“Western Climate Initiative”

Public Utilities and Technology Interim Committee

Utah Legislature

July 18, 2007

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

Pacific Power | Rocky Mountain Power | PacifiCorp Energy

What is the company's position on carbon policy?

"No one should underestimate the challenge of de-carbonizing an economy that has relied on carbon-based fuels for two centuries."

Testimony of David L. Sokol, Chairman and CEO
MidAmerican Energy Holdings Company
Subcommittee on Energy and Air Quality, Committee on Energy and Commerce
U.S. House of Representatives
March 20, 2007

Four Key Points

1. We do not presently possess the generation technologies to deal with the demands of a carbon-constrained world

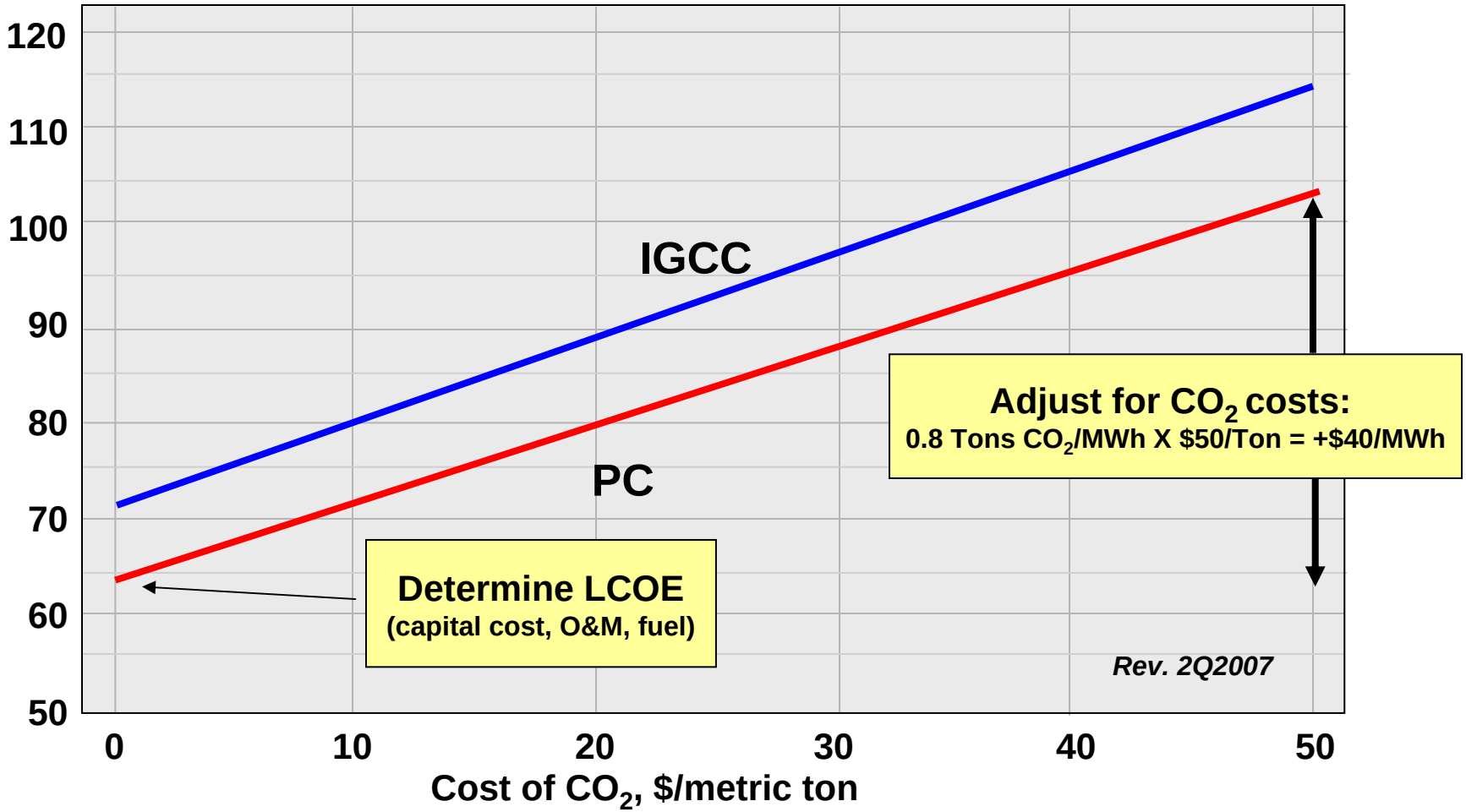
2. With a focused R&D effort, we can develop a low-cost, low-carbon portfolio of advanced electricity technologies

3. These technologies could then be used to significantly reduce U.S. electric sector carbon emissions

4. Deploying these advanced electricity technologies could significantly reduce the cost of future carbon constraints

Coal-Based Generation

Levelized Cost of Electricity, $/MWh (2006 $)



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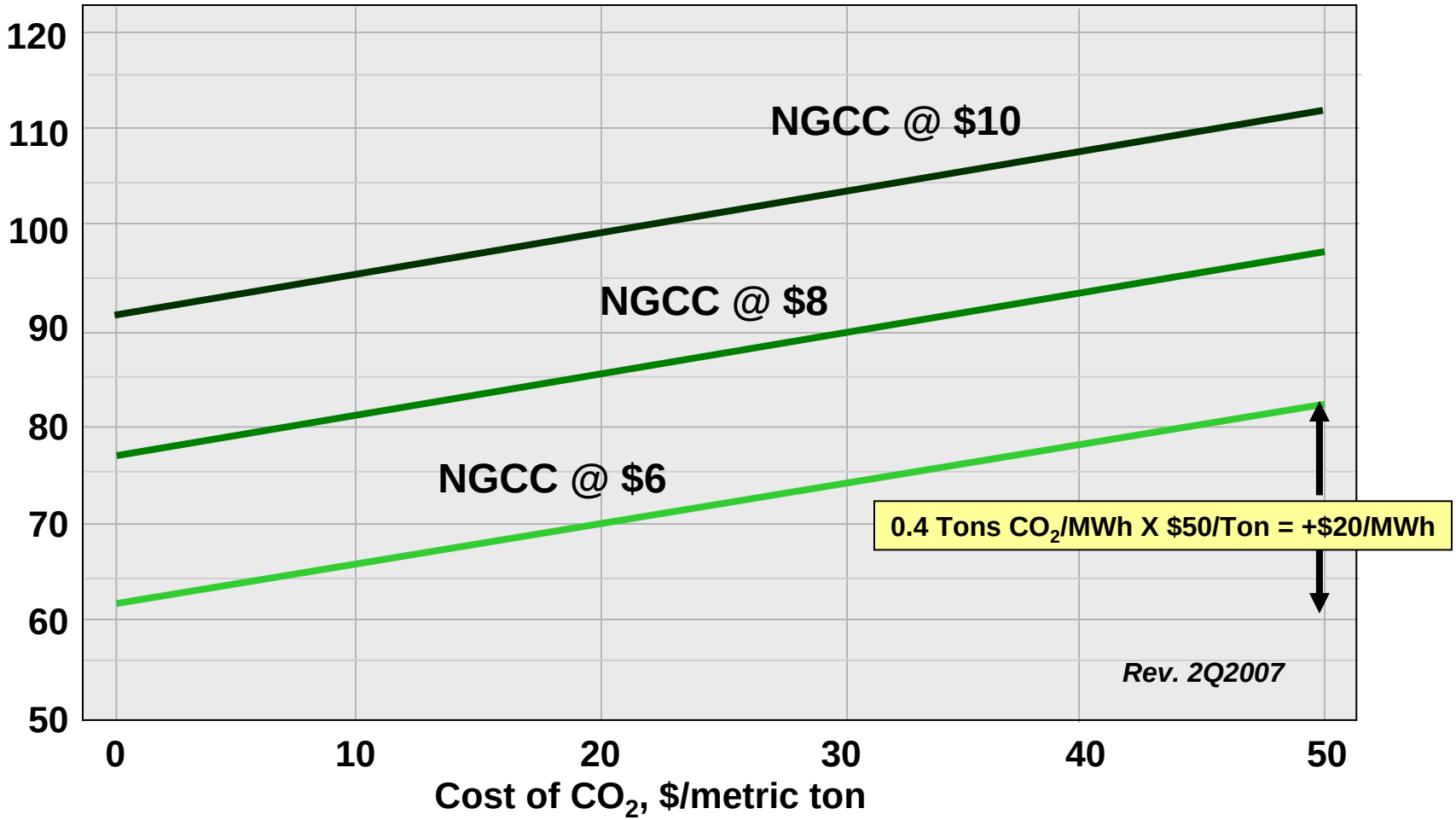
Natural Gas Combined Cycle

Levelized Cost of Electricity, $/MWh (2006 $)



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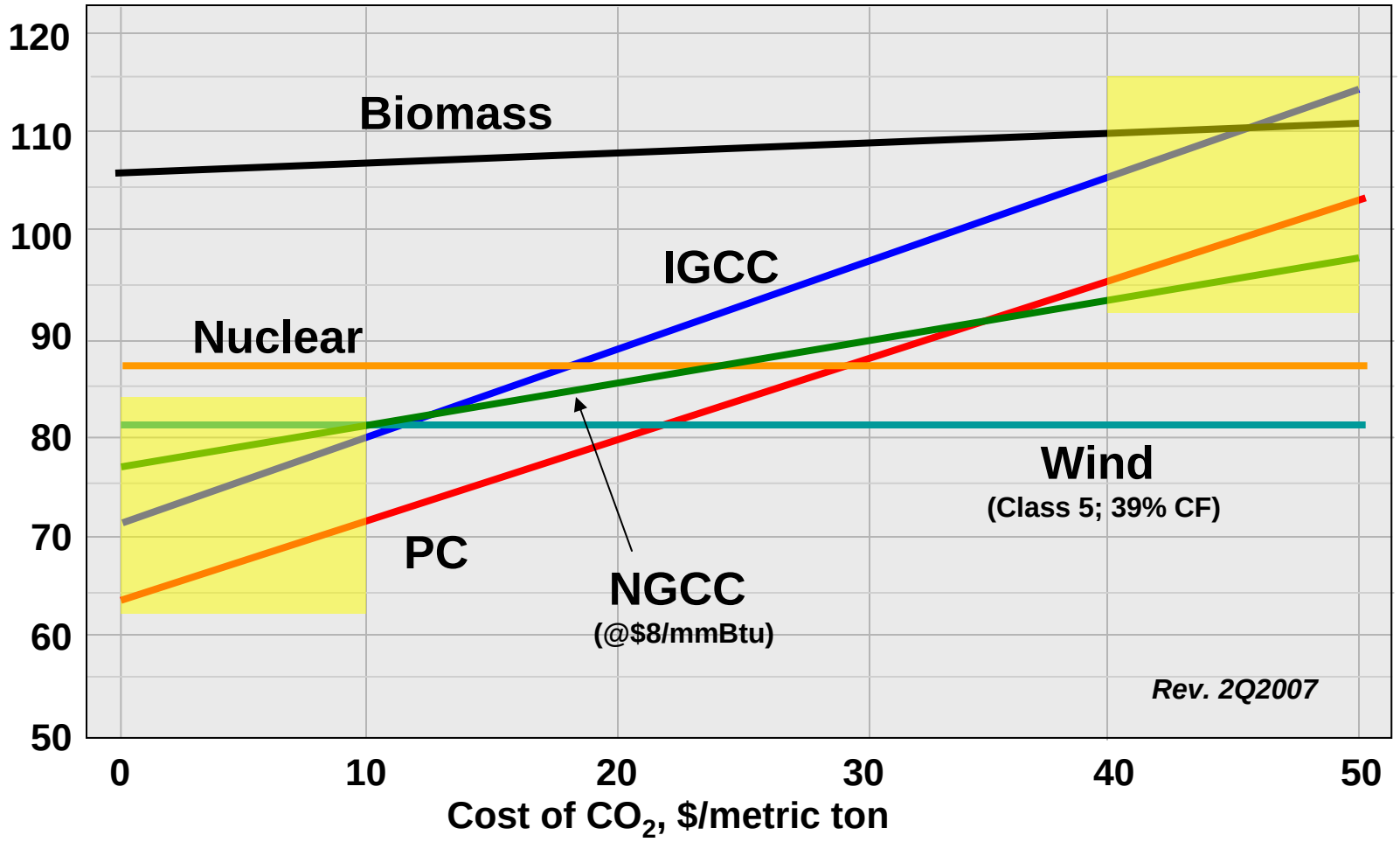
Generation Options in 2010-2015

Levelized Cost of Electricity, $/MWh (2006 $)



Near-Term Implications

- New **nuclear** units have cost advantage at high CO_2 costs, but unlikely to enter operation until after 2015.

- **Renewables** unlikely to extend beyond mandated requirement due to poor comparative economics.
  - Exception: good wind with tax incentives (but limited in scale)

- **As a result, most new base-load generation likely to be brought on line within 10 years will utilize fossil technologies:**
  - Choice of fuels will depend on natural gas prices, capital costs
  - Absent **CCS capability,** CO_2 limits increase cost of electricity

Very limited opportunity for significant economic CO_2 reduction!!!

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Key Technology Challenges

Significant cost-effective CO_2 reductions from the U.S. electric sector will require ALL of the following technology advances:

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+% CO_2 capture and storage in a variety of geologies.

Estimated Average Annual R&D Funding Gap

million $/yr

	2007-2011	2012-2016	2017-2021	2022-2026	2027-2031	Avg
ENABLE ENERGY EFFICIENCY & DER Smart grids and communications infrastructures to enable end-use efficiency and demand response, DER (i.e., Solar PV) and PHEVs. Improve equipment efficiency.	$310	$290	$240	$140	$120	$220
GRID INTEGRATION WITH RENEWABLES A grid infrastructure with the capacity and reliability to operate with 20–30% intermittent renewable generation in specific regions.	$400	$370	$330	$300	$300	$340
NUCLEAR Significant expansion of nuclear energy enabled by continued operation of the existing nuclear fleet and a viable strategy for managing spent fuel. Includes new RD&D for ALWR deployment support.	$170	$170	$170	$100	$100	$140
ADVANCED COAL, CO_2 CAPTURE and STORAGE Commercial-scale coal-based generation units operating with ~90% CO_2 capture and storage in a variety of geologies.	$830	$800	$800	$620	$400	$690
Total	$1710	$1630	$1540	$1160	$920	$1390

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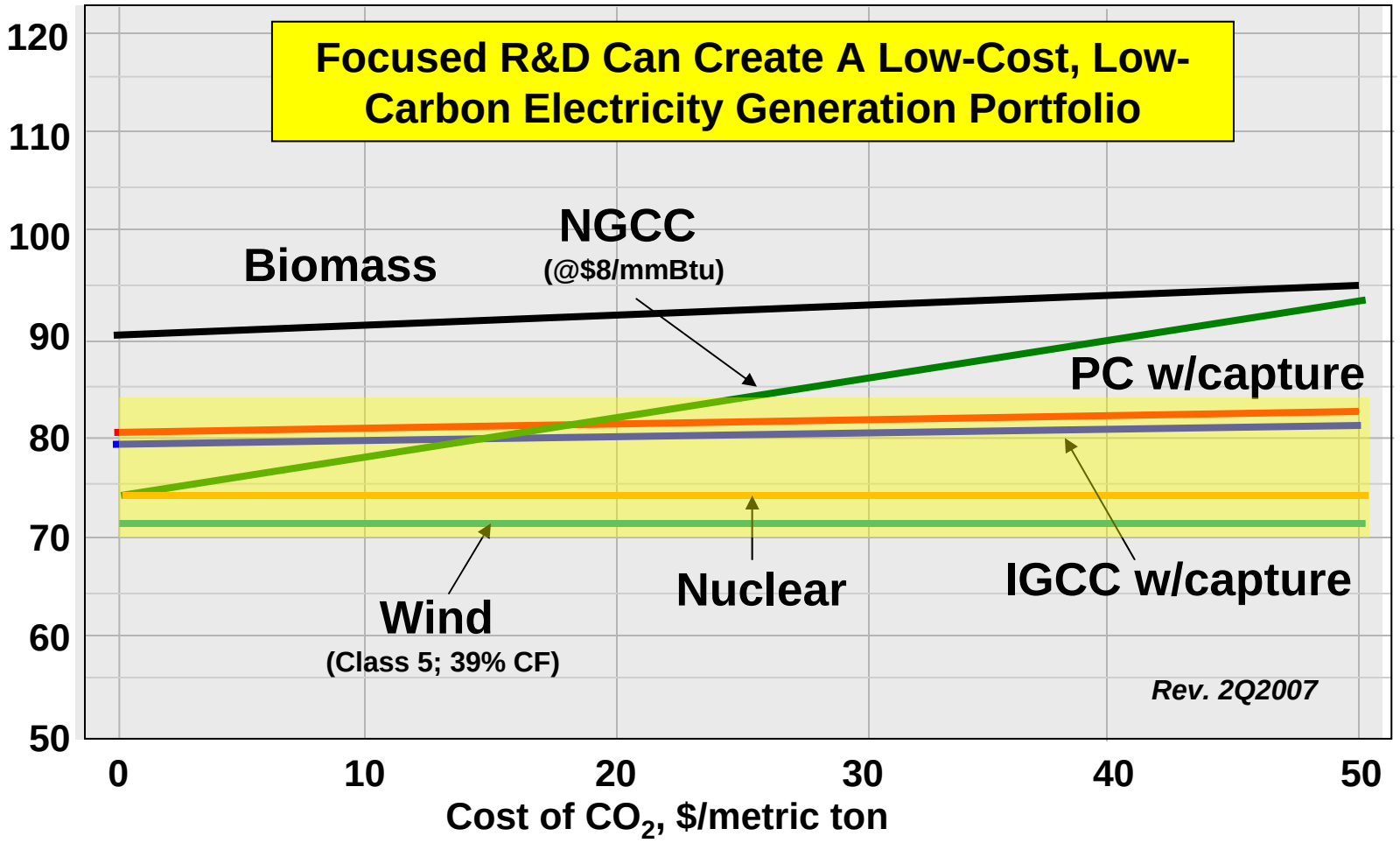
Generation Options in 2020-2025

Levelized Cost of Electricity, $/MWh (2006 $)



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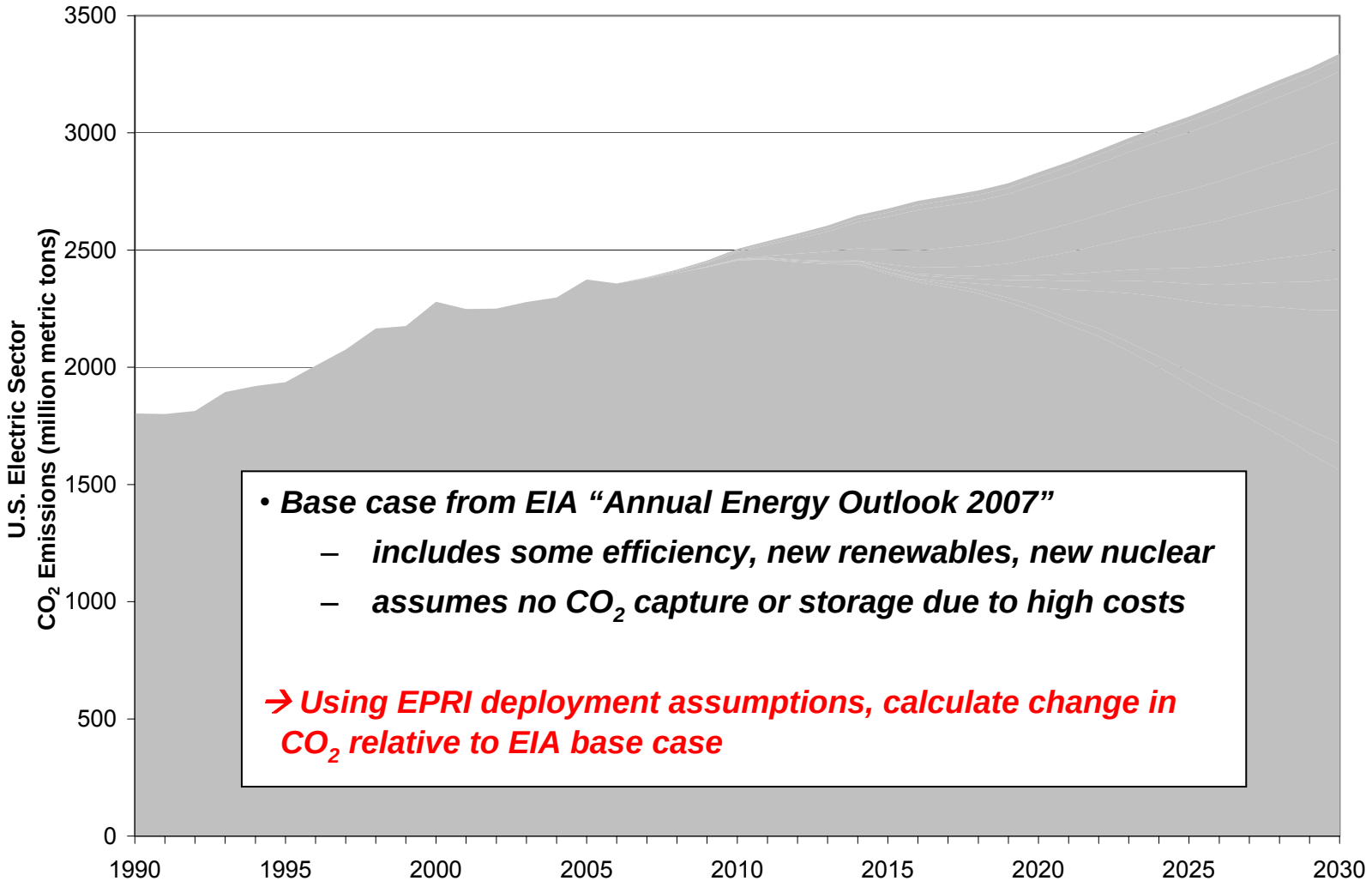
U.S. Electricity Sector CO_2 Emissions

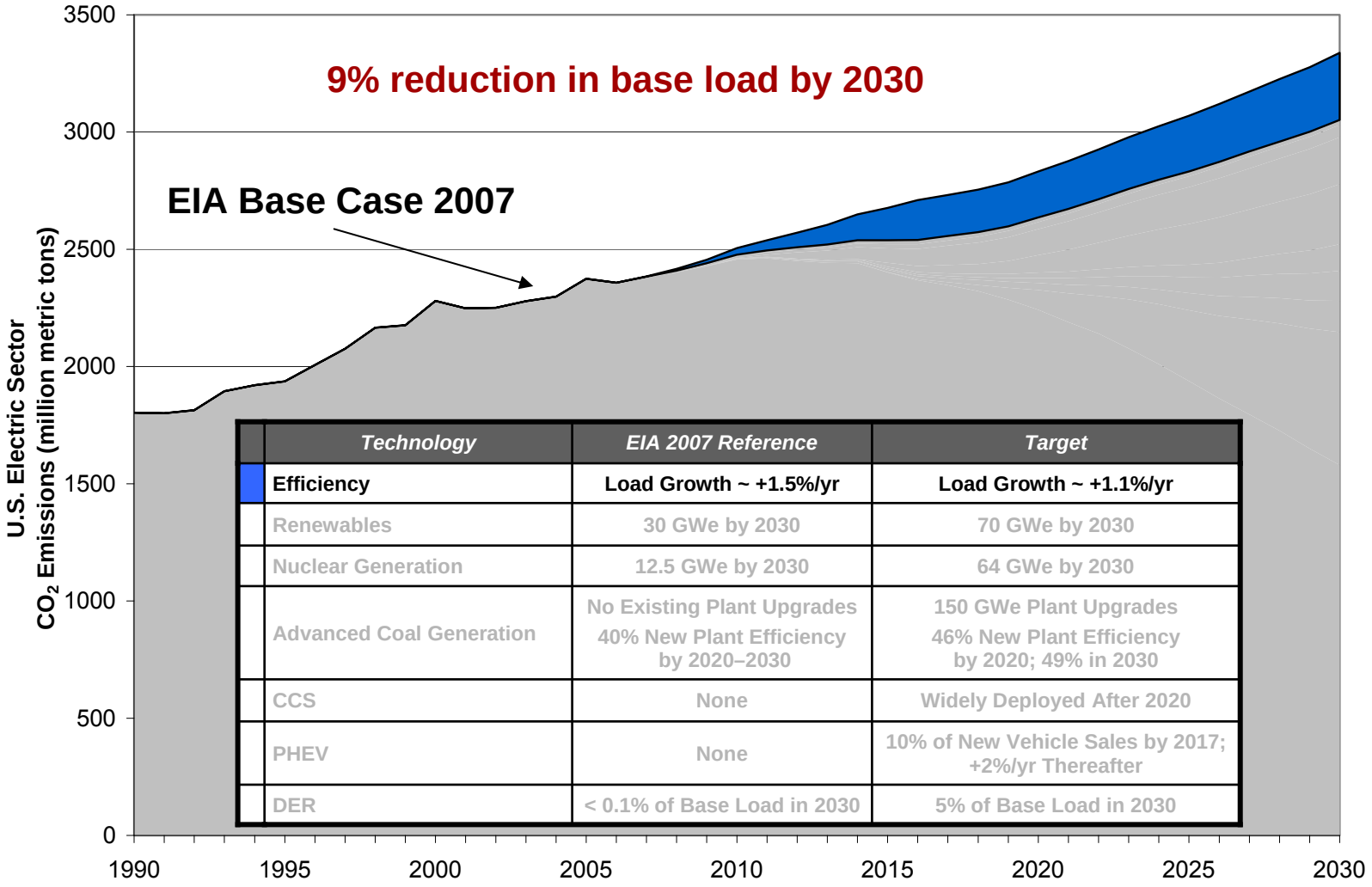


Technology Deployment Targets

Technology	*EIA 2007 Base Case*	*EPRI Analysis Target**
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) ***(including distributed solar)***	**< 0.1% of Base Load in 2030**	**5% of Base Load in 2030**

EPRI analysis targets do not reflect economic considerations, or potential regulatory and siting constraints.

Benefit of Achieving Efficiency Target



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CCS	None	Widely Deployed After 2020
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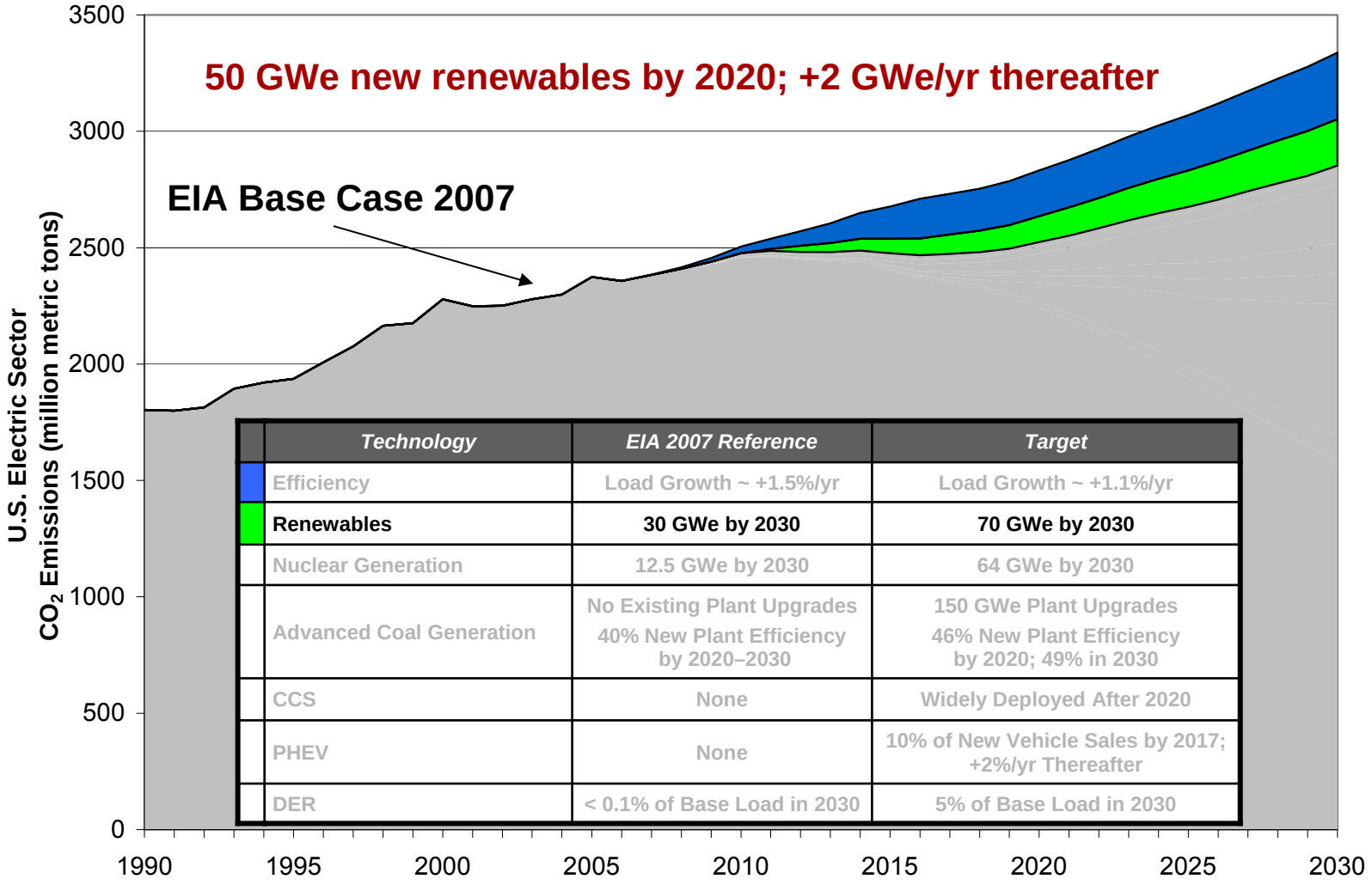
Benefit of Achieving Renewables Target



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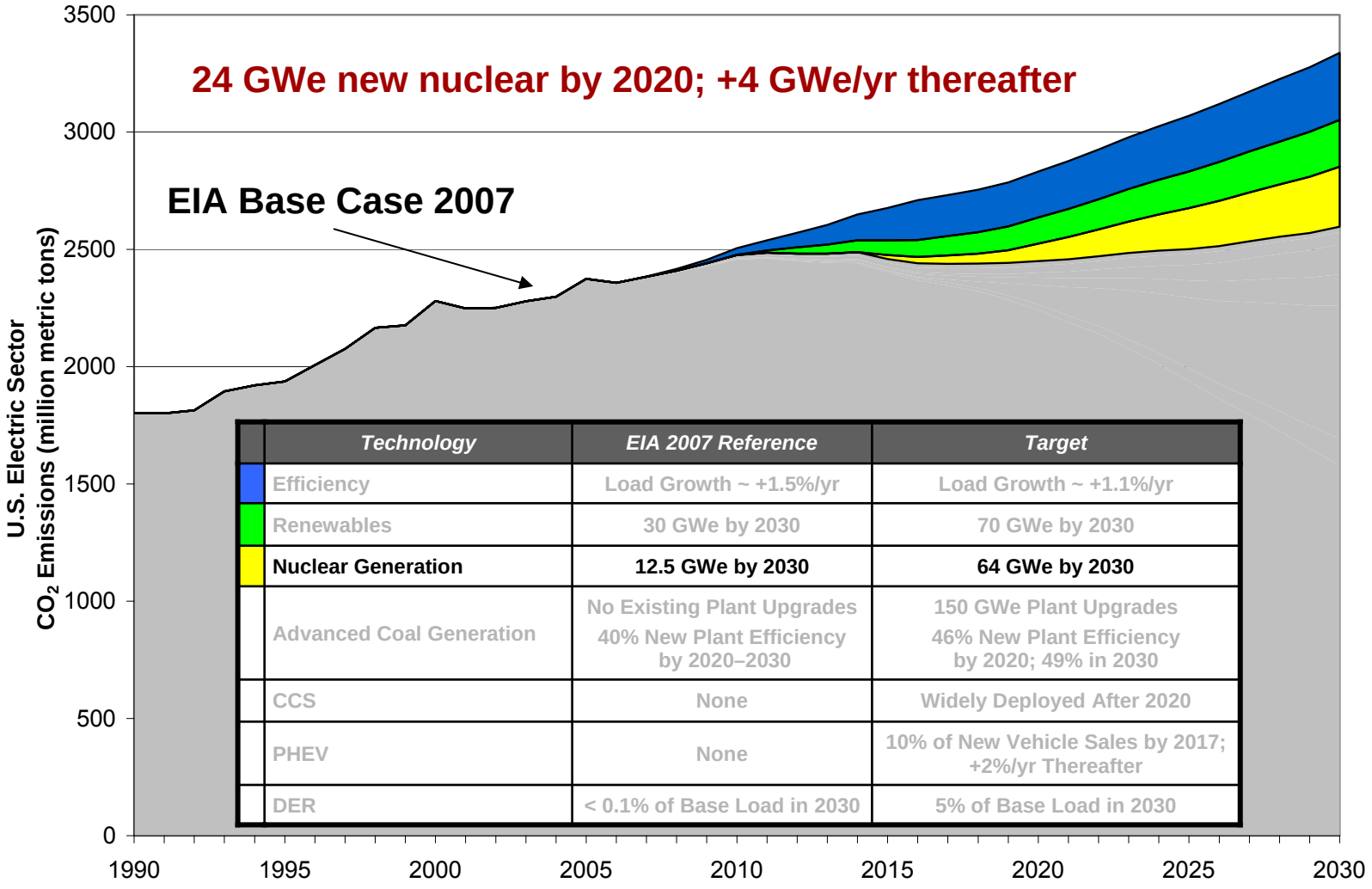
Benefit of Achieving Nuclear Generation Target



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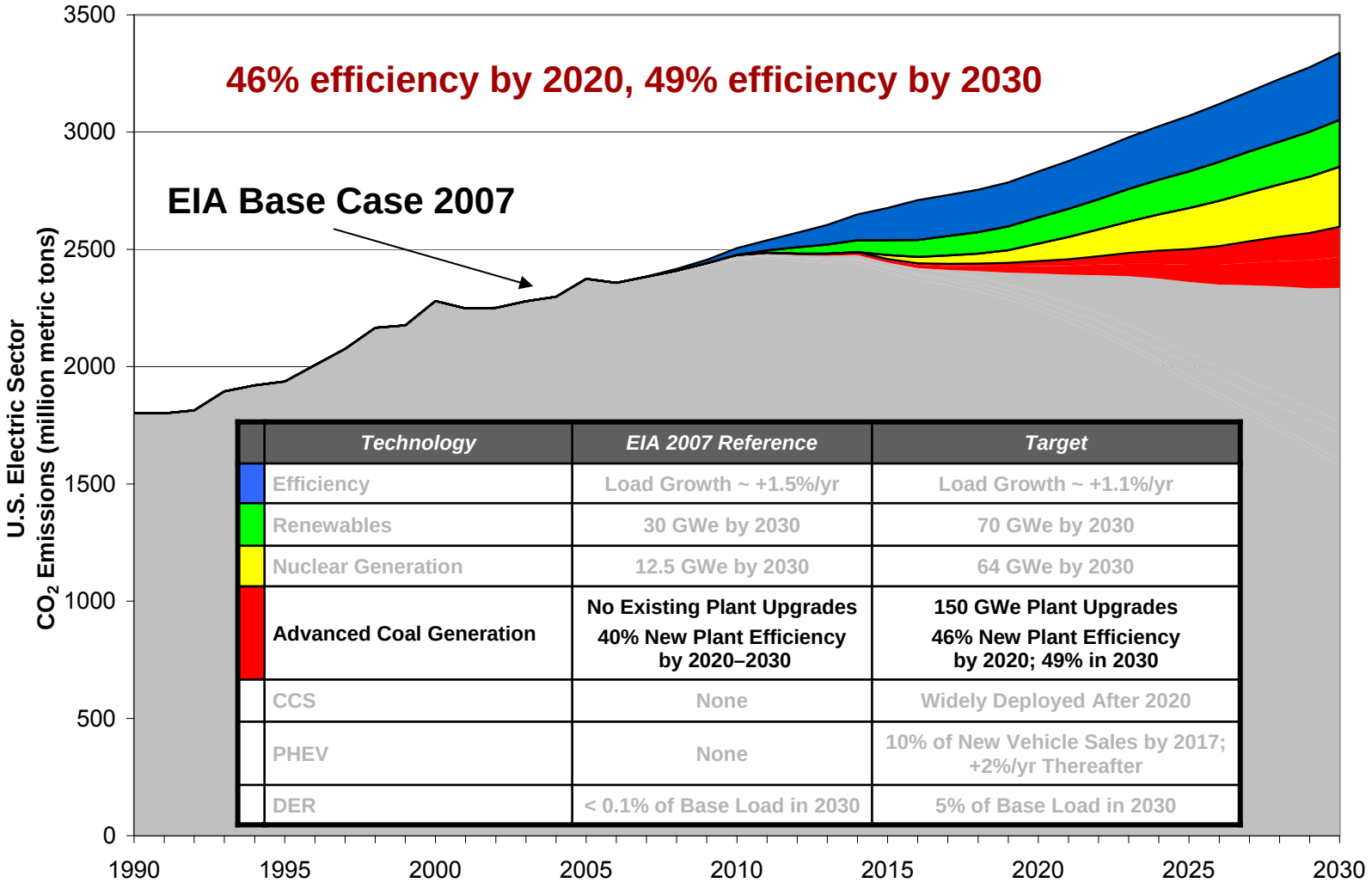
Benefit of Achieving Advanced Coal Target



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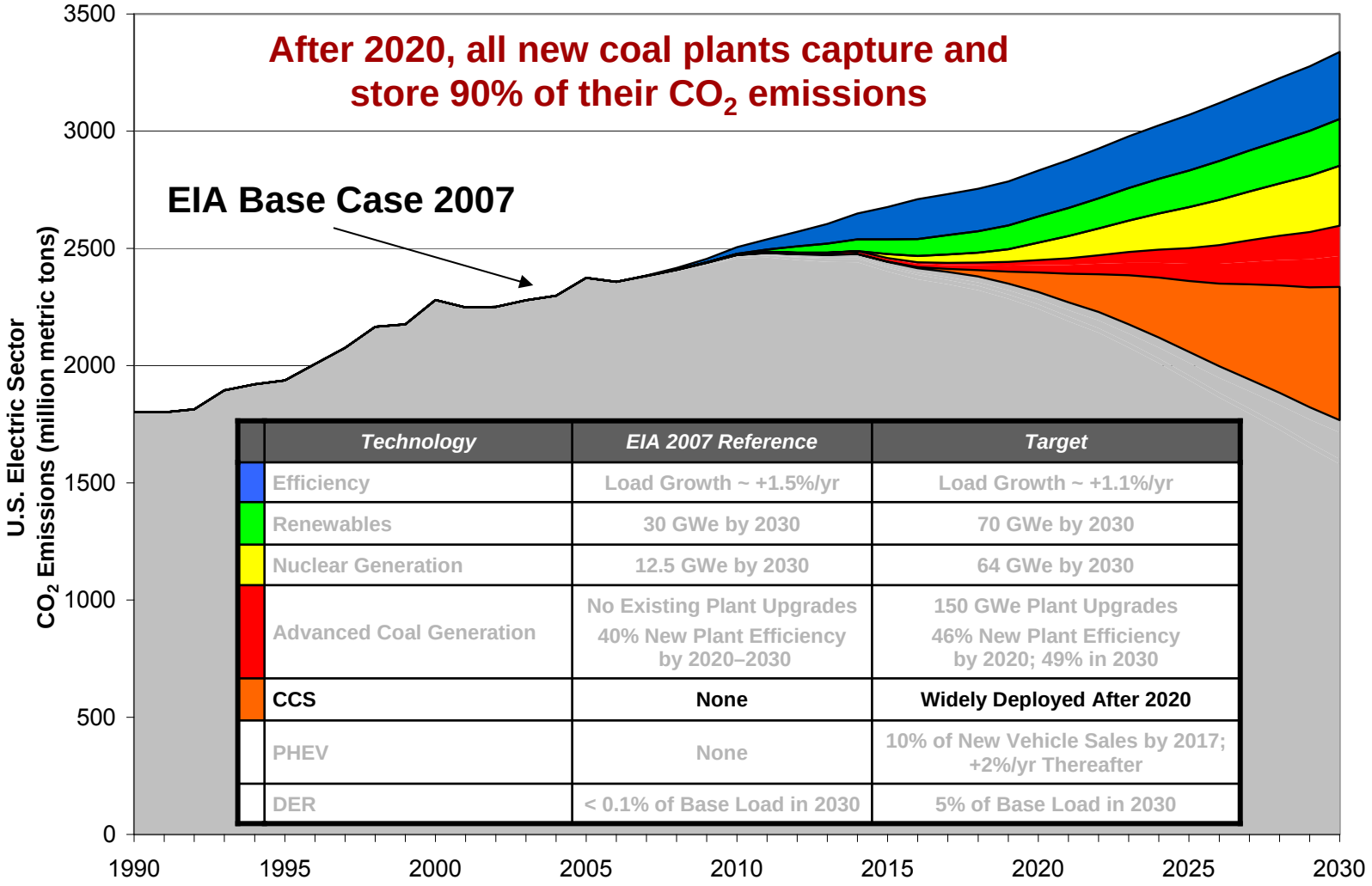
Benefit of Achieving CCS Target



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PHEV	None	10% of New Vehicle Sales by 2017; +2%/yr Thereafter
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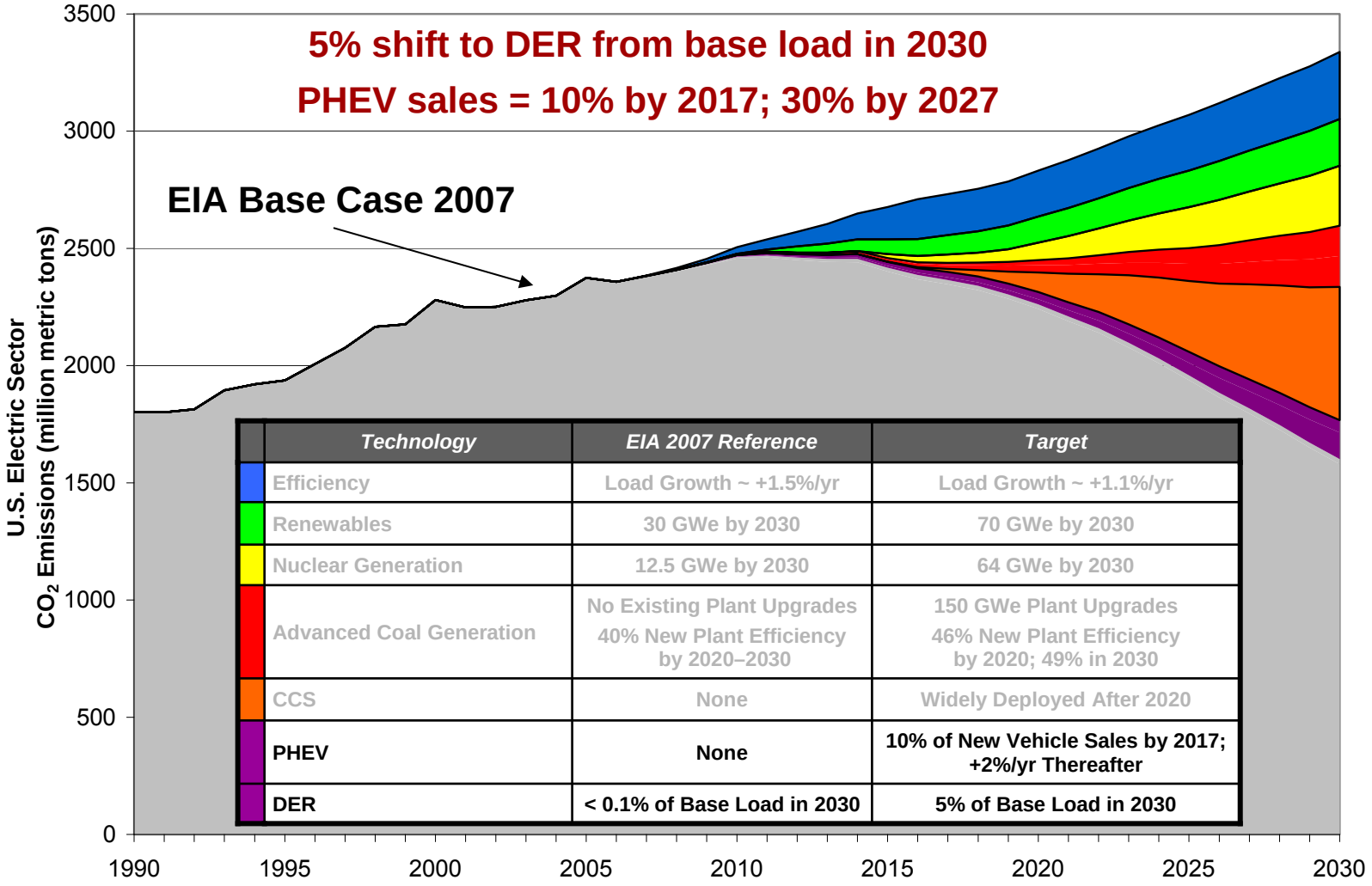
Benefit of Achieving PHEV and DER Targets



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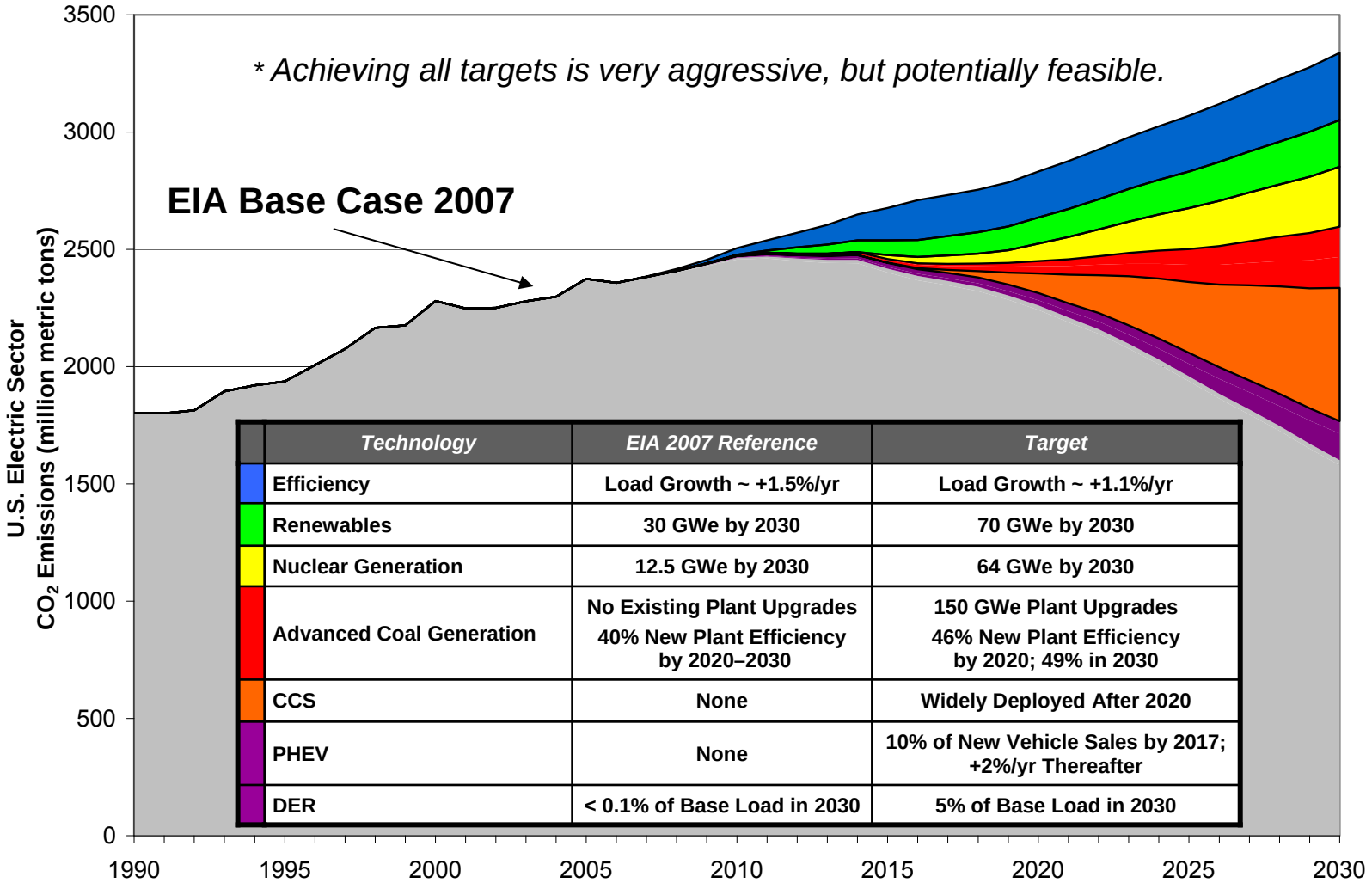
CO_2 Reductions… Technical Potential*



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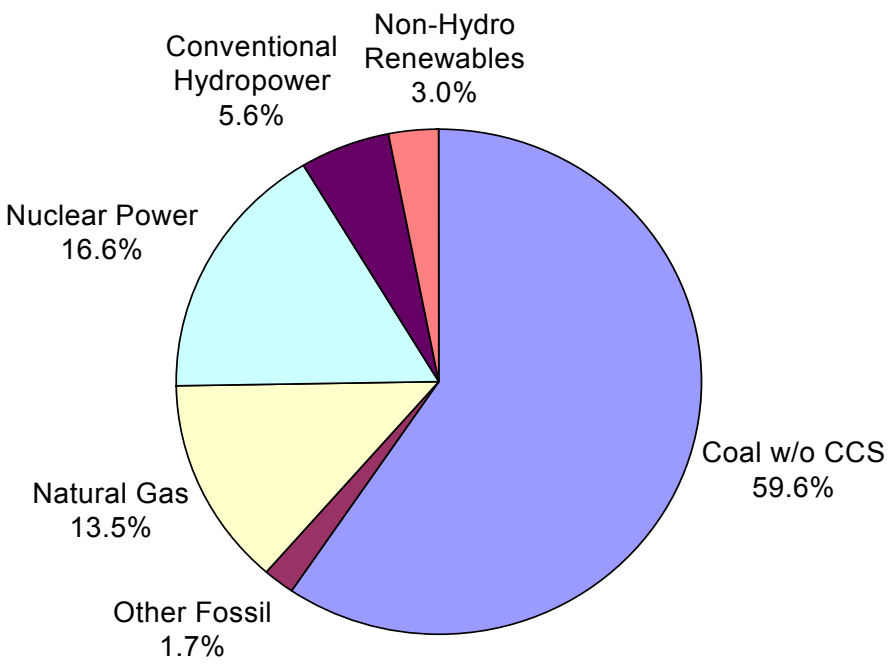
U.S. Electricity Generation: 2030

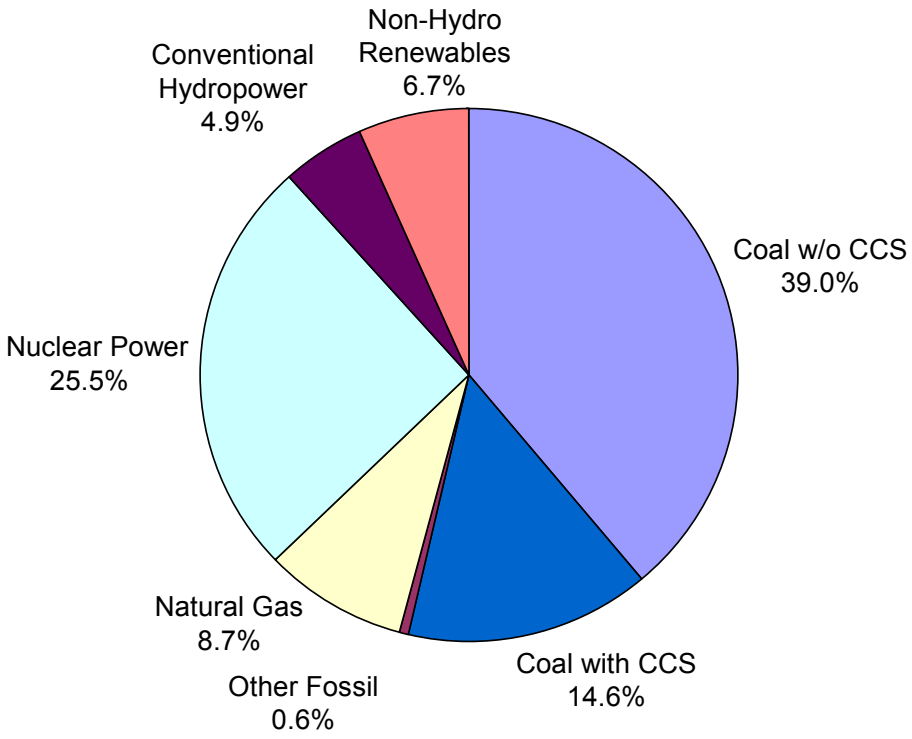
EIA Base Case*

5406 TWh



Advanced Technology Targets

5401 TWh



** Base case from EIA "Annual Energy Outlook 2007"*

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Analysis Method

MERGE Macroeconomic Model

- Top down model of economic growth designed to examine economy-wide impacts of climate policy
- Each country or group of countries maximizes its own welfare
- Prices of each GHG determined internally
- Technological detail in energy sector

Used by US Climate Change Science Program and numerous international and domestic studies

Inputs and Constraints

- Place "prism-like" CO_2 emissions constraint on U.S. economy
- Input same technology cost, performance assumptions as in *Generation Options* analysis for 2020-2025

Summary of Economic Analysis

Absent advanced electricity technologies, CO_2 constraints result in:

- *Price-induced "demand destruction"*
- *Fuel switching to natural gas*
- *Higher electricity prices*
- *High cost to U.S. economy*

With advanced electricity technologies, CO_2 constraints result in:

- *Growth in electrification*
- *Expanded use of coal (w/CCS) and nuclear*
- *Lower, more stable electricity prices*
- *Reduced cost to U.S. economy*

Full report forthcoming as part of August "Summer Seminar"

Conclusions

- The technical potential exists for the U.S. electricity sector to significantly reduce its CO_2 emissions over the next several decades.
- 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.
- A low-cost, low-carbon portfolio of electricity technologies can significantly reduce the costs of climate policy.

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Appendices

The Science of Climate Change

"The topic is too big and too complex for anyone to claim perfect information, particularly at this point in time. It seems to me that some general findings are becoming more clear, most specifically that the climate is warming and that human beings are contributing to this warming through the burning of fossil fuels."

"However, as we attempt to move beyond this level of information to forecasting future impacts, there is far more uncertainty than certainty. We simply don't know how much warming there will be or how much sea levels are likely to increase."

Testimony of David L. Sokol, Chairman and CEO
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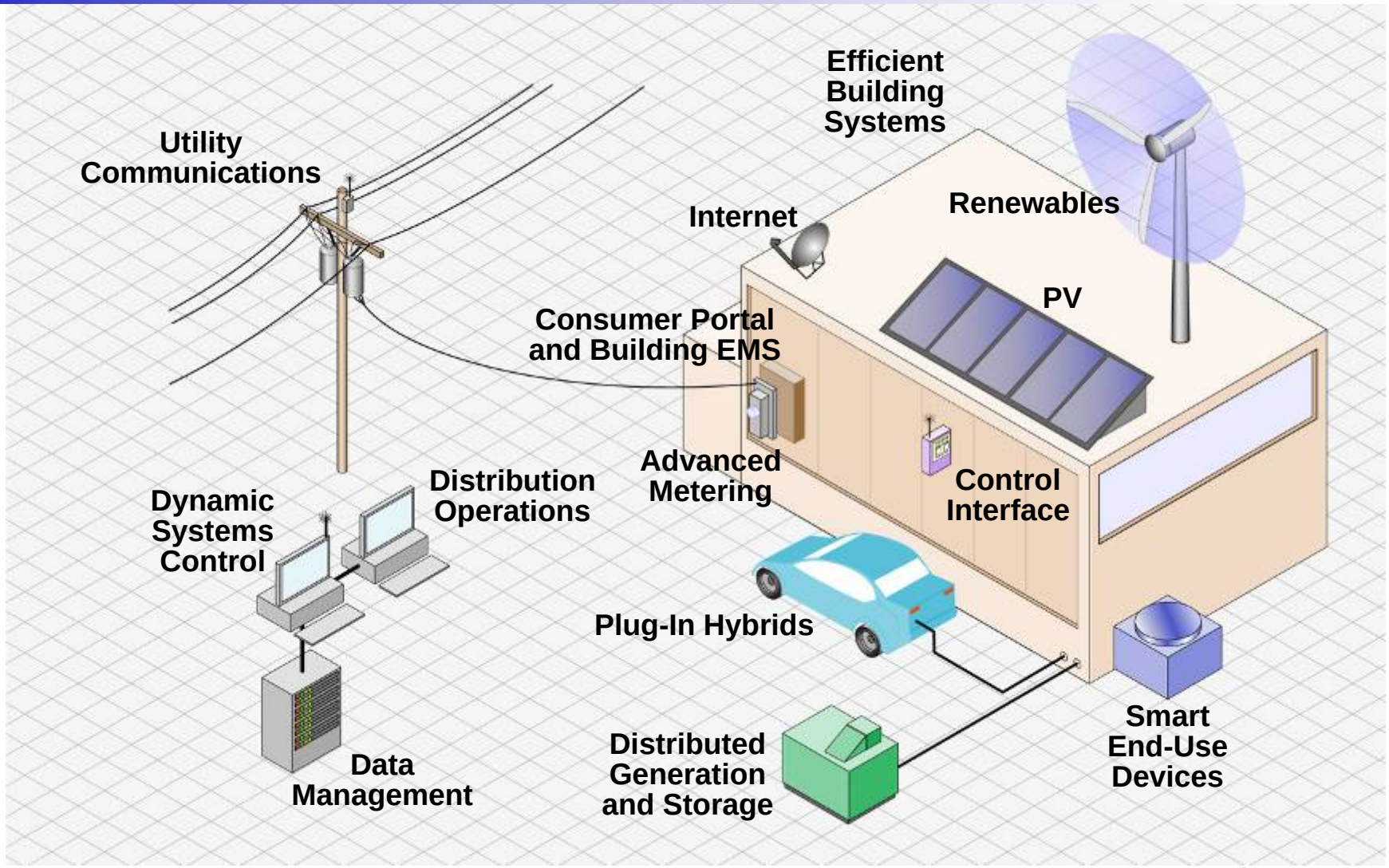
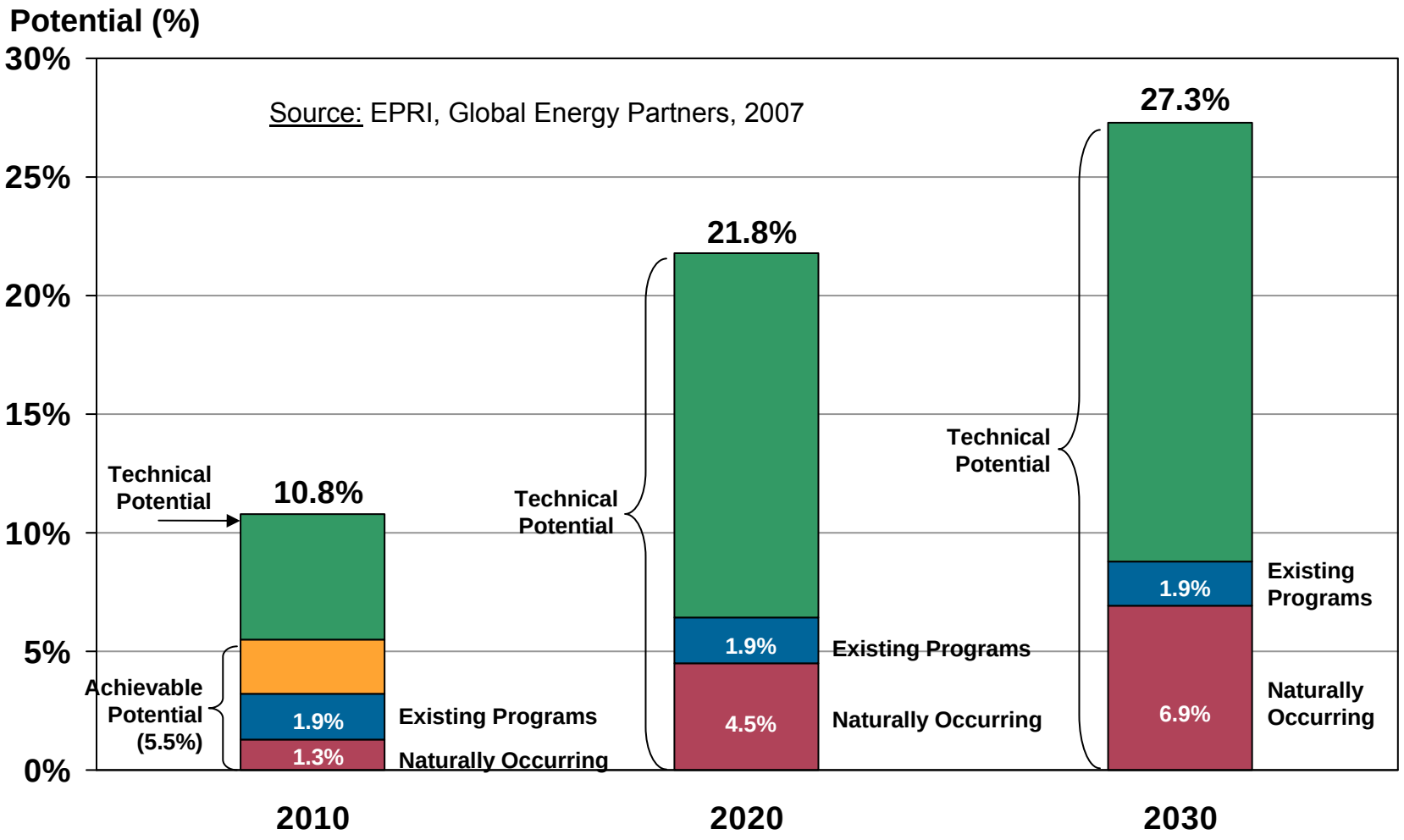
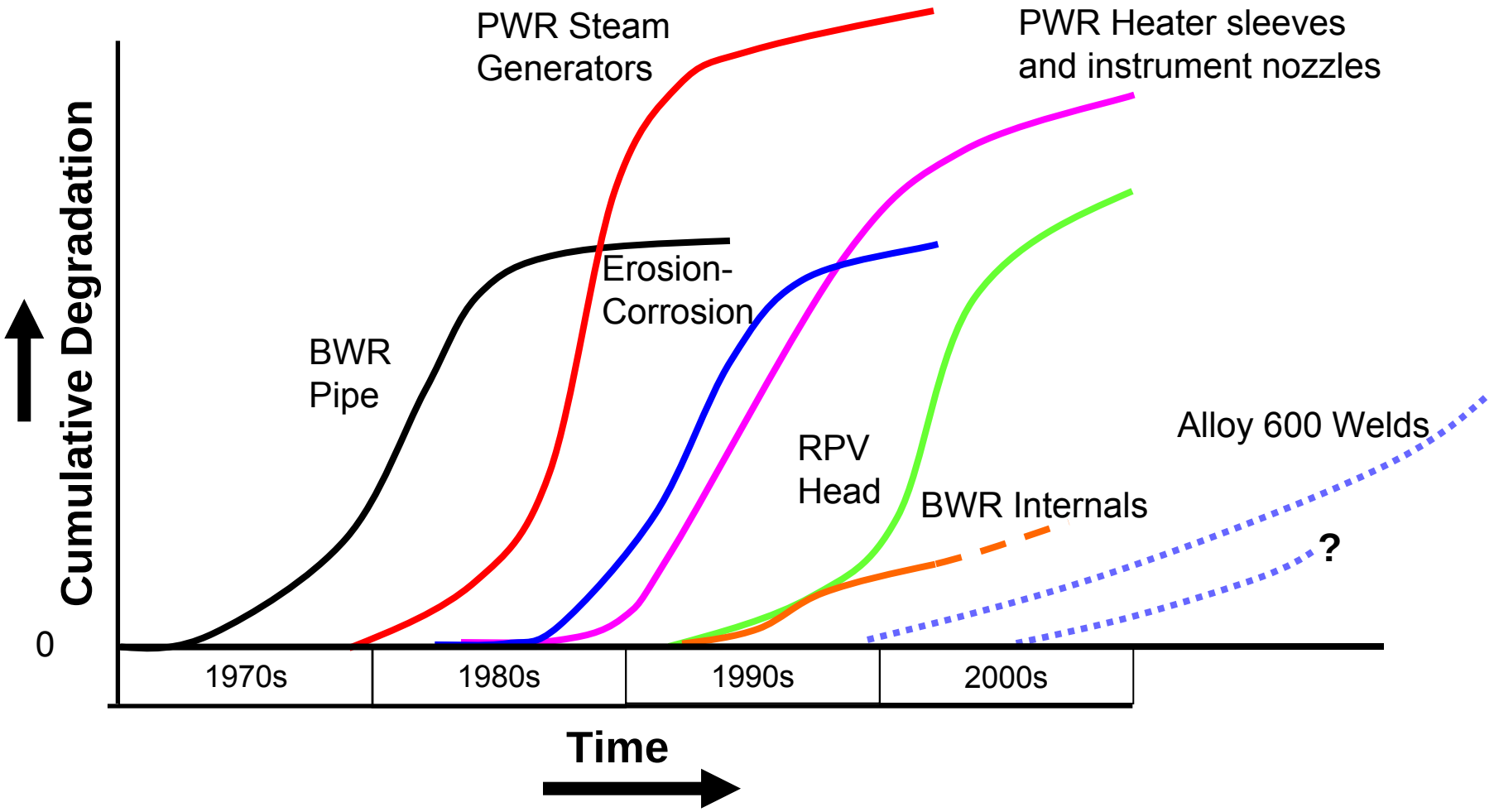
Intelligent Electricity Delivery Infrastructure



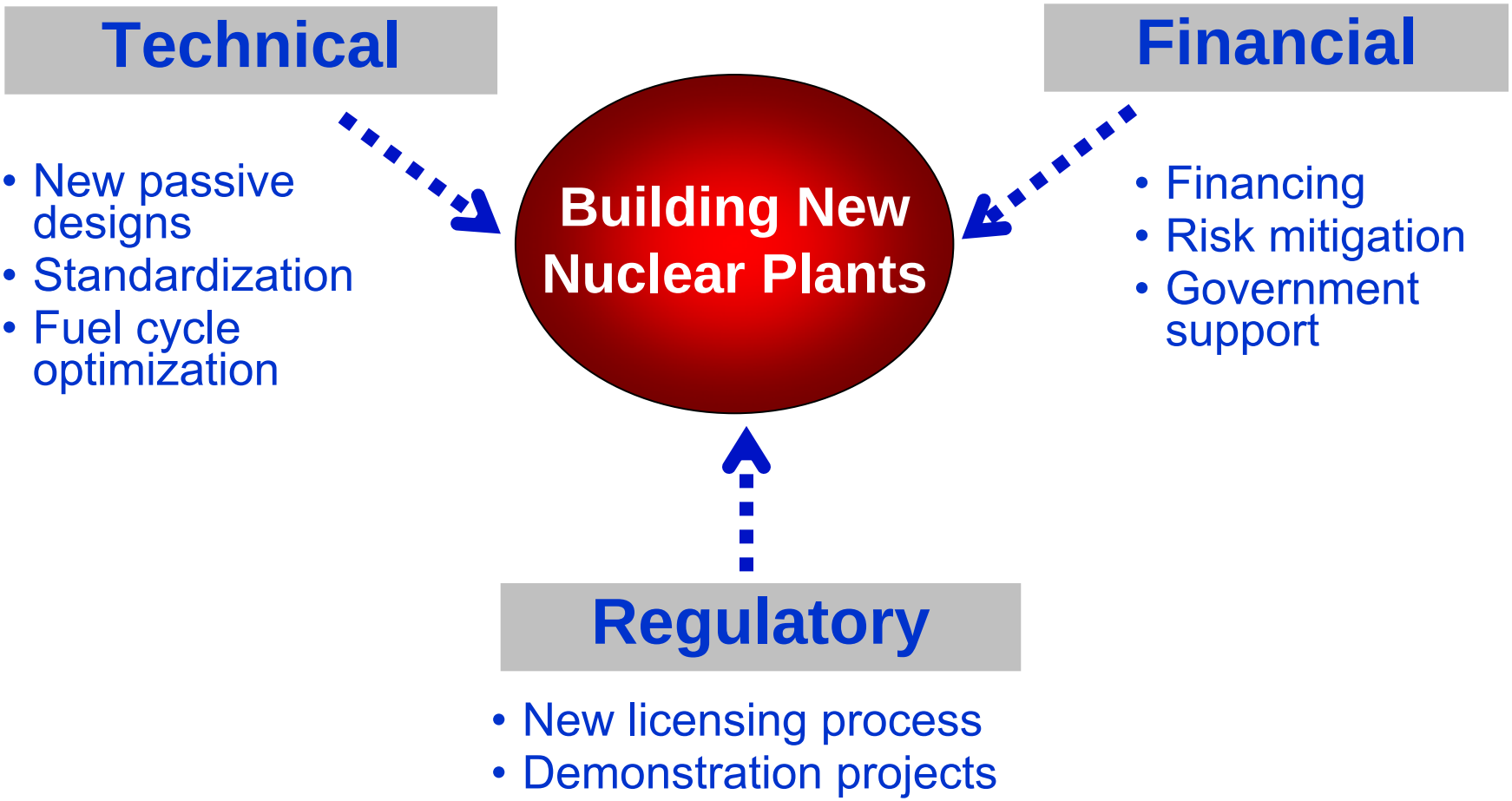
Estimates of Potential Energy Efficiency



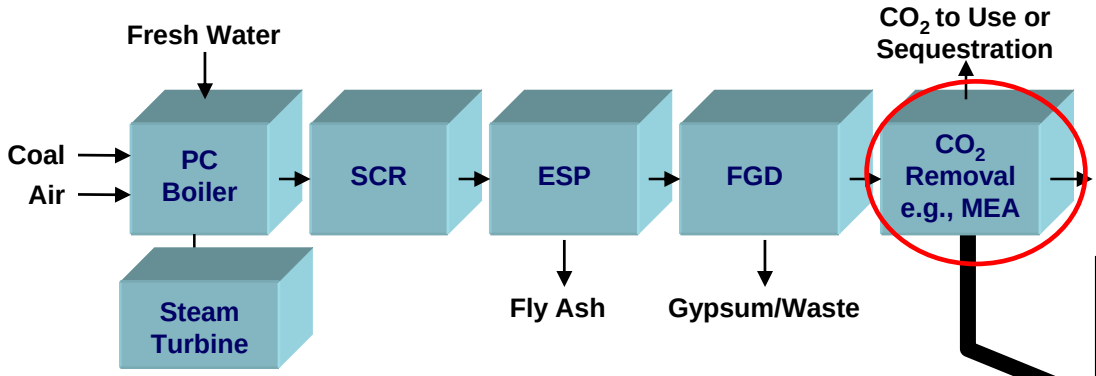
Nuclear Materials Aging and Degradation



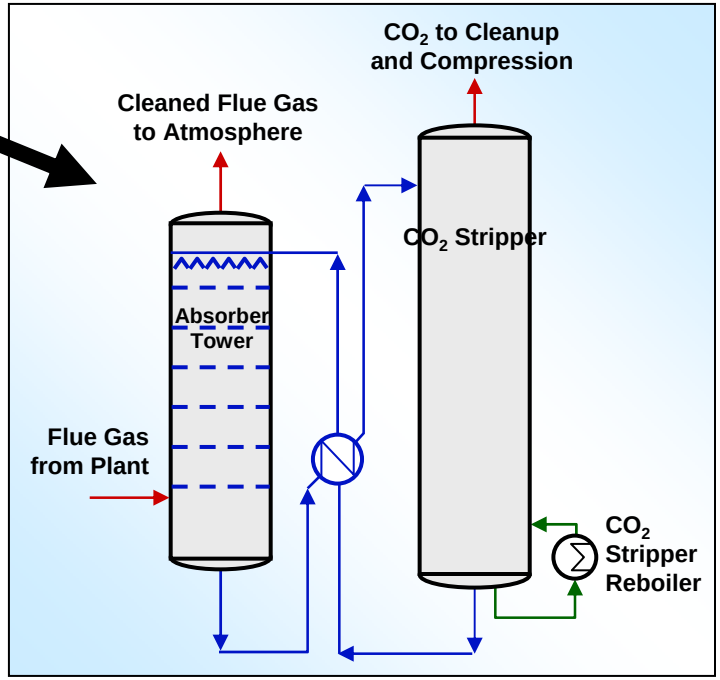
Challenges to New Plant Construction



Pulverized Coal with CO_2 Capture (Today)



Energy Penalty ~29%



- Amine commercially available (multiple suppliers)
- 3 U.S. plants in operation:
  - MEA, <15 MWe, >90% ΔCO_2
- Key requirements:
  - ~5–6 acres for 600 MW plant
  - Near-zero SO_2 and NO_2
  - Large reboiler steam (MEA>KS-1>Ammonia)
- Many new process options being explored

CO_2 Capture = $, Space, Ultra-Low SO_2, and *Lots* of Energy.

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CO_2 Capture and Storage – Research Needs