

# Energy Security and Greenhouse Gas Mitigation: Synergies and Conflicts

Presentation for  
**International Institute for Resource Industries and Sustainability Studies**  
**Haskayne School of Business**  
**The University of Calgary**

Howard Gruenspecht  
Deputy Administrator, EIA  
([howard.gruenspecht@eia.doe.gov](mailto:howard.gruenspecht@eia.doe.gov))  
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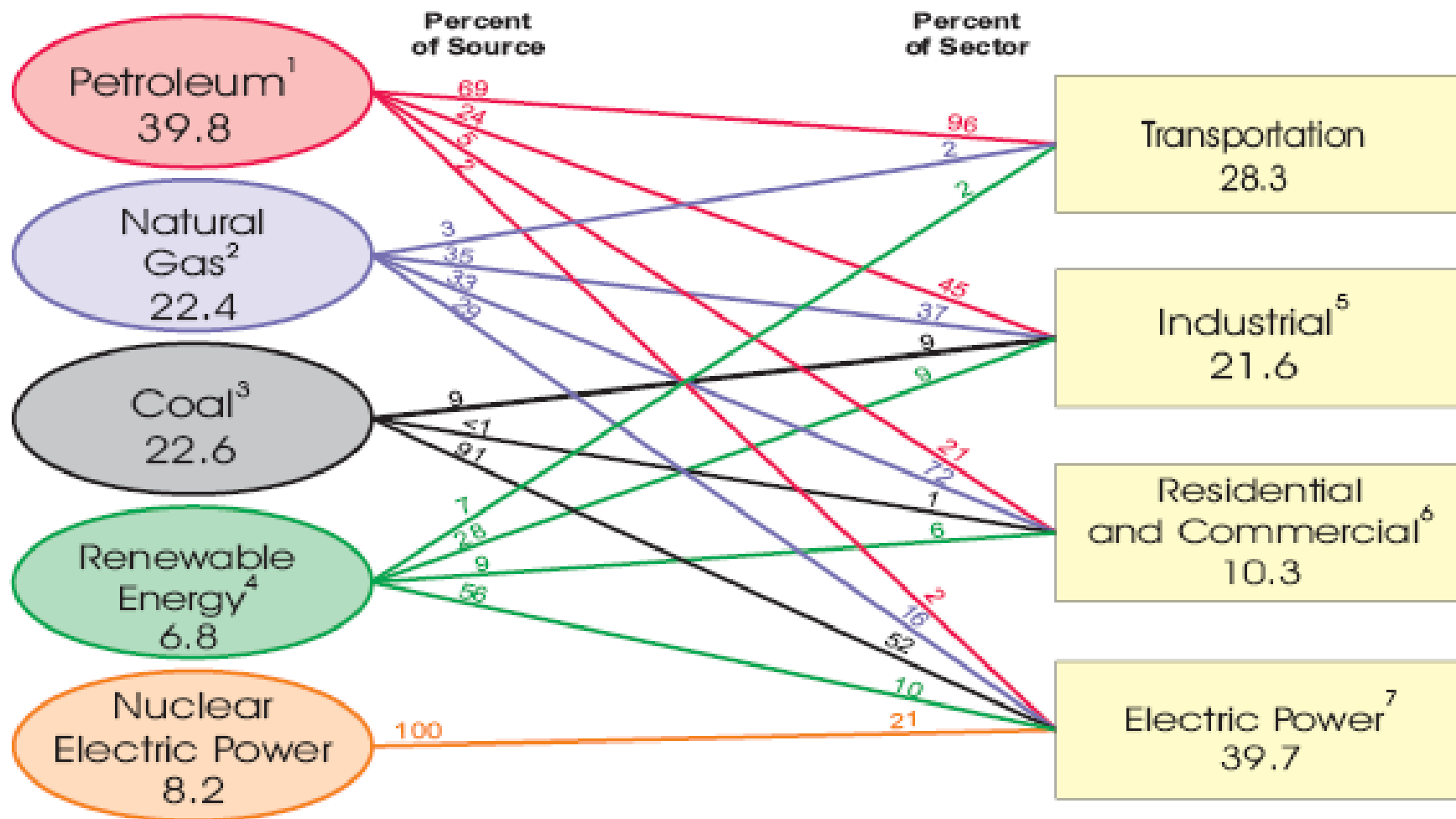


**Energy Information Administration**  
*Official Energy Statistics from the U.S. Government*

# Outline

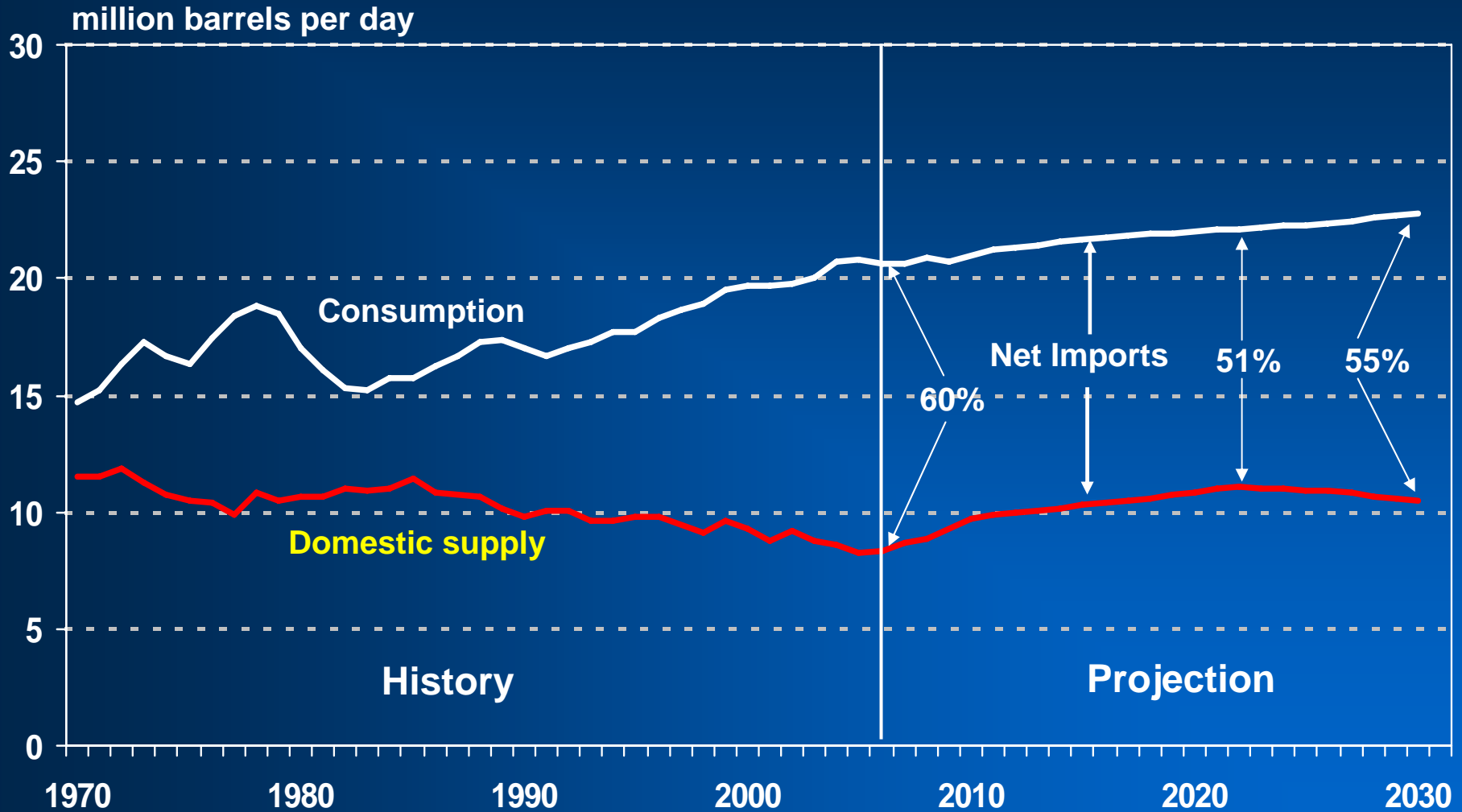
- **Background Data and Projections**
  - U.S. Sources and Uses of Energy, 2006
  - Trends in U.S. Liquids Import Dependence
  - Trends in U.S. Greenhouse Gas Emissions
- **Perspectives on:**
  - Increased renewable fuels use in transportation
  - Impacts of greenhouse gas limitations
- **Canada and the United States: similarities and differences**

# U.S. Primary Energy Use by Fuel and Sector, 2006 (quadrillion Btu)

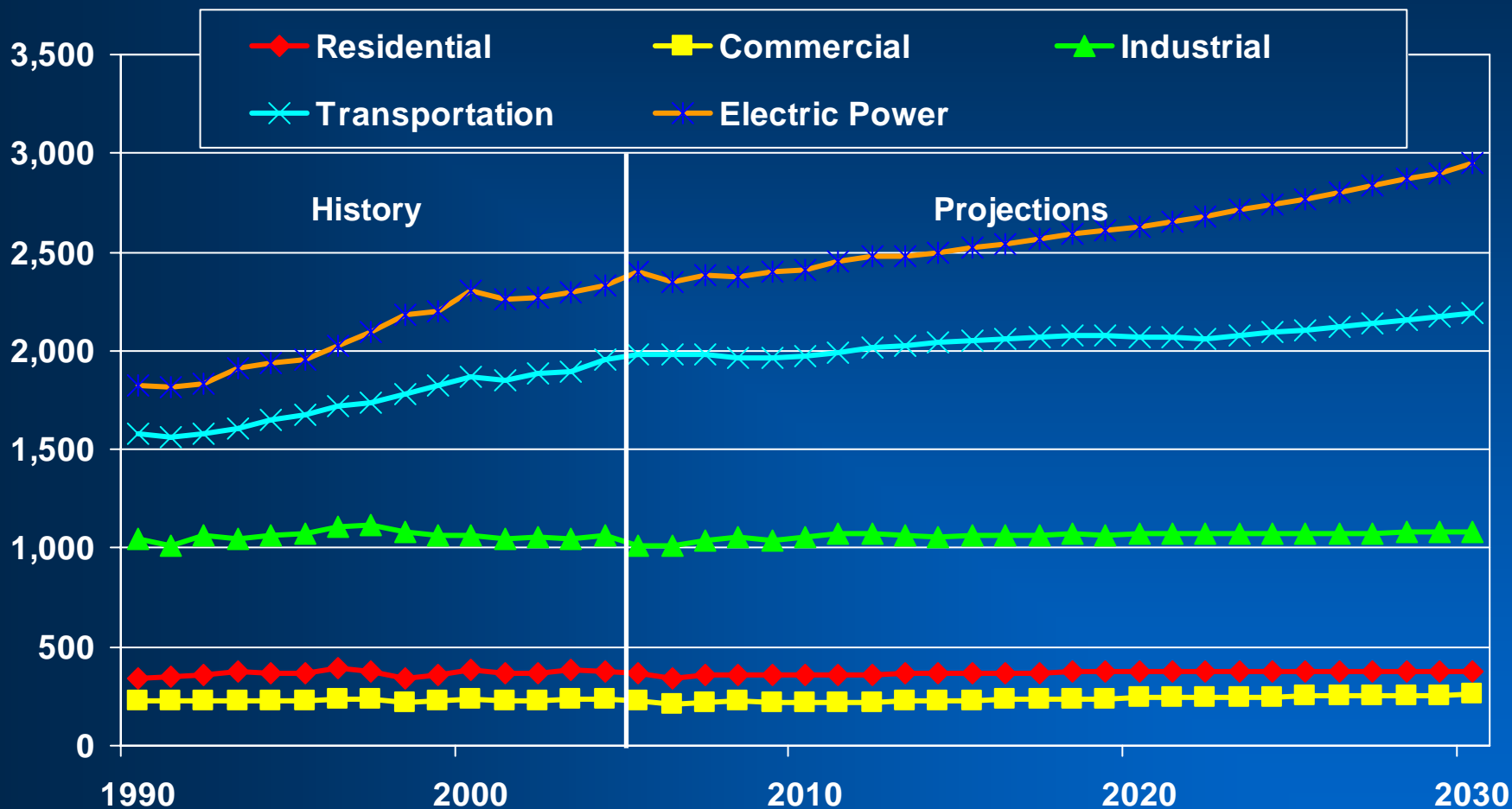


- Oil is used mainly in transportation, where it is (by far) the dominant fuel

# Liquid Fuels Consumption and Domestic Supply AEO2008 Reference Case (w/ EISA2007)



# Energy-related CO<sub>2</sub> emissions by sector AEO2008 Reference Case (million metric tons)



Recent and projected growth in U.S. GHG emissions is concentrated in the transportation and electric power sectors.

# Energy Security and GHG Emission Reduction: Some synergies (S), Some conflicts (C)

- (S) Improved vehicle efficiency: lowers GHG emissions and oil demand/imports (=more energy security?)
- (S/C) Biomass: should it back out coal used in electricity generation or oil used in transport fuels?
- (C) Coal to liquids: reduces oil import dependence, but not helpful on GHGs
- (S/C) CO2 sequestration requirements: helpful on GHGs, hurts coal, but can reduce oil imports via enhanced production from aging fields.

# Renewable Fuels and Transportation

# Transportation and Oil

- **Transportation is the primary driver of oil demand**
  - **In the US, transportation already accounts for nearly 70% of oil use.**
  - **Historically, alternative fuels have not made significant inroads into transportation even in countries where tax policies have made oil-based motor fuels very expensive.**
- **Looking ahead, transportation is likely to account for an even larger share of oil use.**
  - **However, several alternatives to oil could potentially play a growing role in transportation, so that transportation growth does not imply corresponding growth in oil use.**



# Alternatives to Oil in Transportation

- **Biofuels – Ethanol, biodiesel, and biobutanol**
- **Vehicle efficiency**
  - **For constant VMT, each 50 percent increase in on-the-road fuel economy reduces fuel used by 33 percent.**
- **Coal to Liquids (CTL) and Gas-to-Liquids (GTL)**
- **Electricity (from a variety of fossil and non-fossil sources) powering plug-in hybrids for a significant share of overall vehicle miles of travel (VMT).**
- **Hydrogen (from a variety of fossil and non-fossil sources) powering combustion engines or fuel cells**

# 3 Distinct Market Segments for Ethanol

- **Clean, high-octane gasoline blending component market**
  - **Lowest price sensitivity: “must have” item. Example: demand for ethanol in the aftermath of the phaseout of MTBE in spring 2006**
- **Volume enhancement market**
  - **Price competition with conventional fuels on a volume (per gallon) basis**
  - **Key drivers include oil prices, biofuels tax benefits, and biofuels feedstock prices**
- **Energy value (btu content) market**
  - **Price competition with conventional fuels on an energy content (per Btu) basis**
  - **Sensitive to availability of fuel and vehicle infrastructure**

**BOTTOM LINE:** Absent a mandate, ethanol is NOT competitive with petroleum-based fuels in the 3rd (energy value) market segment at projected oil prices. However, EISA 2007 provides a mandate to push ethanol beyond the 10% blending market.

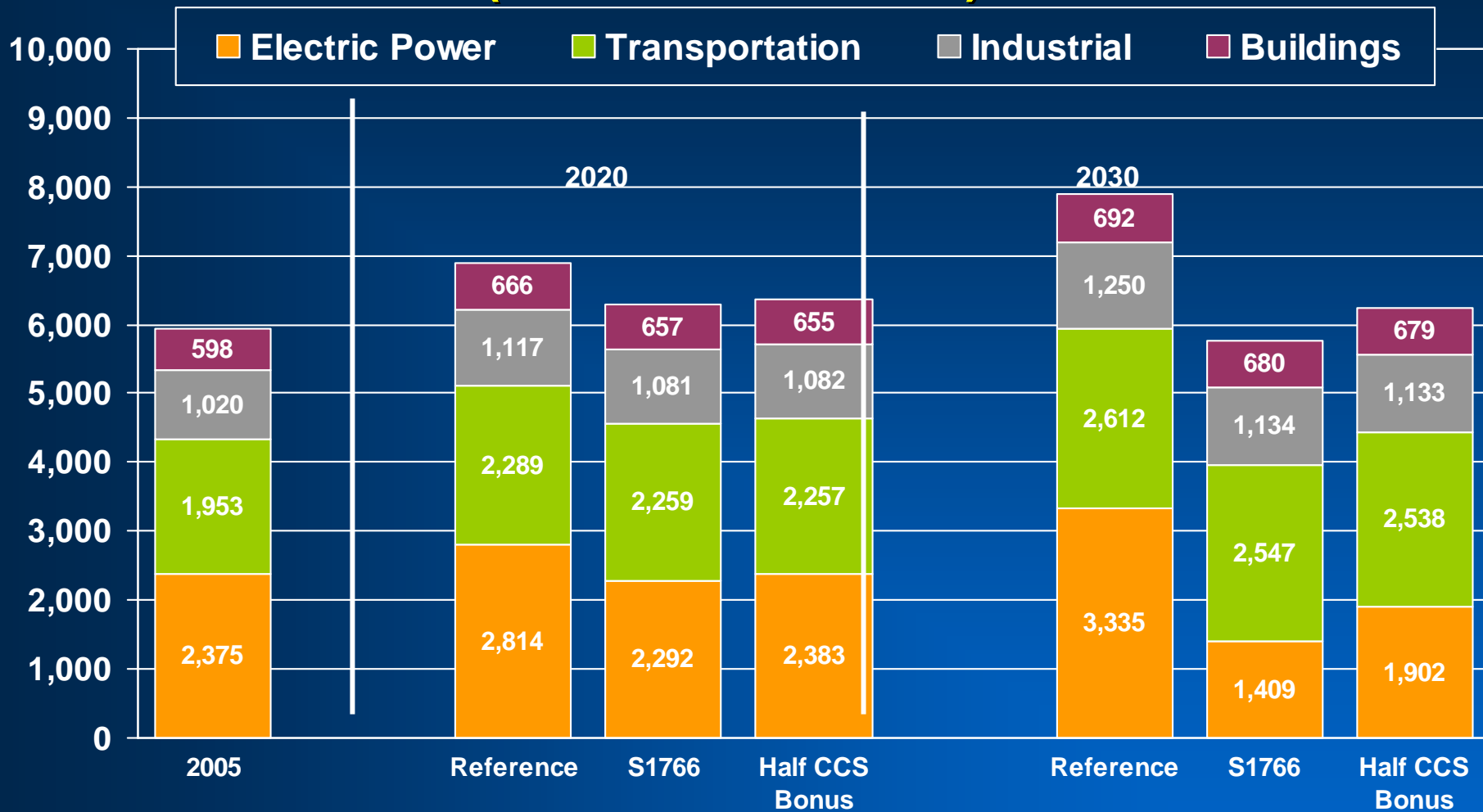
# Reducing Greenhouse Gas Emissions

# Impact of a CO<sub>2</sub> Value on Fossil Fuel Prices

| Fuel     | CO <sub>2</sub> content per million Btu | Delivered Price (2005, all sectors, per million Btu) | Impact of \$10 per ton CO <sub>2</sub> value |         | Impact of \$50 per ton CO <sub>2</sub> value |         |
|----------|---|--|--|---------|--|---------|
|          |   |  | \$   | percent | \$   | percent |
| Coal     | 0.094                                   | 1.57   | 0.94   | 59.9    | 4.70   | 299     |
| Oil      | 0.074                                   | 18.60  | 0.74   | 4.0     | 3.70   | 19.9    |
| Nat. Gas | 0.053                                   | 9.65   | 0.53   | 5.5     | 2.65   | 27.5    |

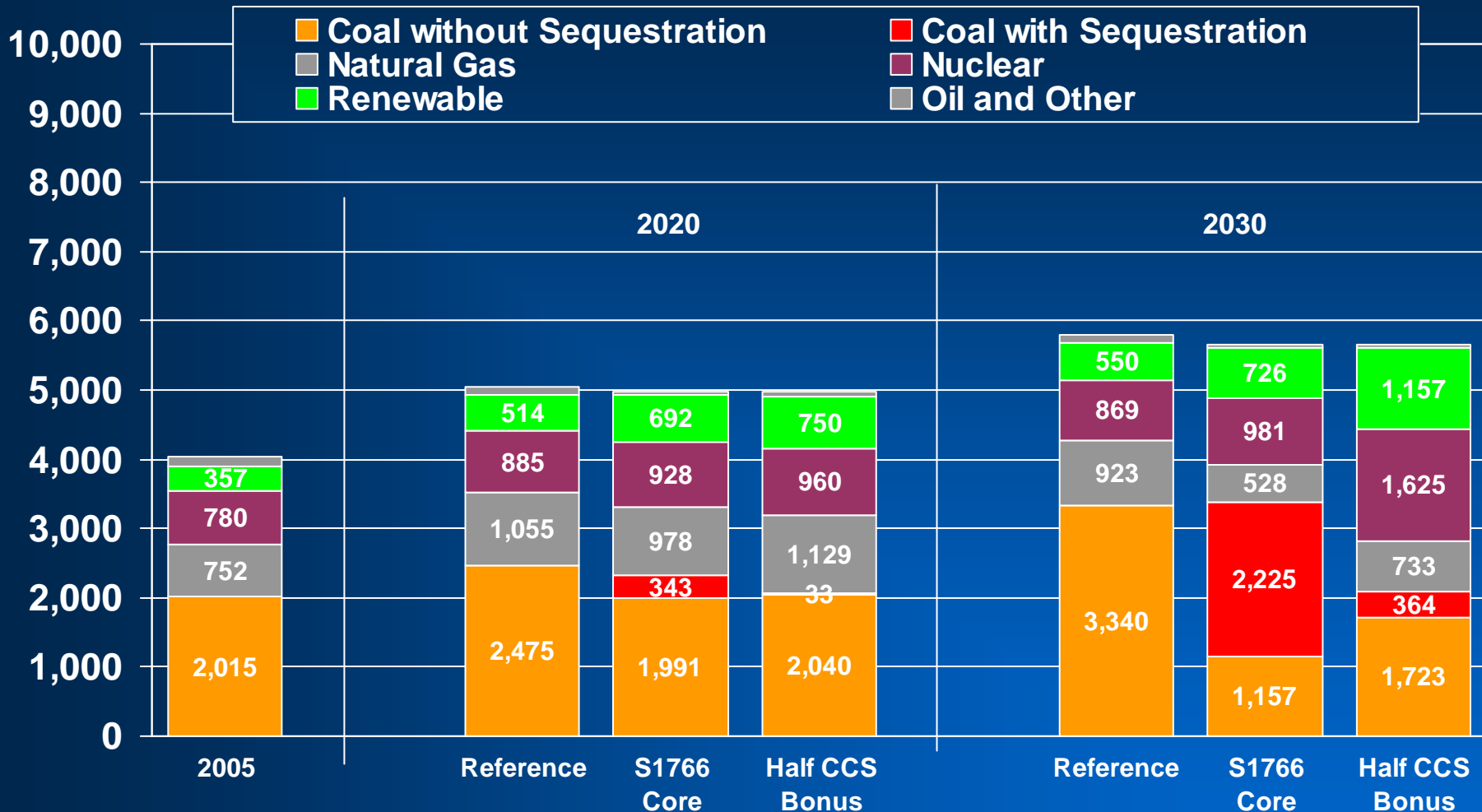
- As shown above, placing a value on GHGs through either a tax or a cap-and-trade program has a relatively large impact on the delivered price of coal.
- This reflects both the substantially lower price of coal relative to other fossil fuels under baseline conditions and its higher emission of CO<sub>2</sub> per unit of energy
- A \$25/ton value on CO<sub>2</sub> raises gasoline prices by about 23 cents per gallon.

# Energy-Related CO<sub>2</sub> Emissions – S.1766 analysis (million metric tons)

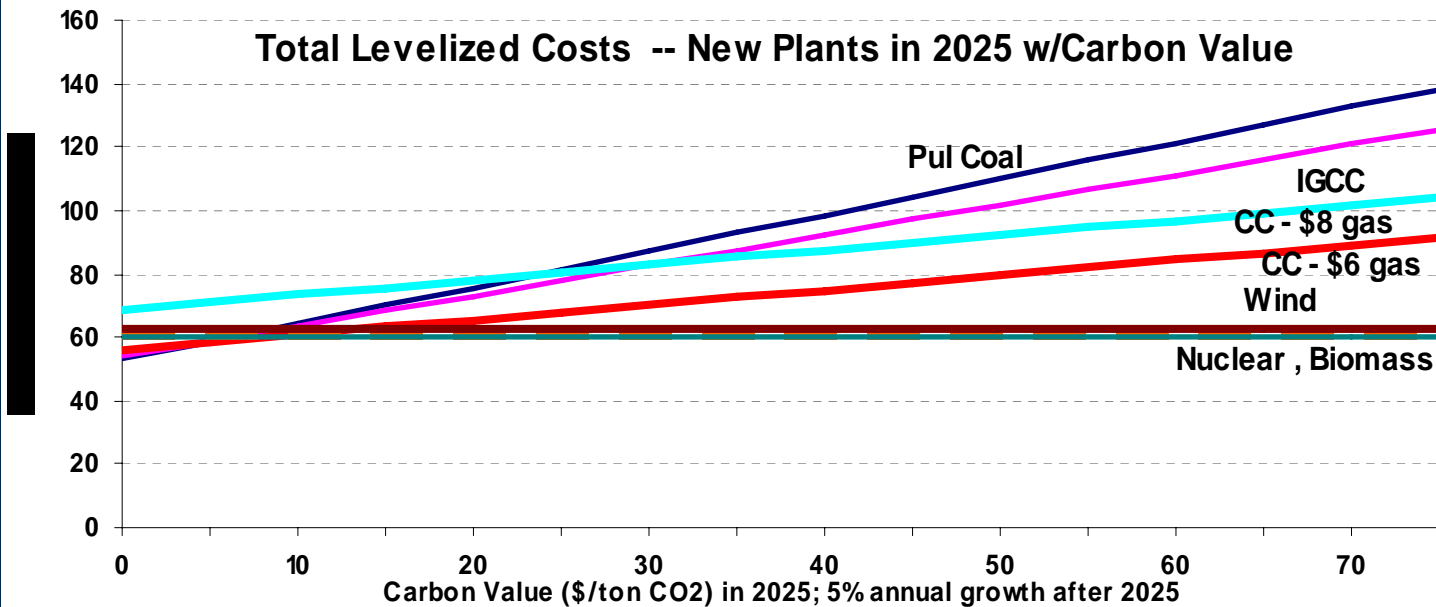
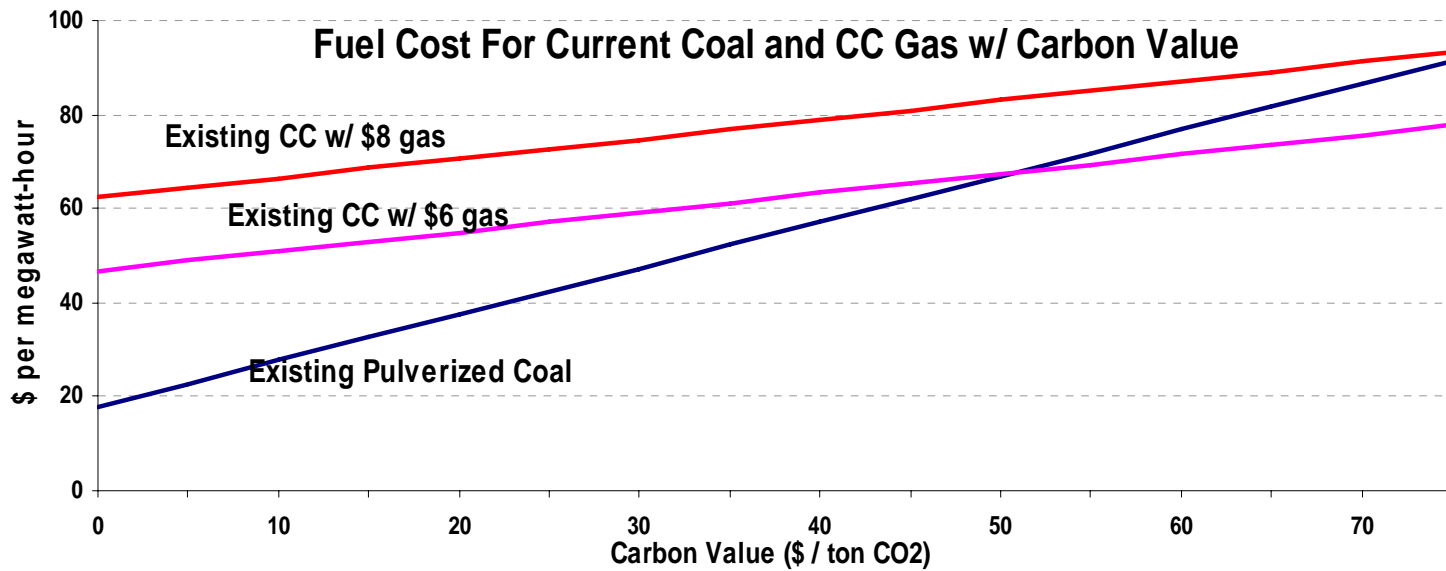


- The electric power sector dominates energy-related CO<sub>2</sub> emission reductions.
- Other sectors play a relatively small role unless other policies are included.

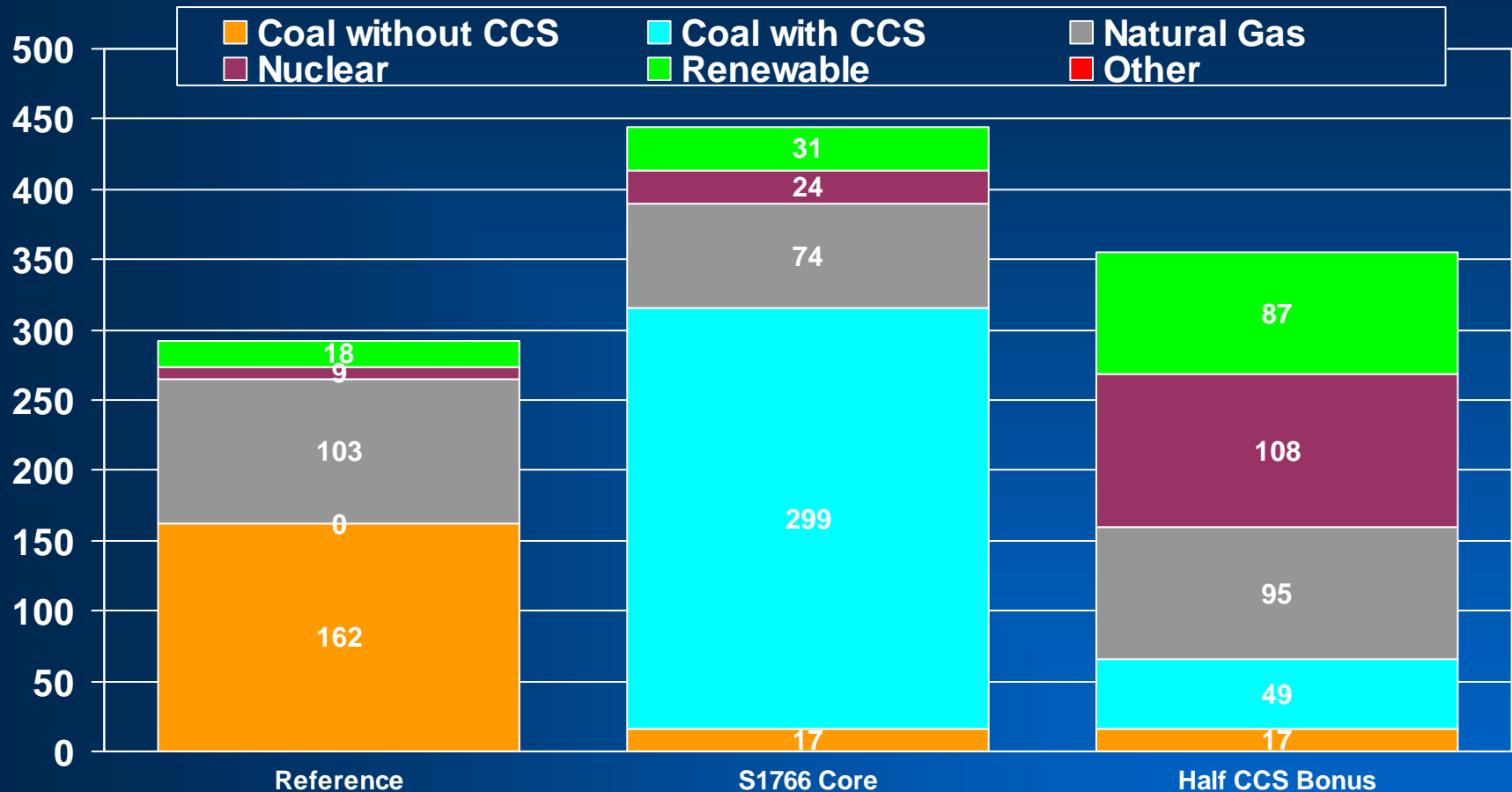
# Electricity Generation by Fuel (billion kilowatthours)



Coal generation in 2030 is near reference case levels when full CCS bonus is assumed. When half the bonus rate is assumed, coal generation in 2030 is close to the 2005 generation level.



# Electricity Cumulative Capacity Additions (gigawatts)



Coal with CCS is the key compliance option in the S. 1766 Core Case, while nuclear and renewables play larger roles when the CCS bonus is reduced by half. Natural gas technology's role falls unless the availability of coal with CCS, nuclear and renewables is limited.

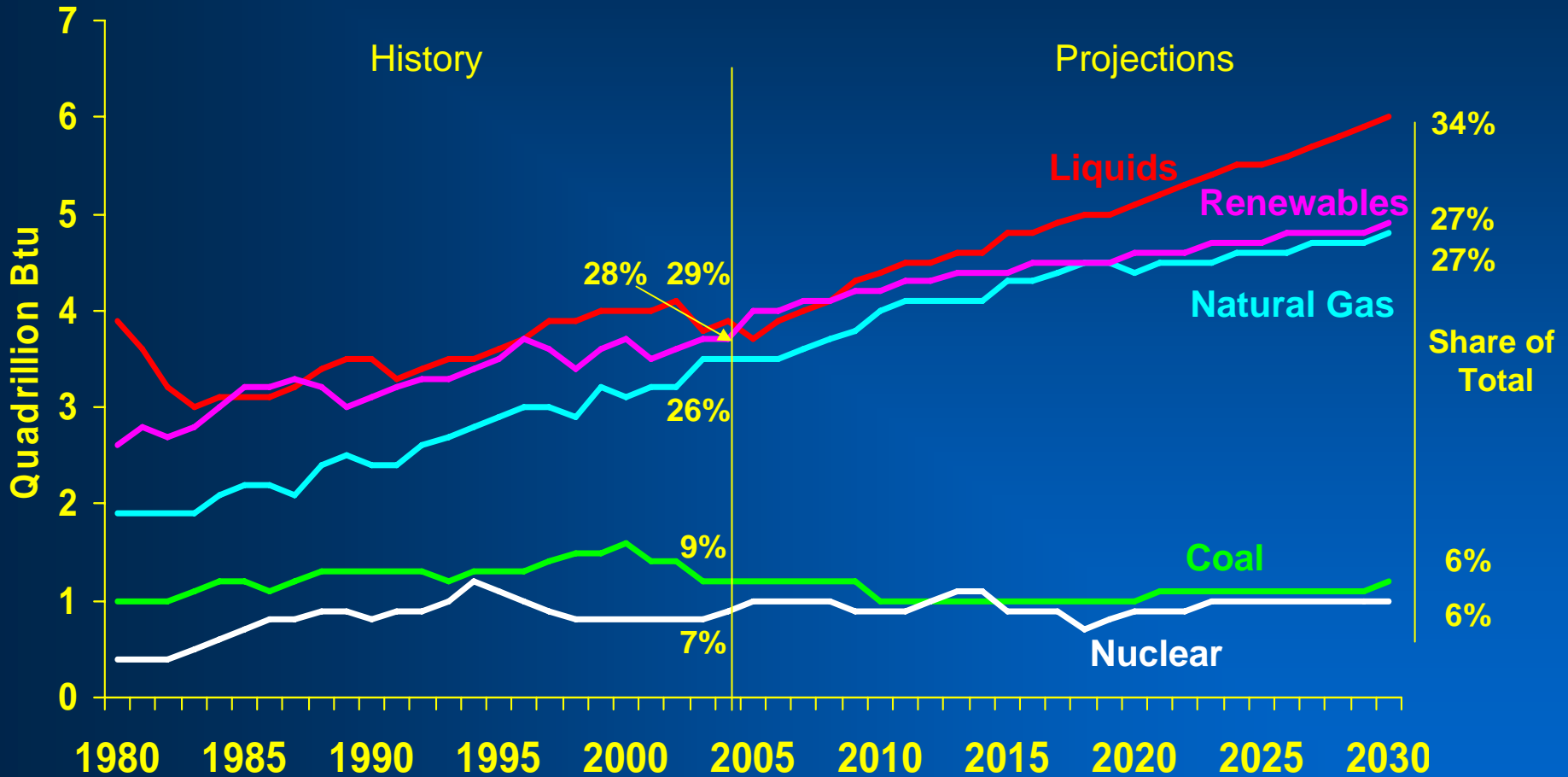


# Key Insights for the U.S.

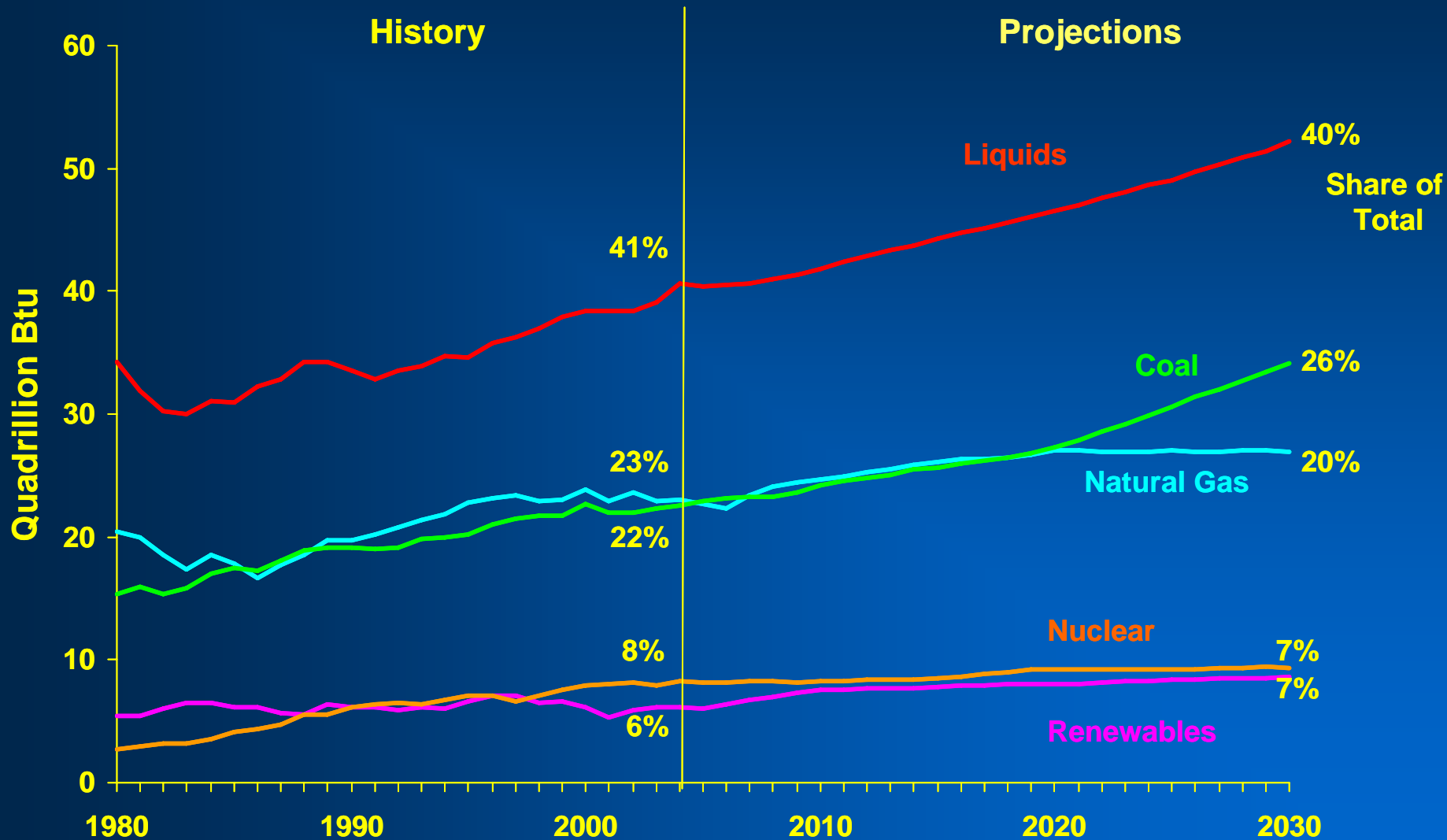
- The “sustainability” of a particular energy mix or technology is open to varying perspectives. Perspectives on sustainability often depend on where the boundaries of the problem are set.
- Biomass is a critical renewable energy resource for both the electric power sector and the transportation sector.
- The delivered price of coal, and its use, would be impacted far more than the price and use of other fuels by a cap-and-trade program to limit greenhouse gas emissions.
- Electricity generation, which in the U.S. relies heavily on coal, is the easiest place to reduce energy-related carbon dioxide (CO<sub>2</sub>) emissions within the U.S. energy system.
  - Significant increases in generation from coal with carbon capture and sequestration (CCS), nuclear and renewables, together with some reductions in electricity demand growth, back out substantial amounts of conventional coal-fired generation by 2030. Without the bonus allowances, nuclear and renewables are more economical than new coal with CCS.
- Discussions of sustainable electricity policies often focus on the mix of new generating capacity. However, policies that accelerate retirements of existing capacity can also increase the total amount of new capacity that is needed.

# Canada and the United States: Similarities and Differences

# Canadian Marketed Energy Use by Resource



# U.S. Marketed Energy Use by Resource

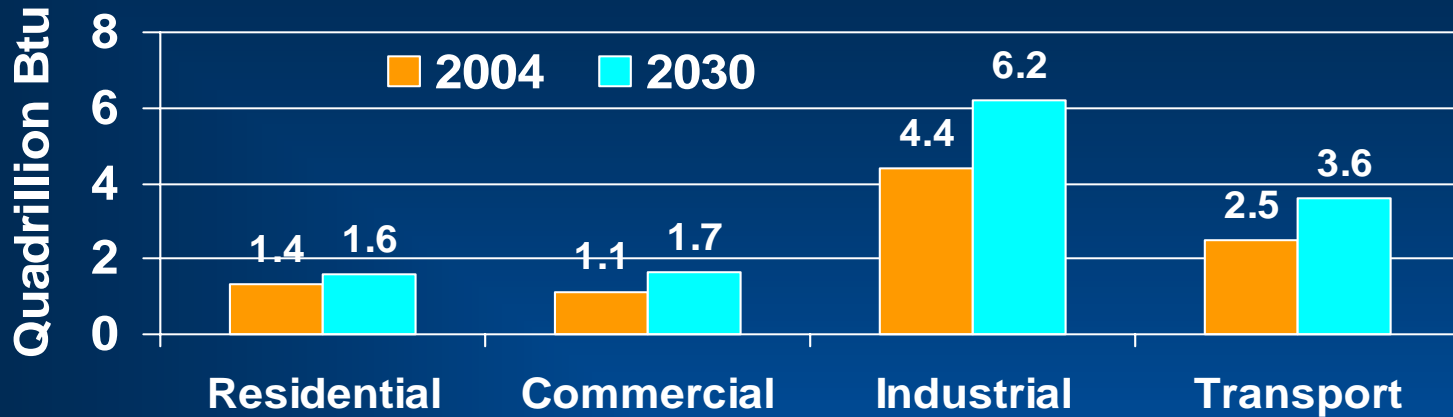


Source: EIA/NAEWG, October 2007

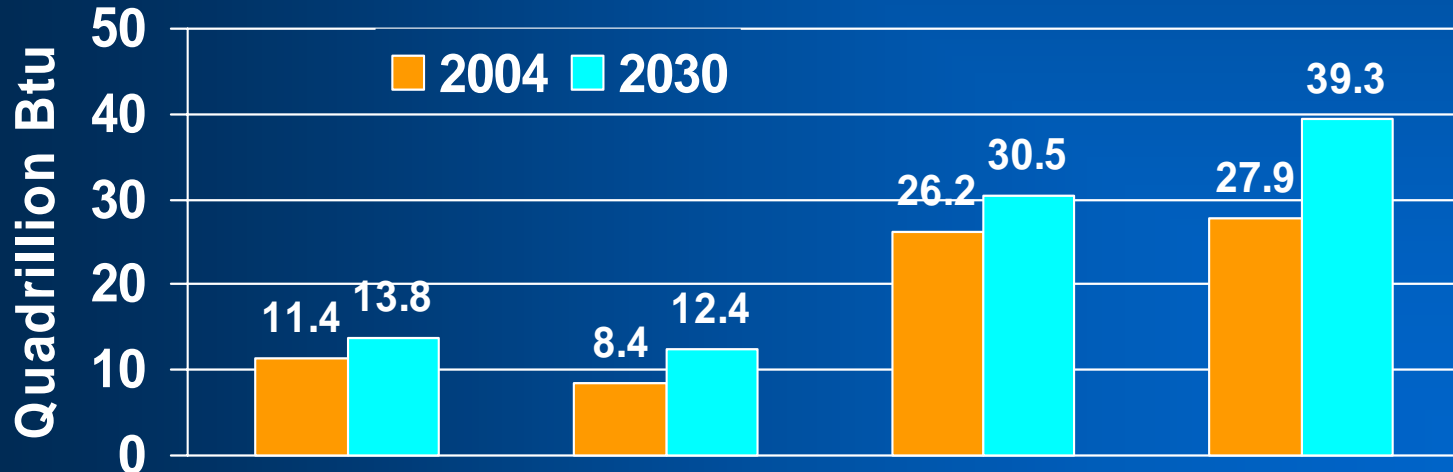
University of Calgary: IRIS talk



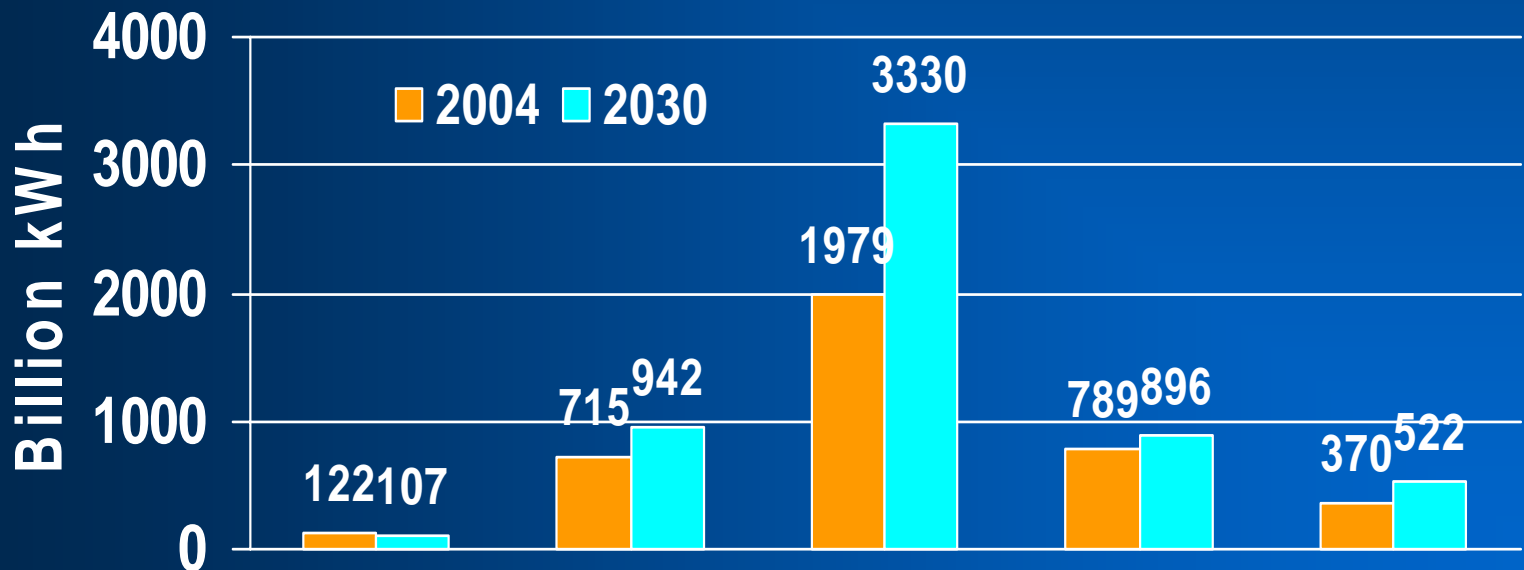
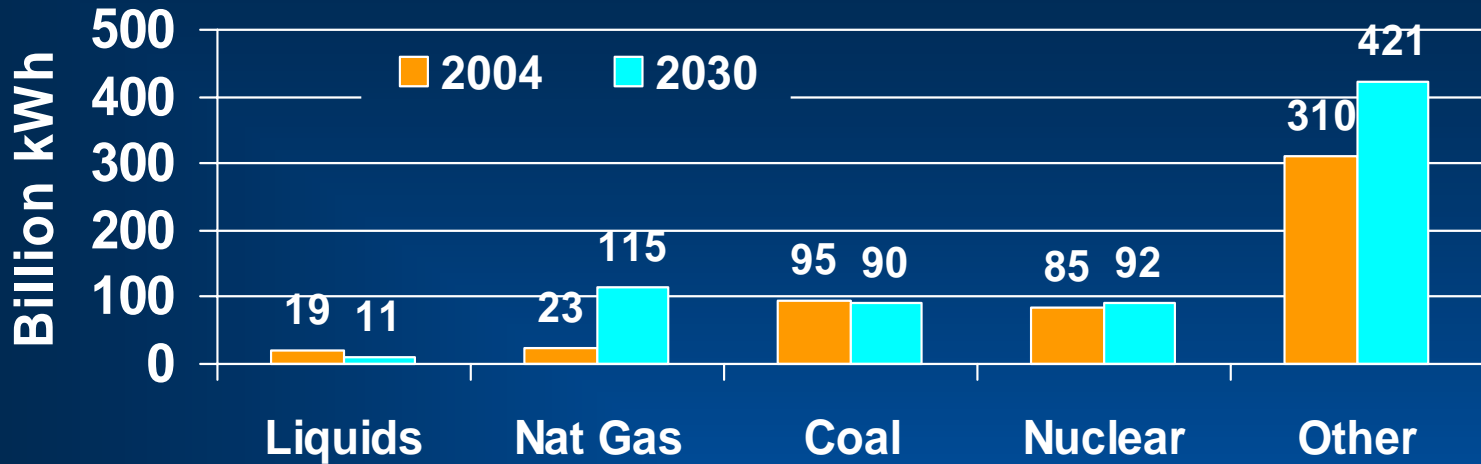
# Canada/U.S. End-Use Energy Consumption



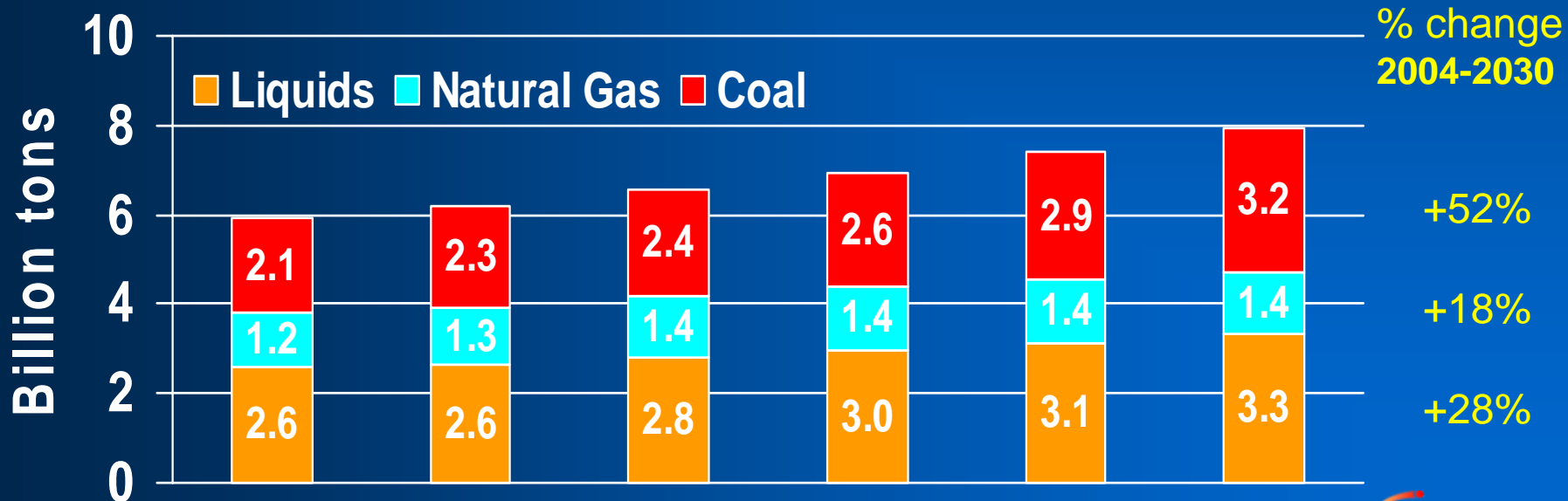
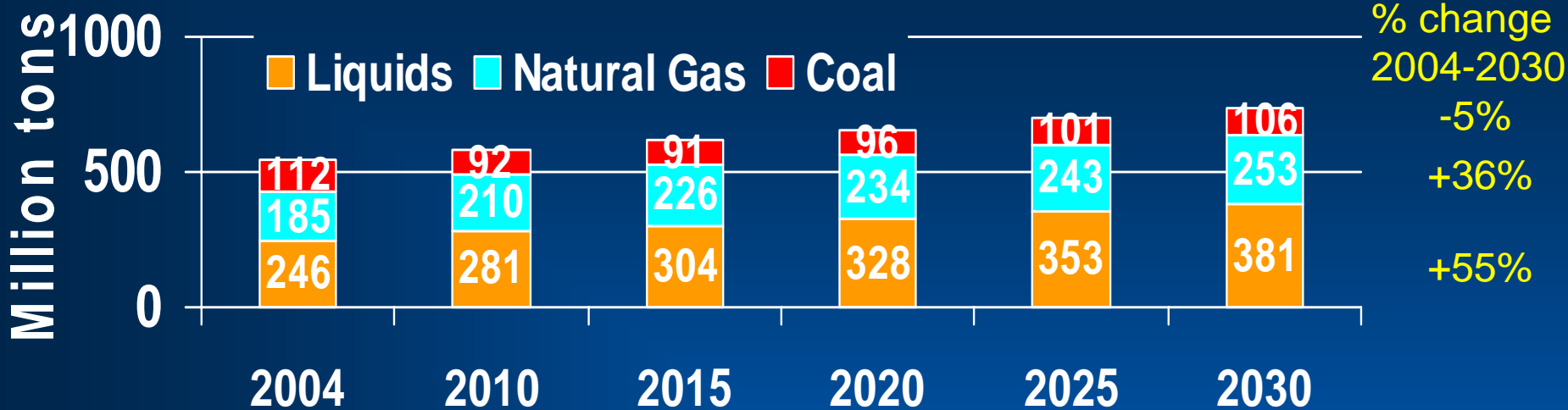
| % Change 2004-30 | CAN | USA |
|------------------|-----|-----|
| Residential      | 19% | 21% |
| Commercial       | 49% | 48% |
| Industrial       | 41% | 16% |
| Transport        | 44% | 41% |



# Canada/U.S. Net Electric Generation by Fuel Type



# Canada/U.S Carbon Dioxide Emissions by Fossil Fuel



Thank You



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