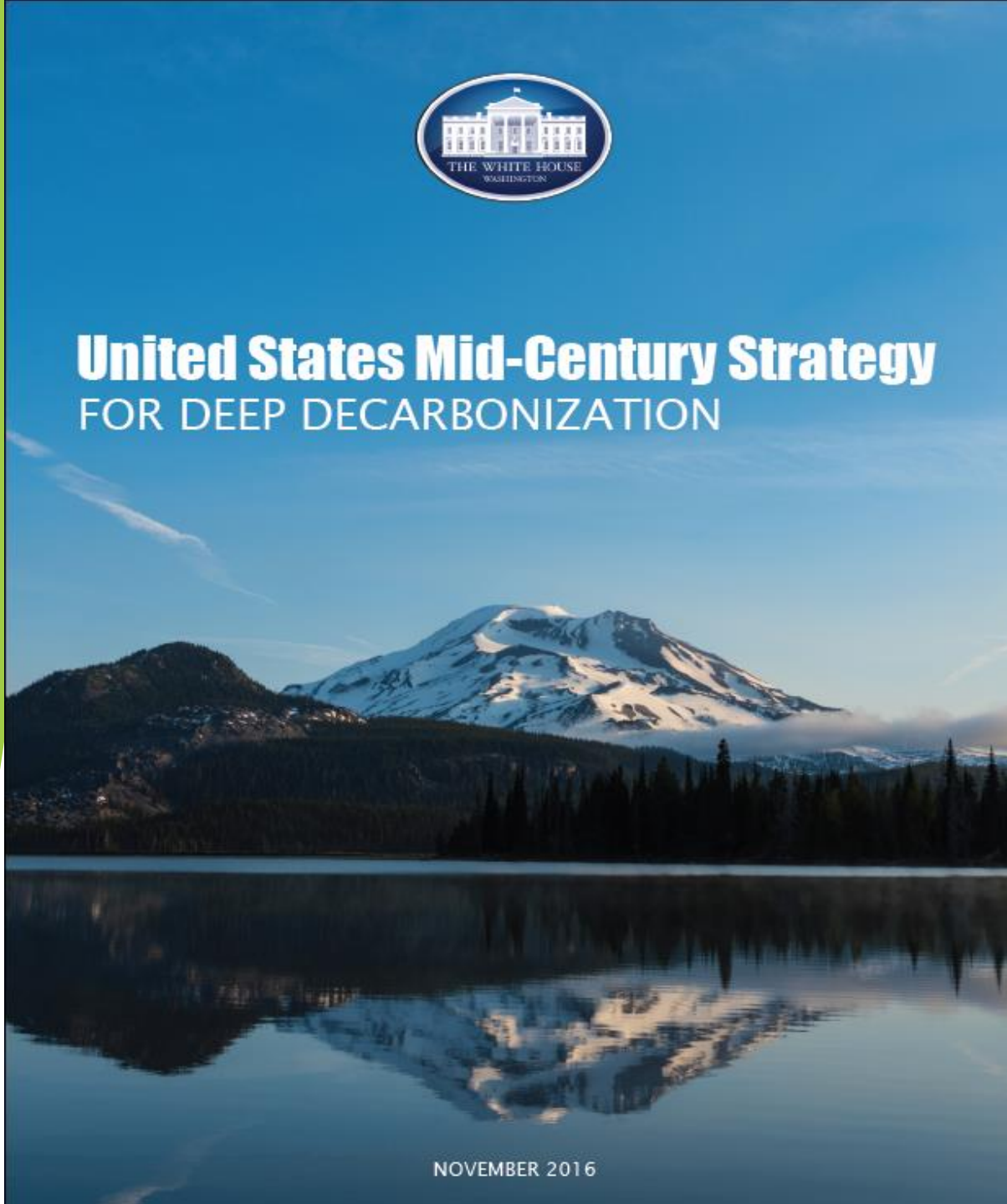




# United States Mid-Century Strategy FOR DEEP DECARBONIZATION



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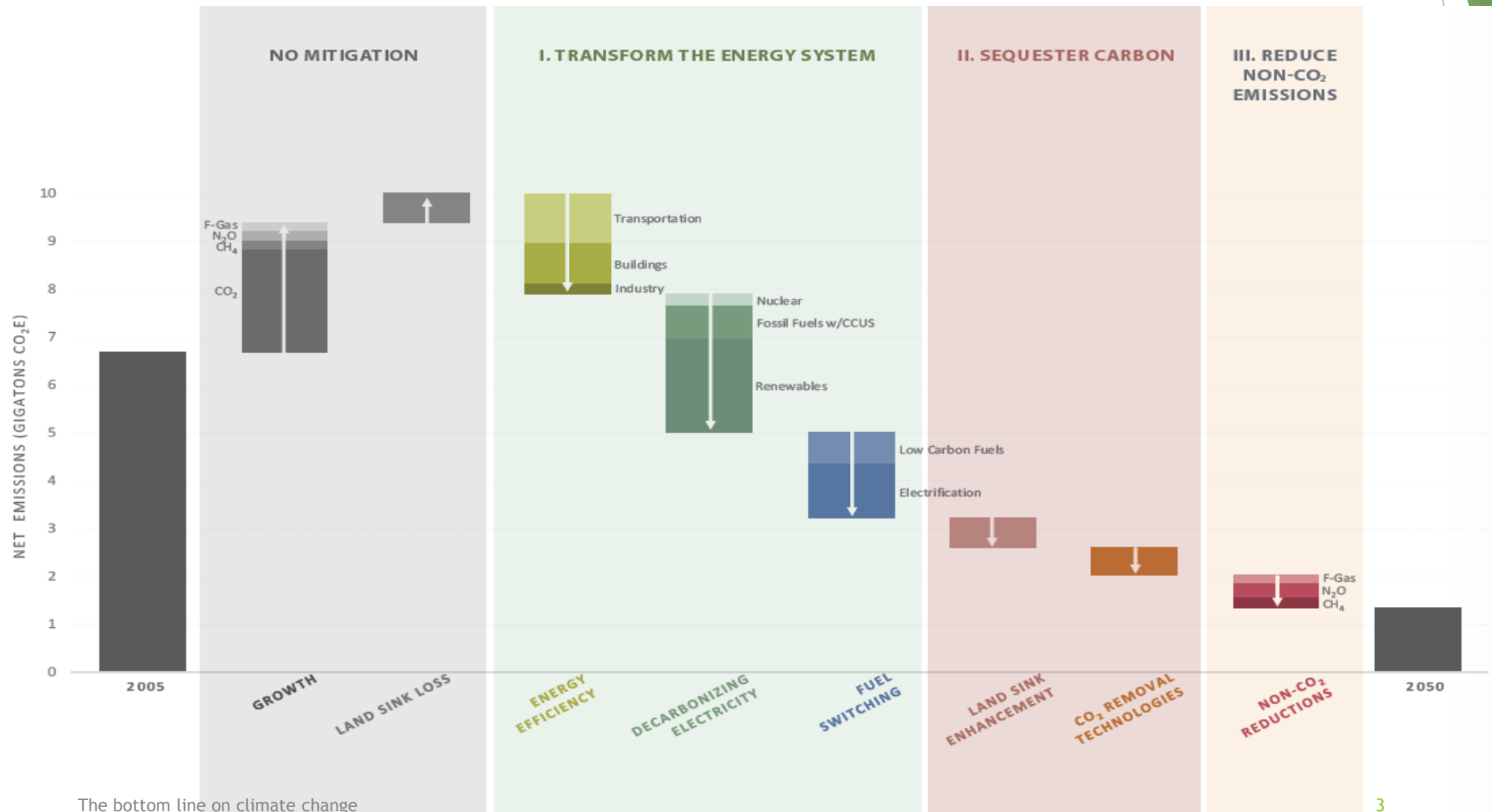
# History & Overview

- Paris agreement:
  - Country NDC targets for 2025/2030
  - Long-term global goal of remaining well below 2° C of warming
  - Invited Parties to submit mid-century low-GHG gas strategies by 2020.
- Canada, Mexico and U.S. and Germany released their mid-century strategies at COP22 in Marrakech November 2016
- Sets out a long-term vision for cost-effectively decarbonizing our economy
- Illustrates pathways to achieve an 80 percent economy-wide emission reduction by 2050



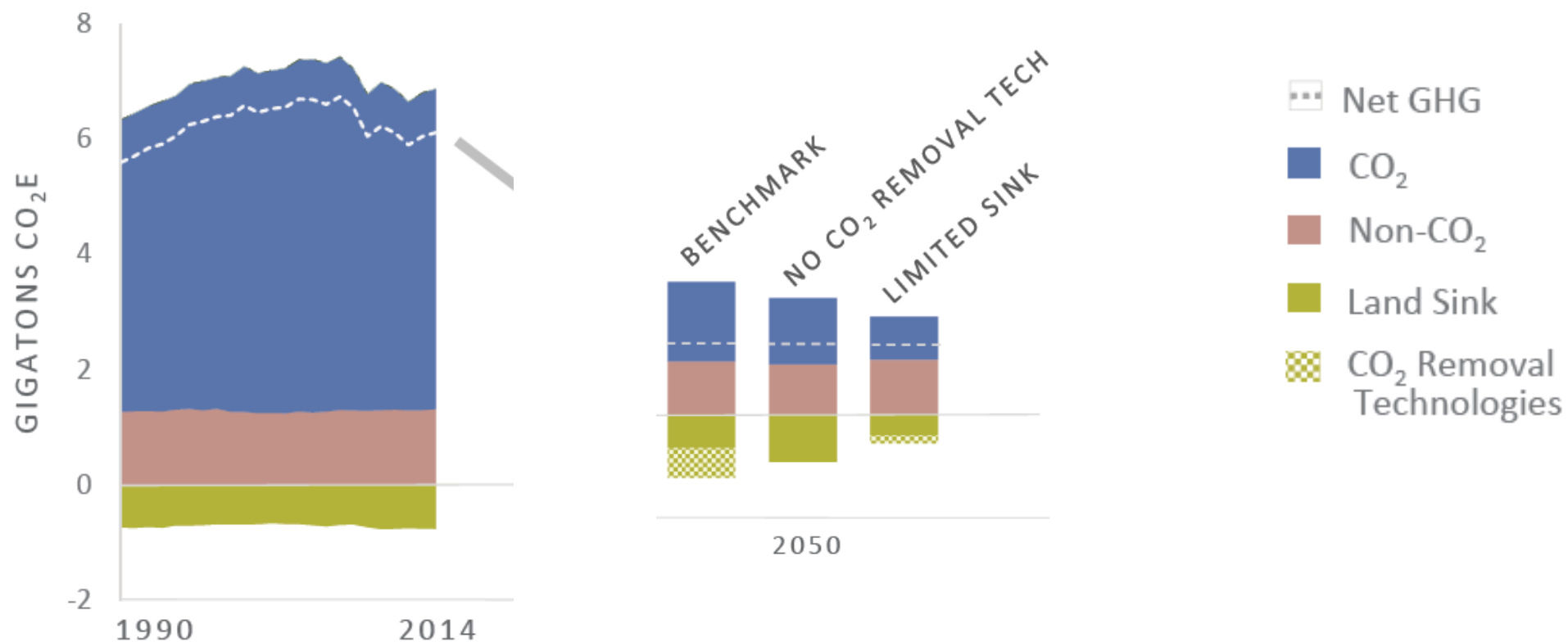
- Describes U.S. action across 3 major categories:
  - Transitioning to a **low-carbon energy system**
  - **Sequestering carbon** through forests, soils and CO<sub>2</sub> removal technologies
  - **Reducing non-CO<sub>2</sub> emissions** such as methane, nitrous oxide and HFCs

# U.S. Mid Century Strategy



Source: *United States Mid Century Strategy for Deep Decarbonization*, November 2016

# Main Scenarios and Negative Emissions Scenarios



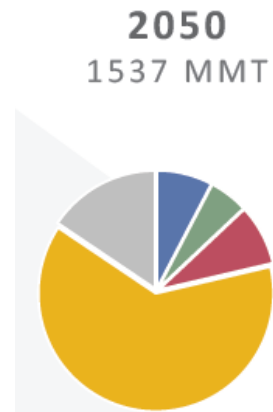
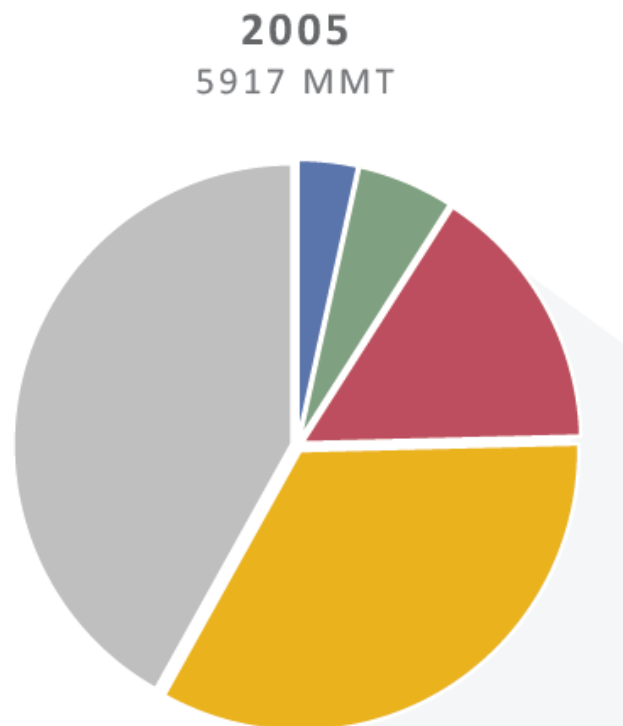
**Benchmark Scenario:** Technology assumptions from DOE Advanced Technology Case; maintained land carbon sink and a broad range of low-GHG technologies, including CO<sub>2</sub> removal technologies

**No CO<sub>2</sub> Removal Technology Scenario:** CO<sub>2</sub> Removal technologies like bioenergy w/carbon capture and storage (BECCS) are unavailable

**Limited Sink Scenario:** Limited availability of CO<sub>2</sub> removal technologies and limited success in maintaining and enhancing the land sink

# MCS Vision for a Low-Carbon U.S. Energy System in 2050

U.S. ENERGY CO<sub>2</sub> EMISSIONS IN 2005 AND 2050  
IN THE MCS BENCHMARK SCENARIO BY SECTOR

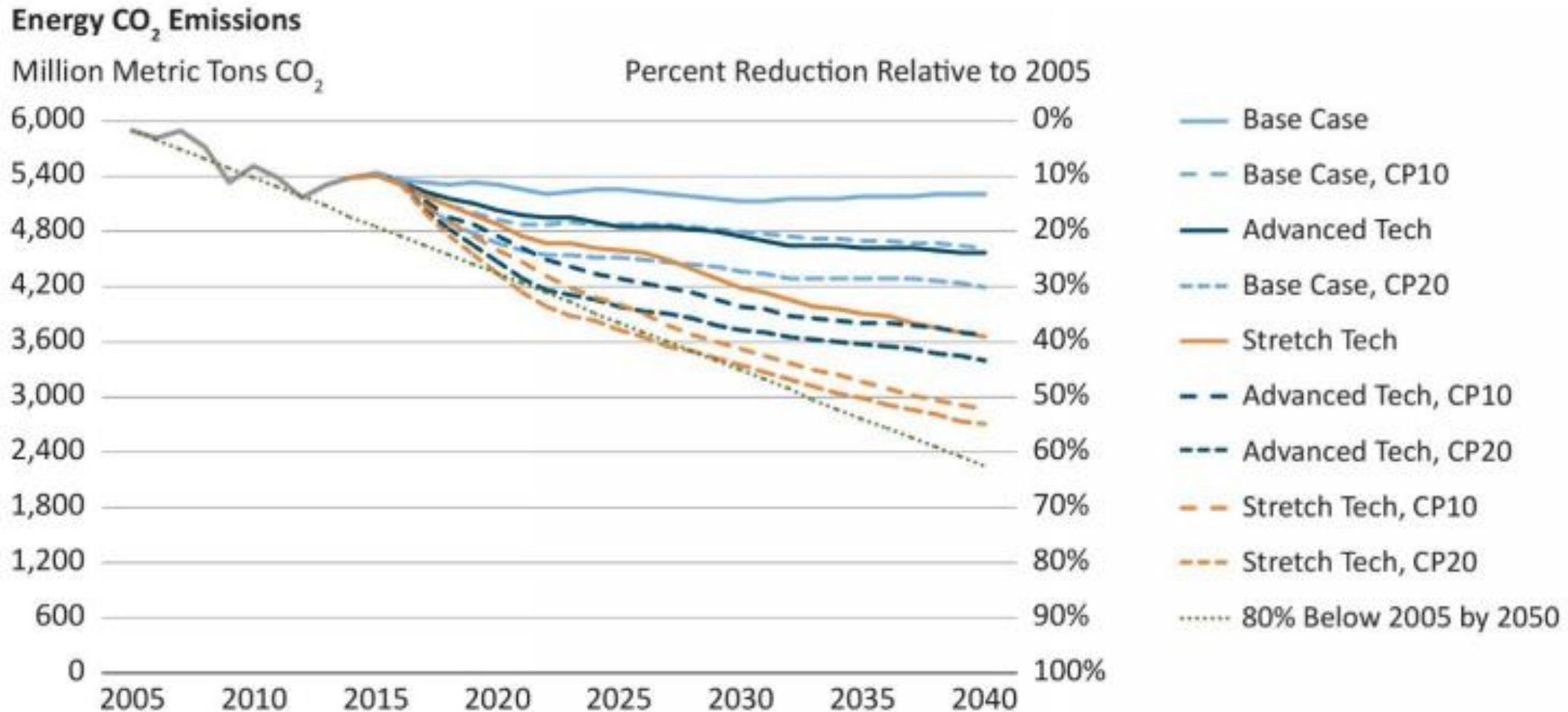


1. Improving energy efficiency, including smart growth.
2. Near-complete decarbonization of electricity.
3. Switching to electricity and other low-carbon fuels in transportation, buildings, and industry.

■ Commercial Buildings  
■ Residential Buildings  
■ Industry  
■ Transportation  
■ Electricity

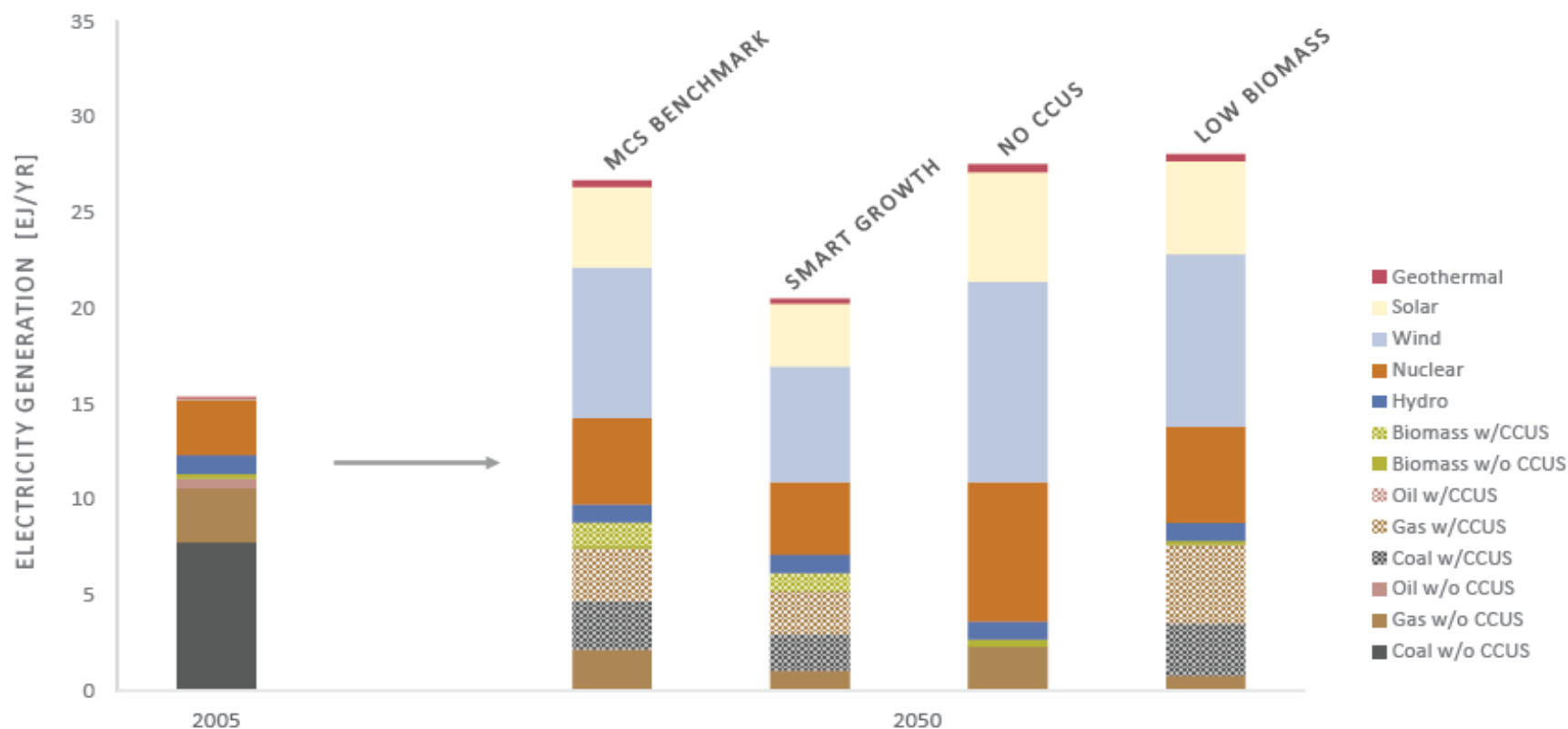


The combination of technology advances and additional policies can drive greater emission reductions than the sum of each approach on its own.



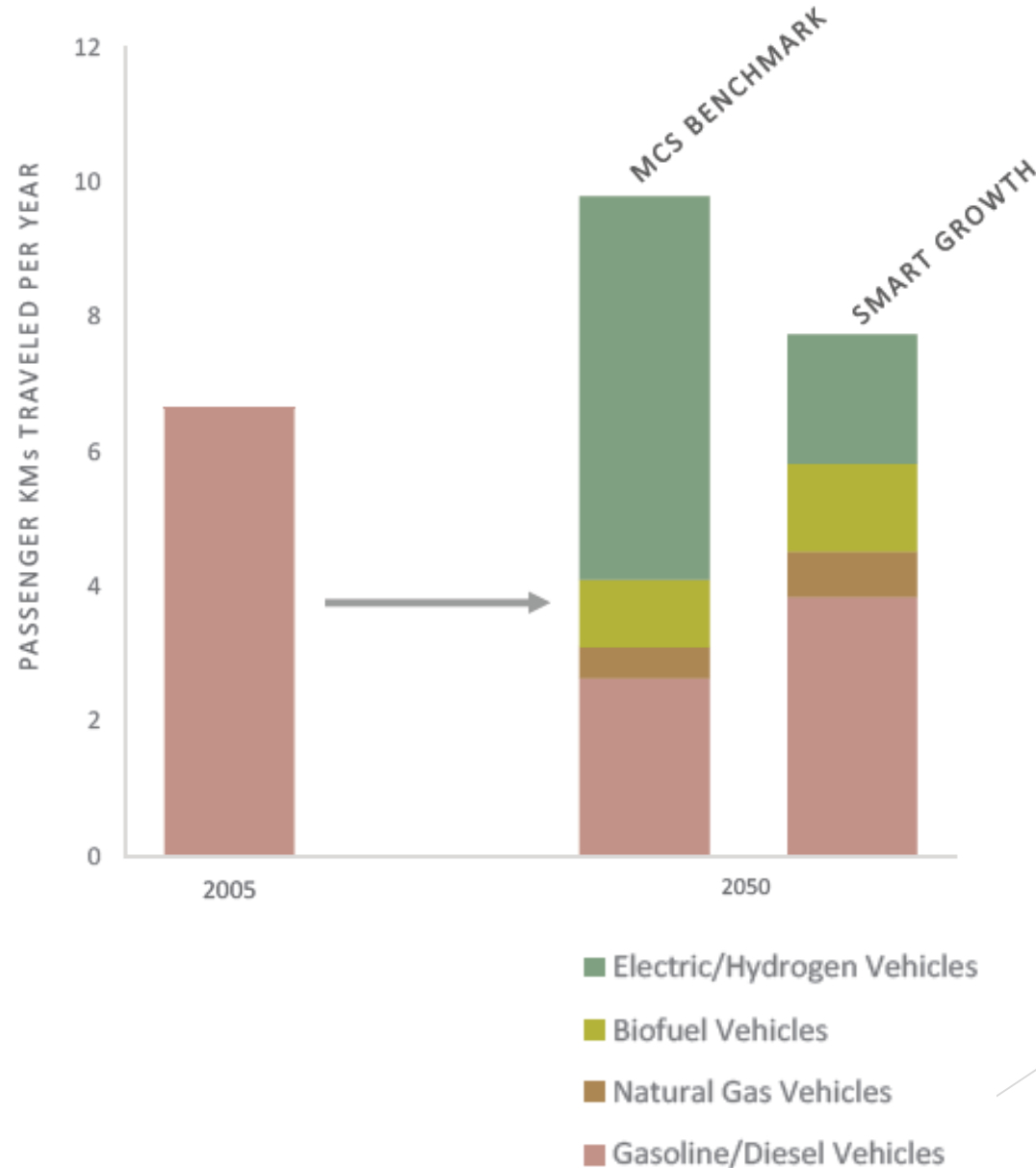
# Electricity Strategy

- Near-complete decarbonization, driven by deployment of renewable energy (primarily wind and solar), nuclear energy, and fossil-fuels and bioenergy with CCS
- A major expansion of generation resources supports both economic growth and the electrification of other sectors



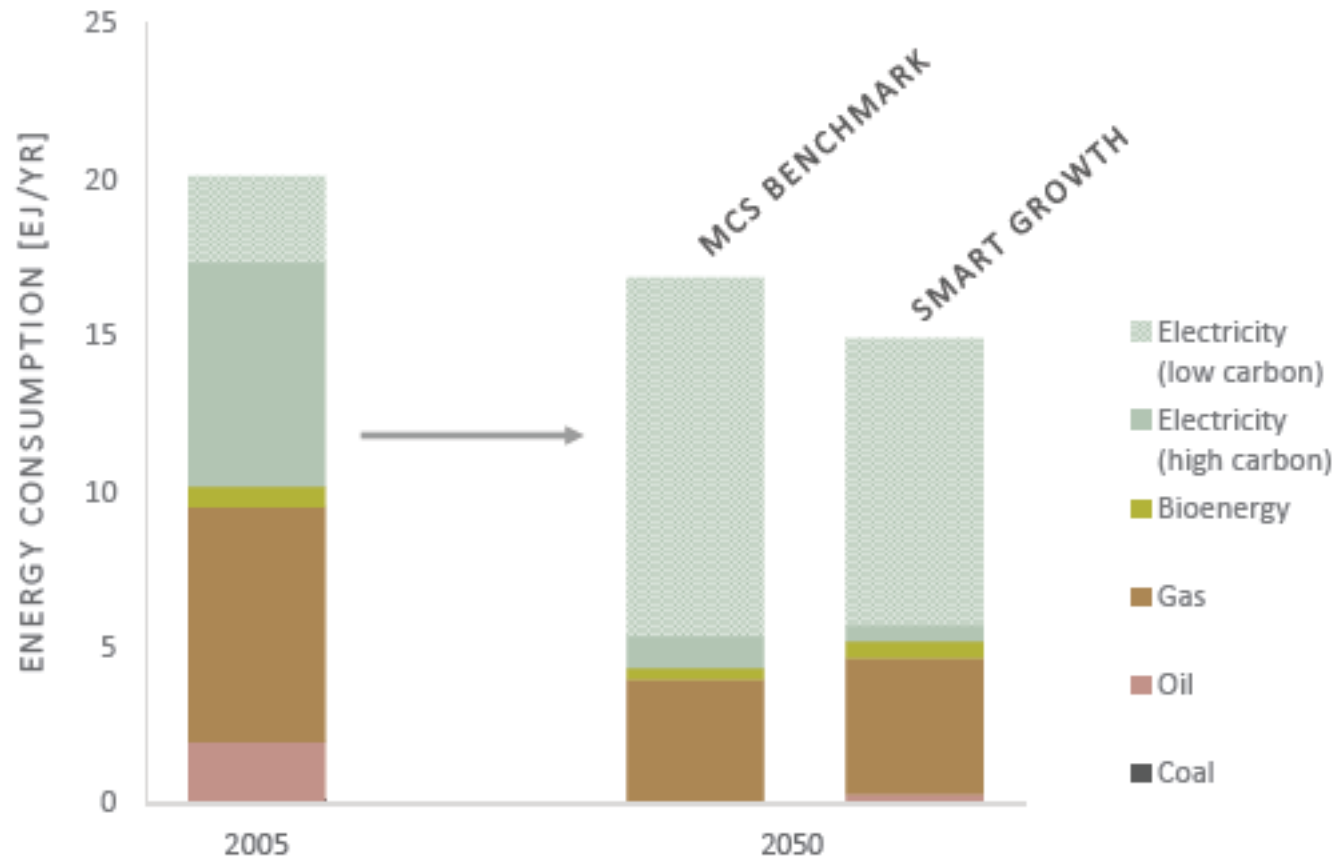
# Transportation Strategy

- Increasing fuel efficiency
- Developing low-carbon transportation fuels and vehicles, including electric vehicles, fuel cell electric vehicles and biomass-fueled vehicles
- Reducing vehicle miles traveled through smart growth and other strategies





# Buildings Strategy



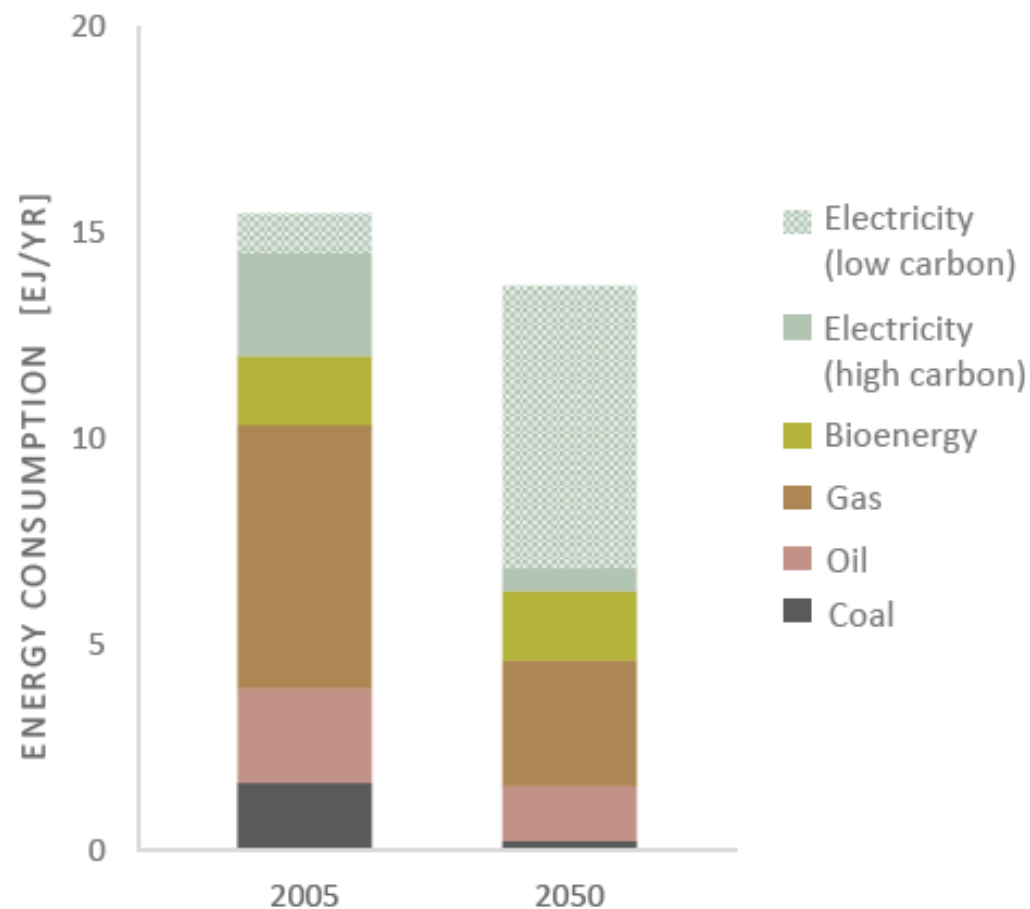
- Increasing energy efficiency
- Increasing electrification of end-uses

# Industry Strategy

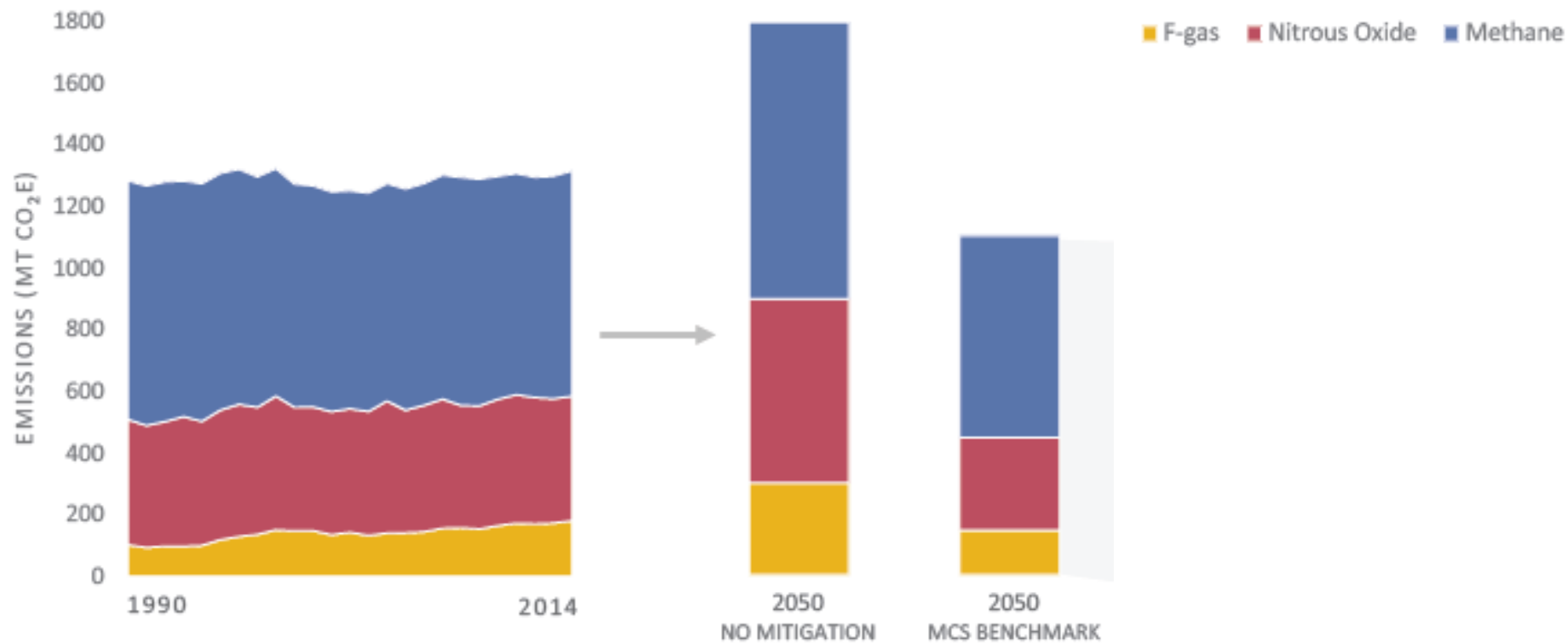
*Industry is very heterogeneous, so decarbonization will be industry- and process-specific.*

Two crosscutting themes:

- Efficiency improvements in new materials and methods
- Switching to low-carbon fuels and feedstocks, including clean electricity



# Opportunities for Reducing Non-CO<sub>2</sub> Emissions

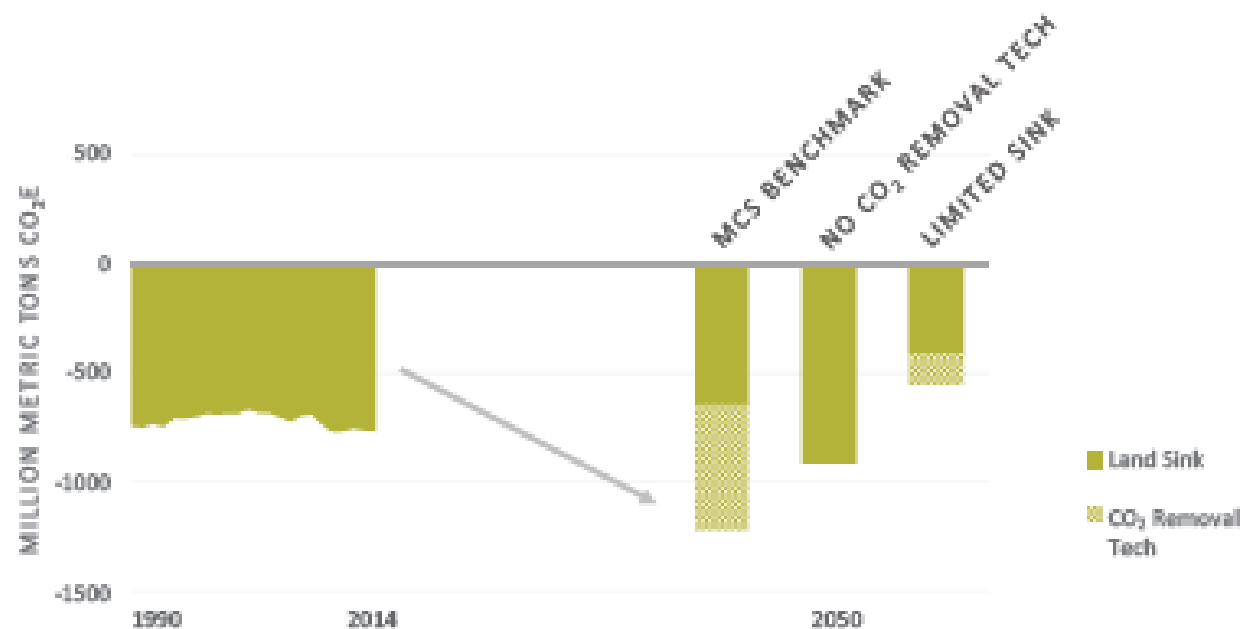


- MCS Benchmark non-CO<sub>2</sub> emissions in 2050 decline modestly compared to current levels but are ~50% lower than the No Mitigation scenario in 2050.
- The Mid-Century Strategy does not account for major technological advances that may be achievable with increased RD&D investment to identify and drive down the costs of opportunities to further reduce non-CO<sub>2</sub> emissions.

BACKUP SLIDES

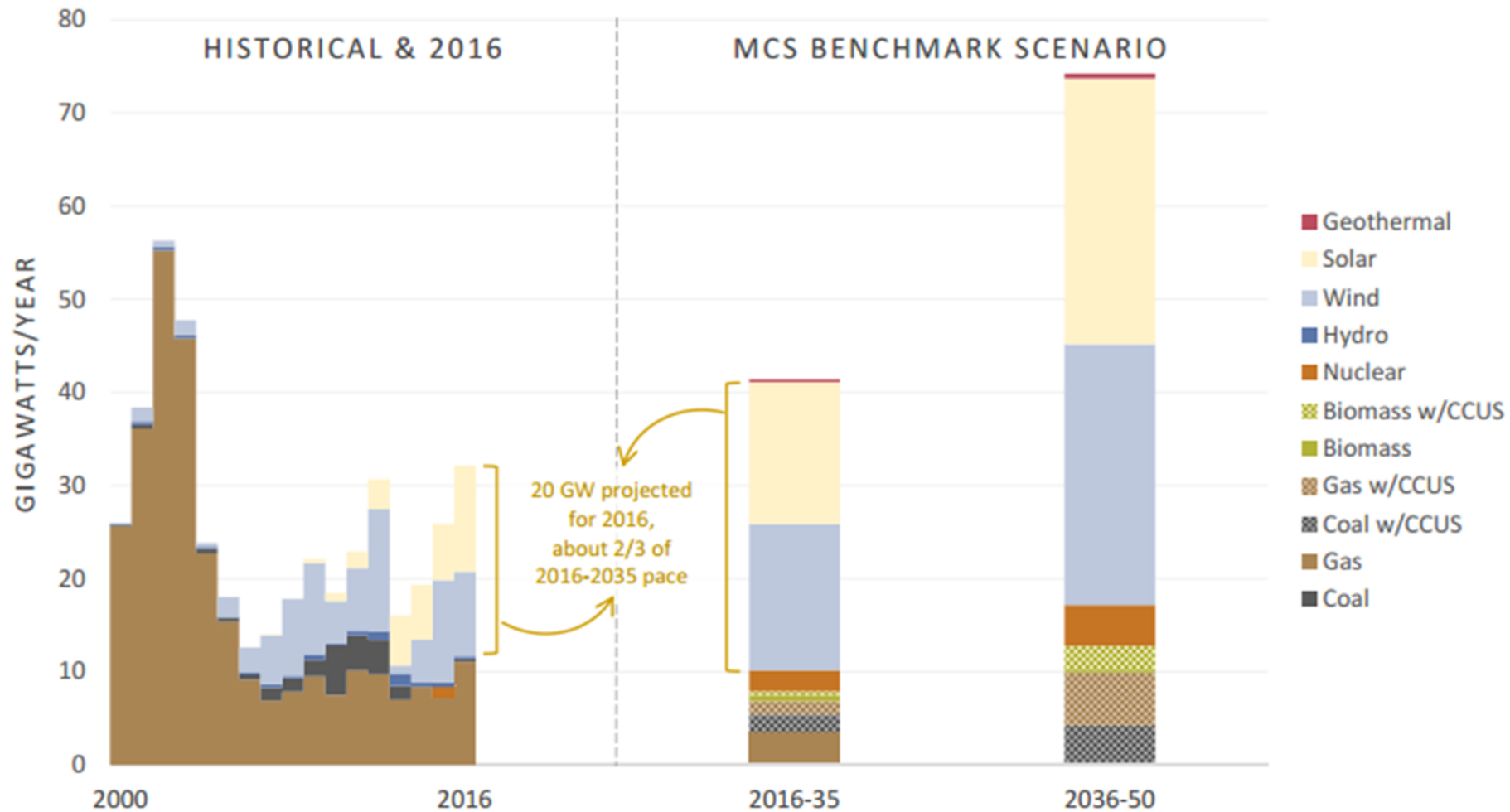
# Reducing Net Emissions with U.S. Lands

2050 land sector and CO<sub>2</sub> removal technologies could sequester 30 to 50 percent of economy-wide GHG emissions



- Finding efficient ways to structure carbon-based incentives in the land sector will be important
- Achieving land sector goals of MCS will require cooperation across a diverse group of stakeholders
- Carbon reporting, accounting and monitoring tools can ensure that we are supporting cost-effective and flexible mitigation strategies
- Timing of land action is critical, and delivering significant land sequestration by 2050 requires investing soon.
- Policy “check points” are vital to assess the impacts of these activities on the land sector

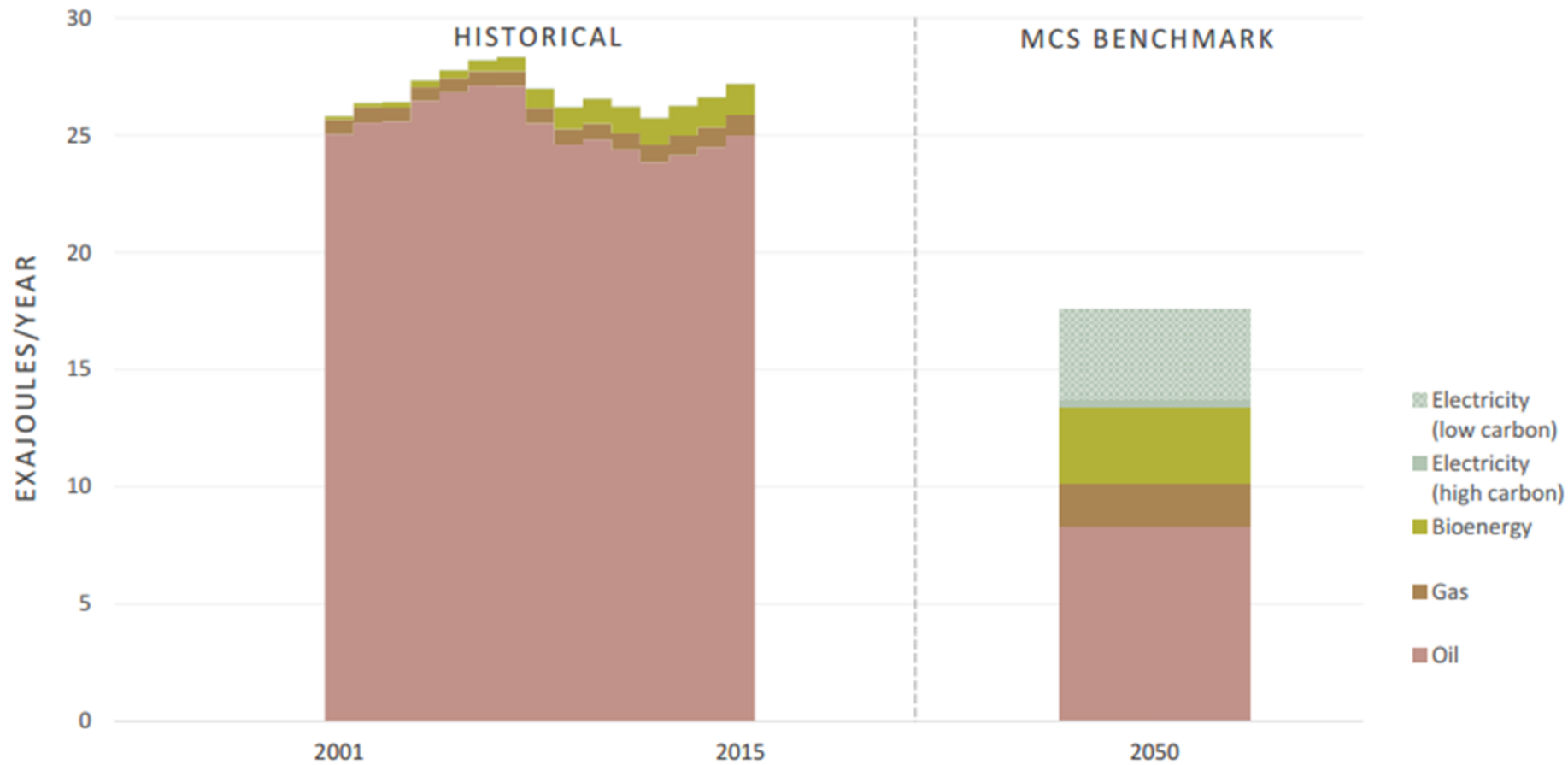
# Electricity Capacity Additions



Source: *United States Mid Century Strategy for Deep Decarbonization*, November 2016

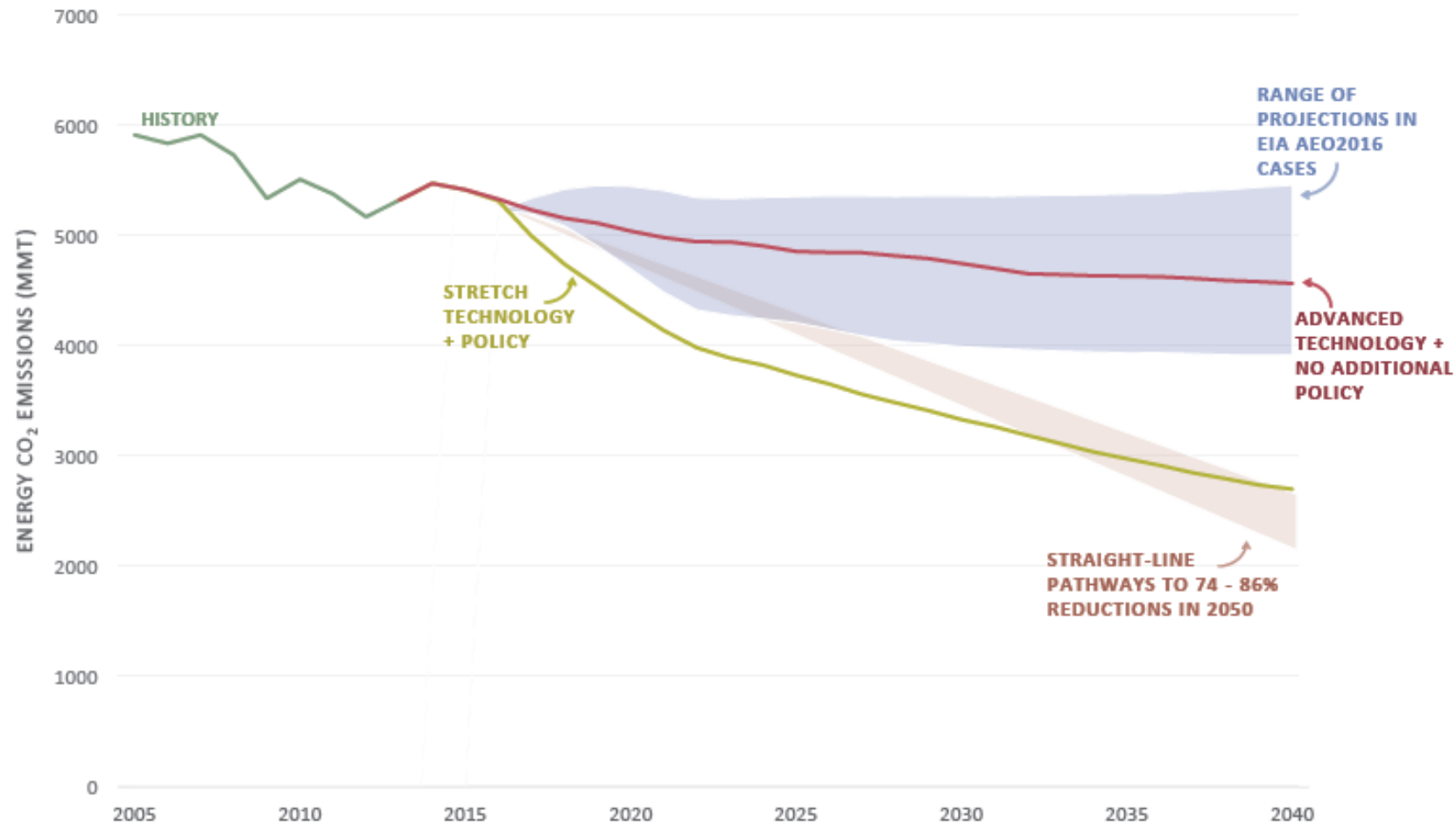


# Transportation Energy Use



Source: *United States Mid Century Strategy for Deep Decarbonization*, November 2016

The combination of technology advances and additional policies can drive greater emission reductions than the sum of each approach on its own.



*MCS scenarios that achieve 80 percent reductions in economy-wide net GHG emissions show energy CO<sub>2</sub> reductions of 74 to 86 percent.*

# U.S. Energy Emissions

