



# Climate and Energy: A View to 2040

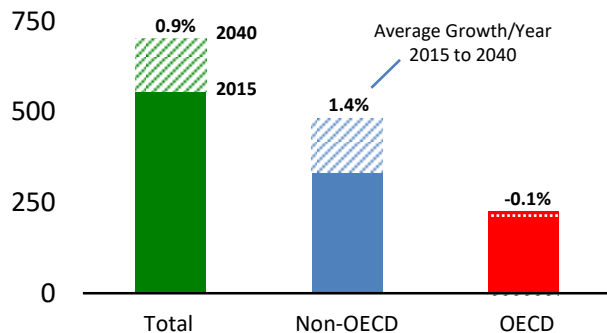
Peter W. Trelenberg

Manager, Environmental Policy and Planning

June 8, 2017

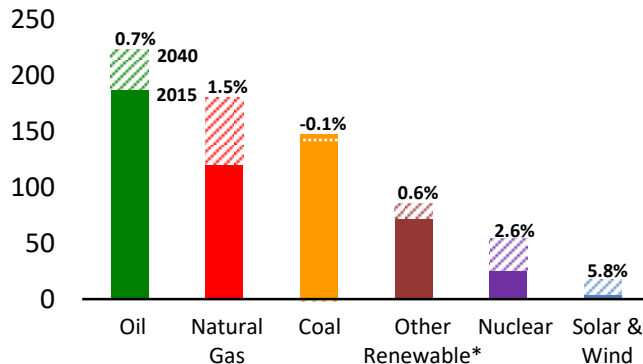
# ExxonMobil Annual Outlook for Energy

Global Energy Demand  
Quadrillion BTUs



Source: ExxonMobil 2017 Outlook for Energy: A View to 2040.

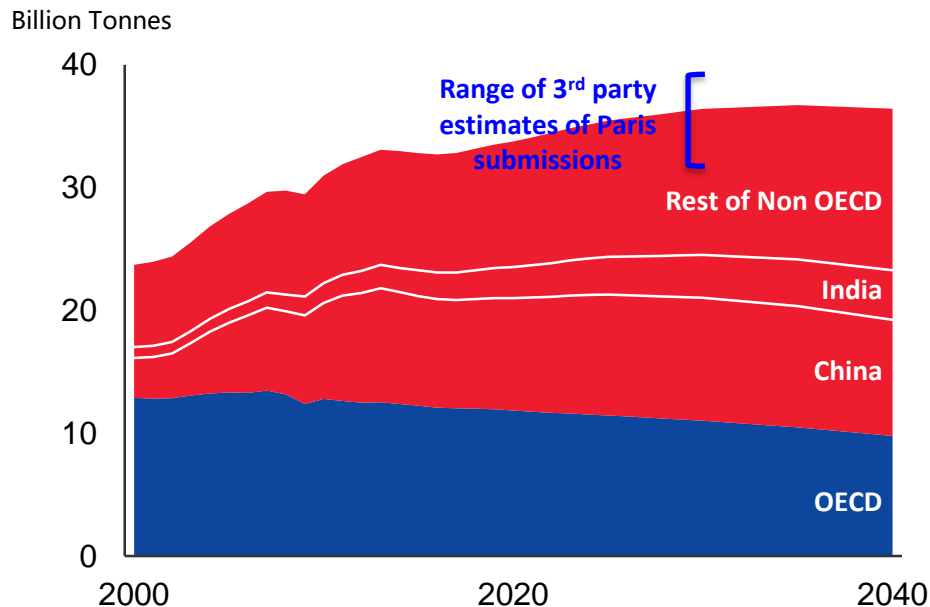
\* Includes hydro, geothermal, bio-energies.



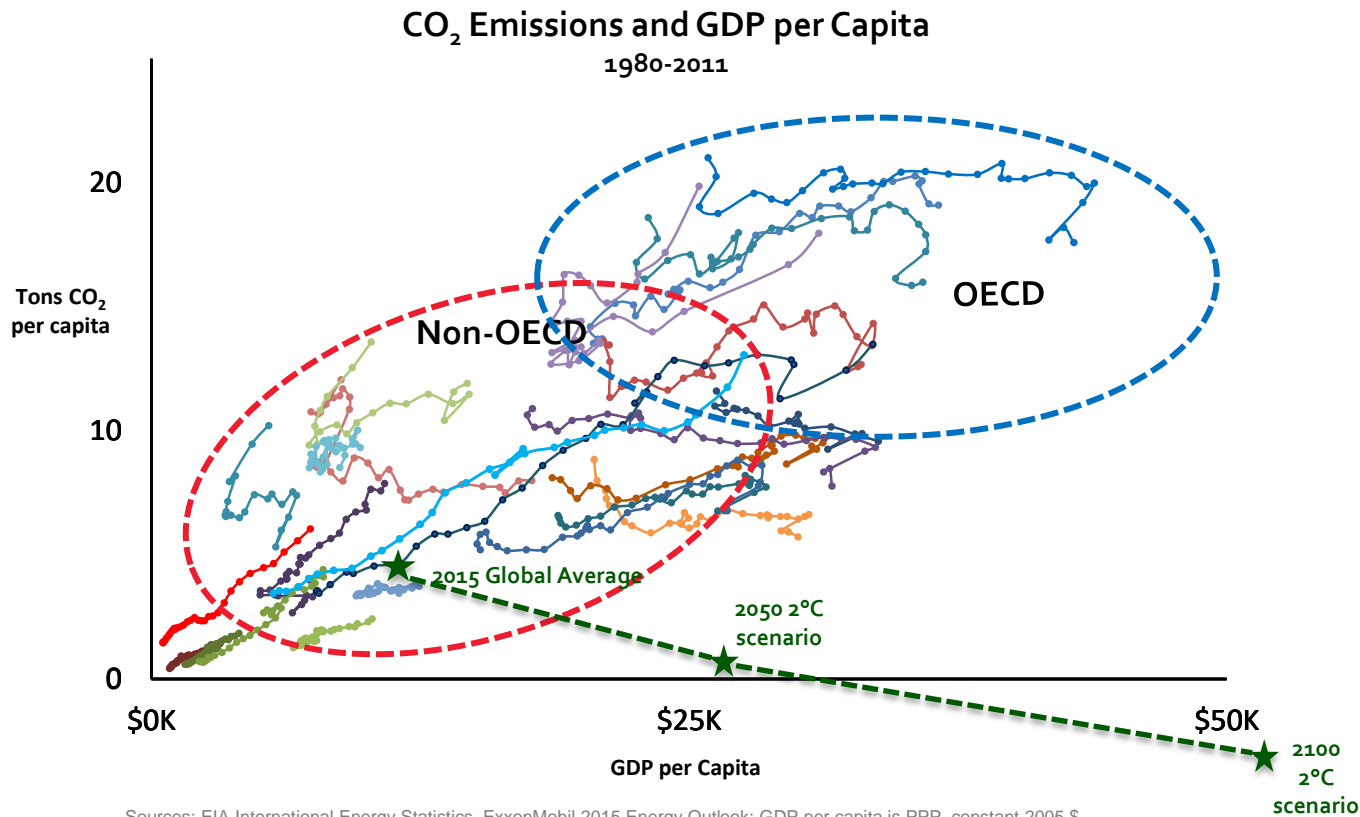
- Developing nations will lead gains in GDP, energy use, driven by growing middle class
- Energy demand grows by 25%, well below GDP due to efficiency gains
- Oil and natural gas expected to meet about 55% of energy demand in 2040
- Lower GHG sources of energy expected to grow fastest

# Energy-related CO<sub>2</sub> Emissions Peak in 2030s

Energy-Related CO<sub>2</sub> Emissions by Region

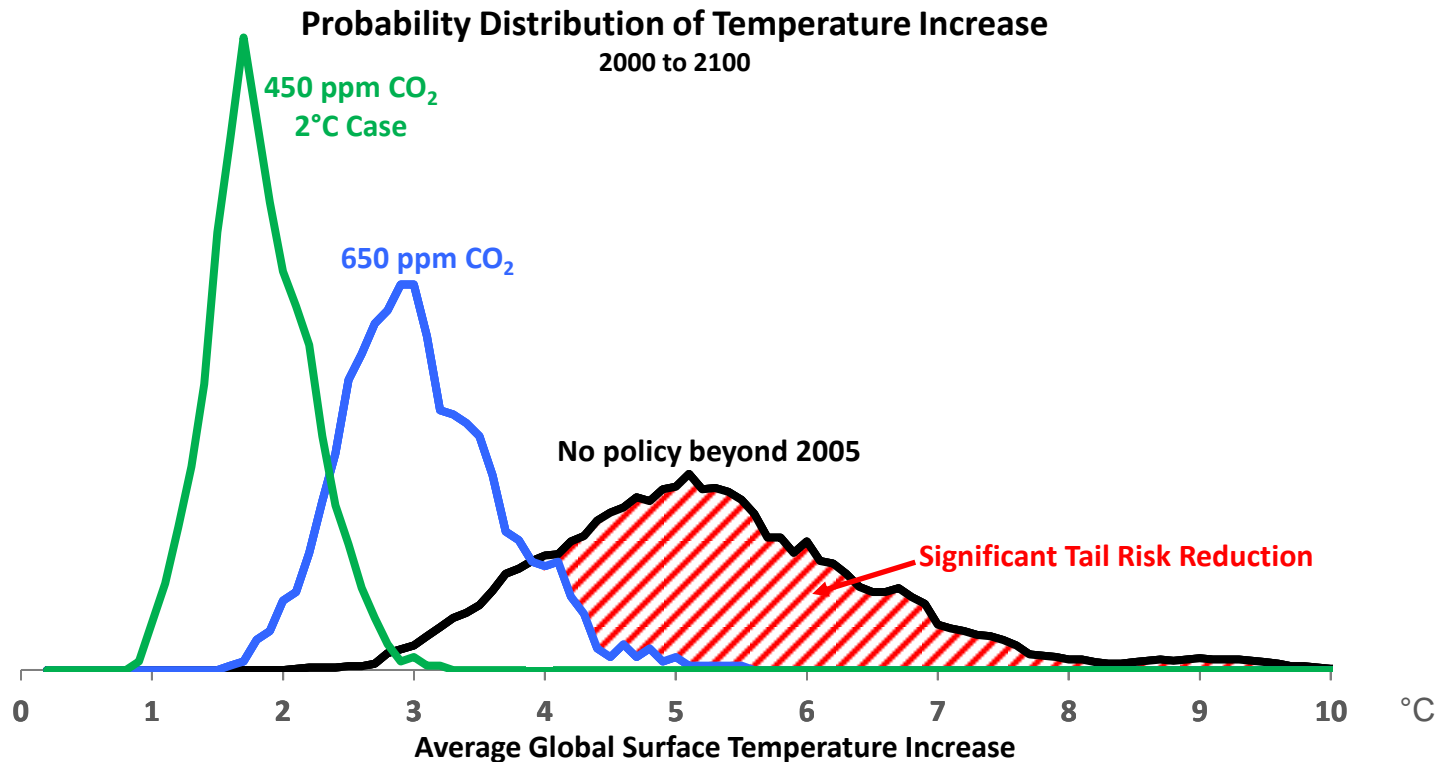


# The 2°C Challenge

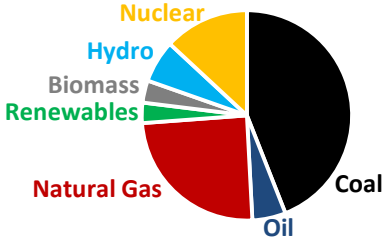





Sources: EIA International Energy Statistics, ExxonMobil 2015 Energy Outlook; GDP per capita is PPP, constant 2005 \$

# Moderate Mitigation Reduces Tail Risk

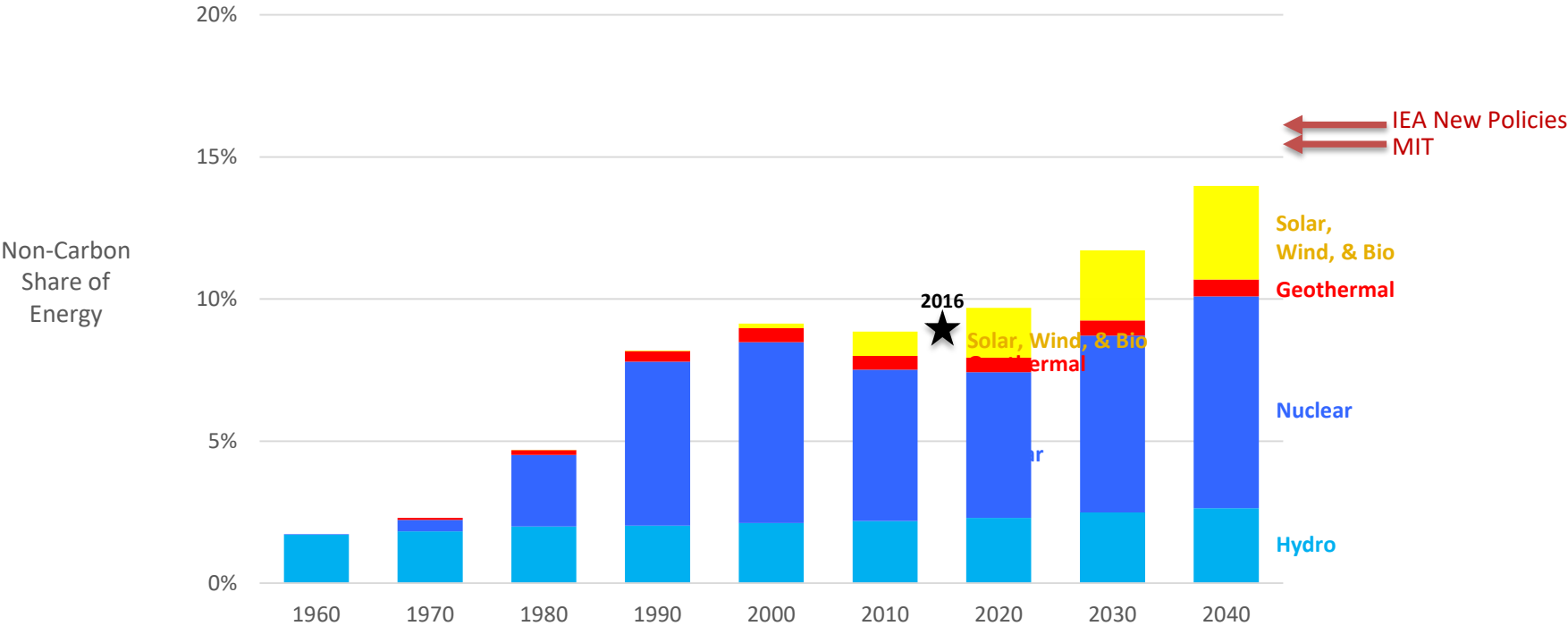


# Options to Lower CO<sub>2</sub> Emissions

2015 Energy Mix		CO <sub>2</sub> Reduction Options
Power		<ul style="list-style-type: none"> <li>• Efficiency</li> <li>• Fuel switching to natural gas</li> <li>• Nuclear</li> <li>• Hydro, biomass, solar, wind, geothermal</li> <li>• Carbon Capture and Storage</li> </ul>
Industry		<ul style="list-style-type: none"> <li>• Efficiency</li> <li>• Fuel switching to natural gas</li> <li>• Electrification</li> <li>• Carbon Capture and Storage</li> <li>• Biofuels</li> </ul>
Transport		<ul style="list-style-type: none"> <li>• Efficiency</li> <li>• Fuel switching to natural gas</li> <li>• Electrification</li> <li>• Biofuels</li> </ul>
ResCom		<ul style="list-style-type: none"> <li>• Efficiency</li> <li>• Fuel switching to natural gas</li> <li>• Electrification</li> <li>• Biofuels</li> </ul>

# Non-Carbon Share of Energy Flat Since Early 1990s

## Modest Growth Anticipated Through 2040

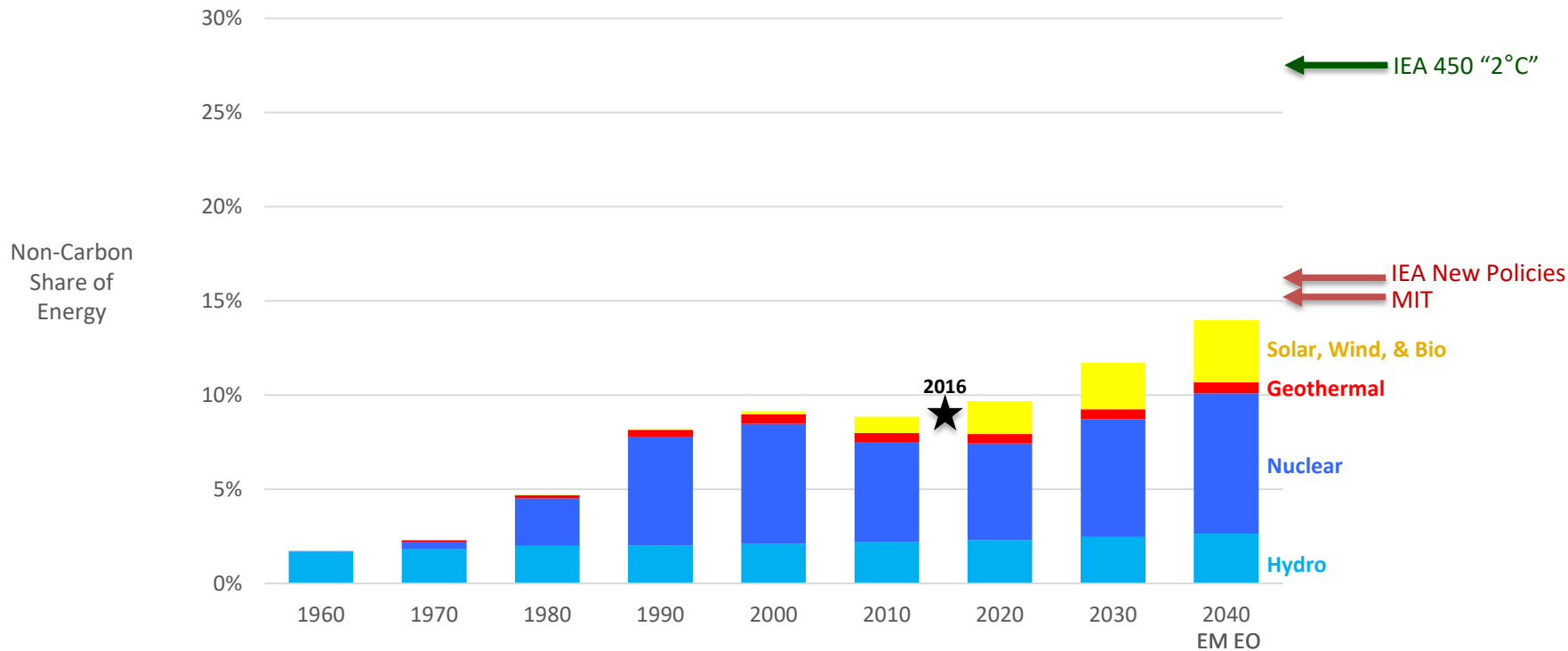


Excludes primitive biomass  
Sources: 2017 ExxonMobil Energy Outlook; IEA World Energy Outlook 2015; MIT 2014 Energy & Climate Outlook



# Non-Carbon Share of Energy Flat Since Early 1990s

## Modest Growth Anticipated Through 2040

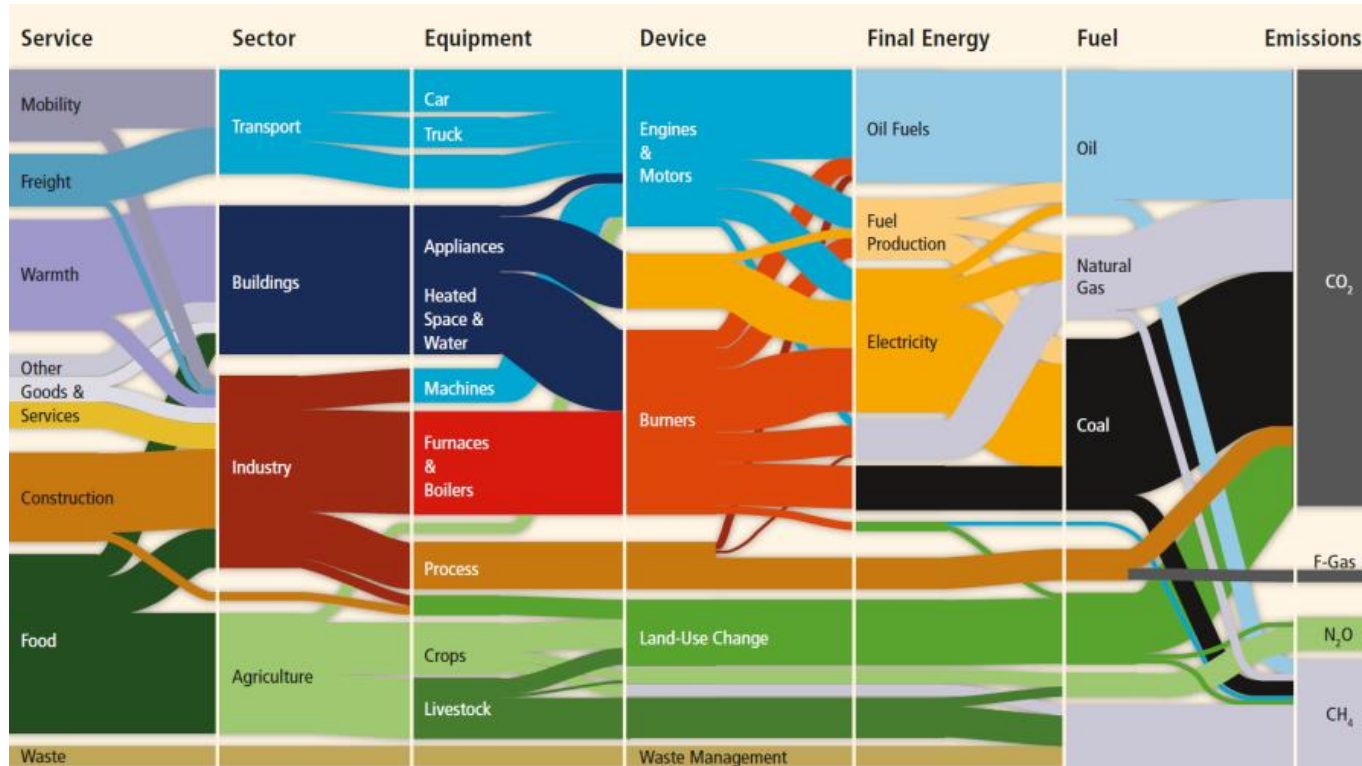


Excludes primitive biomass

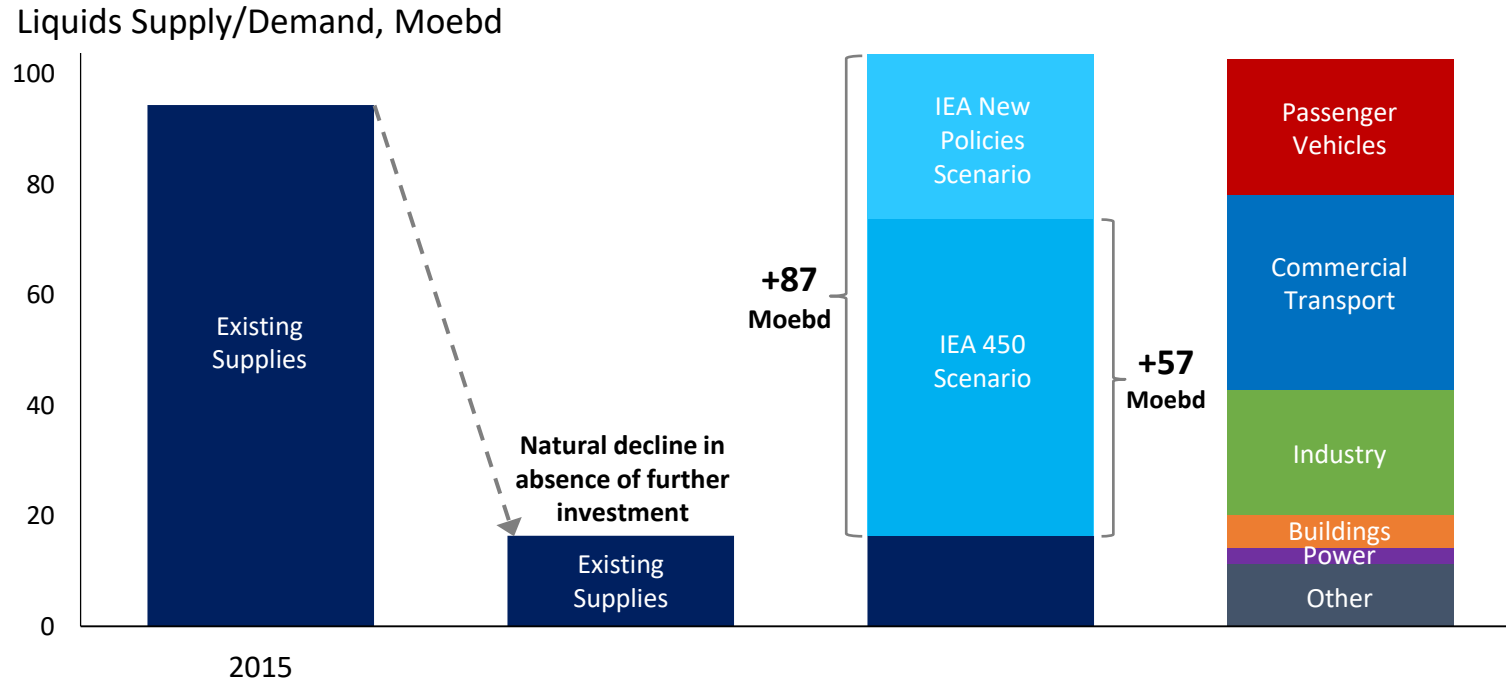
Sources: 2017 ExxonMobil Energy Outlook; IEA World Energy Outlook 2015; MIT 2014 Energy & Climate Outlook



# Complexity and Scale Limit Rate of Transformation

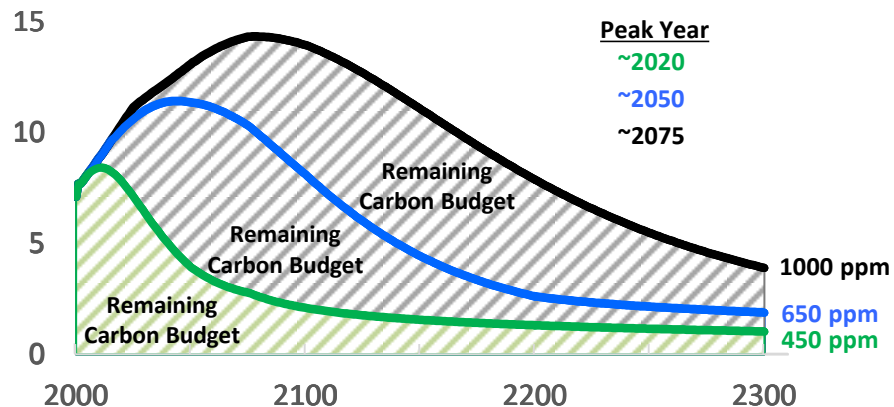


# All Scenarios Require Reinvestment

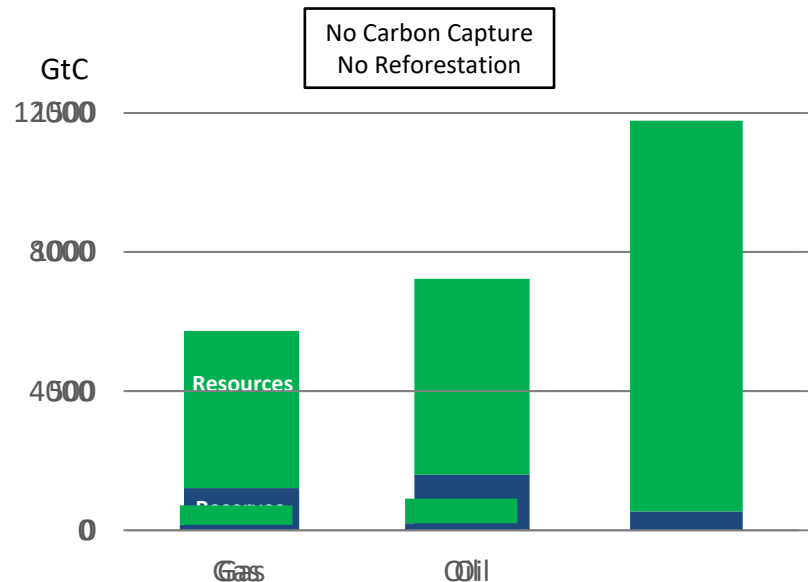


# Optimizing Carbon Budget – Advantages of Natural Gas vs Coal

Emissions, GtC/yr

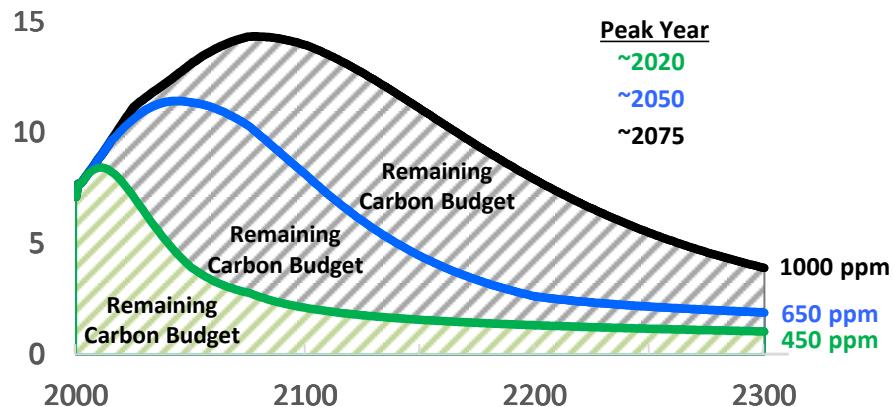


Contained Carbon

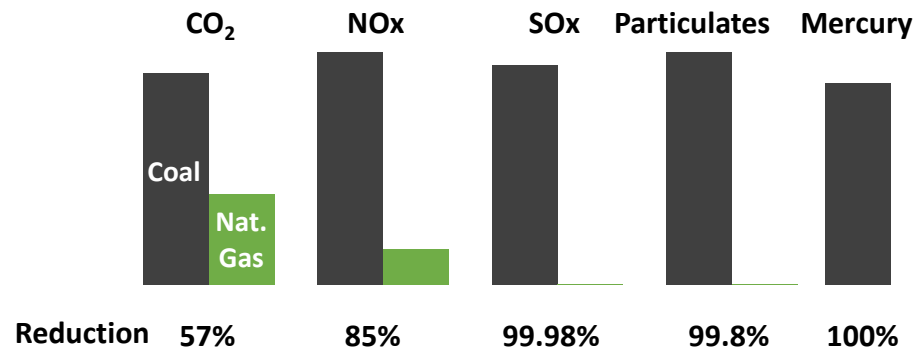


# Optimizing Carbon Budget – Advantages of Natural Gas vs Coal

Emissions, GtC/yr



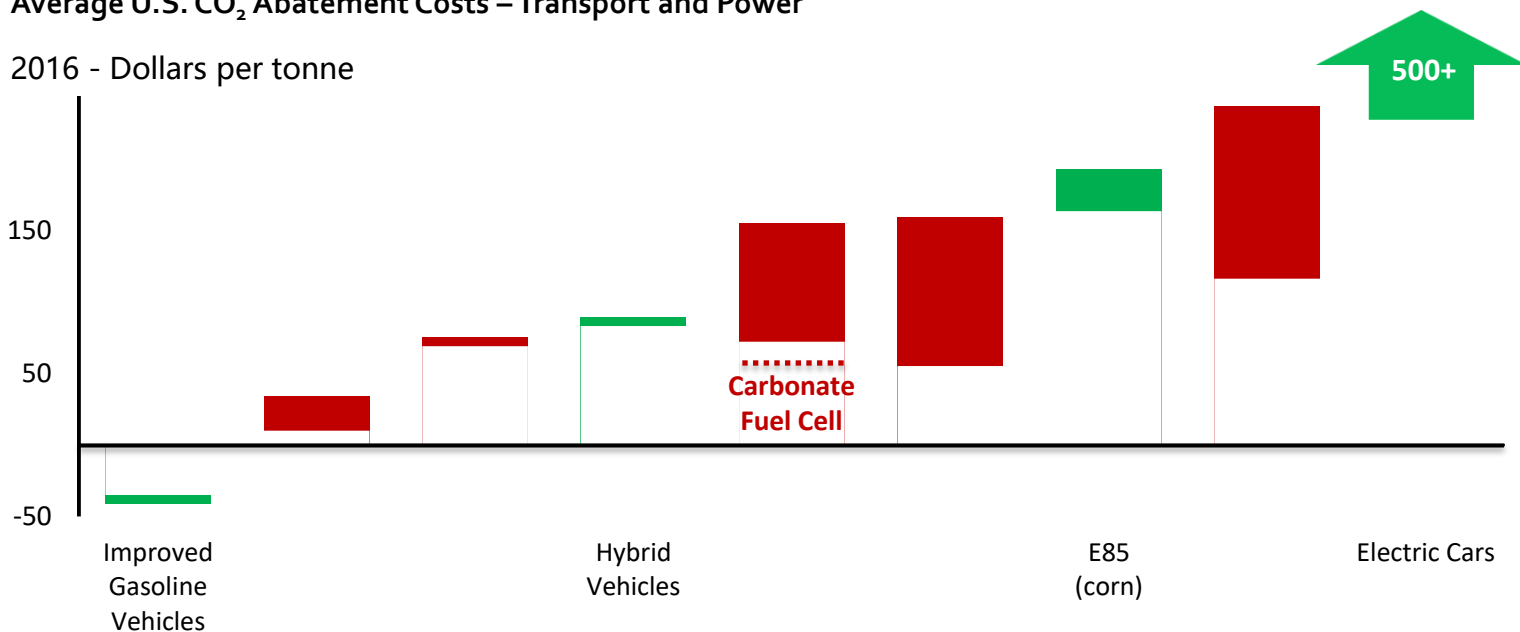
## Emissions Comparison



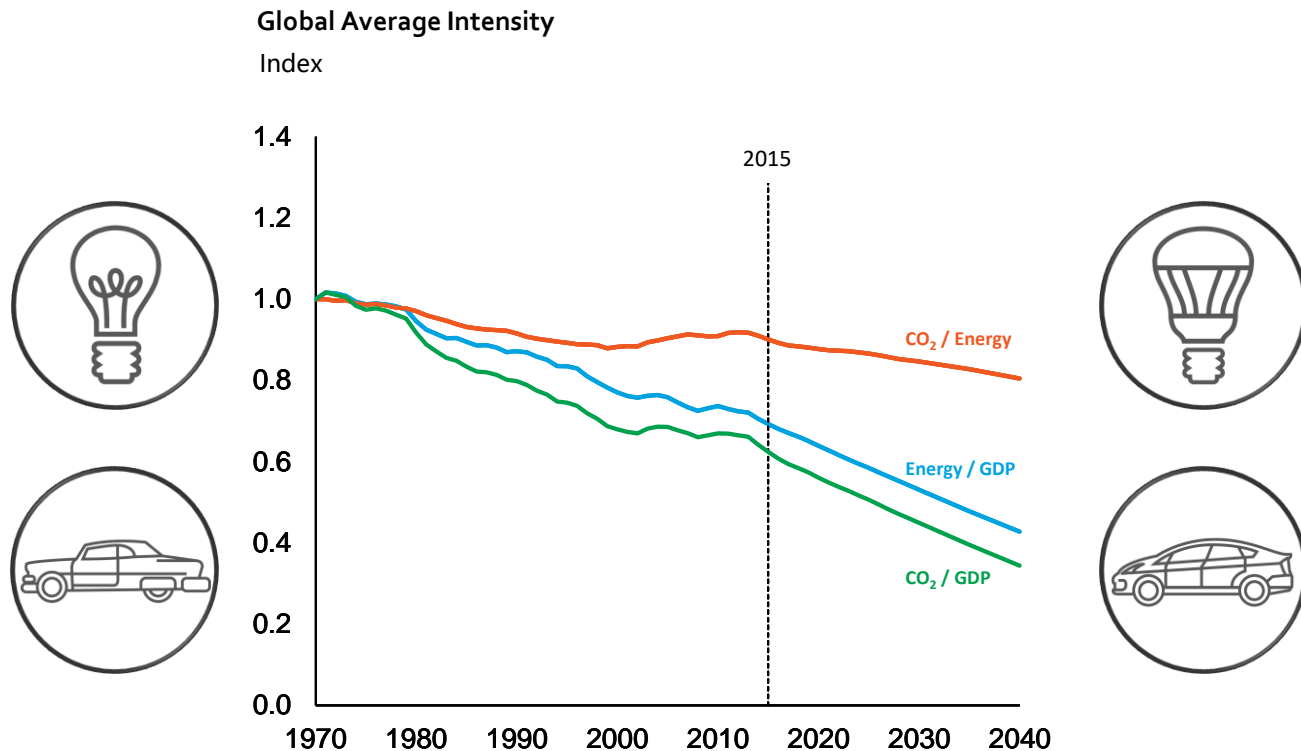
# Relative Cost of CO<sub>2</sub> Emission Reduction Options

Average U.S. CO<sub>2</sub> Abatement Costs – Transport and Power

2016 - Dollars per tonne



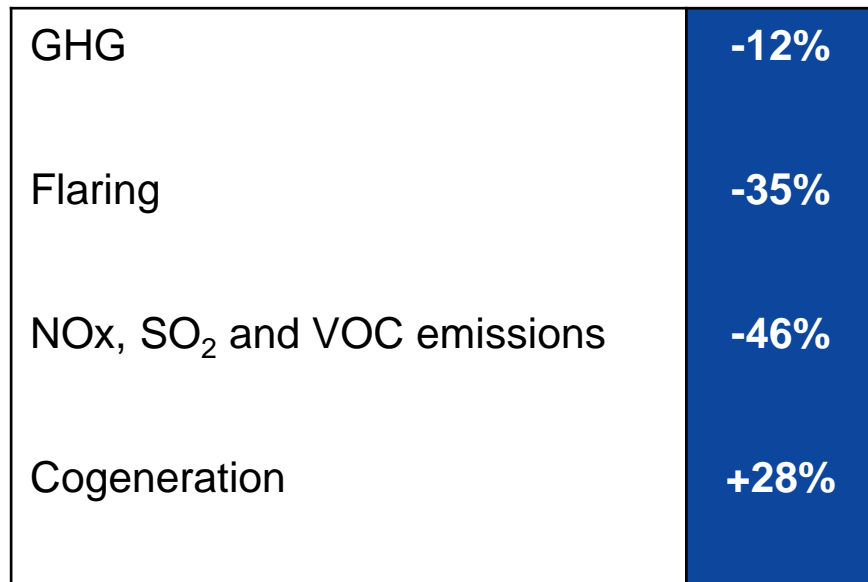
# Technology Helps Us Do More With Less



# Minimizing the Impact of our Operations

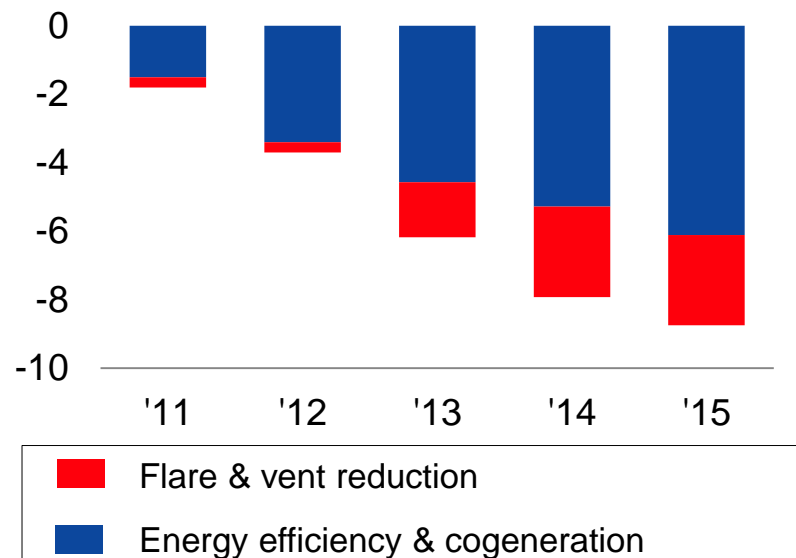
## Key Environmental Metrics

% Change 2015 vs 2006



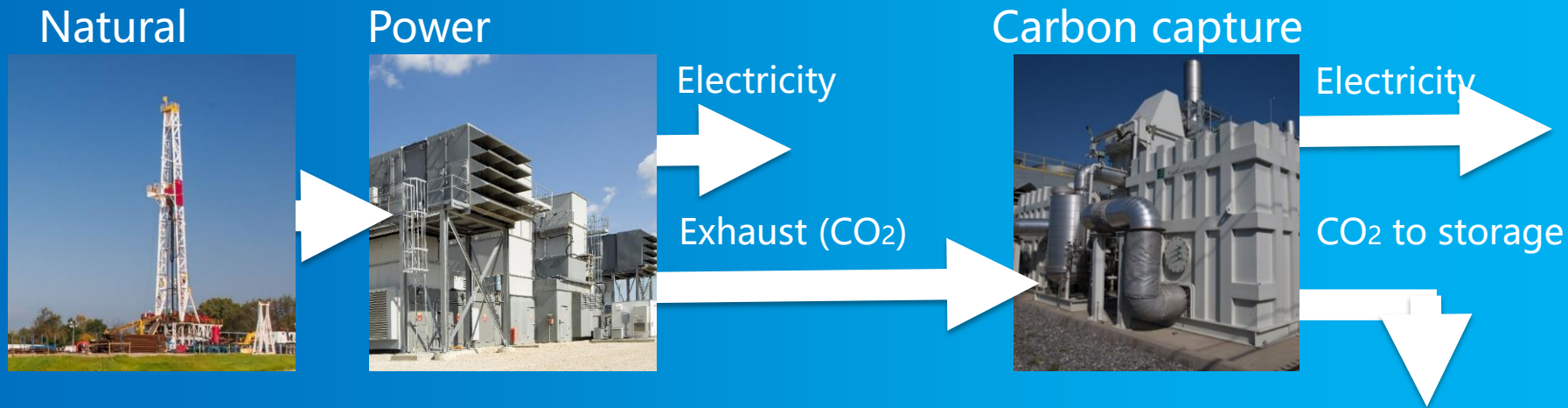
## GHG Emissions Avoided from XOM Actions

Net Equity CO<sub>2</sub> – equivalent emissions  
Millions of metric tons, cumulative



# Power Generation without Emissions

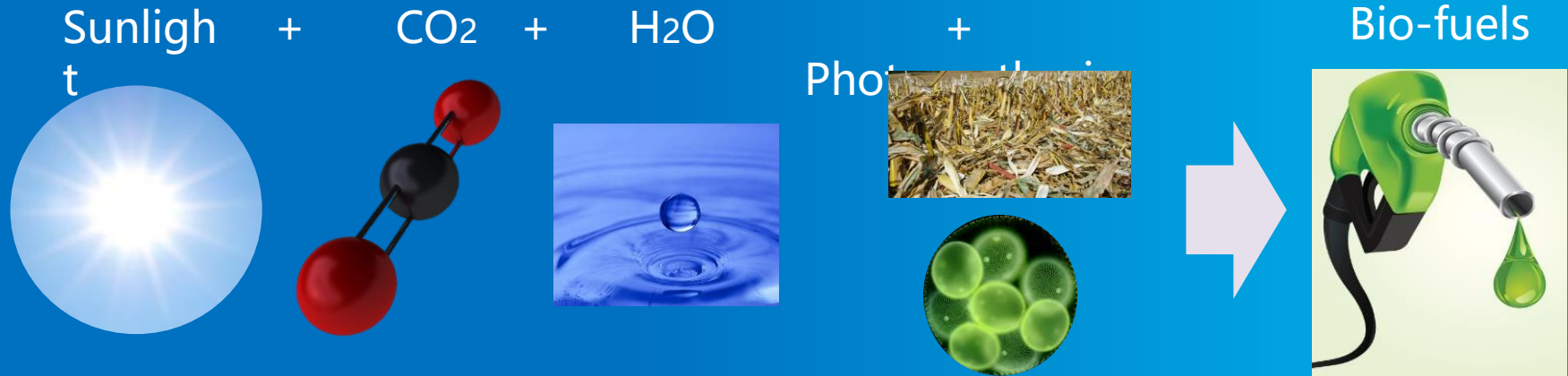
- Today's approach: Power consuming, complex
- Our research: Natural gas power generation without CO<sub>2</sub> emissions





# Low Emissions Transportation Fuel

- Today's approach: Small scale, competes with food and water
- Our research: Large scale, global solutions, non-competitive with food and water



**ExxonMobil**

# CO<sub>2</sub> Capture Using Carbonate Fuel Cells

