



# U.S. CLIMATE POLICIES AND CLEAN ENERGY TECHNOLOGIES

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**EMF Snowmass 2016**



# OUTLINE

1. Near-term Climate Goals --U.S. Climate Goals and Policies and Measures
2. Towards a Low Carbon Future--Current Trends and Future Projections



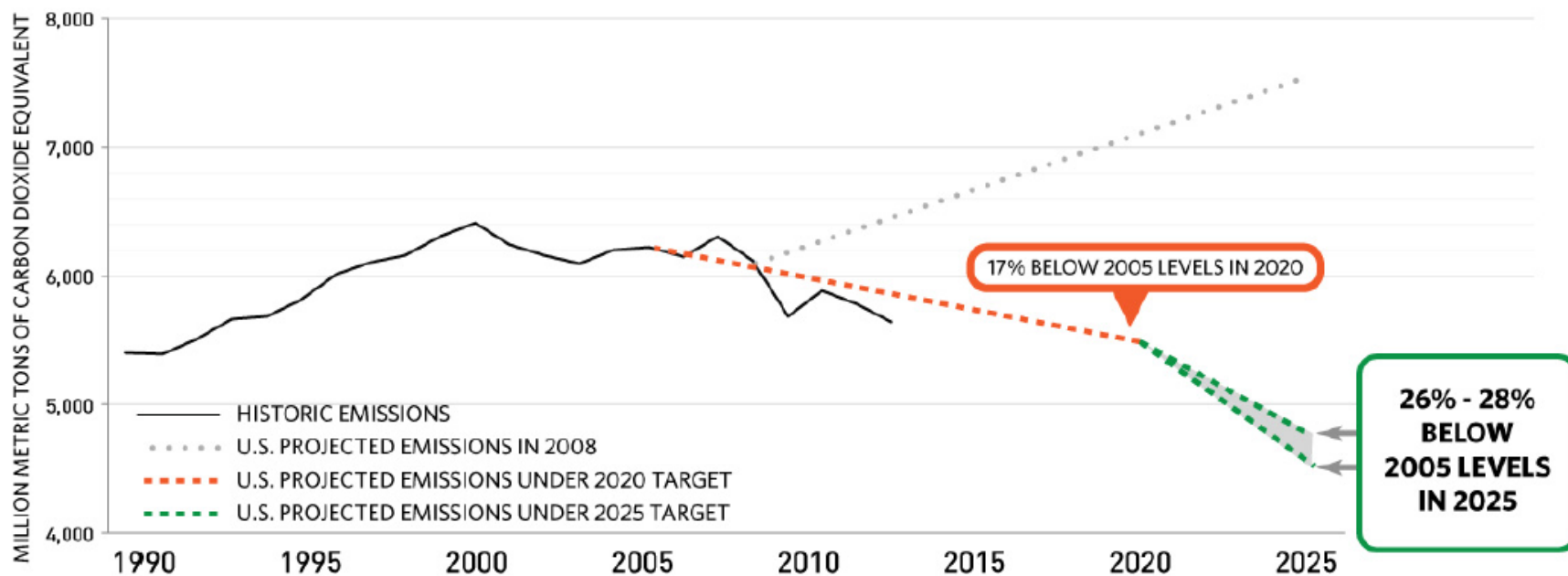
## NEAR-TERM CLIMATE GOALS



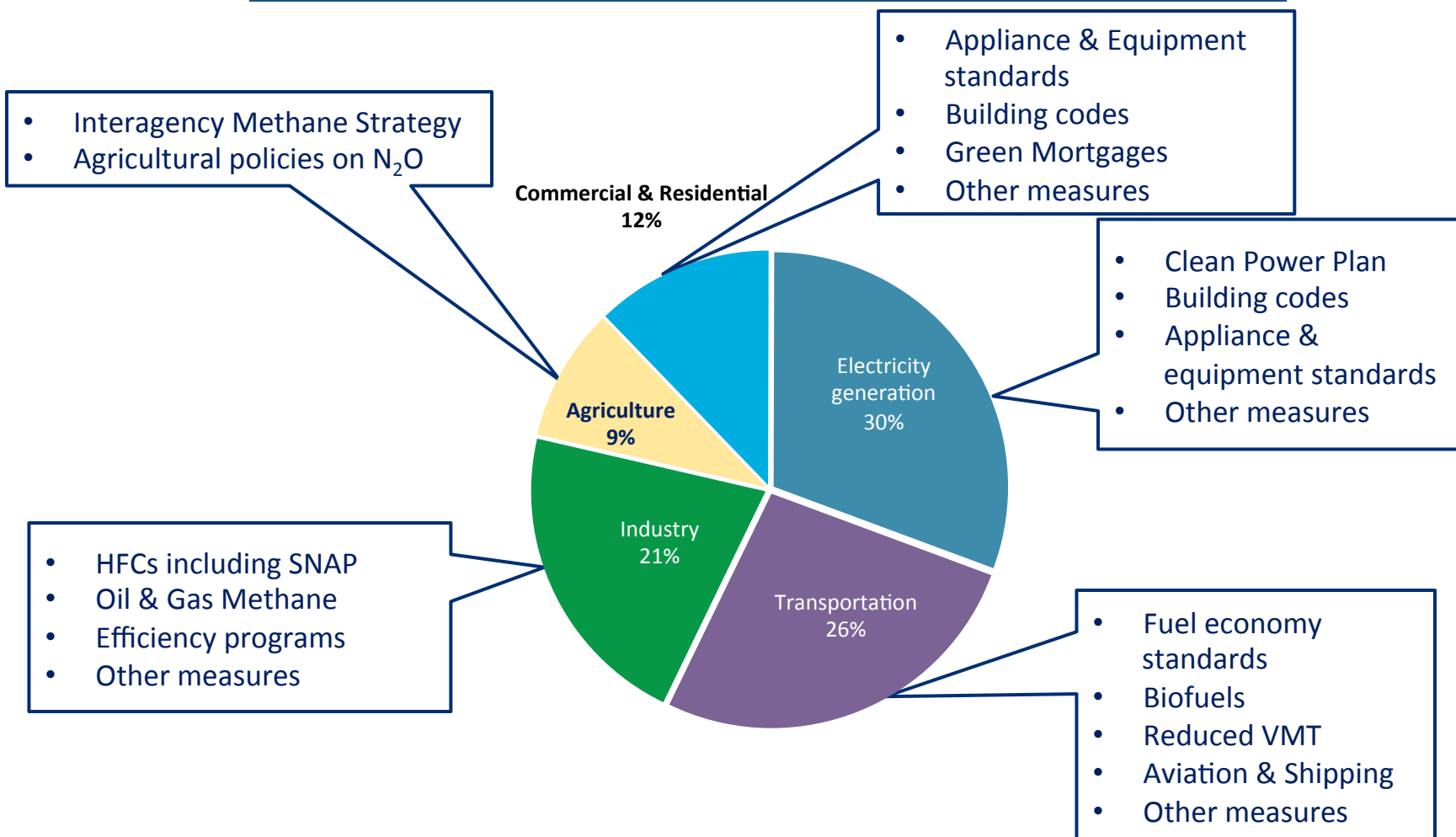
# U.S. CLIMATE GOALS

- In 2009, President Obama set a goal to cut U.S. greenhouse gas emissions in the range of **17% below 2005 levels in 2020**.
- In 2014, the President set a new goal to cut greenhouse gas emissions **26-28% below 2005 levels in 2025**.

## U.S. EMISSIONS UNDER 2020 AND 2025 TARGETS



# U.S. ACTIONS ON CLIMATE



2014 U.S. GHG Emissions by Sector

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# THE PRESIDENT'S CLIMATE ACTION PLAN

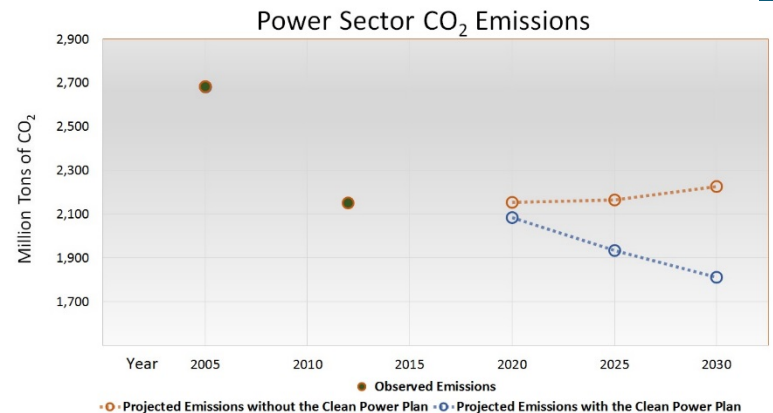
In 2013, President Obama put forth a broad-based plan with three key pillars:

- **Cut Carbon Pollution in America**
  - Implement new regulations such as the Clean Power Plan and vehicle fuel economy standards
- **Prepare the United States for the Impacts of Climate Change**
  - Federal agencies are working to ensure grants, technical assistance, and other programs support smarter, more resilient investments.
- **Lead International Efforts to Combat Global Climate Change and Prepare for its Impacts**
  - The 2015 Paris Agreement establishes a long term, durable global framework to reduce global greenhouse gas emissions.

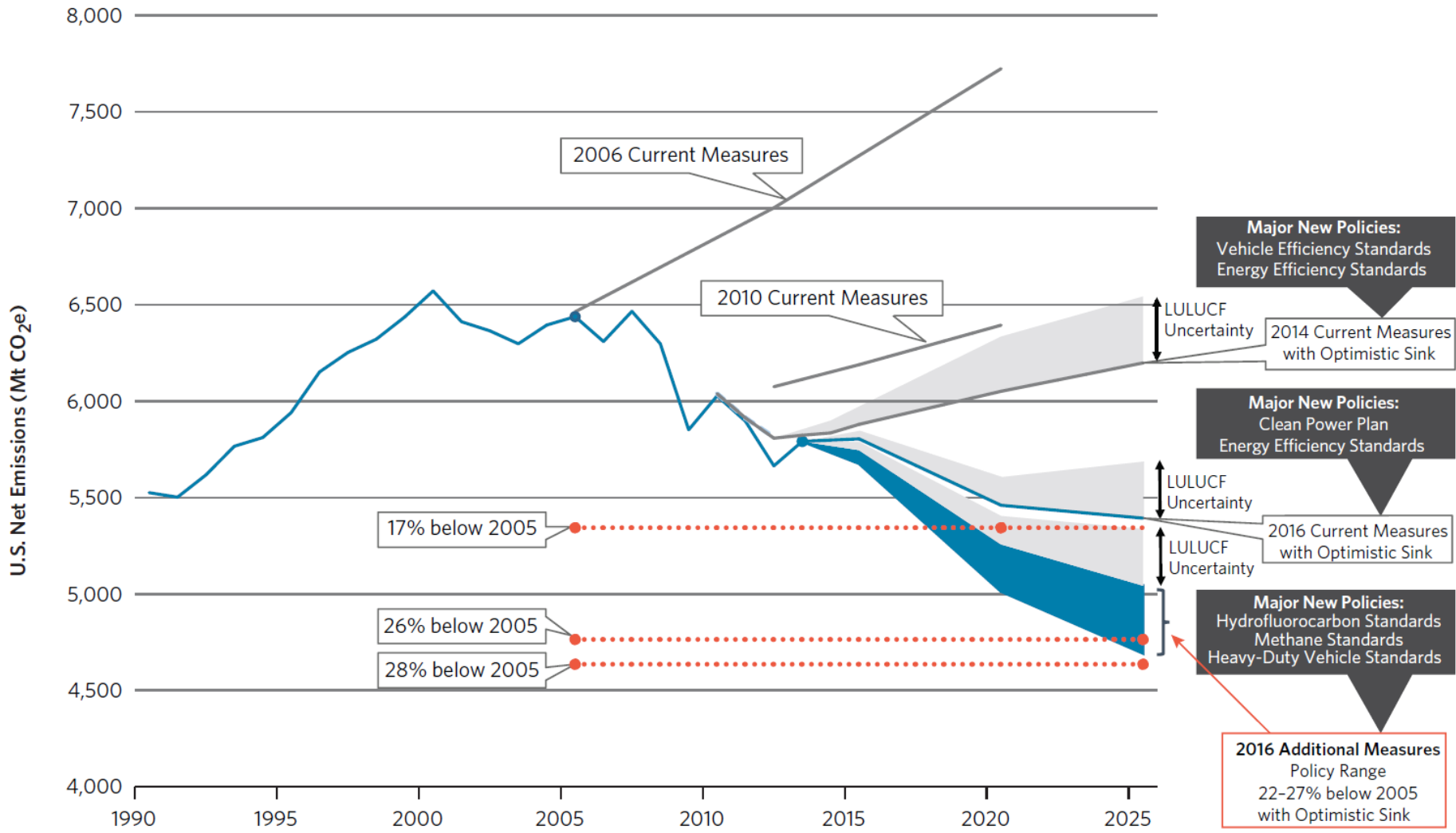


# THE CLEAN POWER PLAN

- Sets flexible and achievable standards to reduce power sector CO<sub>2</sub> emissions by 32 percent from 2005 levels by 2030 — cutting carbon pollution by 870 million tons
  - First-ever national standards that address carbon pollution from power plants.
  - Regulates existing and new, modified or reconstructed plants
- Implementation of the Clean Power Plan will occur at the state and tribal level.
- The Supreme Court issued a stay in February 2016



# 2016 BIENNIAL REPORT—U.S. GREENHOUSE GAS PROJECTIONS



Second Biennial Report of the United States of America, 2016

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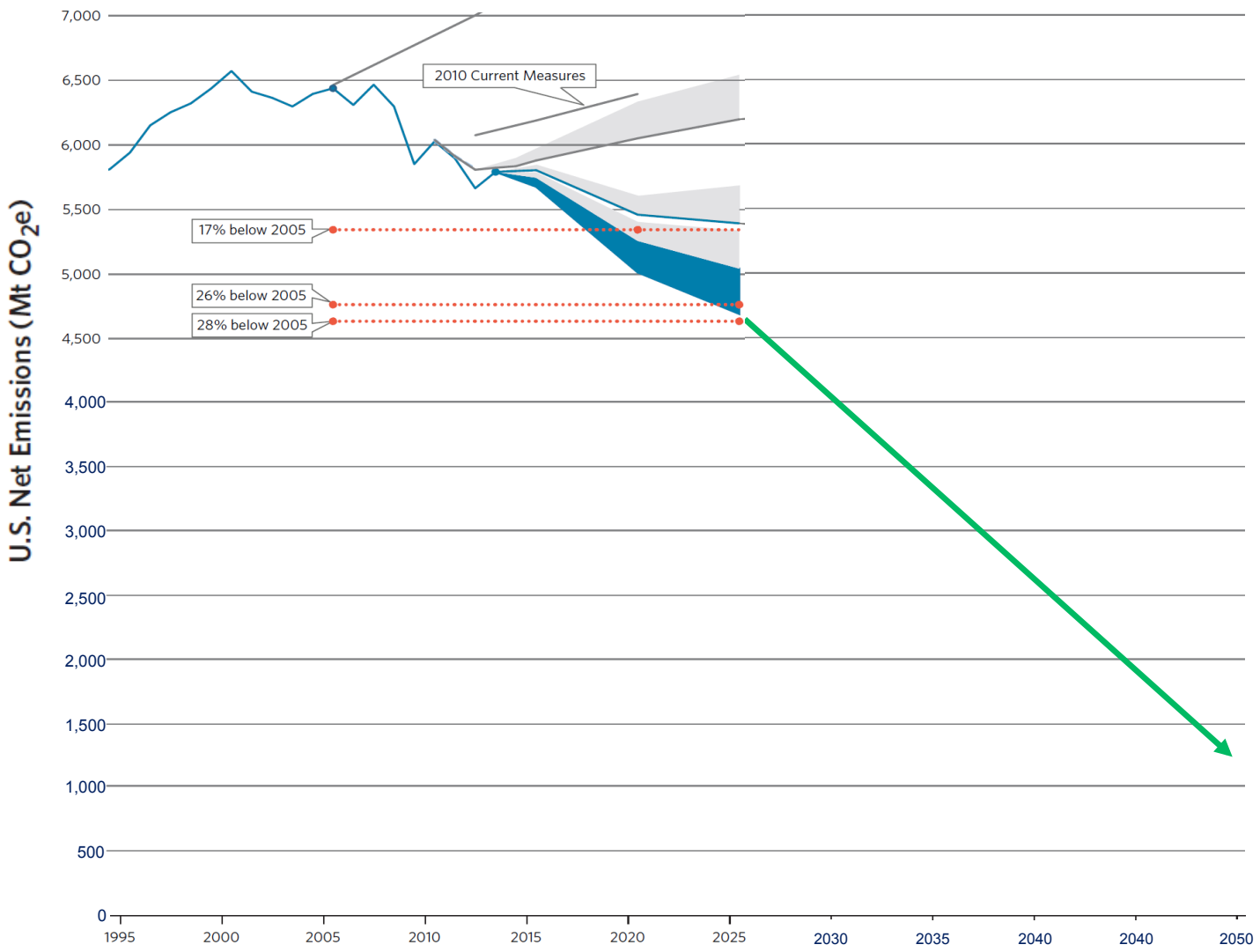


## NEAR-TERM U.S. CLIMATE POLICY ANALYSIS CONCLUSIONS

- Reference projections (no additional policies or measures) of future greenhouse gas (GHG) emissions are decreasing with each update
- For the first time, U.S. baseline projections show decreasing GHG emissions
- Significant policies and measures underway to reduce GHG emissions



# BUT WE NEED TO DO MORE TO ENSURE THAT WE STAY ON THE PATH TOWARD 80% ECONOMY-WIDE EMISSIONS REDUCTIONS BY 2050



Modified from Figure 5 in the Second Biennial Report of the United States of America, 2016

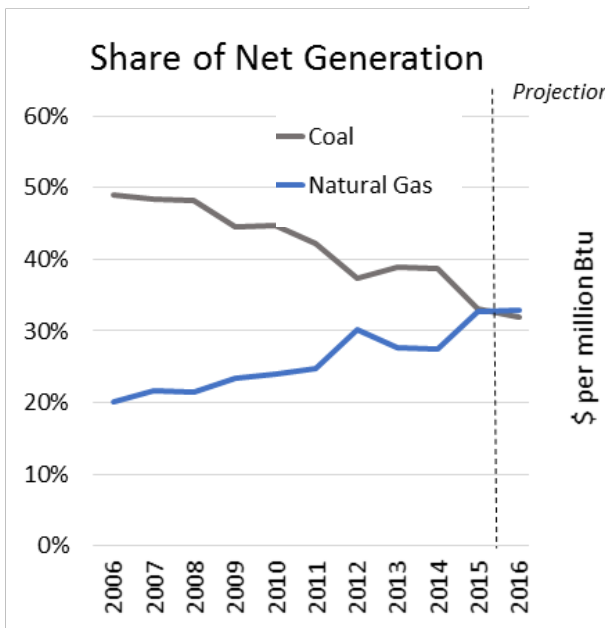


# TOWARDS A LOW CARBON FUTURE

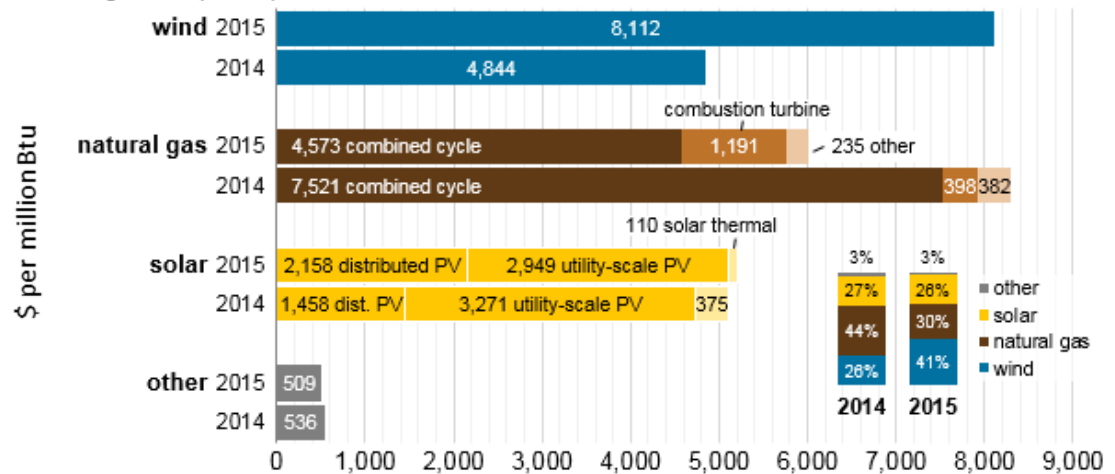


# DRIVERS OF CHANGE IN THE POWER SECTOR: NATURAL GAS, WIND, SOLAR

- Over the last decade the shift away from traditional baseload units has accelerated dramatically as natural gas prices have declined to record-low levels.
- Wind added the most electric generation capacity in 2015, followed by natural gas and solar.
- EIA projects that planned utility-scale solar additions will total 9.5 GW in 2016, the most of any single energy source.



U.S. electric generation capacity additions, 2015 vs. 2014  
megawatts (MW<sub>AC</sub>)



Sources: Energy Information Administration, Electric Power Monthly and Short Term Energy Outlook

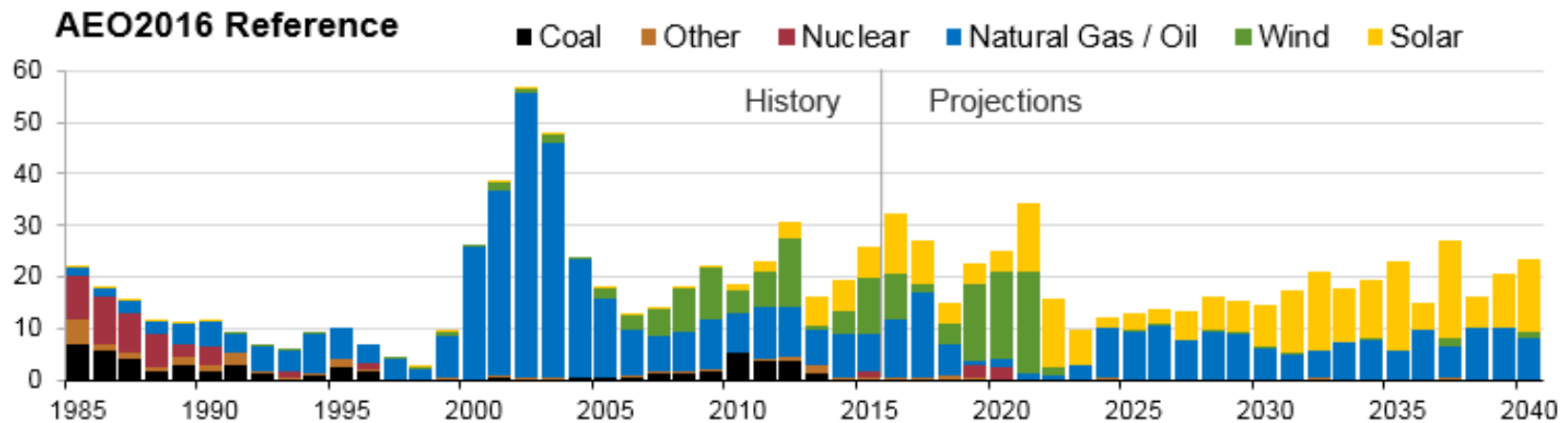
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# REFERENCE PROJECTIONS OF CAPACITY ADDITIONS

## Energy Information Administration Annual Energy Outlook 2016 Reference Case Generation Capacity Additions

annual capacity additions, gigawatts



Source: Energy Information Administration, "Annual Energy Outlook Early Release," May 2016



## RESEARCH QUESTION

What would greenhouse gas emissions be in a scenario that includes energy technology goals for current RD&D funding levels as published in the 2017 fiscal year Administration budget request?



# ANALYSIS CASES

Case	Description
<b>EPSA Base Case</b>	AEO 2015 High Oil and Gas Resource Case plus the Clean Power Plan, wind and solar tax credit extensions, updated CCS cost and performance estimates, and updated solar and wind cost and performance estimates (consistent with AEO 2016)
<b>Advanced Technology Case</b>	Target DOE energy program goals (including cost and performance goals sourced from FY17 target budget) overlaid on top of the EPSA Base Case
<b>Advanced Technology Side Case</b>	Same as Advanced Technology Case but with AEO 2015 Reference natural gas and oil assumptions
<b>Advanced Technology Carbon Price (CP) 10 Cases</b>	Advanced Technology Case coupled with a \$10 per ton carbon price (starting in 2017), rising at 5% per year in real dollars
<b>Advanced Technology Carbon Price (CP) 20 Cases</b>	Advanced Technology Case coupled with a \$20 per ton carbon price (starting in 2017), rising at 5% per year in real dollars



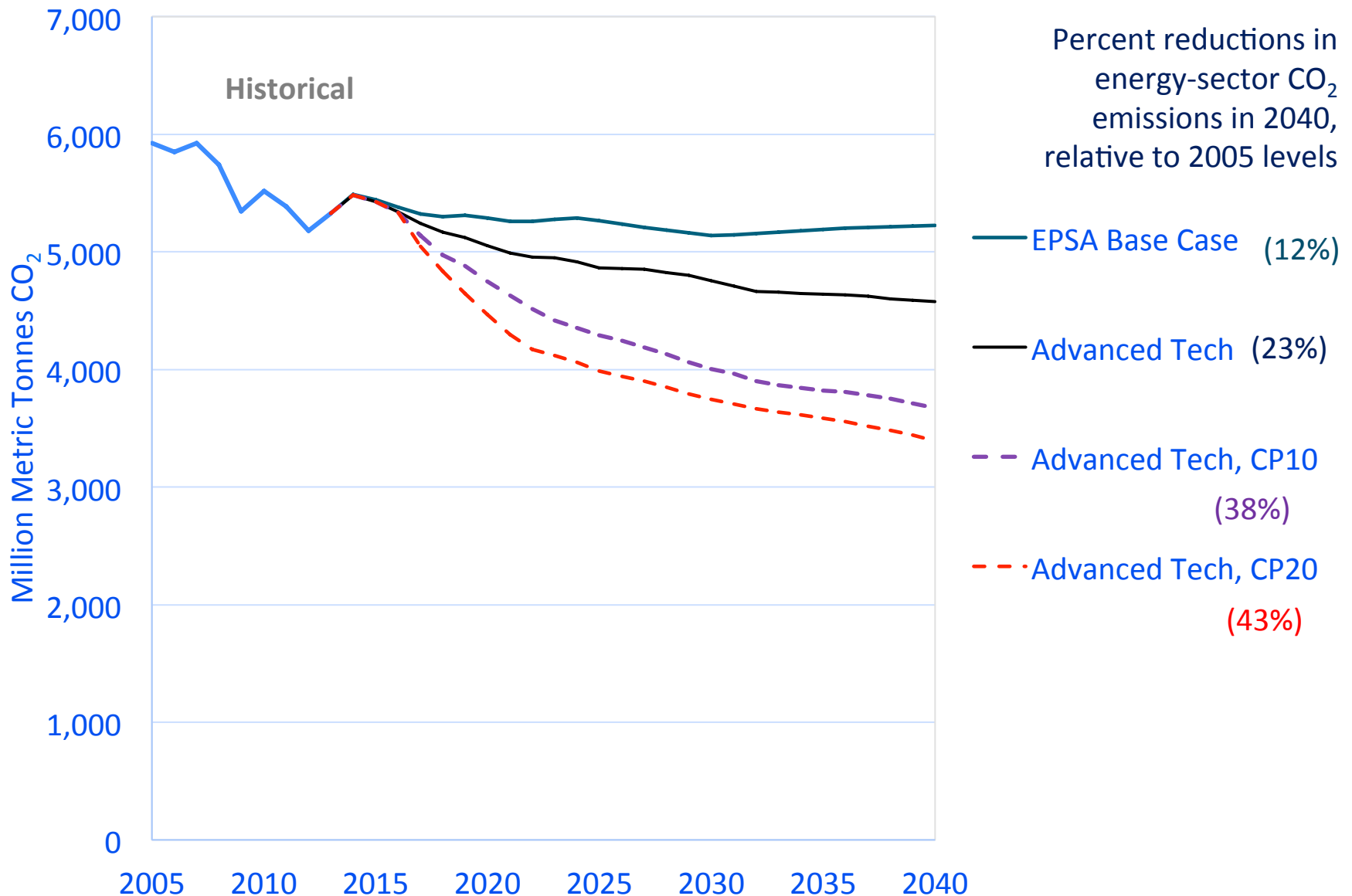
## ADVANCED TECHNOLOGY ASSUMPTIONS

- Input assumptions are based on input from DOE's program offices, for example:
  - Costs and heat rate projections for new and retrofitted coal and natural gas combined cycle CCS plants
  - Costs and plant build times for state-of-the art nuclear reactors
  - Reserve sharing capability, load shifting, spinning reserves and transmission capacity
  - Wind costs and capacity factors, solar costs, hydropower costs and resource availability, and geothermal site costs
  - Costs and conversion efficiency for biofuel processing; higher fuel economy and lower costs for vehicles
  - Manufacturing and refining energy efficiency improvements; stringency of standards and building codes, shell performance, and consumer acceptance in the buildings sector
- Analysis was completed using the EPSA-NEMS model

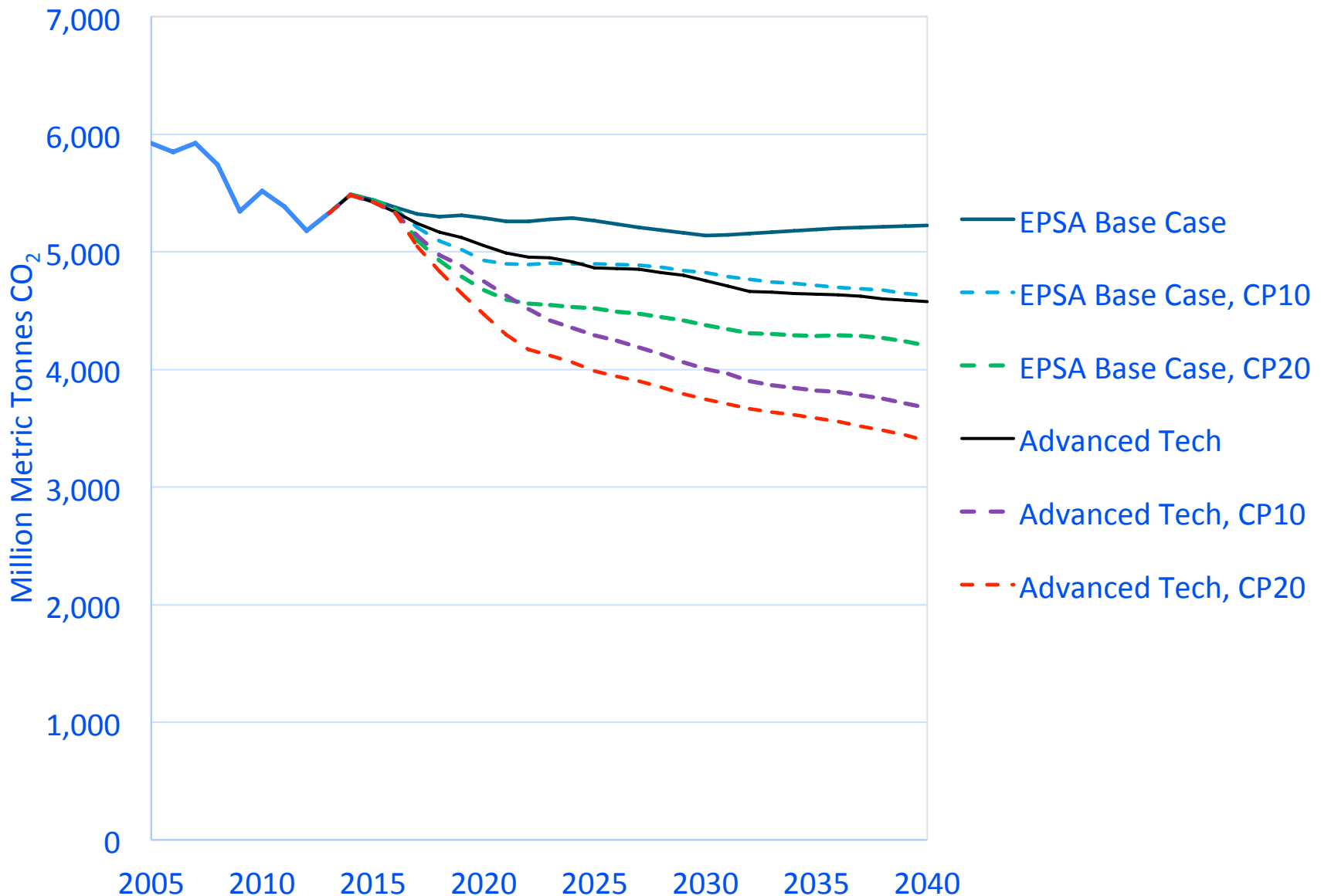




# ADVANCED TECHNOLOGY CASE ACHIEVES GHG REDUCTIONS BEYOND CURRENT POLICIES AND MEASURES



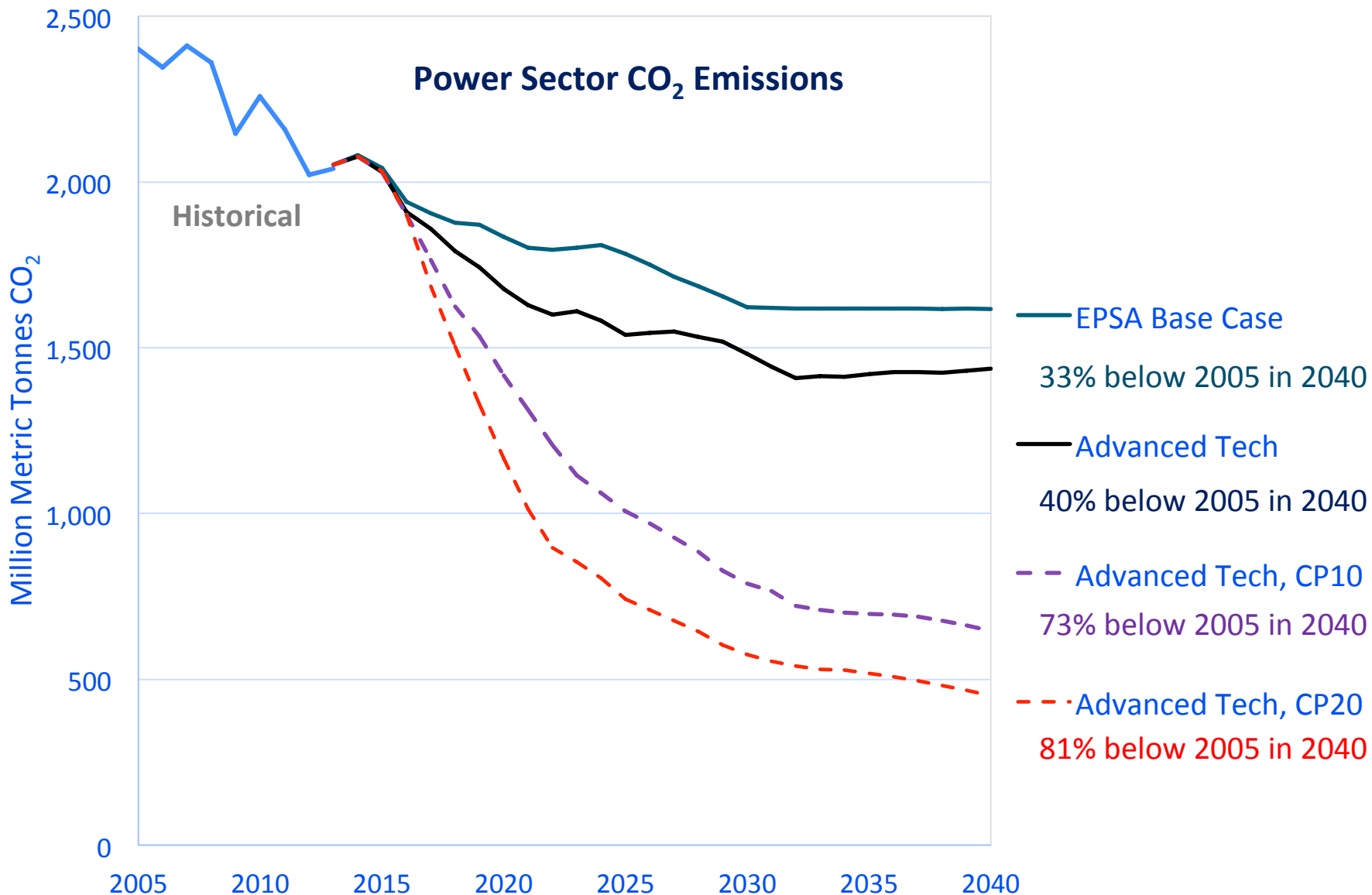
# ADVANCED TECH PLUS A MODEST CARBON PRICE ACHIEVES MORE GHG REDUCTIONS THAN A MODEST CARBON PRICE ALONE



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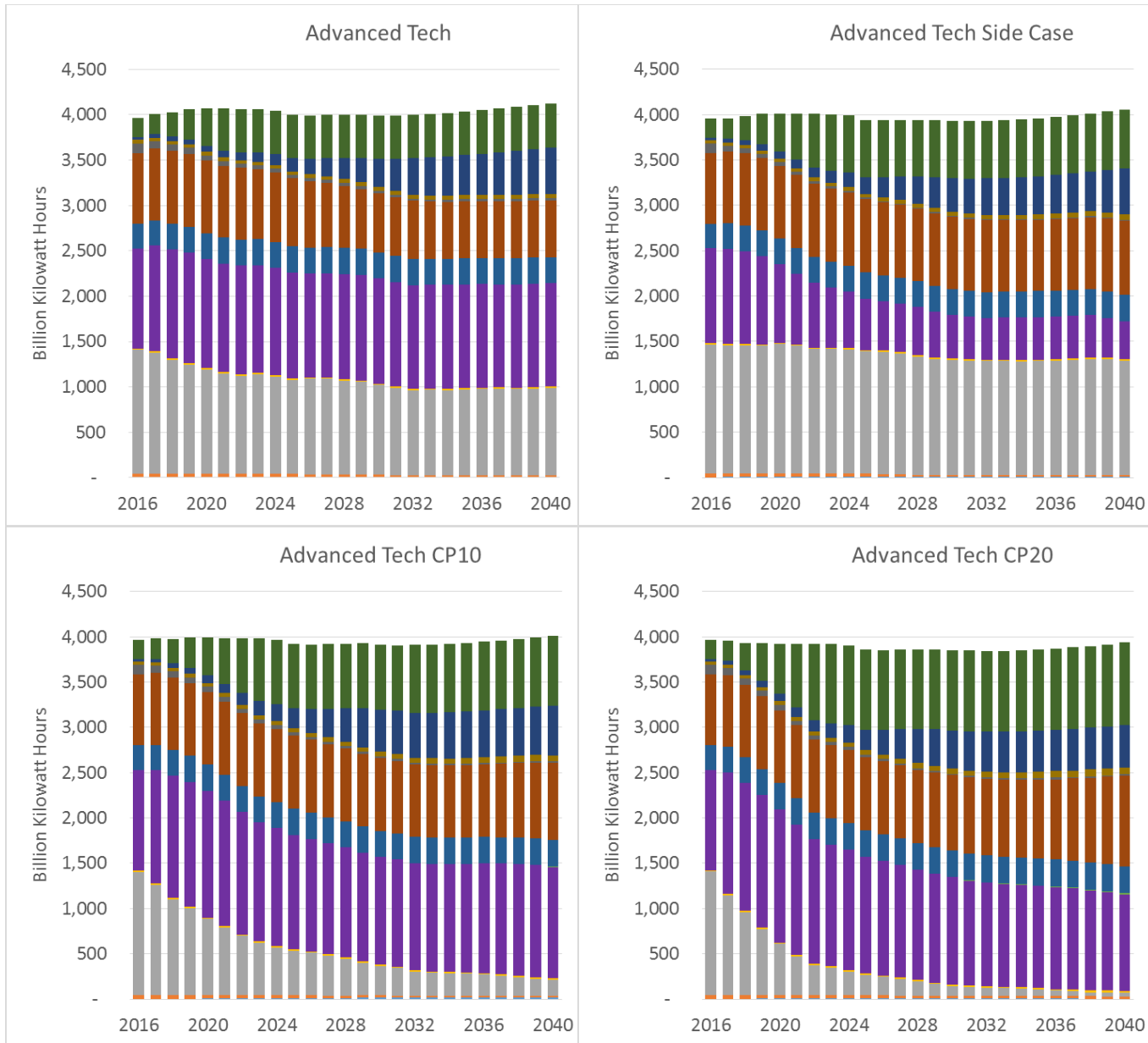
# A MODEST CARBON PRICE PLUS ADVANCED TECHNOLOGY ASSUMPTIONS ACHIEVES DEEP REDUCTIONS IN THE POWER SECTOR



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# GENERATION MIX VARIES SIGNIFICANTLY DEPENDING ON NATURAL GAS PRICE AND POLICY

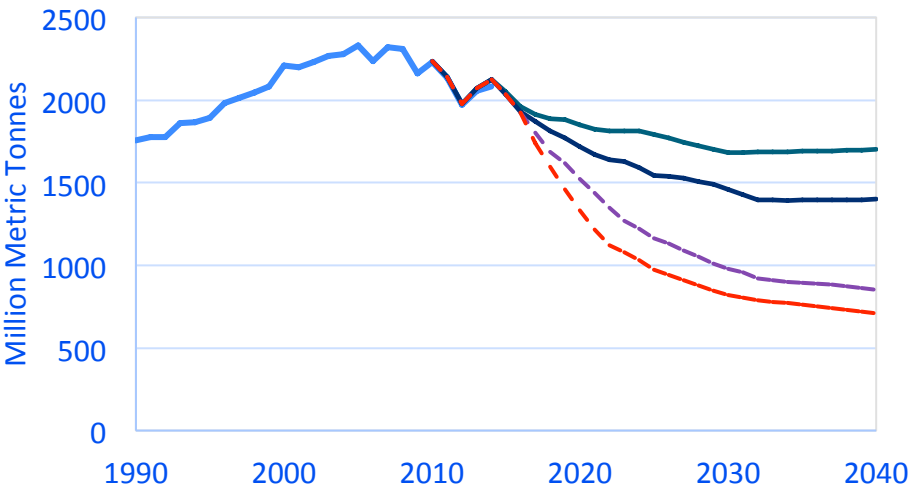


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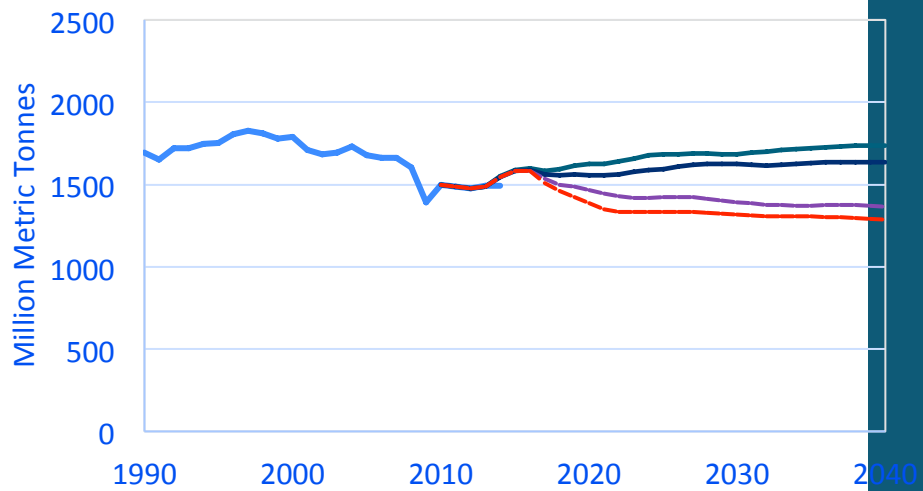


# DECARBONIZATION OF END-USE SECTORS REQUIRES DIFFERENT APPROACHES FOR DIFFERENT SECTORS

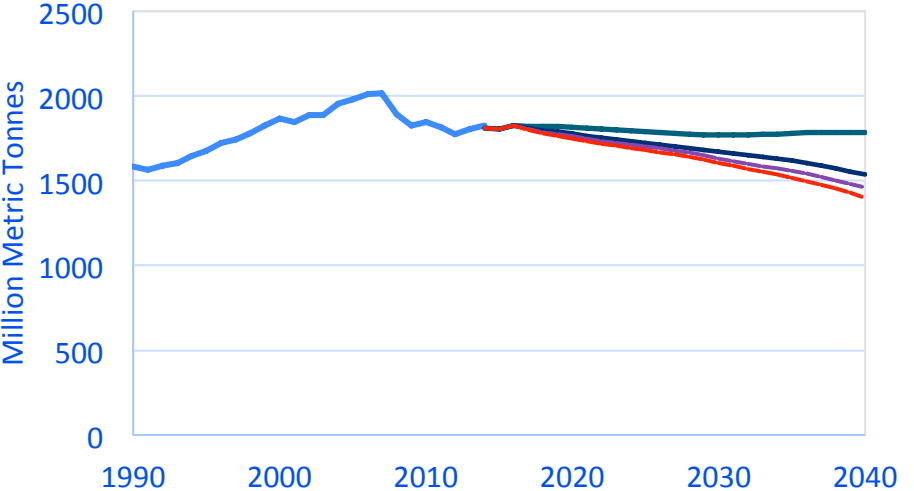
Buildings Sector



Industrial Sector



Transportation Sector

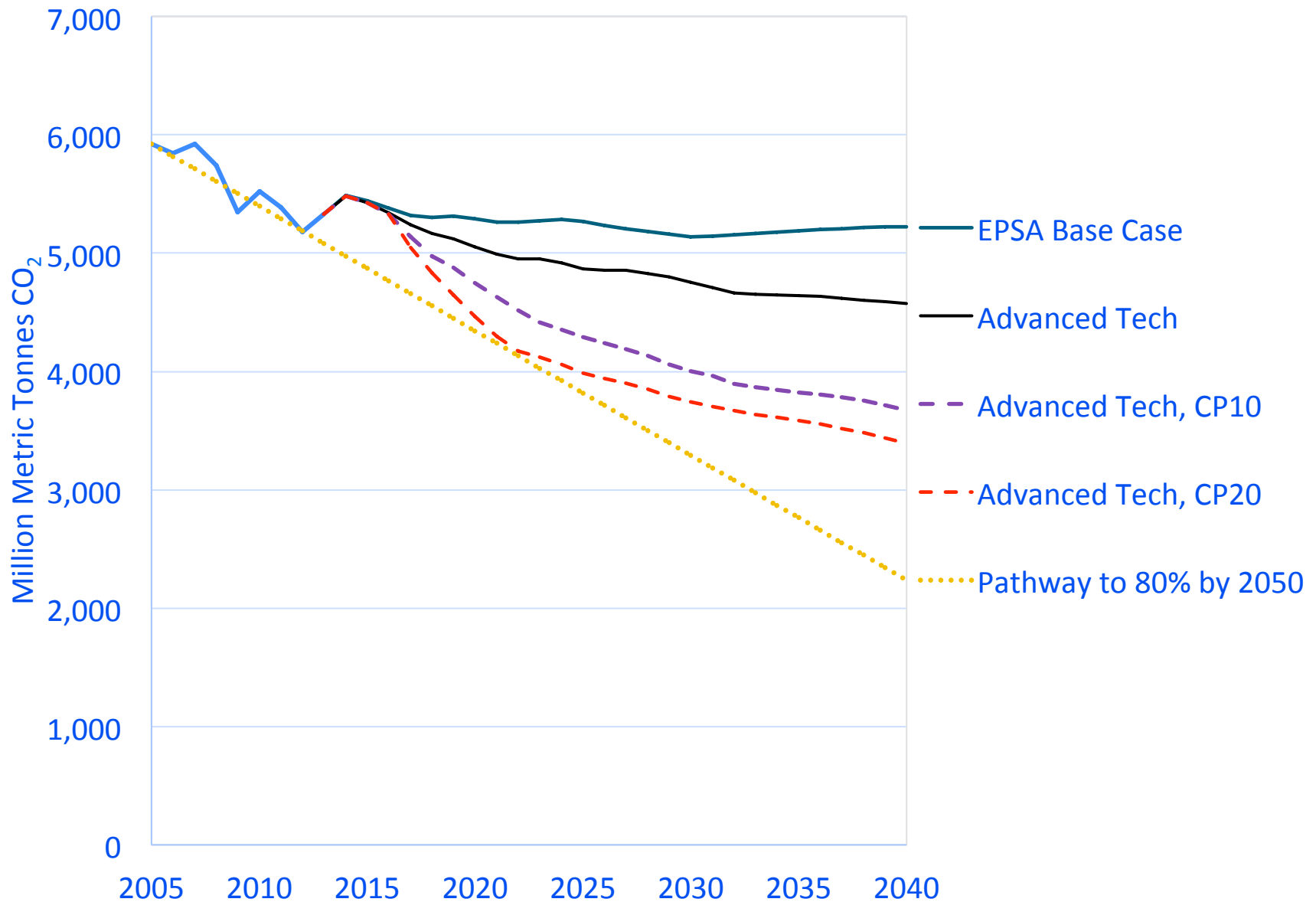


- EPSA Base Case
- Advanced Tech
- - Advanced Tech, CP10
- - Advanced Tech, CP20

\*Includes direct fuel use and electricity emissions apportioned to the various end-use sectors



# WE WILL NEED ADDITIONAL CLEAN ENERGY TECHNOLOGY PUSH AND POLICY PULL TO ACHIEVE A LOW CARBON FUTURE



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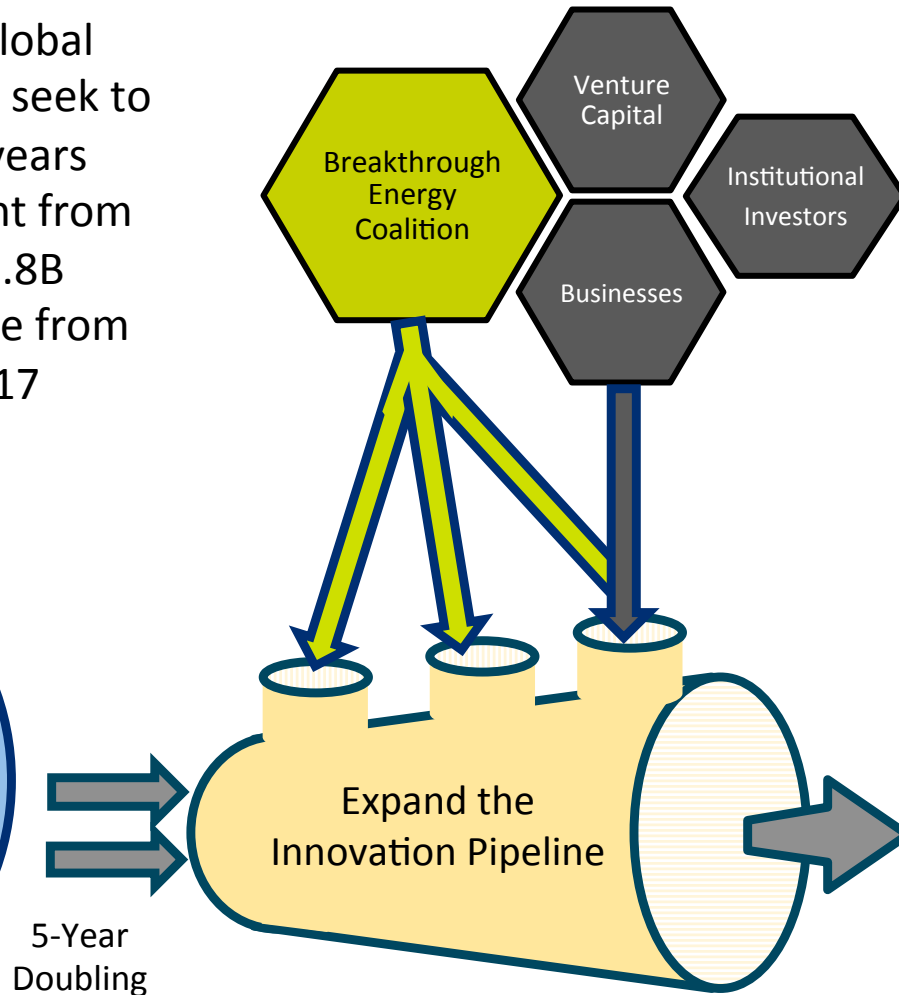
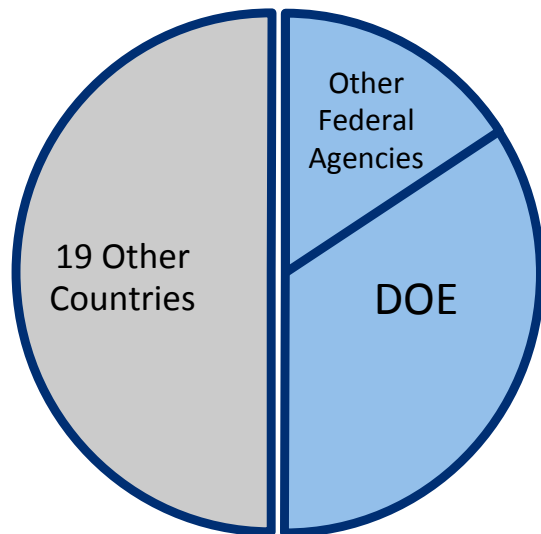
## CONCLUSIONS

- Advanced Technology Case achieves significant GHG reductions
- Advanced Technology Case combined with a modest carbon price drives additional GHG reductions beyond what would be achieved from a modest carbon price alone
- Clean energy technology deployment and carbon policy affects sectors differently—different approaches are needed for each sector
- We are not on track yet for a low carbon future—both policies and measures (“policy pull”) and clean energy technology deployment (“technology push”) need to be part of the solution

# MISSION INNOVATION

## PARIS - NOV. 30, 2015

- 20 countries, (80% of Global Clean Energy R&D,) will seek to double funding over 5 years
- U.S.: Double investment from \$6.4B in FY 2016 to \$12.8B
- DOE: \$1B (21%) increase from \$4.8B to \$5.9B in FY 2017



Breakthrough Energy Coalition committed to expand investment into earlier stages of innovation through commercialization

Support U.S. economic and environmental objectives; enable U.S. role in expanding global markets; improve global standard of living



Thank You!

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