



# ***Carbon Capture with Fuel Cell Power Plants***

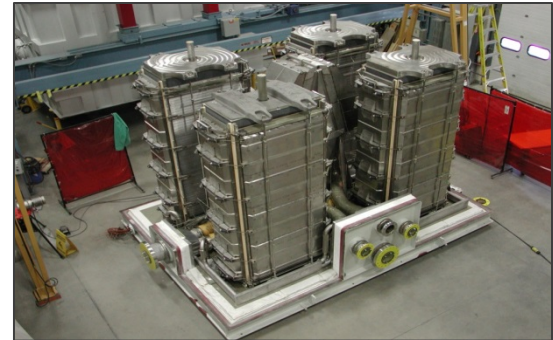
***United States Energy Association  
March 16, 2017***

**ExxonMobil**

**fuelcellenergy**

# Agenda

- **FuelCell Energy**
  - *Fuel Cells and Carbon Capture*
  - *DOE Office of Fossil Energy Program*
- **ExxonMobil**
  - *Carbon Capture and Sequestration Experience*
  - *Fuel Cell Technology*
- **Summary**



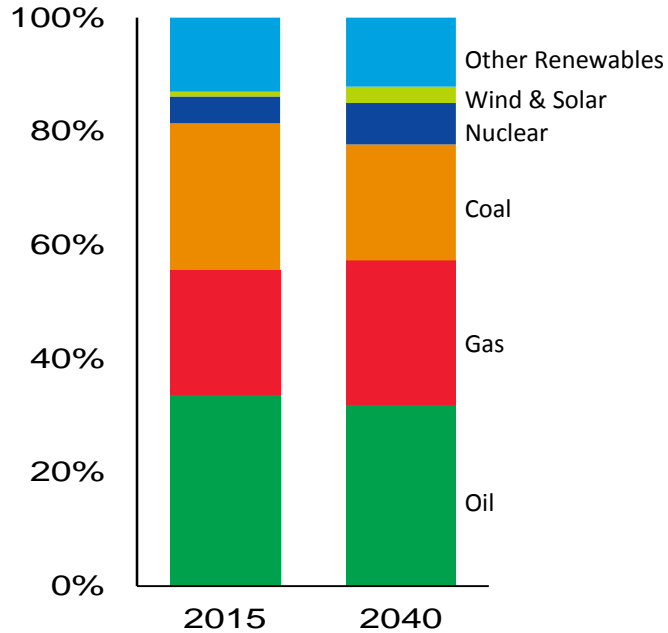
## Delivering clean and innovative solutions for the supply, recovery & storage of energy

- More than 50 installations globally with the world's leading companies
- Installations and operations on 3 continents
- Billions of KWh's of ultra-clean power delivered
- American designed & manufactured

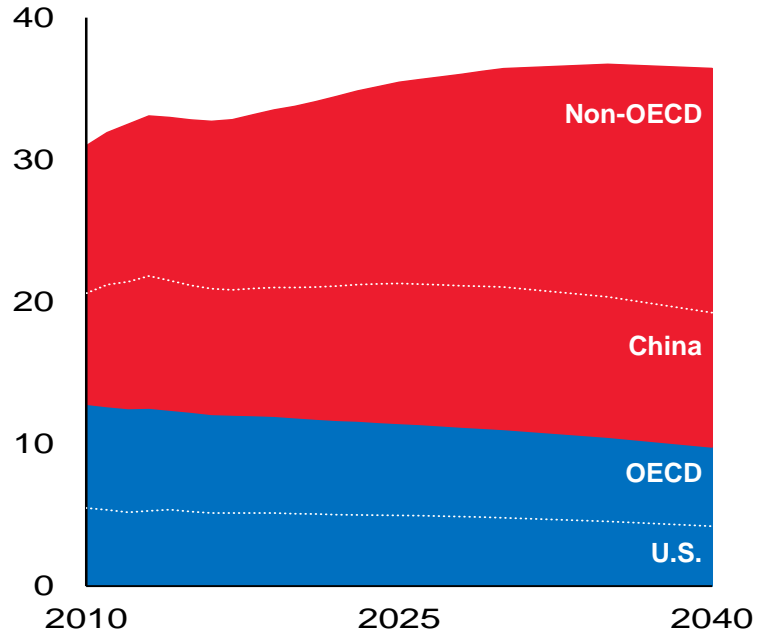


# Energy Mix Shifts to Lower-Carbon Fuels

**Global Energy Mix**  
Percent



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



Source: 2017 ExxonMobil Energy Outlook

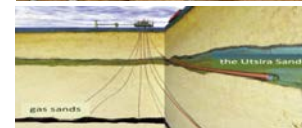
# Long-Term Stabilization Requires Transformation



Efficiency /  
Reduce Demand



Decarbonize Global  
Economy



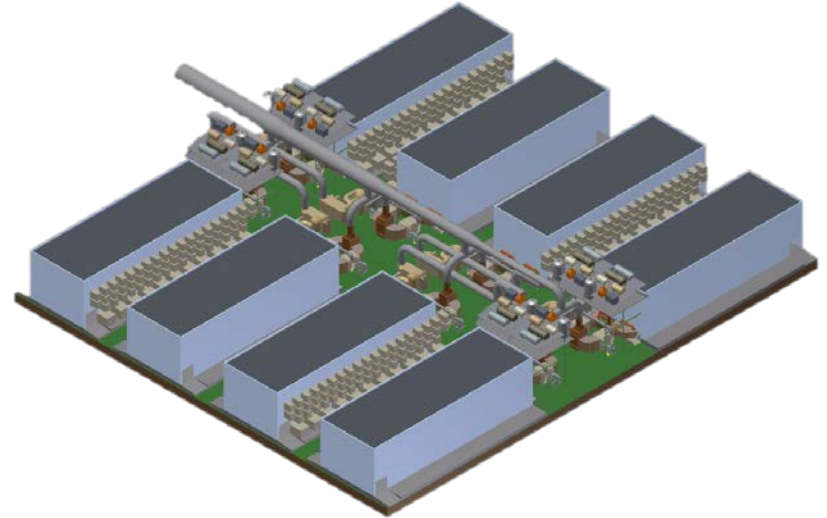
Negative GHG  
Emissions

## Value Drivers

- Conventional carbon capture approaches are energy intensive – typically consume ~20% of host power plant output
- Carbonate fuel cells can be configured to capture CO<sub>2</sub> as a side reaction of power generation
- Power generation during carbon capture adds value stream that improves carbon capture economics

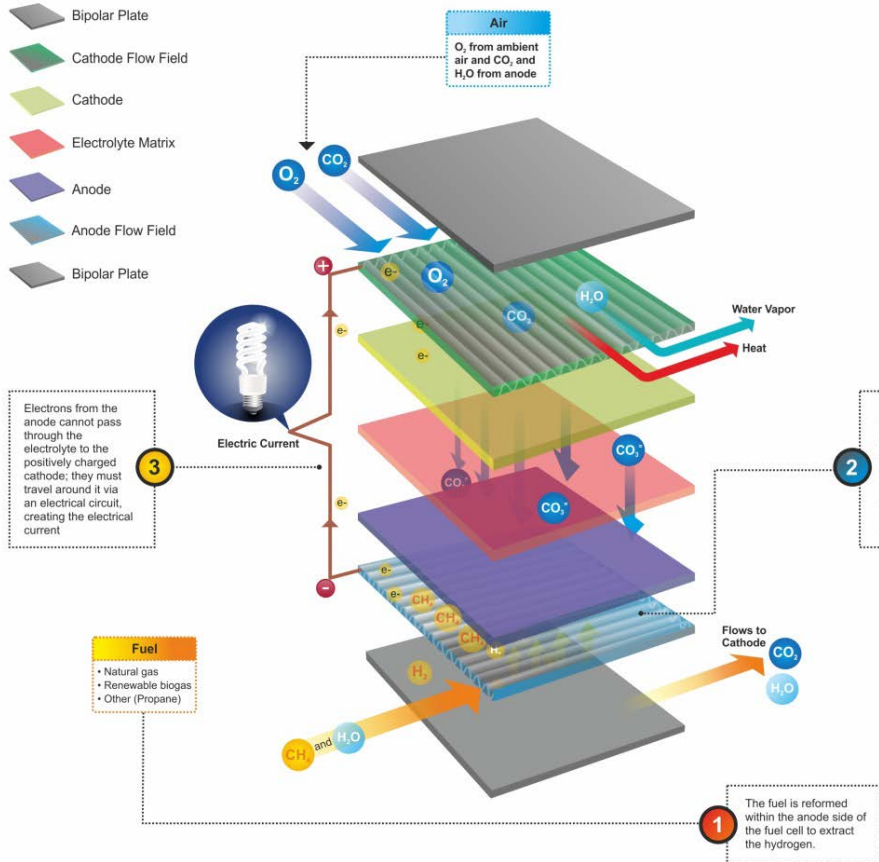
## Current Actions

- US DOE Office of Fossil Energy contract with FCE for development and pilot demonstration of capture from coal source
- FCE and ExxonMobil evaluation of capture from natural gas turbine exhaust stream



**350MW Plant for capture from coal systems, developed in DOE program**

Based upon work supported by the Department of Energy under Award Number DE-FE0026580

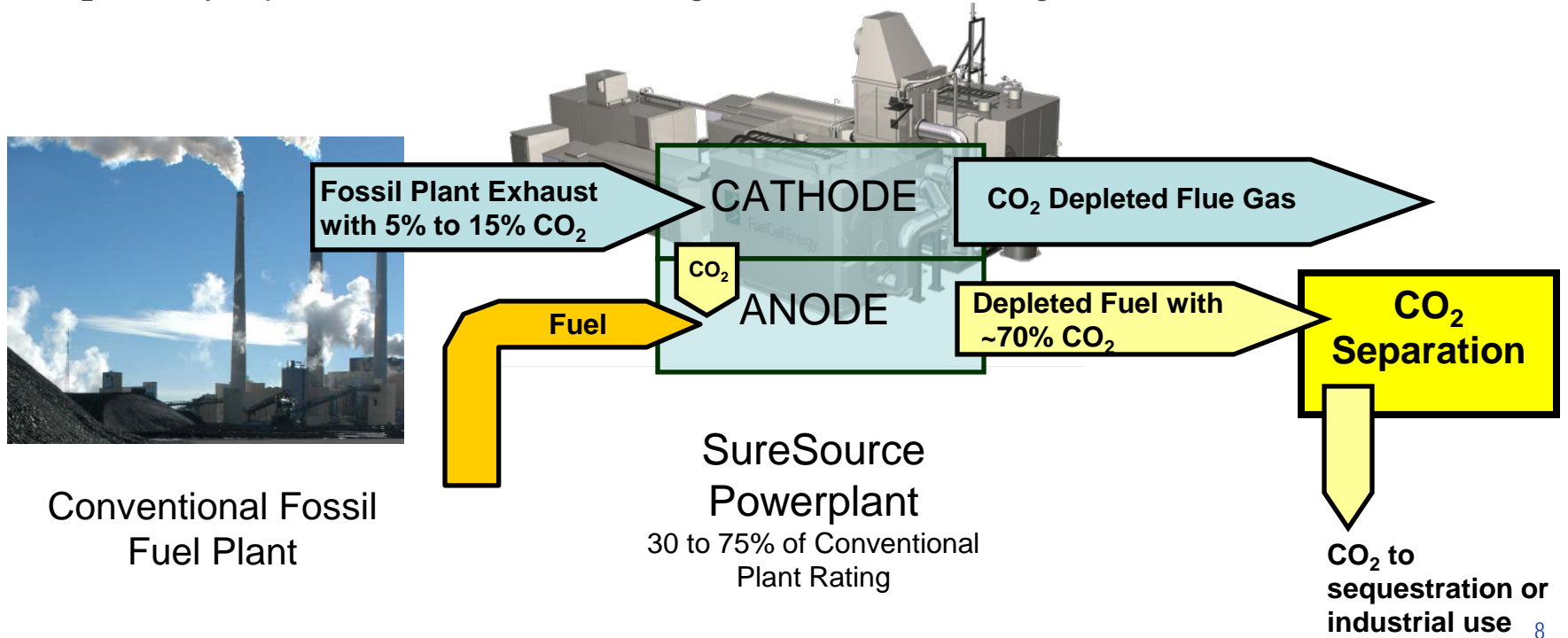


## Core of Carbon Capture

- Designed for Industrial and Utility Power Applications
  - Refined from DOE supported initial development
  - Power generation without combustion
  - Key DFC attributes allow for unique adaptations:
    - Internal Reforming
- Creates Hydrogen Fuel from Methane***
- Carbonate Electrolyte
- Provides CO<sub>2</sub> transfer mechanism that allows for concentration and capture***

# Fuel Cell Carbon Capture

- Carbonate electrochemical process transfers  $\text{CO}_2$  from Air Electrode (Cathode) to Fuel Electrode (Anode)
- $\text{CO}_2$  is easily separated from Anode exhaust gas because it is no longer diluted with air





- **Large-scale CC from coal-fired plants**
  - Ultimate objective of DOE-supported development
- **CC from distributed natural gas plants**
  - Provide low-carbon baseload or peaking Plants.
- **CC from industrial processes**
  - Reduced carbon footprint from processes such as cement production
- **CC and Enhanced Oil Recovery (EOR)**
  - On-site generation from associated gas with CO<sub>2</sub> capture for EOR



- DOE funded project to demonstrate capture from coal power generation
- Opportunity to use pilot to demonstrate natural gas capture under ExxonMobil Joint Development program
- **Southern selected Plant Barry as best site choice**
  - Coal and natural gas power generation
  - Plot space availability
  - Existing flue connection supporting past carbon capture projects
  - Supportive management and staff
- **Project will be single SureSource 3000-based capture system**
  - 90% capture from 3MW of coal exhaust



**James M. Barry Electric Generating Station**  
**Alabama Power/Southern Co.**

- **Location:** Bucks, AL
- **Nameplate Capacity:** >2 GW
- **Fuel:** Mix of Coal and Natural gas

# Example of Near Term System



- **Carbon Capture Fuel Cell Farm with 12 SureSource 3000<sup>tm</sup>-based capture systems**
  - 18 MW at 90% capture (500 tons/day from coal flue plus 200 tons/day from fuel cell ng)
  - 27 MW at 70% capture (700 tons/day from coal flue plus 300 tons/day from fuel cell ng)
- **3 acres total site**
- **Potential to expand incrementally as needed**

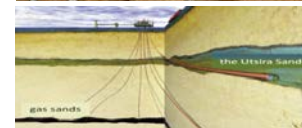
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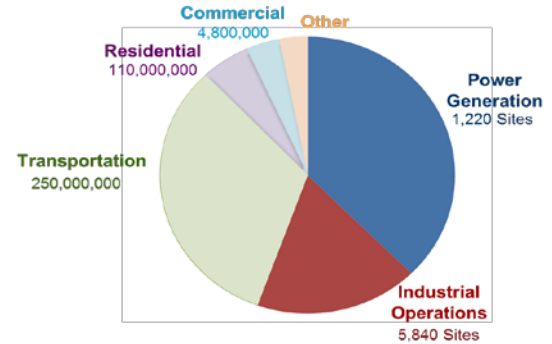


Negative GHG  
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# CO<sub>2</sub> Capture and Storage Background

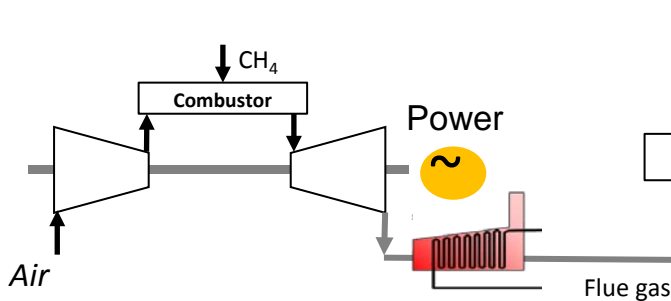
- Power generation and industrial operations major sources of CO<sub>2</sub>
- Amine CO<sub>2</sub> capture proven technology
- Storage technology proven, at small scale

## CO<sub>2</sub> Sources (U.S.)

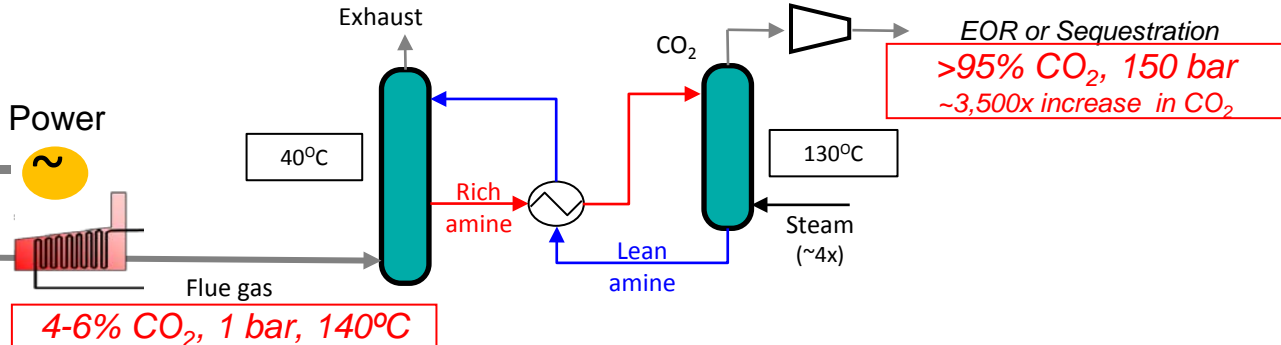


Note: CO<sub>2</sub> source data from EPA

## Natural Gas Power Plant



## Liquid Amine CO<sub>2</sub> Capture Plant



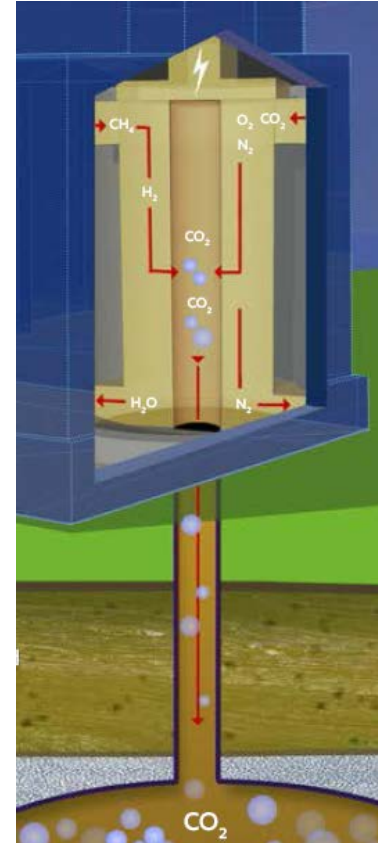
# ExxonMobil's CCS Experience

- Working interest in approximately 25% of the world's CCS capacity
  - ~7 million metric tons CO<sub>2</sub> captured for sequestration annually
- Current CCS efforts focus on:
  - Developing technologies to reduce CO<sub>2</sub> capture costs
  - Advocating for sound policy



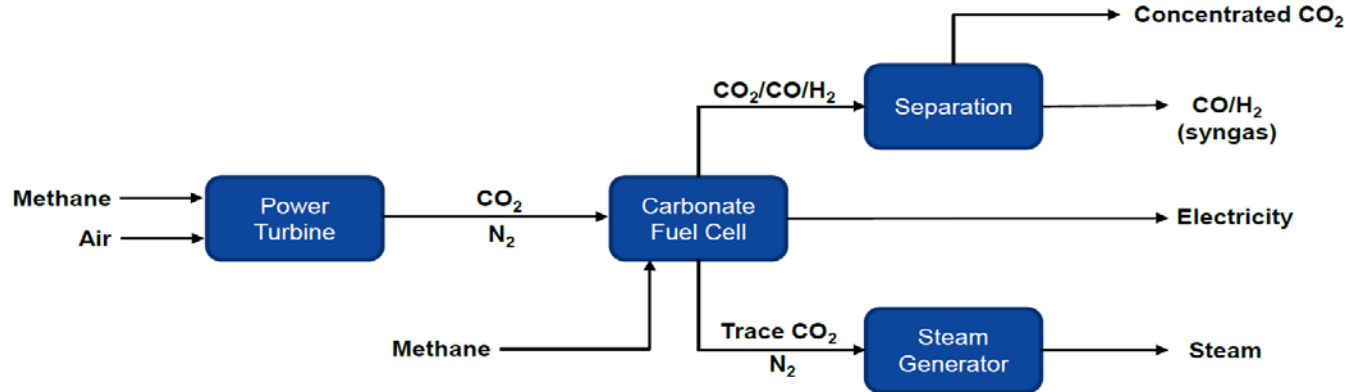
# Why fuel cell carbon capture?

- Commercially available technology
- Modular design
- Lower costs - generates power while capturing CO<sub>2</sub>
- Applicable to natural gas & coal-fired power plants
- Domestic fuel source with minimal CO<sub>2</sub> emissions
- American ingenuity for global application



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

- Fuel cell carbon capture enables typical 500 megawatt (MW) gas-fired power plant to generate additional 120 MW of power
- Potential to capture 90 percent of a natural gas-fired power plant's CO<sub>2</sub> emissions
- Further potential to produce up to 150 million cf/day of hydrogen





# Summary

- Making a domestic fuel source even more environmentally friendly
- Utilizing commercially proven fuel cell technology
- Modular and lower costs
- Invented in America
- Collaboration brings together world-leaders in respective industries

