Life Cycle Analysis of Alternate Pathways for Production and Delivery of Hydrogen for Vehicles

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Presentation Overview

- Alternative Transportation Fuels
- Hydrogen
- LCA Goal/Scope
- EIO-LCA application
- Preliminary Conclusions

Alternative Transportation Fuels

- Motivation
  - Petroleum problems: decreasing reserves, increasing costs, security
  - Increasing demand for transportation fuels
  - Reduce greenhouse gas emissions
- Options
  - Hydrogen, ethanol, plug-hybrids, biodiesel

Hydrogen for Transportation

- No emissions at point of use
- Produced from primary source of energy
  - Majority from natural gas
  - Goal: Electrolysis from non-fossil source
- *Energy Carrier*

Hydrogen LCA Overview

- Goal/Scope
  - Evaluate well-to-tank emissions for production and distribution
  - Deliver 250,000 kg/day to Pittsburgh, Cleveland/Akron, Columbus (40 years)
  - Quantify differences between process (GaBi - NETL) and EIO LCA approaches
- Production Pathways
  - Coal gasification
  - Natural gas steam methane reforming

Economic Input-Output LCA

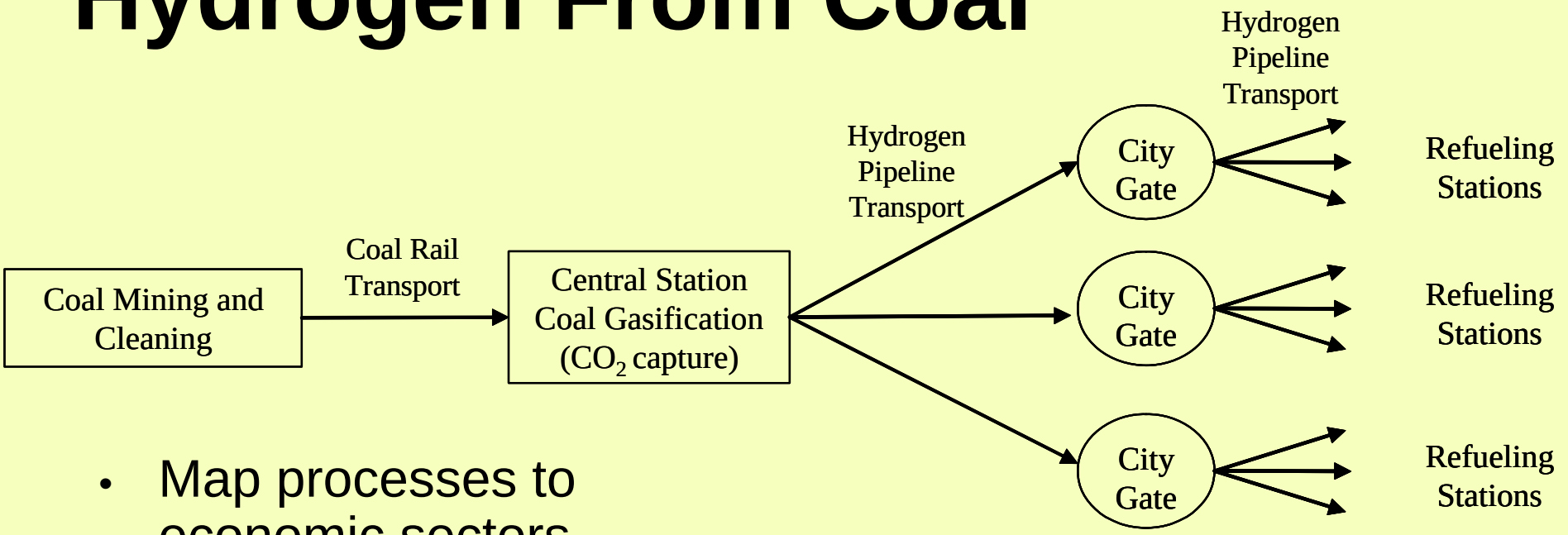
- Based on economic transactions in the U.S.
- U.S. economy split into 491 sectors (NAICS)
- Identifies direct & indirect economic inputs
- Model extended to environmental and energy analysis

Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach
(Hendrickson, Lave, Matthews; 2006)

EIO-LCA Effects Example

- Direct
  - Inputs needed for final production of hydrogen (coal, water, etc.)
- Indirect
  - **ALL** inputs needed in supply chain
  - e.g. coal mining, rail transportation
- Calculation yields every dollar input needed

Hydrogen From Coal

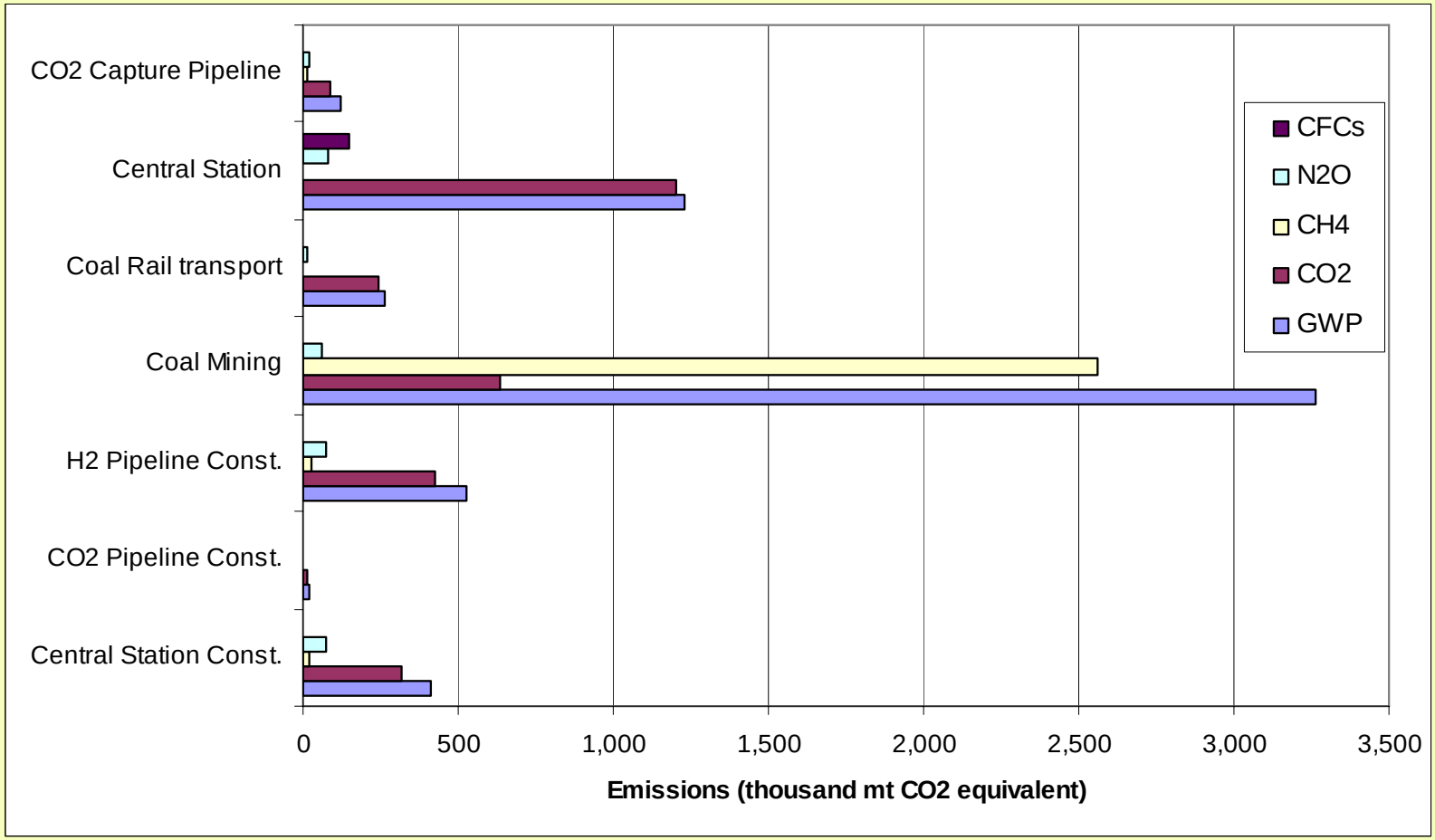


- Map processes to economic sectors
  - Coal mining
  - Rail transportation
- Central Station mapped to power generation sector
  - Select EIO results modified

- Technical/Economic model for EIO inputs
- Emissions
  - Construction
  - Operation/Maintenance

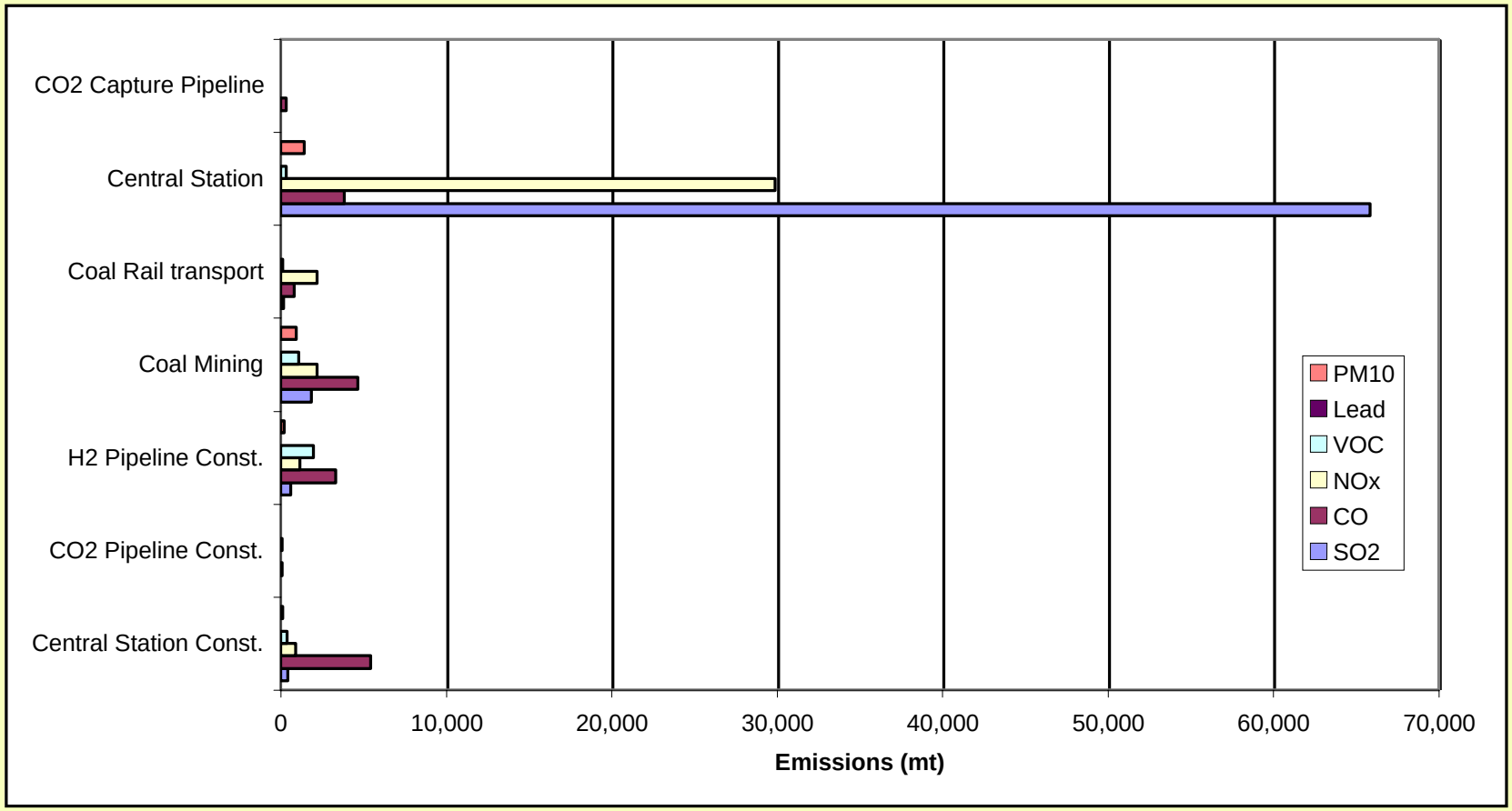
H_2 from Coal Preliminary Results

Greenhouse Gas Emissions

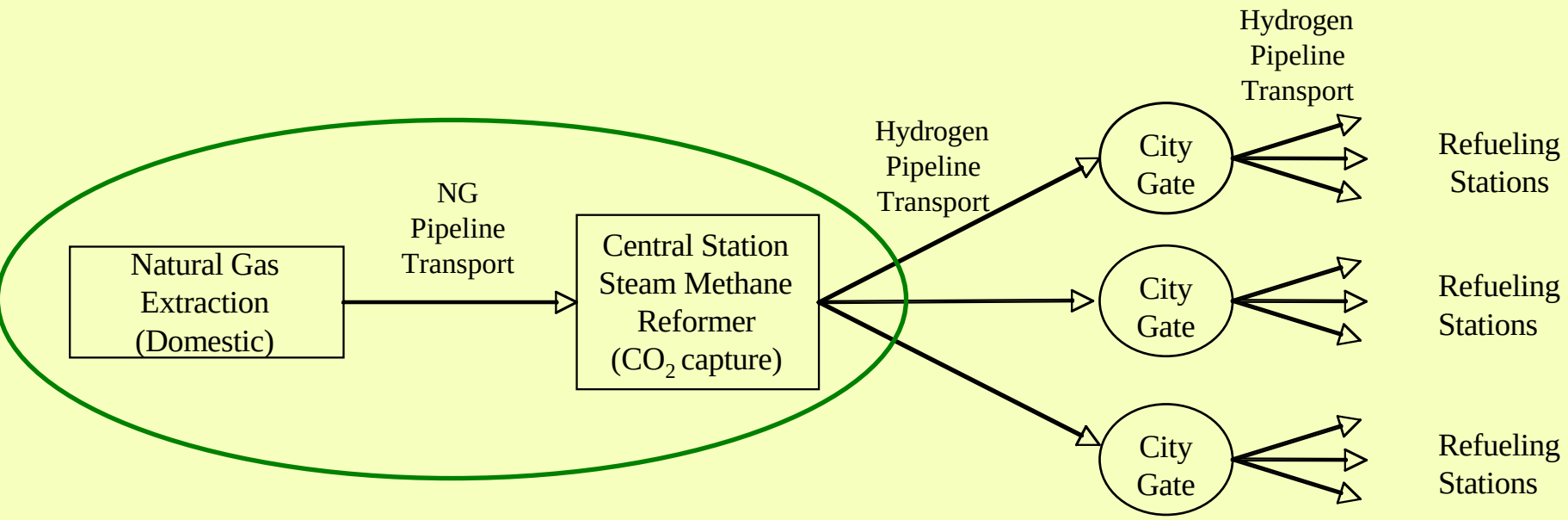


H_2 from Coal Preliminary Results

Criteria Pollutant Emissions

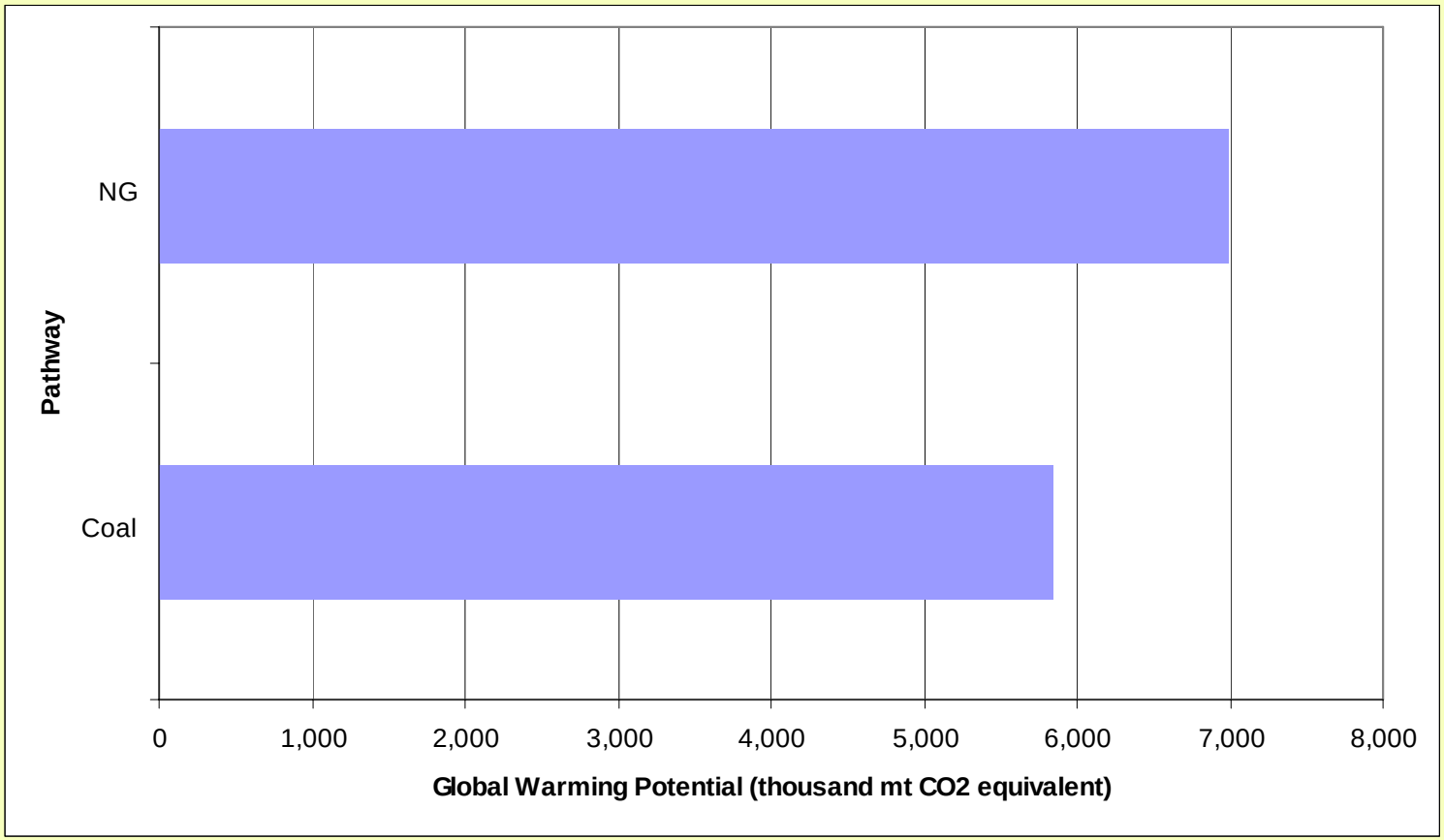


Hydrogen from Natural Gas

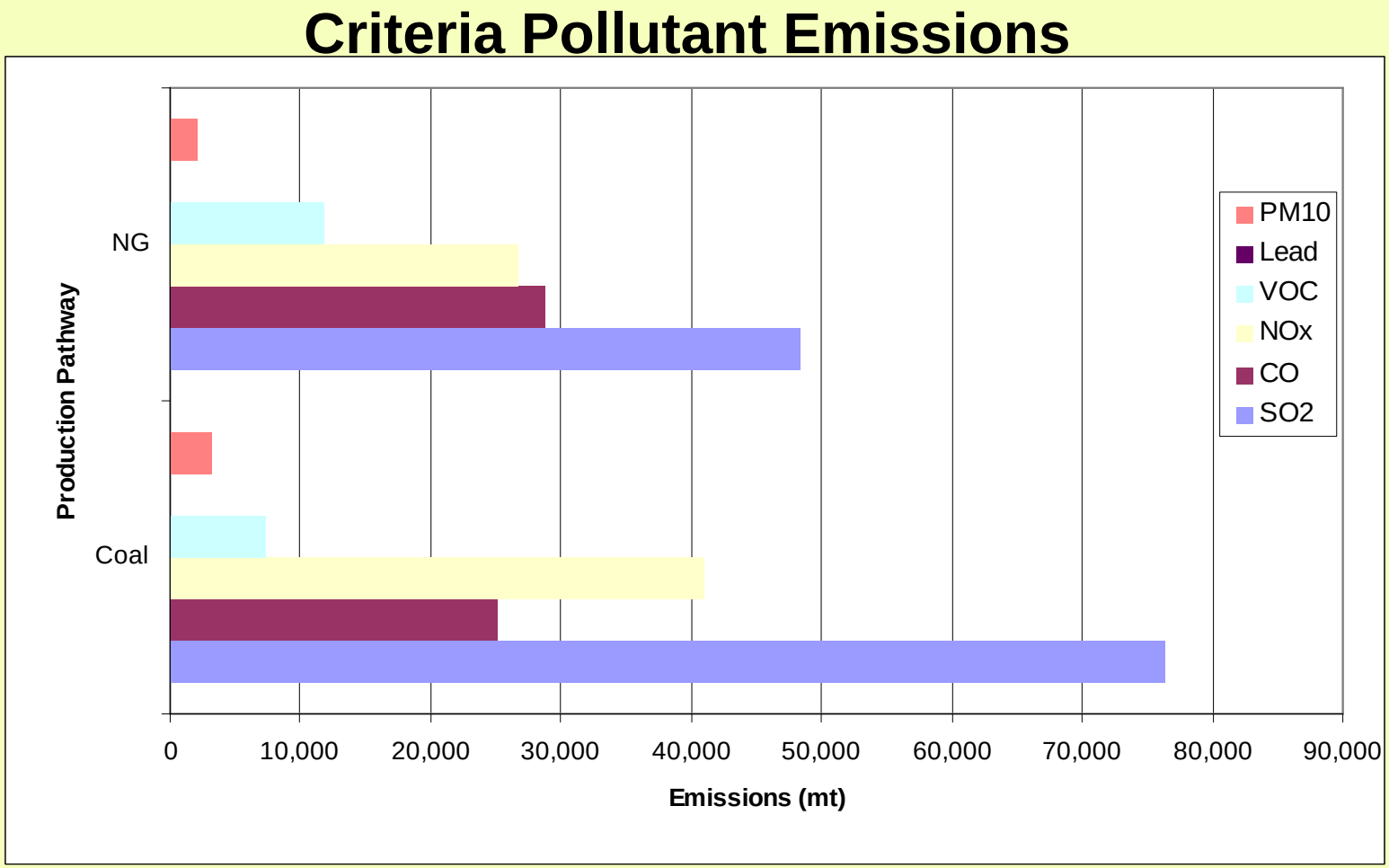


Result Comparison

Greenhouse Gas Emissions



Result Comparison



Preliminary Conclusions

- GWP emissions similar for both pathways (with CO_2 capture)
- Entire US light duty fleet using hydrogen from domestic reserves (no other uses considered)
  - Coal: 470 years
  - Natural gas: 19 years
- Other Considerations
  - Domestic supply
  - Environmental concerns

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