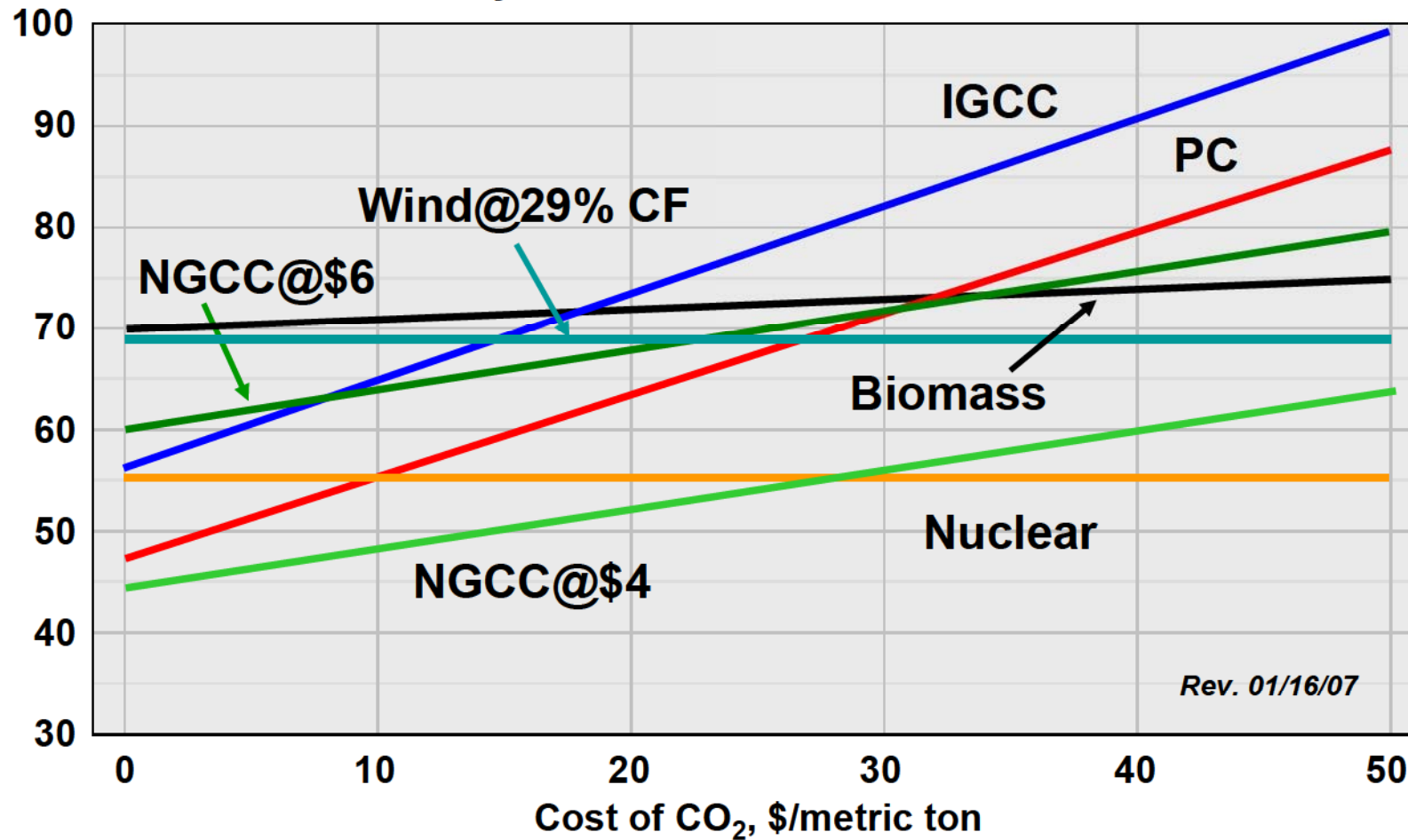


Levelized Cost of Electricity, \$/MWh



Comparative Costs in 2010-2015

Levelized Cost of Electricity, \$/MWh



Near-Term Implications

- New advanced light water reactors have cost advantage, but unlikely to enter operation until after 2015
- Absent nuclear, most new base-load generation will utilize fossil technologies (NGCC, PC, and IGCC) without CO₂ capture and storage.
 - IGCC at present 10-20% higher than PC
 - Choice of PC vs. NGCC will depend on natural gas prices
- Renewables unlikely to extend beyond mandated requirement due to poor comparative economics



Very limited opportunity for significant economic CO₂ reduction!!!

Key Technology Challenges

The U.S. electricity sector will need ALL of the following technology advancements to significantly reduce CO₂ emissions over the coming decades:

1. Smart grids and communications infrastructures to enable end-use efficiency and demand response, distributed generation, and PHEVs.
2. A grid infrastructure with the capacity and reliability to operate with 20-30% intermittent renewables in specific regions.
3. Significant expansion of nuclear energy enabled by continued safe and economic operation of existing nuclear fleet; and a viable strategy for managing spent fuel.
4. Commercial-scale coal-based generation units operating with 90+% CO₂ capture and storage in a variety of geologies.

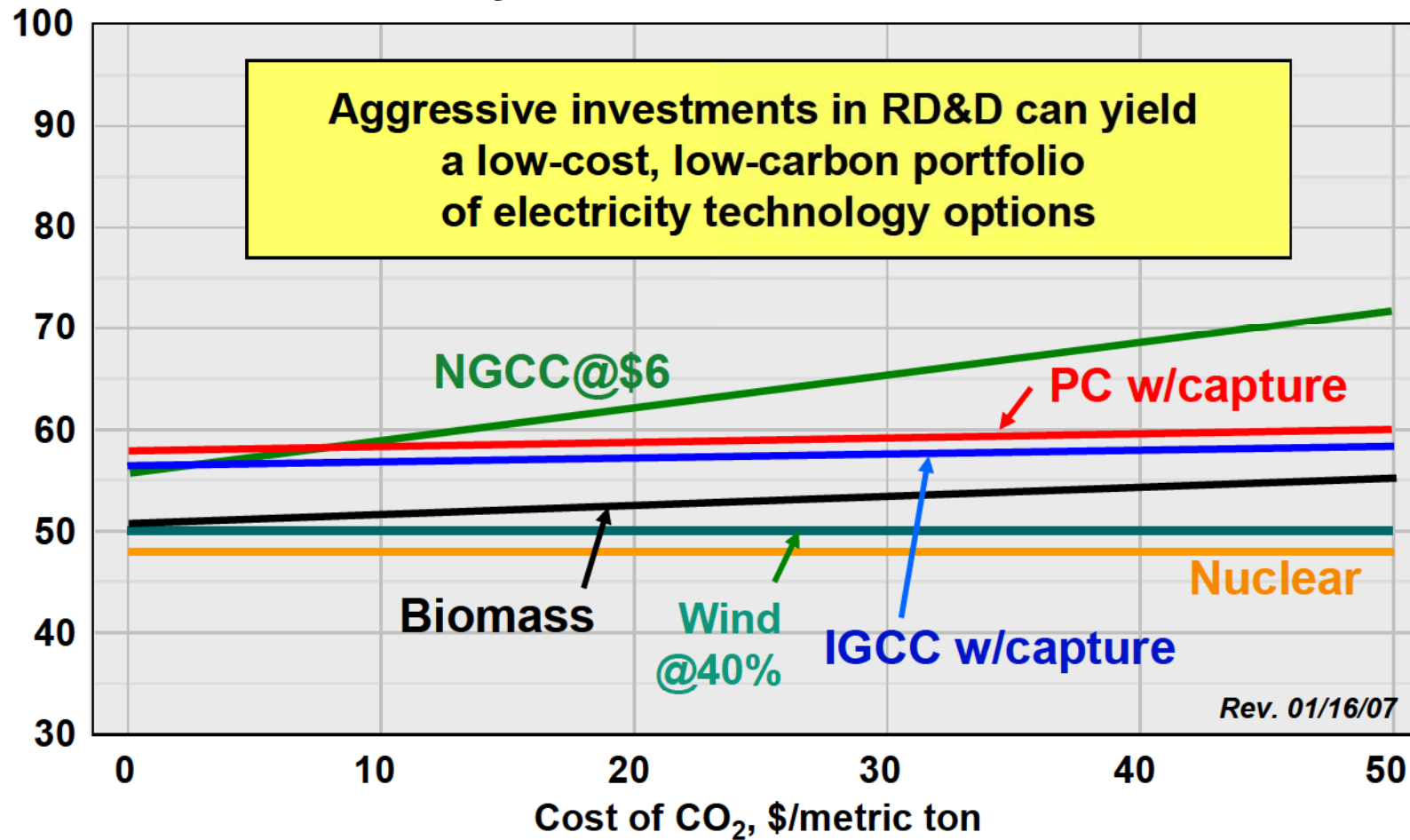
Average Annual Funding Needs (2005-30)

(including nuclear closed fuel cycle, CO₂ storage)

	Research	Development	Demonstration	Early Deployment	Enhanced Performance	Total
DISTRIBUTION INTEGRATION Smart grids and communications infrastructures to enable end-use efficiency and demand response, distributed generation, and PHEVs.	\$25M/yr	\$51M/yr	\$64M/yr	\$80M/yr	\$0M/yr	\$220M/yr
GRID INTEGRATION A grid infrastructure with the capacity and reliability to operate with 20-30% intermittent renewables in specific regions.	\$40M/yr	\$80M/yr	\$70M/yr	\$33M/yr	\$117M/yr	\$340M/yr
NUCLEAR Significant expansion of nuclear energy enabled by continued safe and economic operation of existing nuclear fleet; and a viable strategy for managing spent fuel.	\$247M/yr	\$493M/yr	\$40M/yr	\$0M/yr	\$40M/yr	\$820M/yr
ADVANCED COAL, CO₂ CAPTURE and STORAGE Commercial-scale coal-based generation units operating with 90+% CO ₂ capture and storage in a variety of geologies.	\$52M/yr	\$91M/yr	\$228M/yr	\$249M/yr	\$0M/yr	\$620M/yr
Total (Public + Private Sectors)	\$364M/yr	\$716M/yr	\$401M/yr	\$362M/yr	\$157M/yr	\$2000M/yr

Comparative Costs in 2020-2025

Levelized Cost of Electricity, \$/MWh

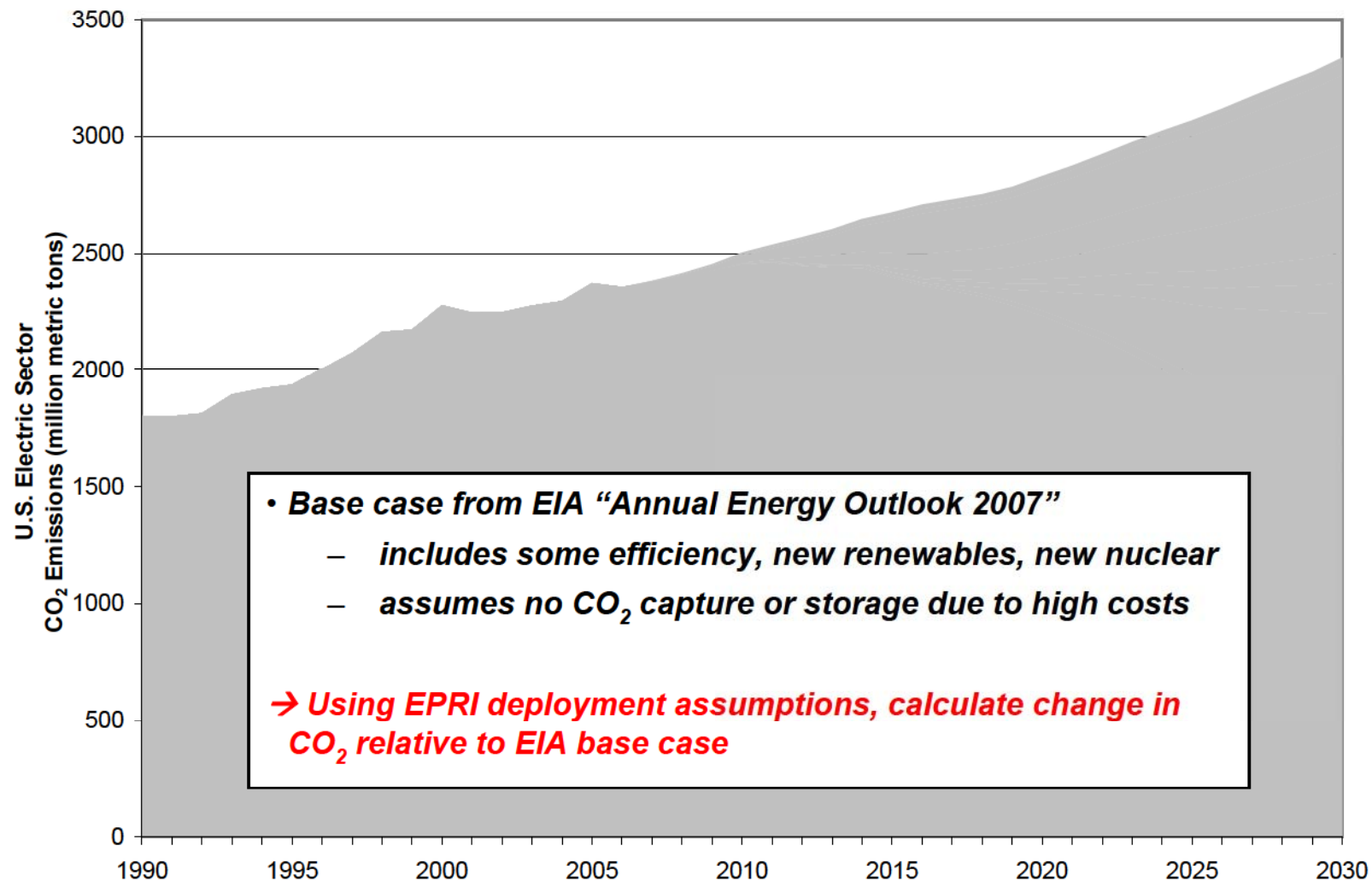


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U.S. Electricity Sector CO₂ Emissions

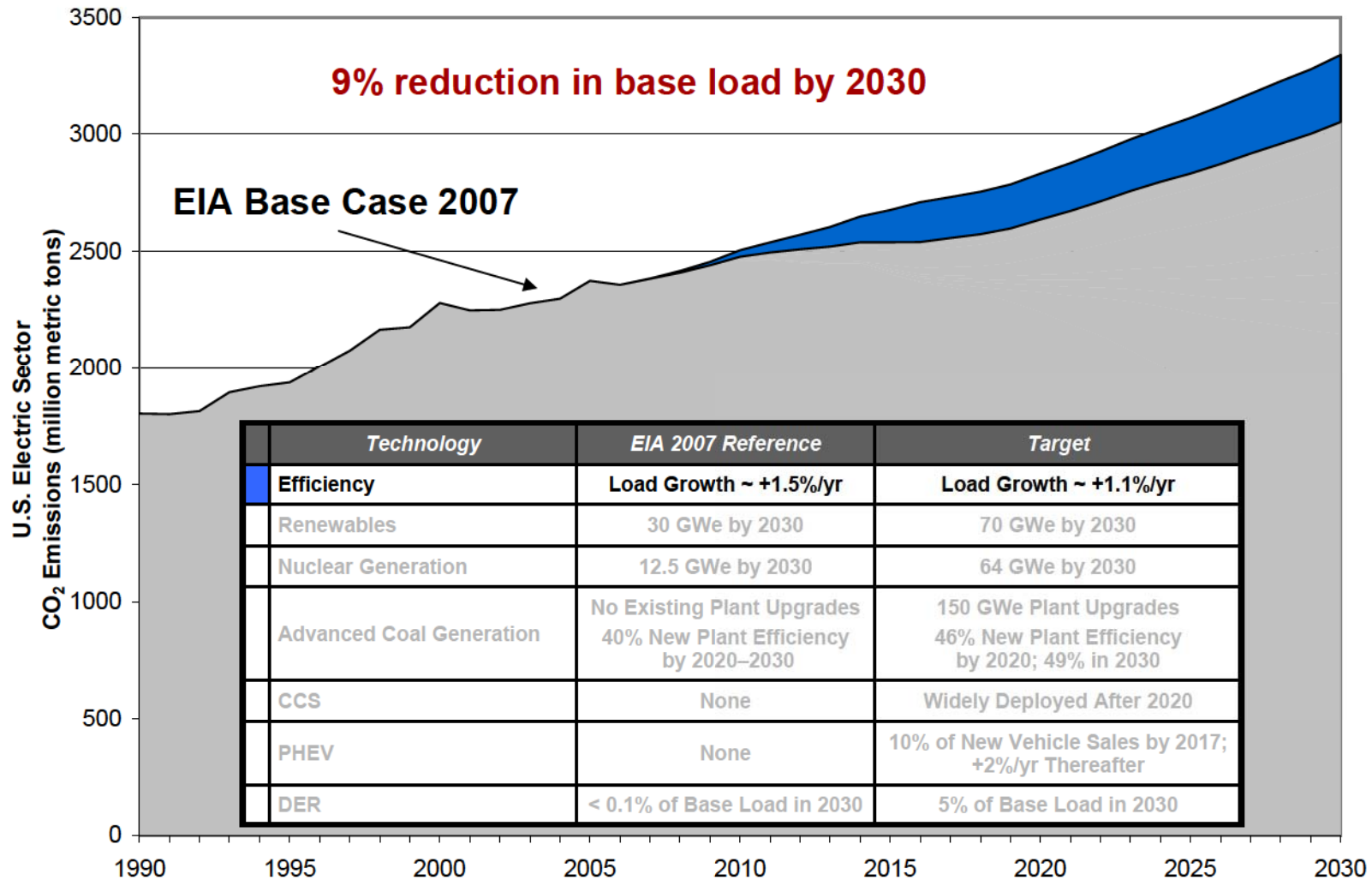


Technology Deployment Targets

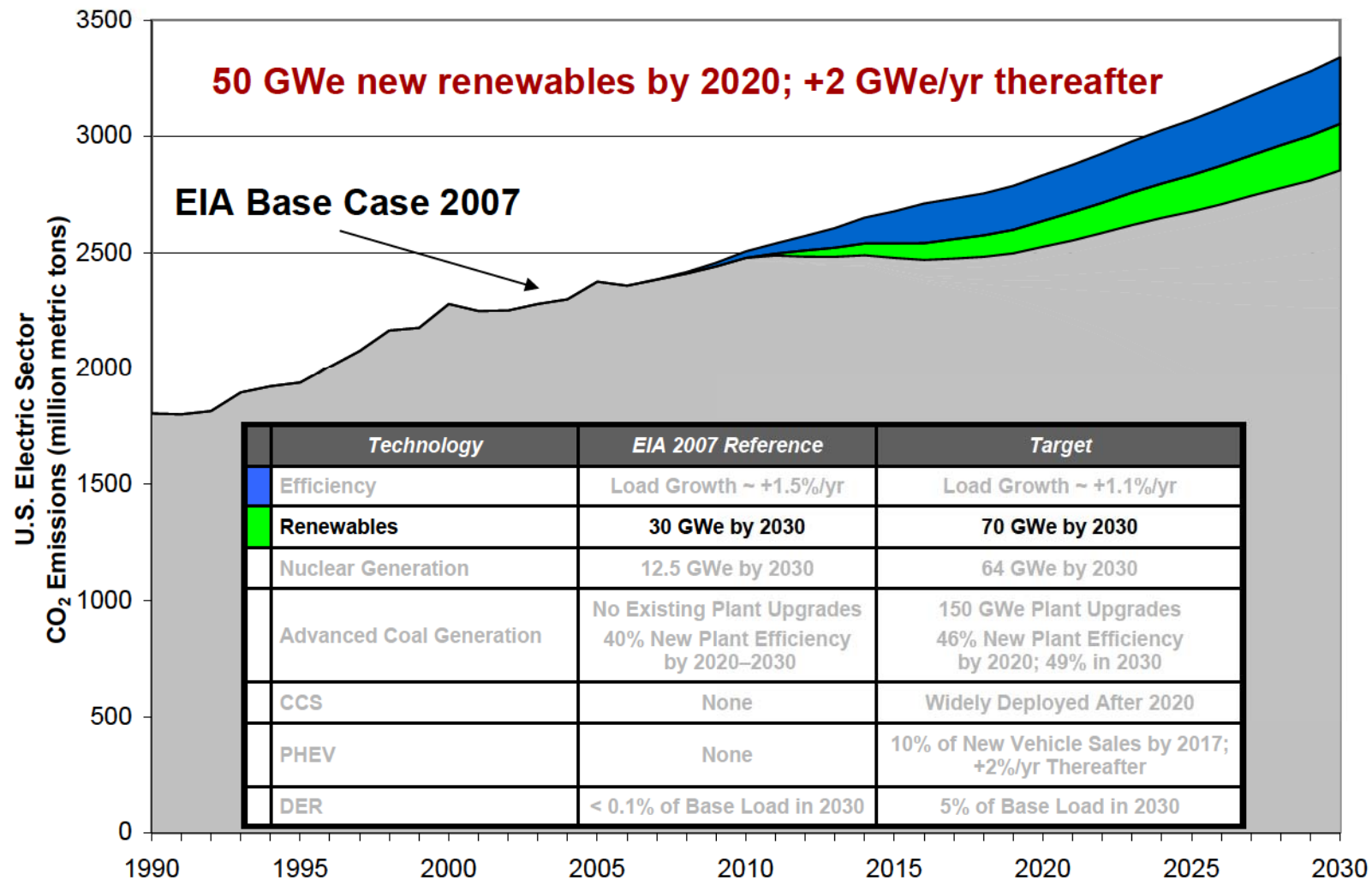
<i>Technology</i>	<i>EIA 2007 Base Case</i>	<i>EPRI Analysis Target*</i>
Efficiency	Load Growth ~ +1.5%/yr	Load Growth ~ +1.1%/yr
Renewables	30 GWe by 2030	70 GWe by 2030
Nuclear Generation	12.5 GWe by 2030	64 GWe by 2030
Advanced Coal Generation	No Existing Plant Upgrades 40% New Plant Efficiency by 2020–2030	150 GWe Plant Upgrades 46% New Plant Efficiency by 2020; 49% in 2030
Carbon Capture and Storage (CCS)	None	Widely Available and Deployed After 2020
Plug-in Hybrid Electric Vehicles (PHEV)	None	10% of New Vehicle Sales by 2017; +2%/yr Thereafter
Distributed Energy Resources (DER) <i>(including distributed solar)</i>	< 0.1% of Base Load in 2030	5% of Base Load in 2030

- EPRI analysis targets do not reflect potential regulatory and siting constraints. Additional economic modeling in progress

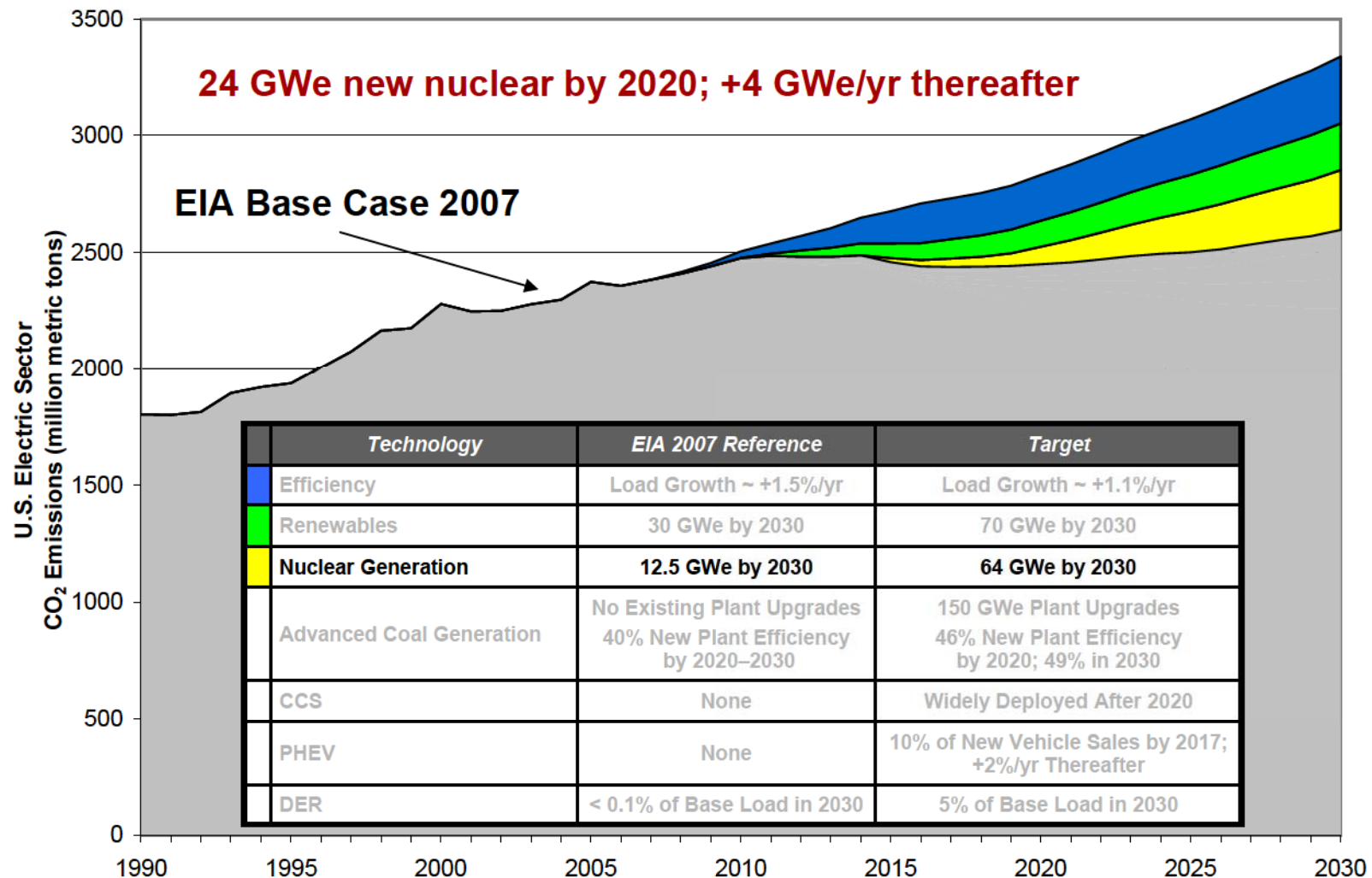
Benefit of Achieving Efficiency Target



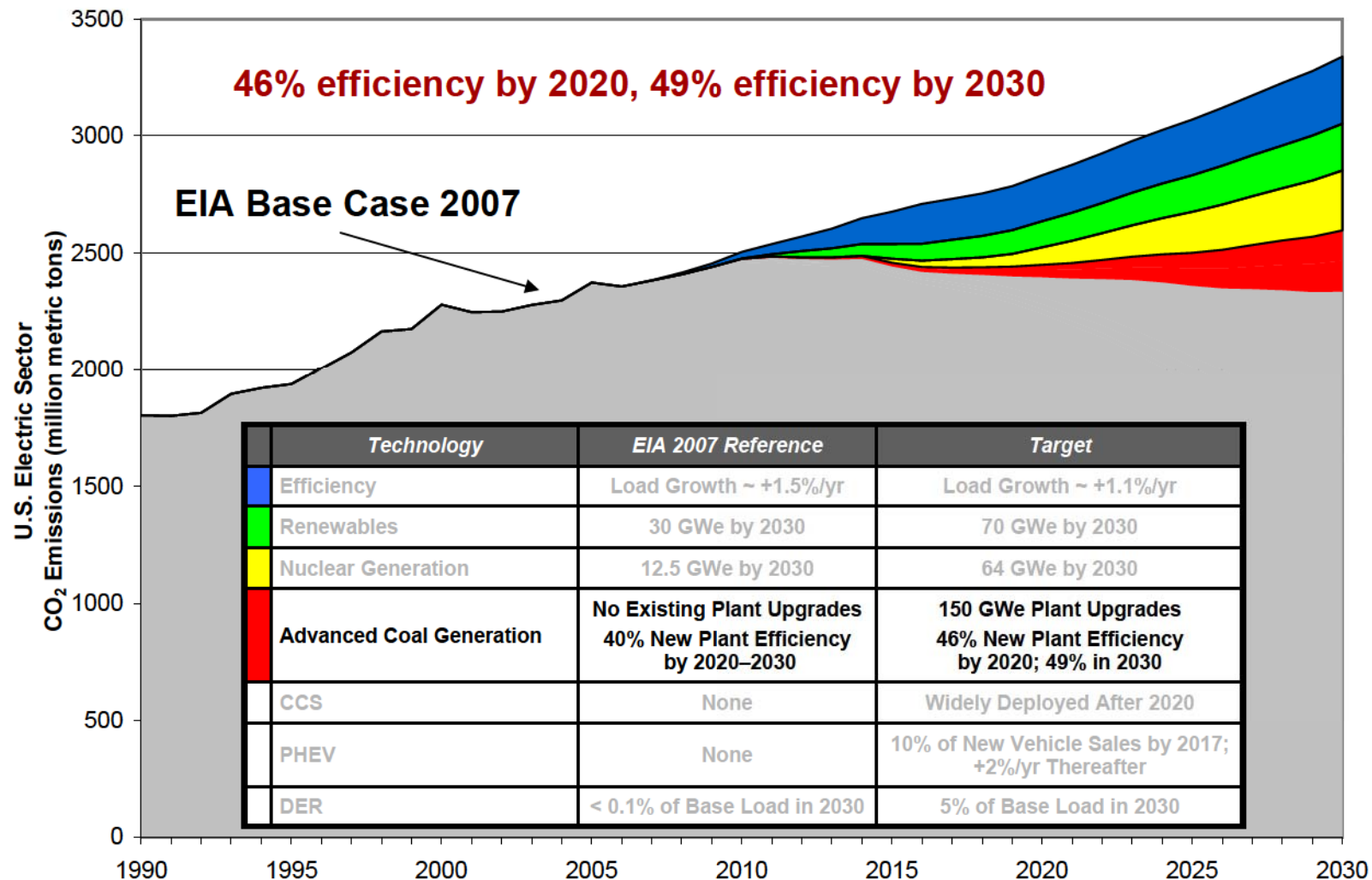
Benefit of Achieving Renewables Target



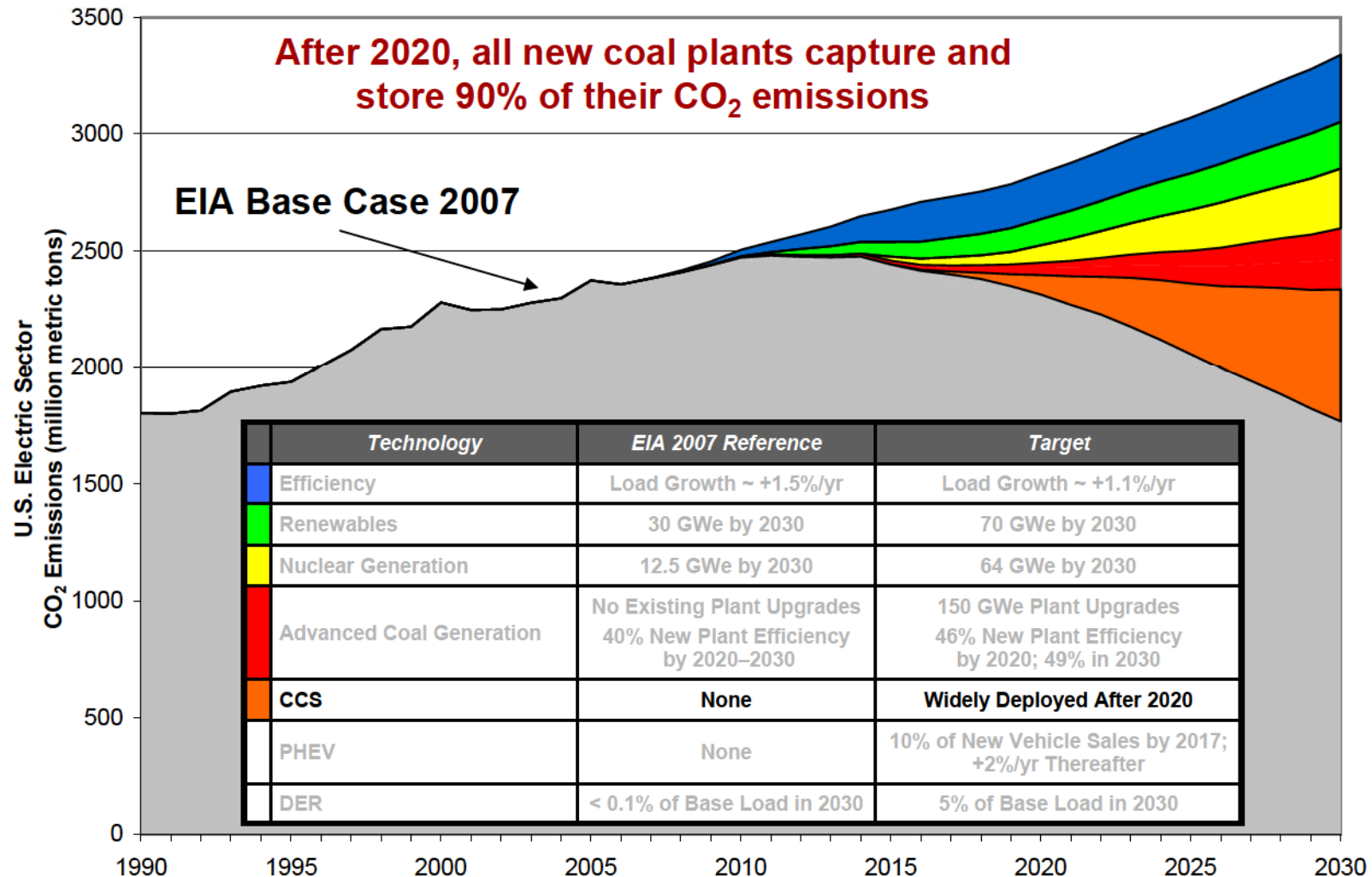
Benefit of Achieving Nuclear Generation Target



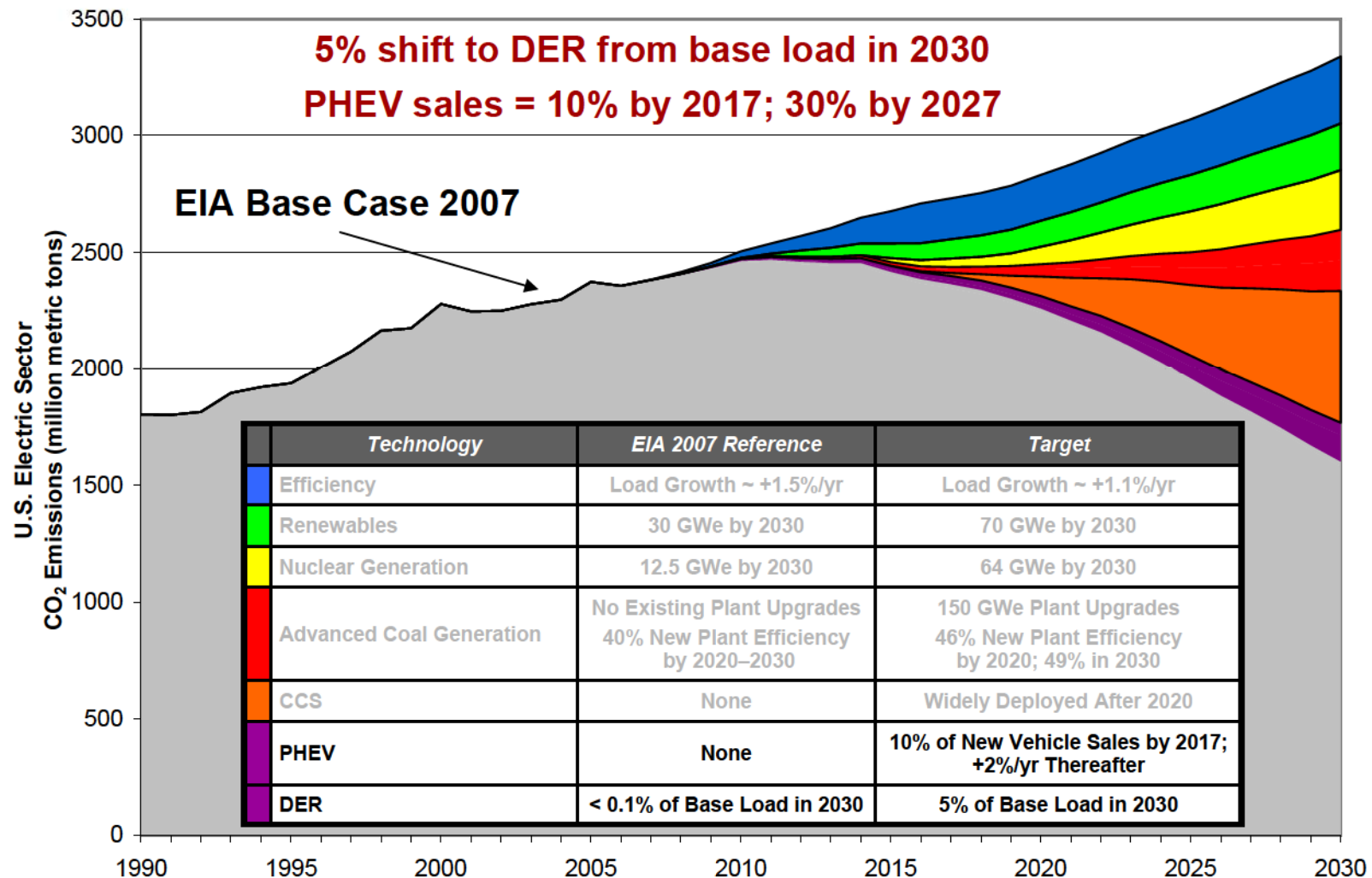
Benefit of Achieving Advanced Coal Generation Target



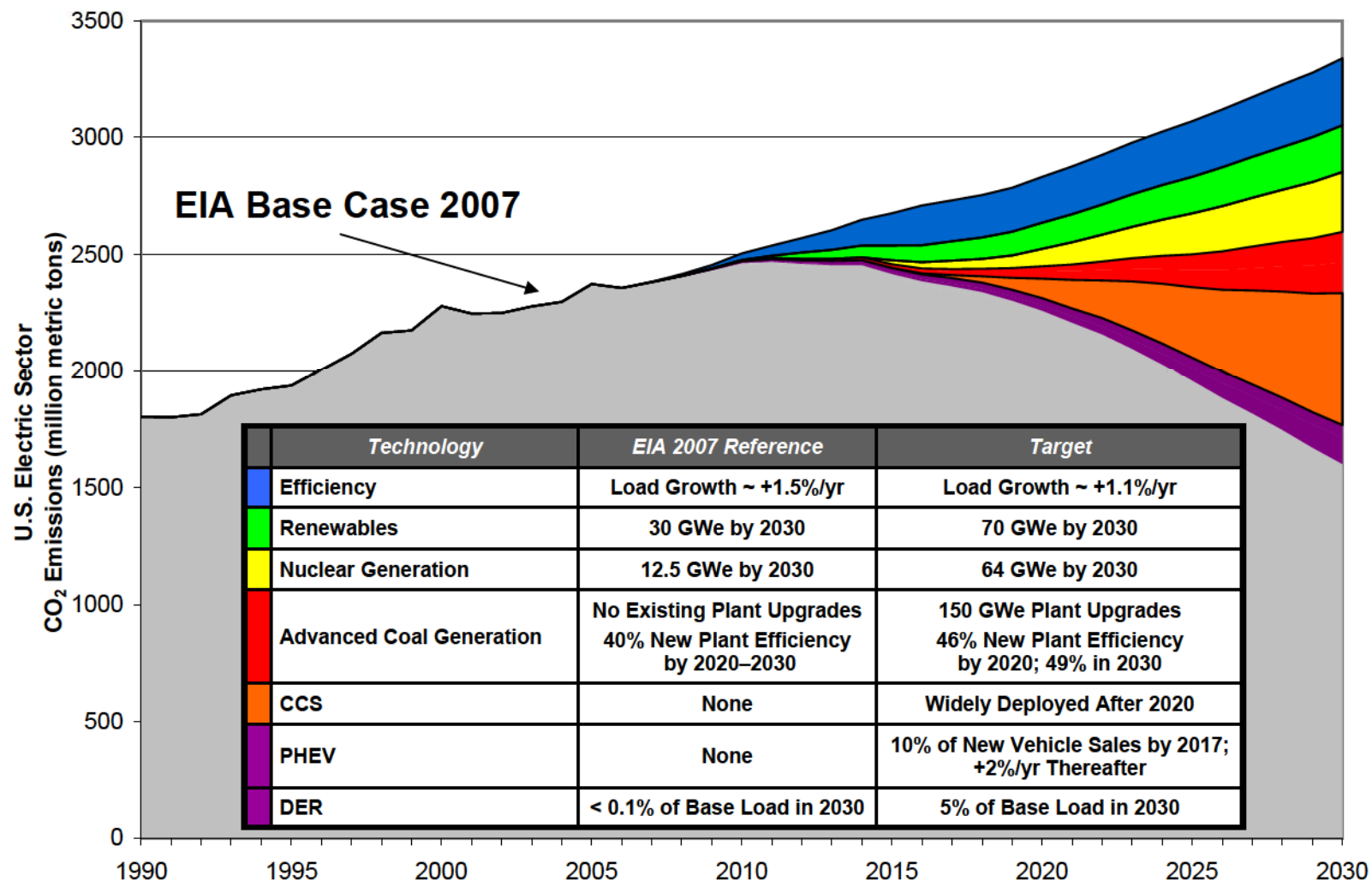
Benefit of Achieving the CCS Target



Benefit of Achieving PHEV and DER Targets

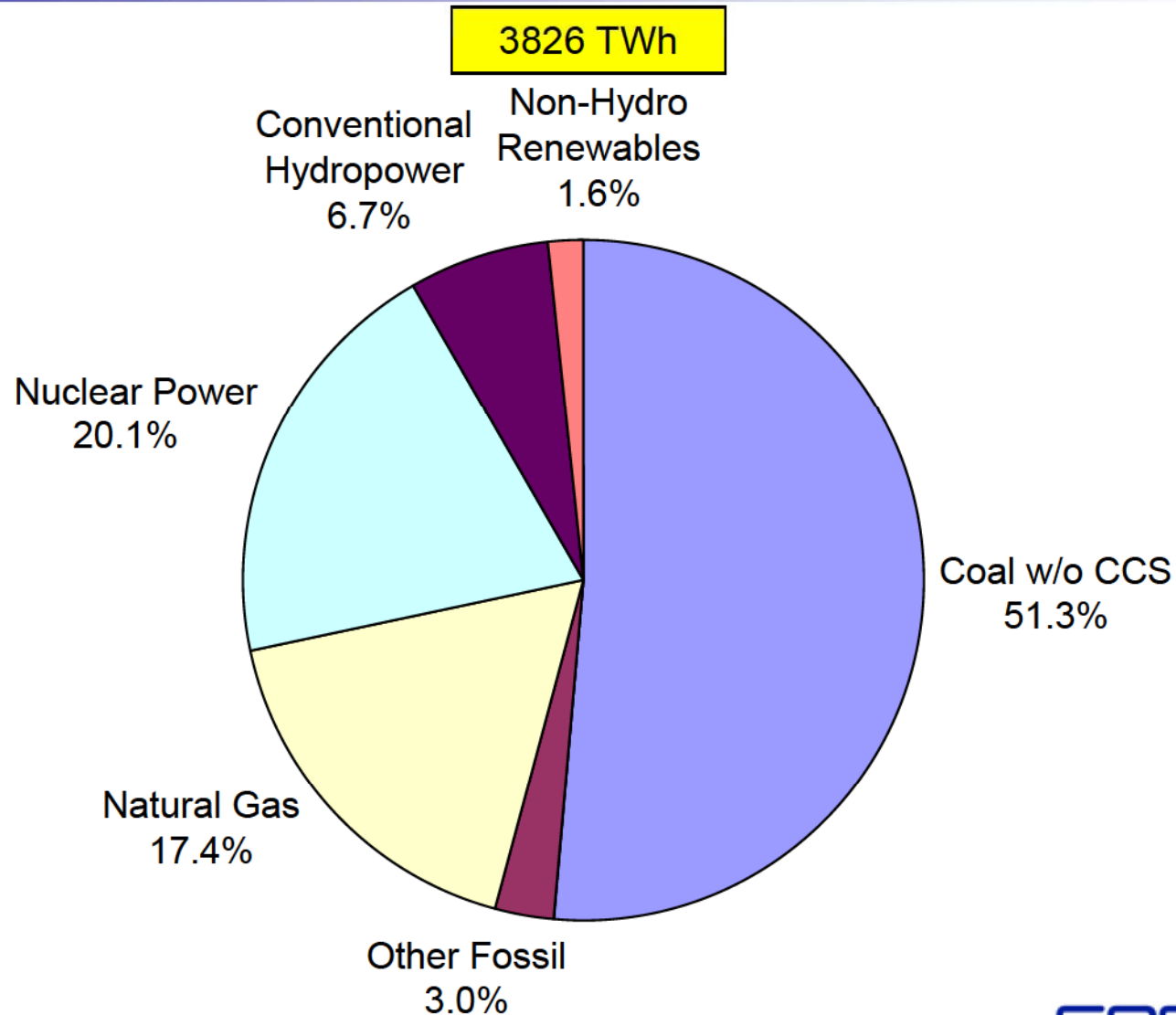


CO₂ Reductions ... Technical Potential*

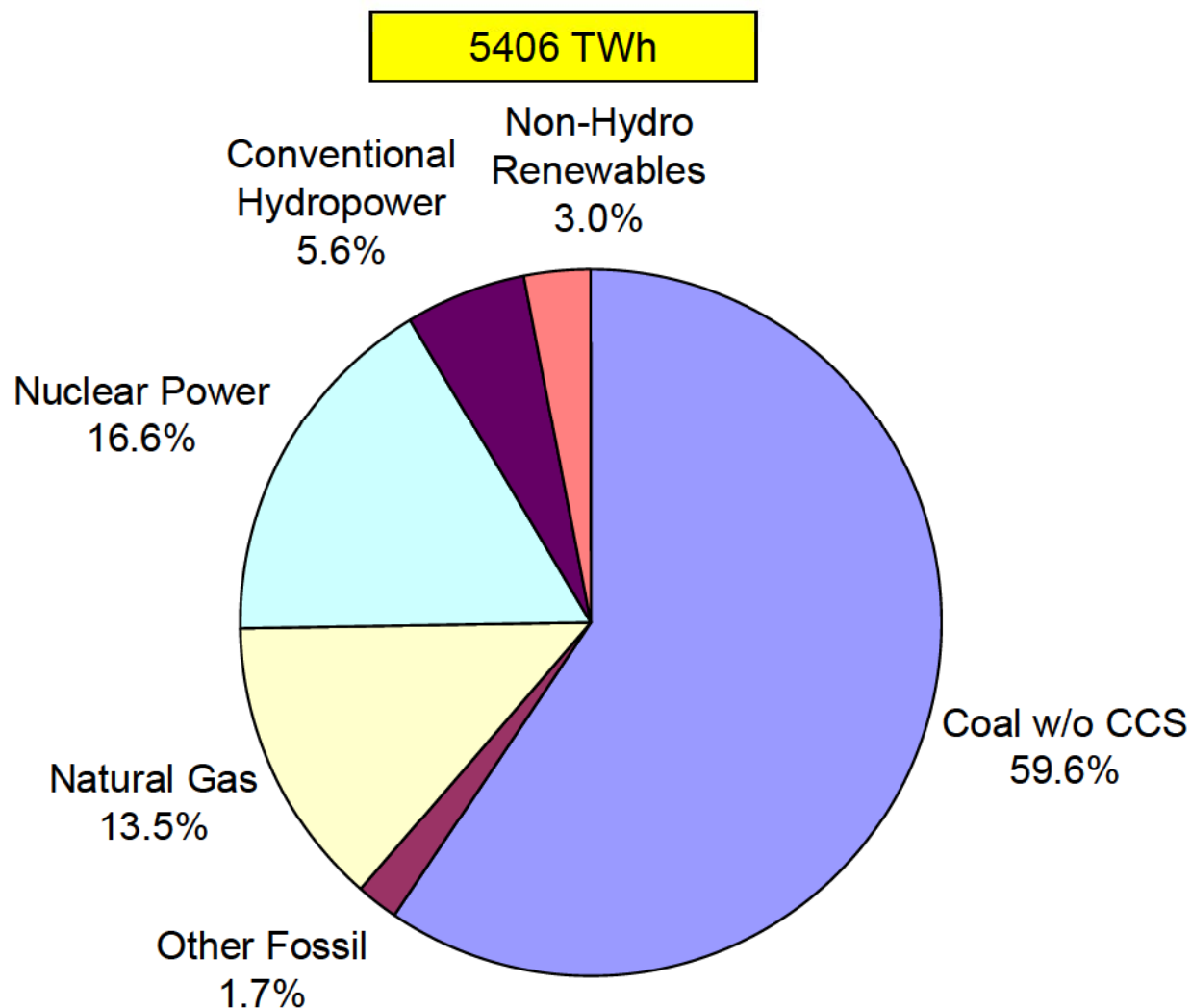


* Achieving all targets is very aggressive, but potentially feasible.

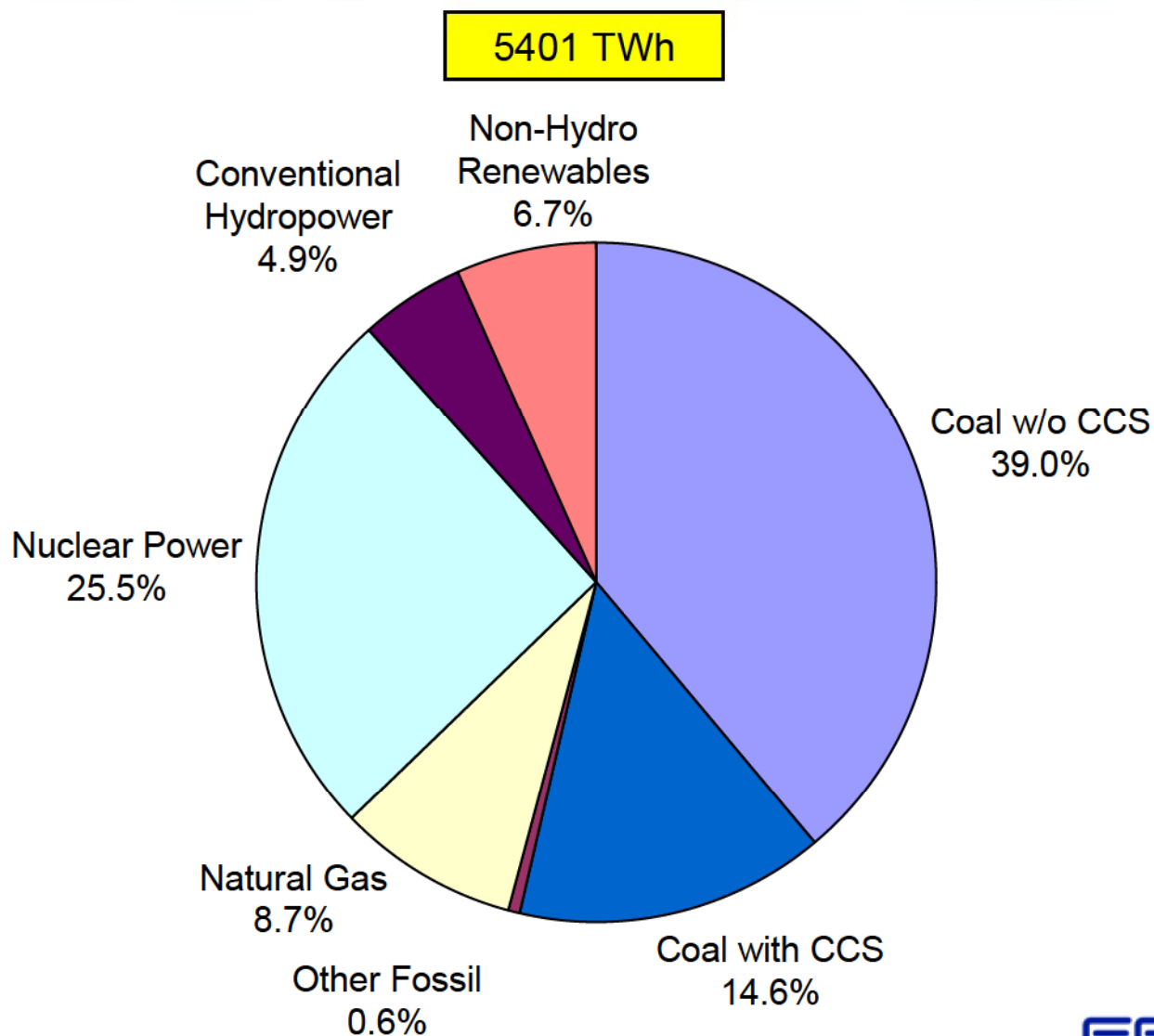
Total U.S. Electricity Generation: 2005 EIA



Total U.S. Electricity Generation: 2030 EIA Base Case



Total U.S. Electricity Generation: 2030 Advanced Technology Targets



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