

An Overview of Gasification Systems

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Why the Interest in Coal Gasification?

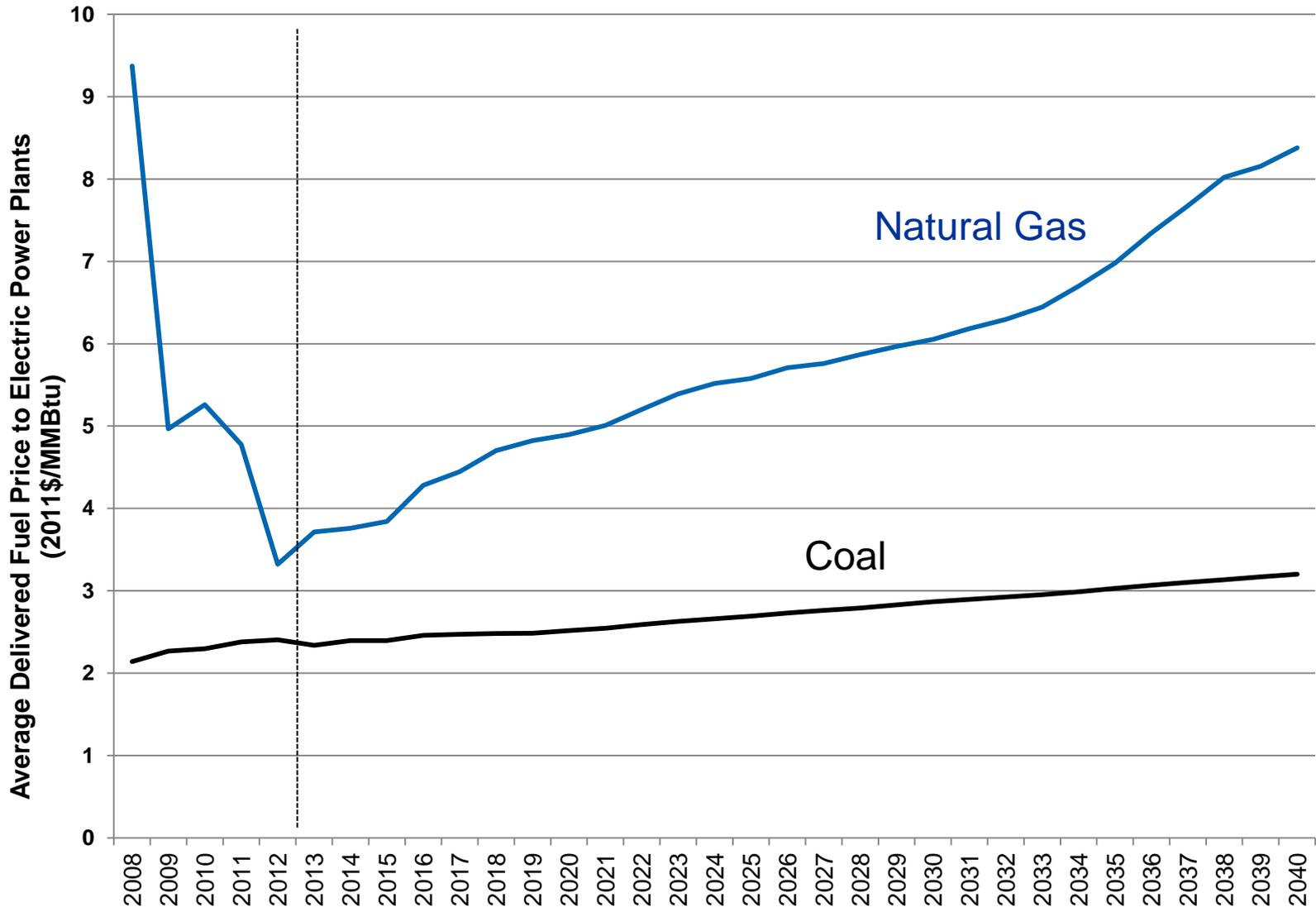
Energy diversity/security – the U.S. has a lot of coal

Gasification can be used to make multiple products:
(hydrogen [H₂], fertilizer, chemicals and transportation fuels from coal)

Can be the lowest cost option to make power with carbon dioxide (CO₂) capture and storage

CO₂ is a global problem, and most of the world does not have cheap natural gas

Coal and Natural Gas Prices



Source: EIA's Annual Energy Outlook 2013 Reference Case, 2008-2040

World LNG Estimated July 2013 Landing Prices



Let's Start with Combustion Chemistry



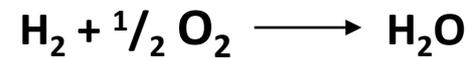
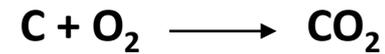
COAL



AIR



Combustion with Oxygen



FIRE

Gasification – Differences from Combustion

Add water and high pressure

Use less air or oxygen

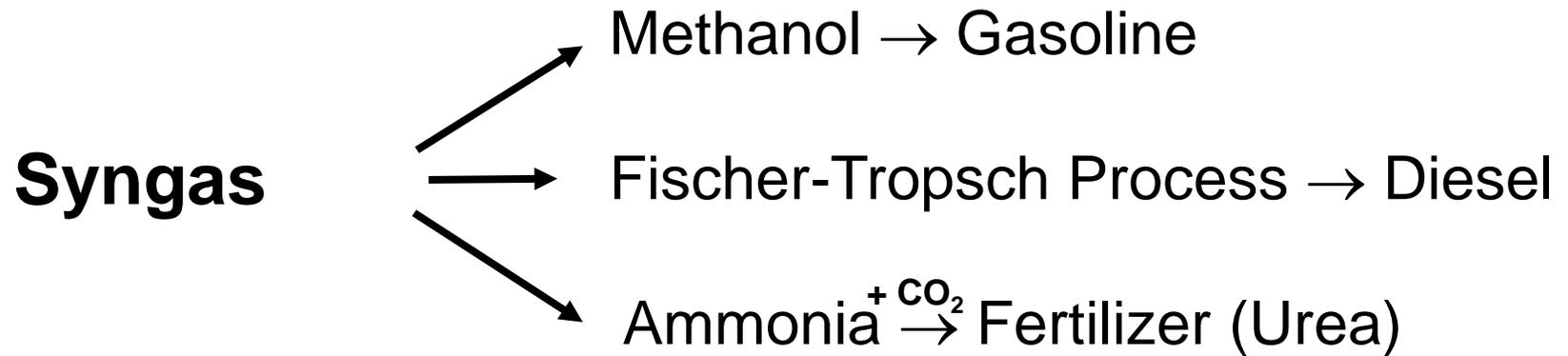
Gasification exit gases are at high pressure, so smaller volume, smaller reactors

Combustion makes heat + CO_2 + H_2O

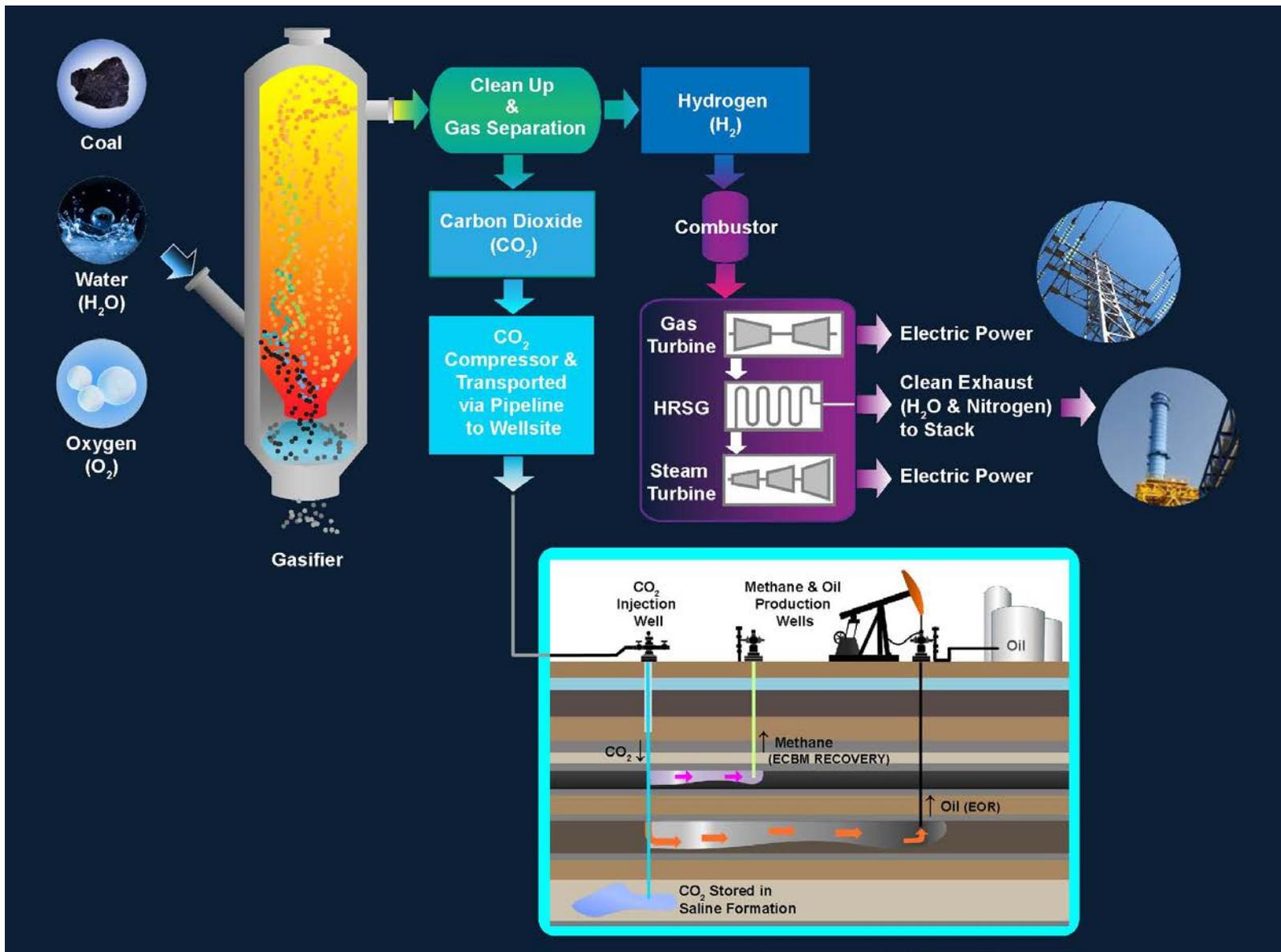
Gasification makes less heat + carbon monoxide + hydrogen ($\text{CO} + \text{H}_2$); called **Syngas**

Why do we want to make Syngas?

Chemicals and Products from Gasification



DOE Vision of Gasification-based Clean Power



Power

Integrated Gasification Combined Cycle (IGCC)

Syngas for power may use air or oxygen

- Air (79% nitrogen; 21% oxygen)
 - Nitrogen adds mass going through the turbine
 - No added cost for oxygen production
- Oxygen
 - More efficient gasification process
 - Less mass (no nitrogen) makes contaminant cleanup (sulfur, mercury, etc) and CO₂ sequestration less expensive

Integrated

- Designed to minimize heat /efficiency losses

Combined Cycle

- Both combustion & steam turbines for improving efficiency

CO₂ product for enhanced oil recovery (EOR)

IGCC Technology in Early Commercialization

Nation's 1st Commercial-scale IGCC plants

Each achieving: > 97% sulfur removal > 90% NOx reduction

Wabash River

- ConocoPhillips Gasifier
- 1996 Power plant of the Year Award*
- Achieved 77% availability **

Tampa Electric

- General Electric Gasifier
- 1997 Power plant of the Year Award*
- First dispatch power generator
- Achieved 90% availability **



Edwardsport 630 MW IGCC Project

Duke Energy

2 x GE Gasifier

2 x GE 7 FB combustion turbines

– 232 MWe each

GE steam turbine

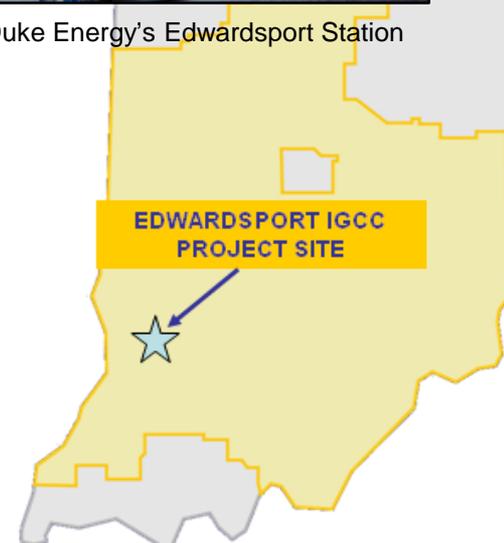
– 320 MWe

1.5 million tons of coal per year

Operational – June 2013



Gasifier being installed at Duke Energy's Edwardsport Station



DOE Supported IGCC Demonstration Projects



SCS Energy Hydrogen Energy California

Kern County, CA

Up to 300 MWe (net) & 1.0 MT/yr Urea

1- Mitsubishi Heavy Industries gasifier
90% Carbon capture

Fuel: Sub-bituminous coal/petcoke
EOR – ~2.6 MM TPY

- Construction: Jan 2015
- Operation: Jul 2019

Summit Power Texas Clean Energy Project

Penwell, TX

200 MWe (net) & .7 MT/yr Urea

2 -Siemens SFG-500 gasifiers
90% Carbon Capture

Fuel: Sub-bituminous Powder River Basin
EOR – ~2.2 MMTPY

- Construction: 3rd Q2013
- Operation: Nov 2017

Southern Company Kemper County Energy Facility

Kemper County, MS

582 MWe (net)

2 – KBR TRIG™ gasifiers
65% Carbon capture

Fuel: Mississippi lignite
EOR – ~3.0 MM TPY

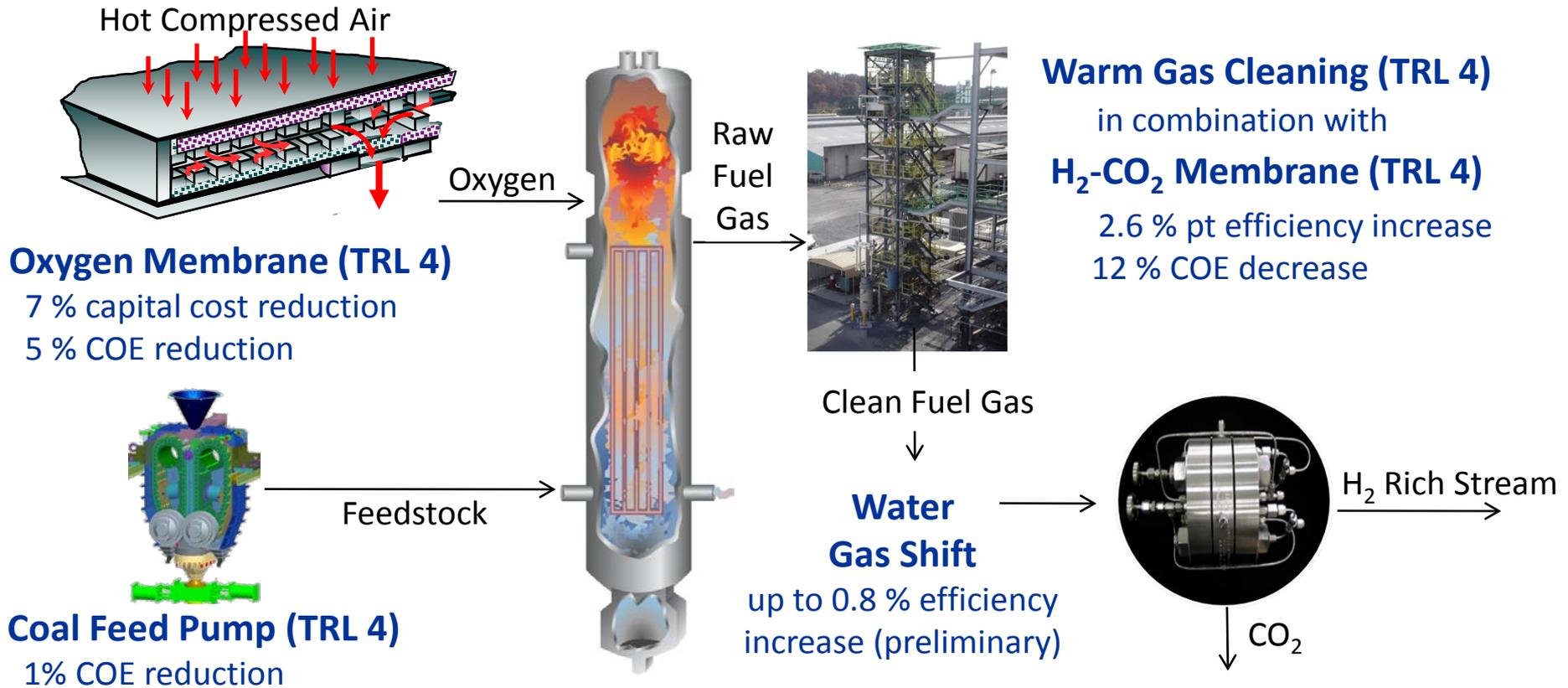
- Construction: >60% complete
- Operation: May 2014

DOE Gasification Systems Program R&D Goal

The goal of the Gasification Systems Program is to reduce the cost of electricity with carbon capture, while increasing power plant availability and efficiency, while maintaining the highest environmental standards

Gasification Systems Program

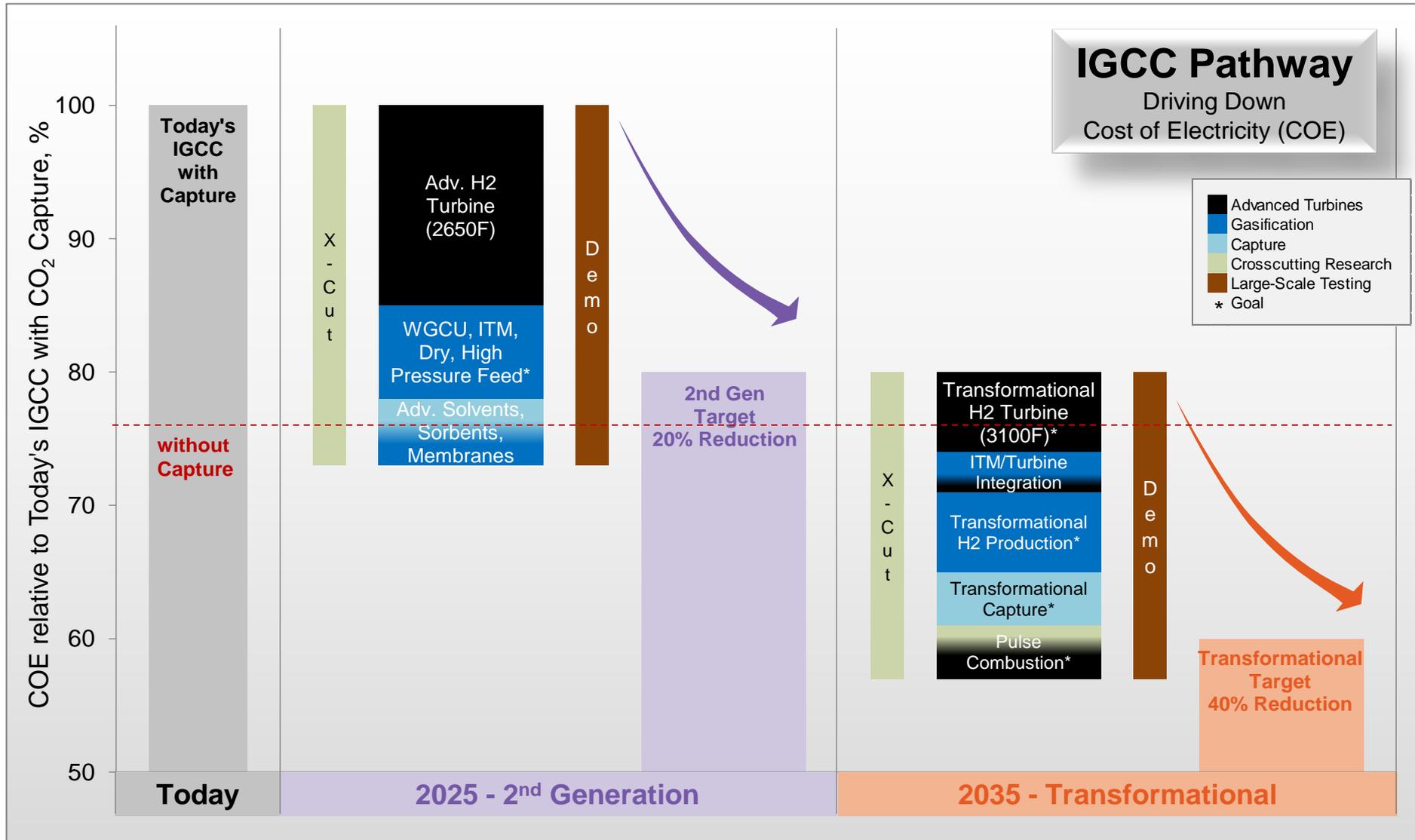
Key Technologies



Improvements in Reliability, Availability, and Maintainability

- Syngas cooler availability
- Refractory durability
- Dynamic simulator
- Temperature control
- Slag model development
- CFD gasifier modeling

Gasification Systems Pathway



FY13 Gasification Systems Solicitation

Three Topic Areas

Topic 1 – Coal Feed Technologies - Low-rank Coal Feed or Coal-woody Biomass Feed Technologies

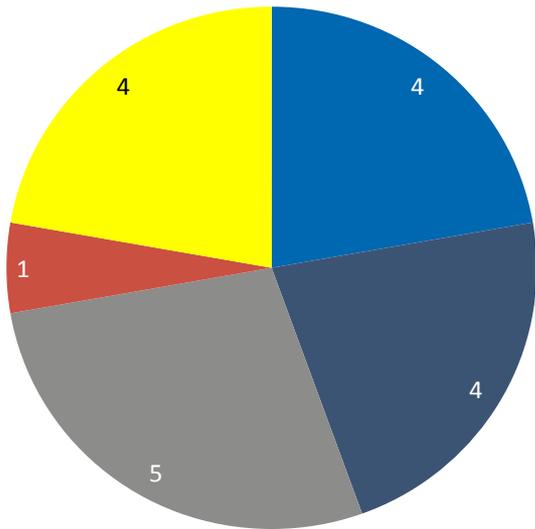
Topic 2 – Lower-cost Oxygen Production Systems

Topic 3 – High Hydrogen Syngas Production -- 6 projects

- All projects must culminate in economic analyses showing technology value for power with 90% carbon capture, and ofr liquid fuels production
- Two projects will use co-feed: coal and natural gas
- Three will make methanol, and three will make diesel fuel
- Include molten char gasification, new hydrogen membrane, fluid bed water gas shift, and two will include data from the pilot scale Pratt and Whitney Rocketdyne gasifier test

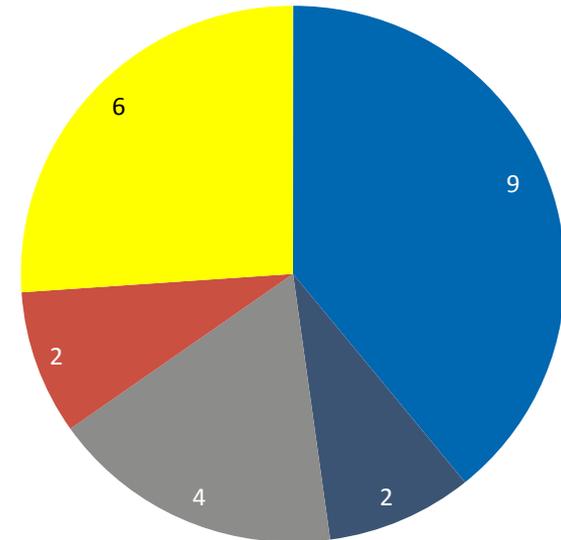
Proposed/Planned Gasification Plants U.S.

2010



Total: 22

2013



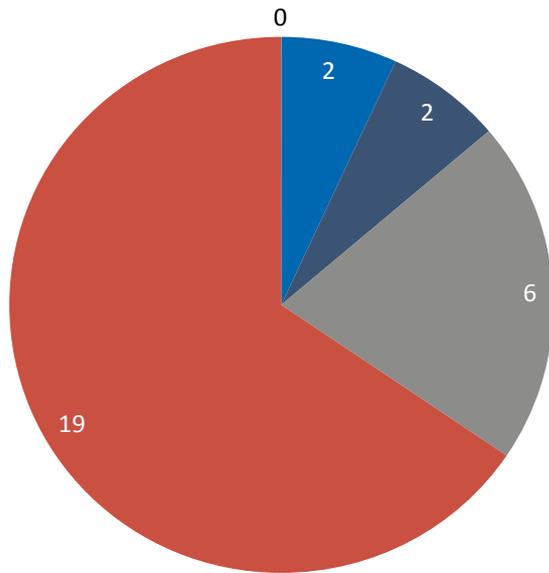
Total: 23

- CTL
- SNG
- IGCC
- CTC
- Polygen

Preliminary Data

Proposed/Planned Gasification Plants Worldwide (Non-U.S.)

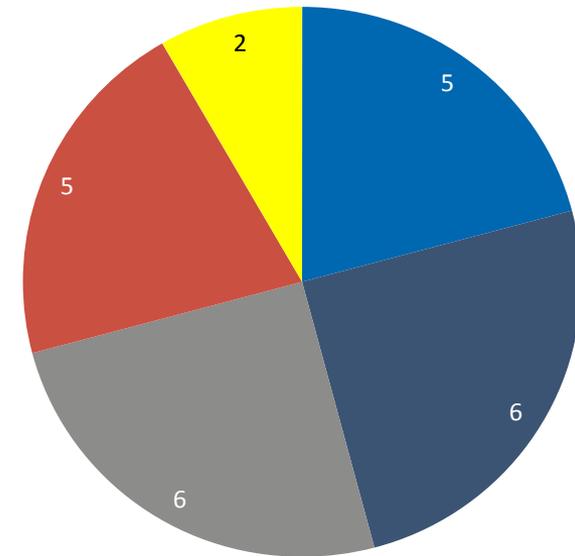
2010



Total: 29

2013

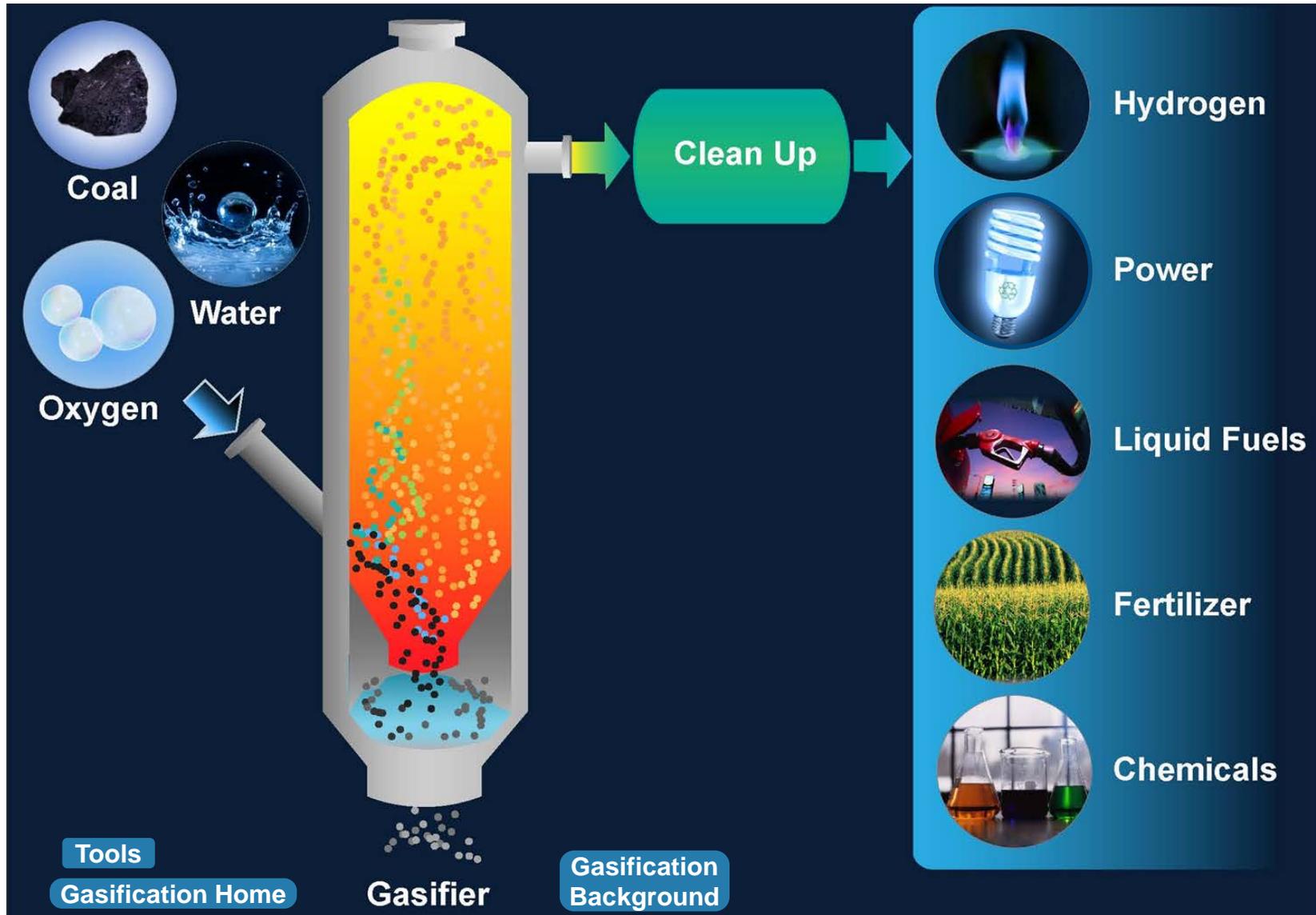
- CTL
- SNG
- IGCC
- CTC
- Polygen



Total: 24

Preliminary Data

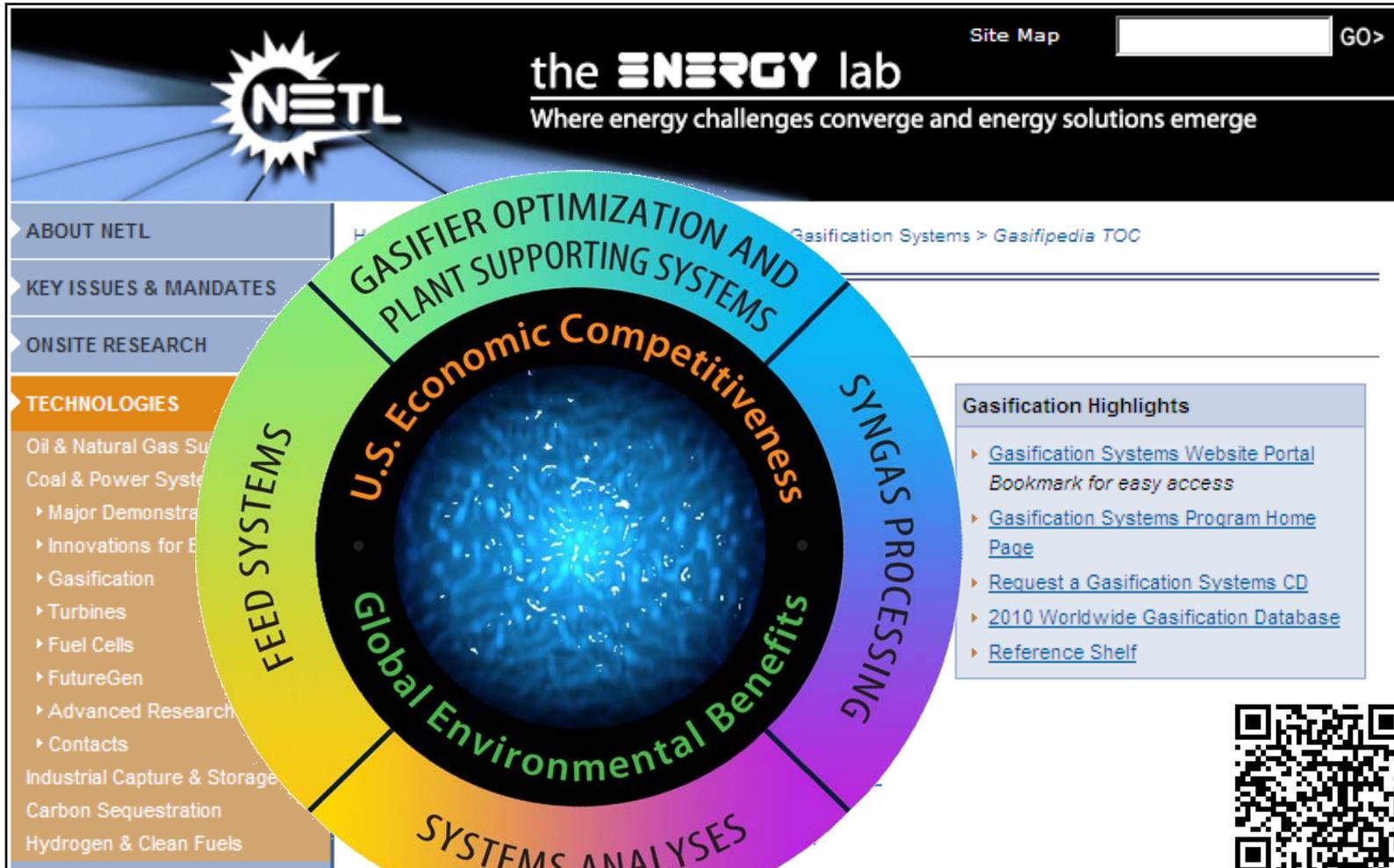
Gasifipedia: Internet Gasification Encyclopedia



Visit NETL Gasification Website

www.netl.doe.gov/gasification-portal.html

Google the term "Gasifipedia" 



The screenshot shows the NETL Gasification Systems Website Portal. The top navigation bar includes the NETL logo, the text "the ENERGY lab", and the tagline "Where energy challenges converge and energy solutions emerge". A search bar and a "GO" button are also present. The main content area displays "Gasification Systems > Gasifipedia TOC". A large circular diagram is overlaid on the page, featuring a central blue image of a gasification reactor. The diagram is divided into four quadrants: "FEED SYSTEMS" (top-left, green), "SYNGAS PROCESSING" (top-right, blue), "SYSTEMS ANALYSES" (bottom, purple), and "GASIFIER OPTIMIZATION AND PLANT SUPPORTING SYSTEMS" (bottom-left, yellow). The central circle is labeled "U.S. Economic Competitiveness" and "Global Environmental Benefits". A sidebar on the left lists various technologies, and a "Gasification Highlights" box on the right provides links to key resources. A QR code is located in the bottom right corner of the screenshot.

Site Map GO>

the **ENERGY** lab
Where energy challenges converge and energy solutions emerge

Gasification Systems > Gasifipedia TOC

Gasification Highlights

- ▶ [Gasification Systems Website Portal](#)
Bookmark for easy access
- ▶ [Gasification Systems Program Home Page](#)
- ▶ [Request a Gasification Systems CD](#)
- ▶ [2010 Worldwide Gasification Database](#)
- ▶ [Reference Shelf](#)

NETL

ABOUT NETL

KEY ISSUES & MANDATES

ONSITE RESEARCH

TECHNOLOGIES

- Oil & Natural Gas Su
- Coal & Power Syste
- ▶ Major Demonstrat
- ▶ Innovations for E
- ▶ Gasification
- ▶ Turbines
- ▶ Fuel Cells
- ▶ FutureGen
- ▶ Advanced Research
- ▶ Contacts
- Industrial Capture & Storage
- Carbon Sequestration
- Hydrogen & Clean Fuels

FEED SYSTEMS

GASIFIER OPTIMIZATION AND PLANT SUPPORTING SYSTEMS

SYNGAS PROCESSING

SYSTEMS ANALYSES

U.S. Economic Competitiveness

Global Environmental Benefits