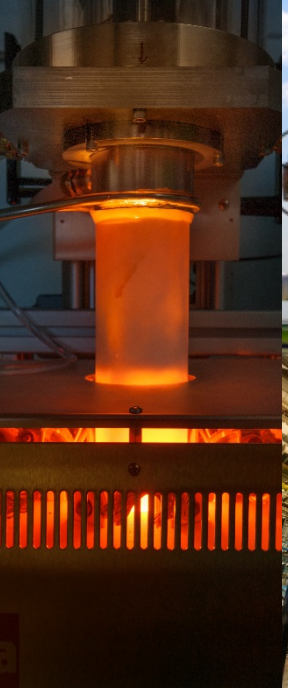
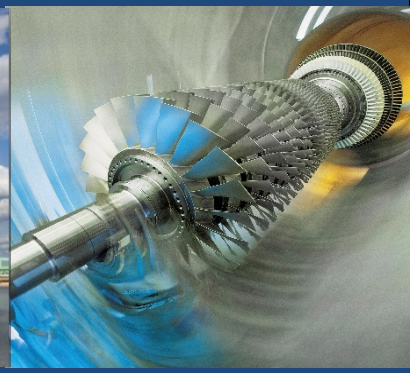




U.S. DEPARTMENT OF ENERGY | Office of Fossil Energy

The Future of Coal

"Carbon Free Fossil Energy"

Wyoming Mining Association

June 6, 2019 Cody, WY

Lou Hrkman

Deputy Assistant Secretary

Clean Coal and Carbon Management

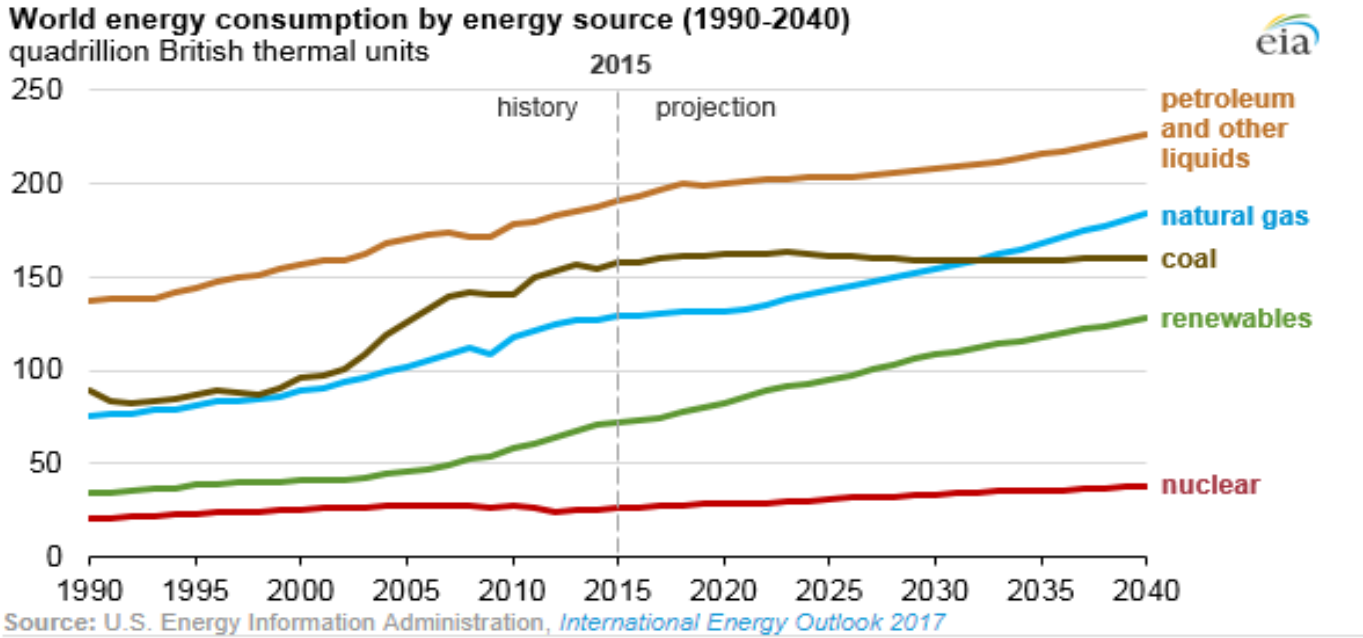
FOSSIL ENERGY is critical in all sectors of the US Economy

CCUS is A platform technology for many industrial sectors

EIA, *Annual Energy Outlook 2017*, Reference Case, https://www.eia.gov/totalenergy/data/monthly/pdf/flow/css_2017_energy.pdf

The World is Hungry for Energy

EIA projects 28% increase in world energy use by 2040

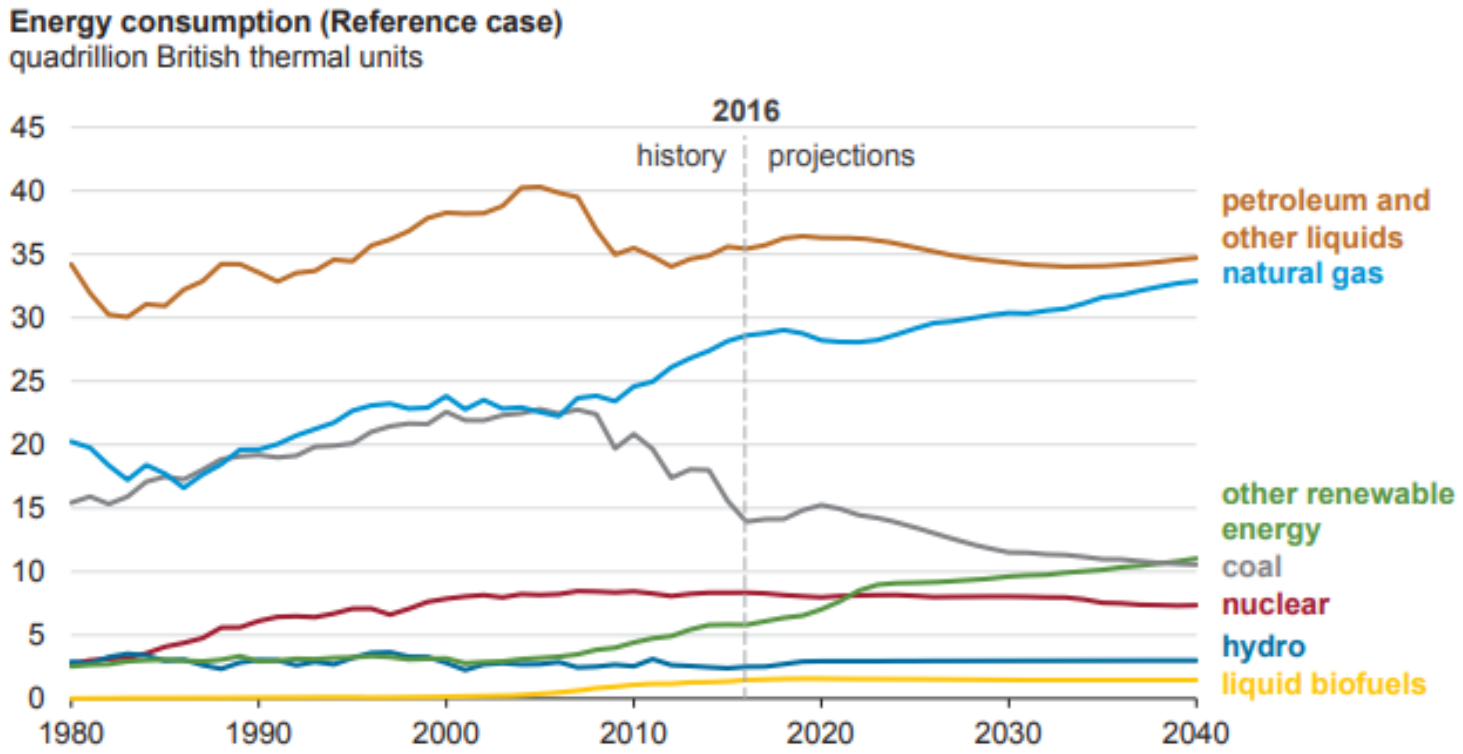


Asia (which includes China and India) accounts for more than 60% of the world's total increase in energy consumption from 2015 through 2040.

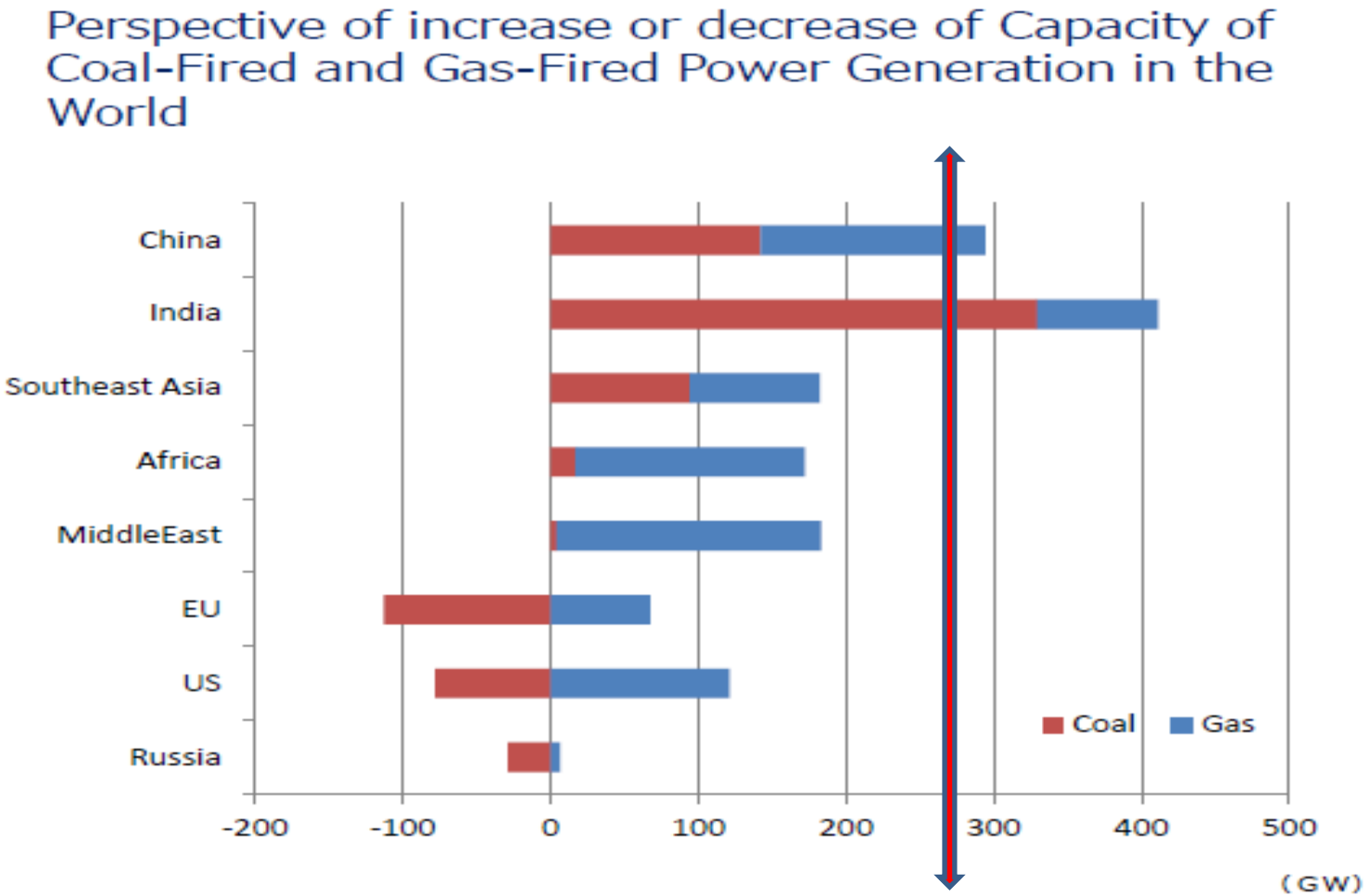
"Fossil fuels will still account for more than 3/4ths of the world's energy consumption through 2040"

The World Will Require CCUS technologies

Domestic Energy Consumption to 2040



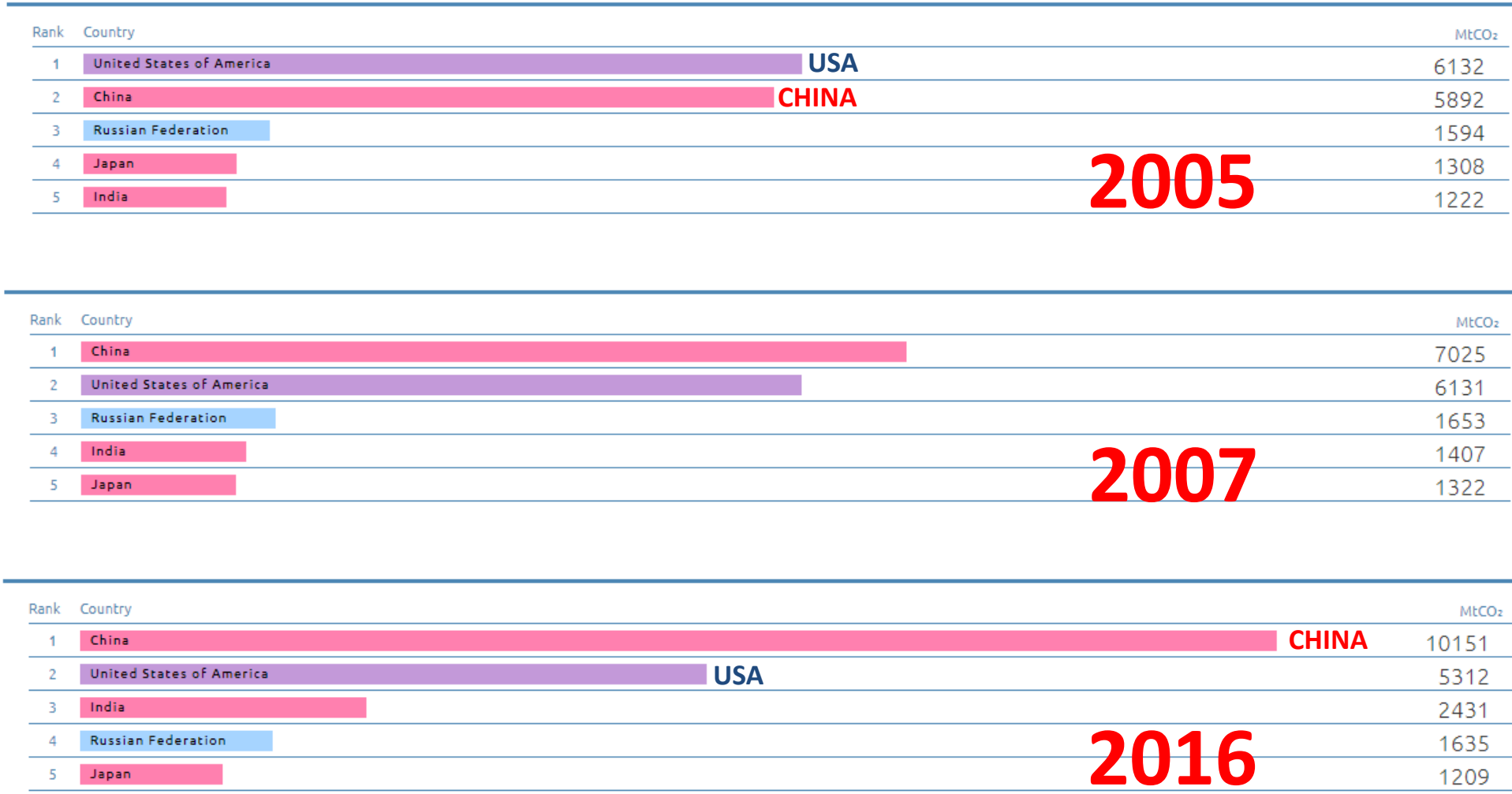
2040 Outlook



Point of Comparison
Today-US ~260 GW

(Source: IEA World Energy Outlook 2017)

GHG Emissions by Country 2005-2017



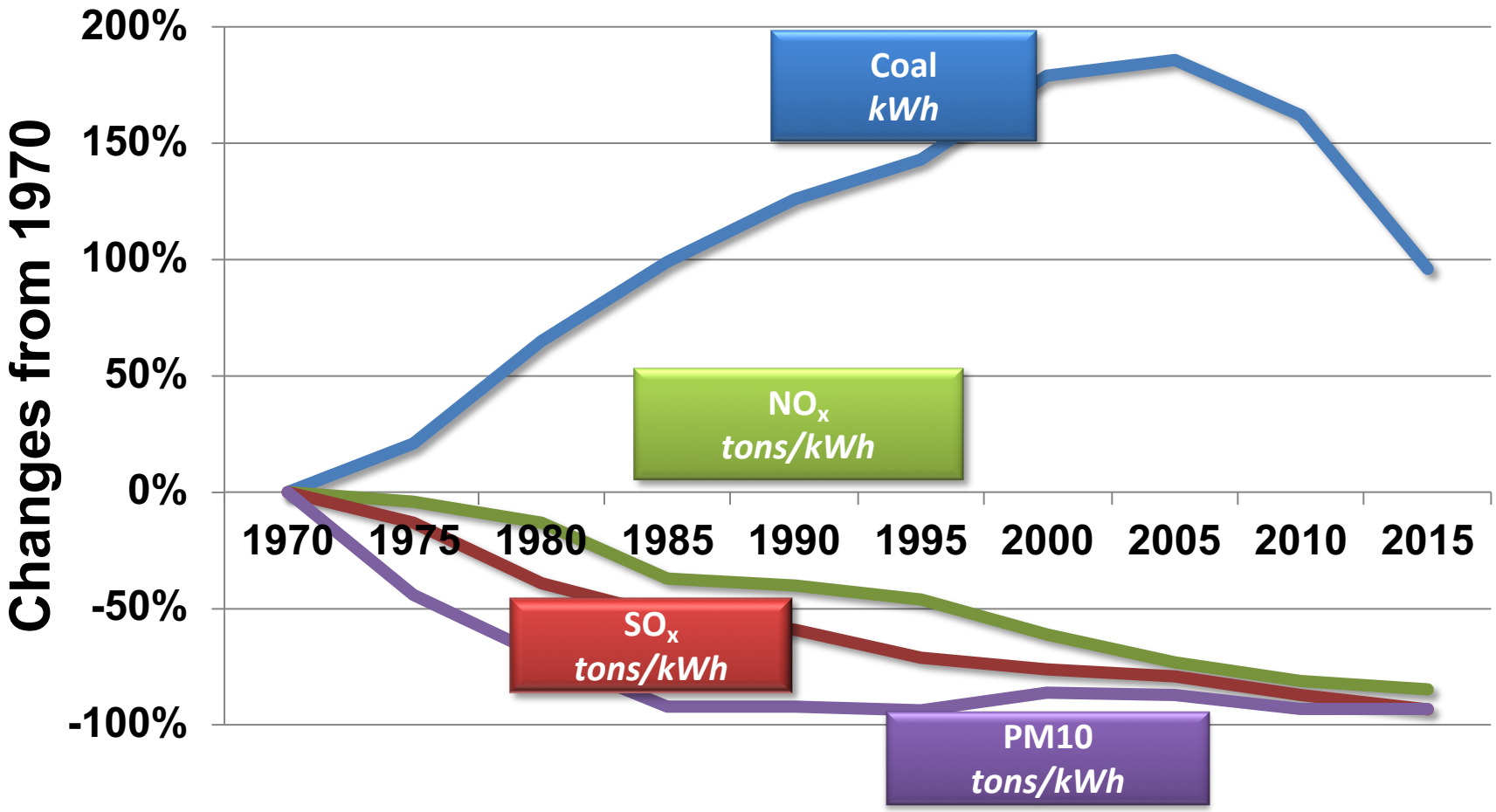
Source—Global Carbon Atlas

History of Successful DOE R&D to Advance Emission Controls

DOE has a history of advancing commercially successful R&D, with national economic and environmental benefits. For example:

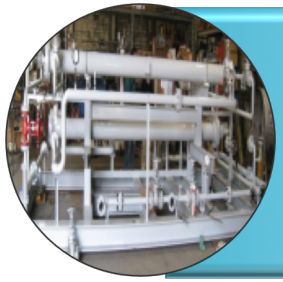
- Low NOx burners developed by DOE are installed commercially on about 75% of U.S. coal-fired power plants;
- Selective Catalytic Reduction (SCR) technologies developed through DOE programs are now commercially installed on about half our nation's coal fleet;
- Multi-pollutant control technologies including mercury have experienced significant sales in the commercial market; and
- Technologies to help recycle coal combustion products (Coal Ash) were developed through DOE programs and a large commercial recycling industry exists today in the U.S.

Coal Power: Emissions fell as Coal generation grew

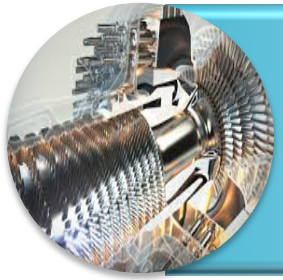


Department of Energy Investments Clean Coal and Carbon Management

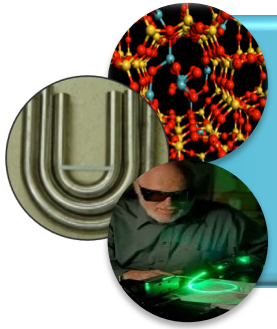
Office of Clean Coal and Carbon Management – What we do



Carbon Capture, Utilization and Storage
R&D and scale-up technologies for capturing and using or storing CO_2 from new and existing industrial and power-producing plants



Advanced Energy Systems
Technologies that improve plant efficiency and performance, increase plant availability, and maintain the highest environmental standards

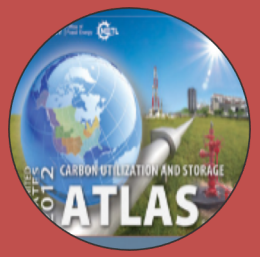


Cross Cutting Research and Systems Integration
Materials, sensors, and advanced computer systems for future power plants and energy systems, as well as testing and validating technologies into integrated systems

Federal Investment in CCUS R&D Has Been Significant

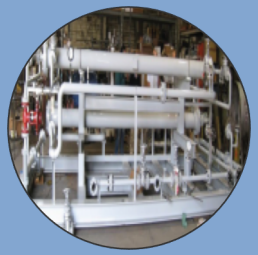
CO_2 utilization

R&D to convert CO_2 to value-added products



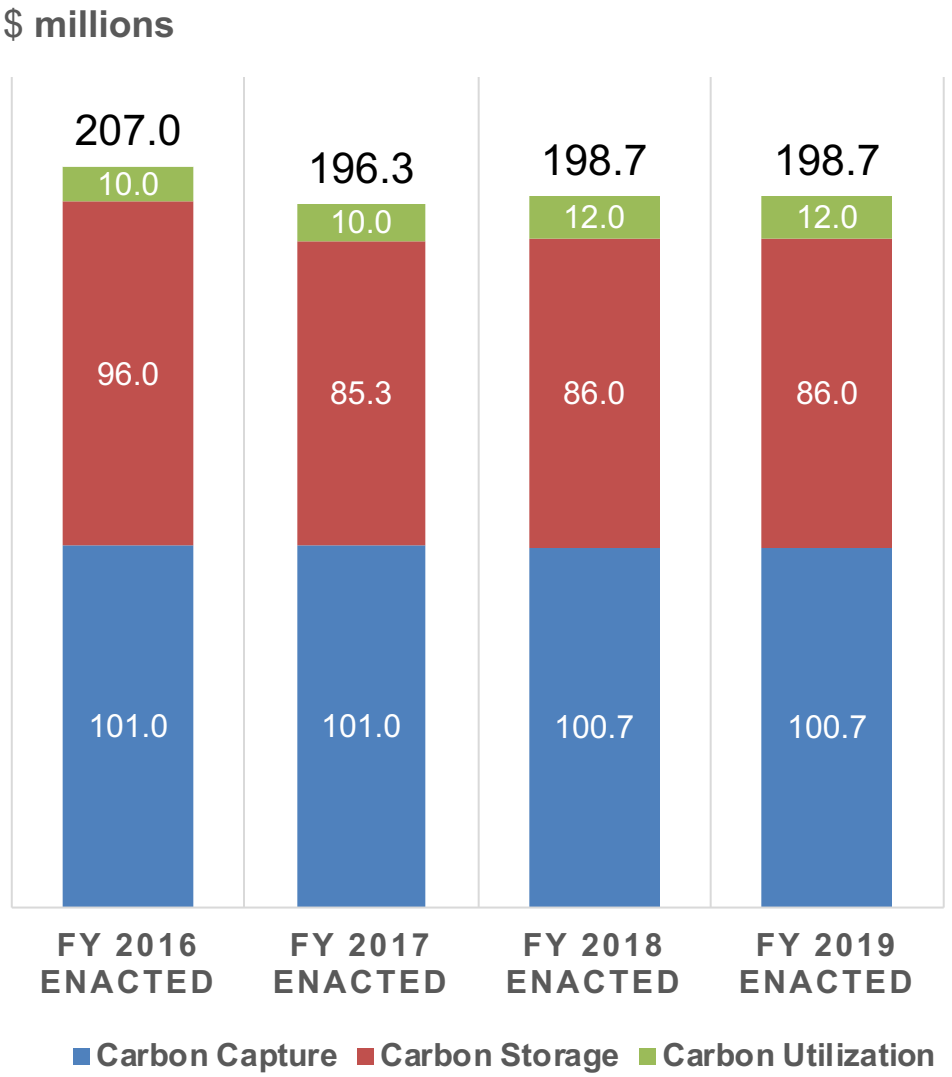
Carbon storage

Safe, cost-effective, and permanent geologic storage of CO_2

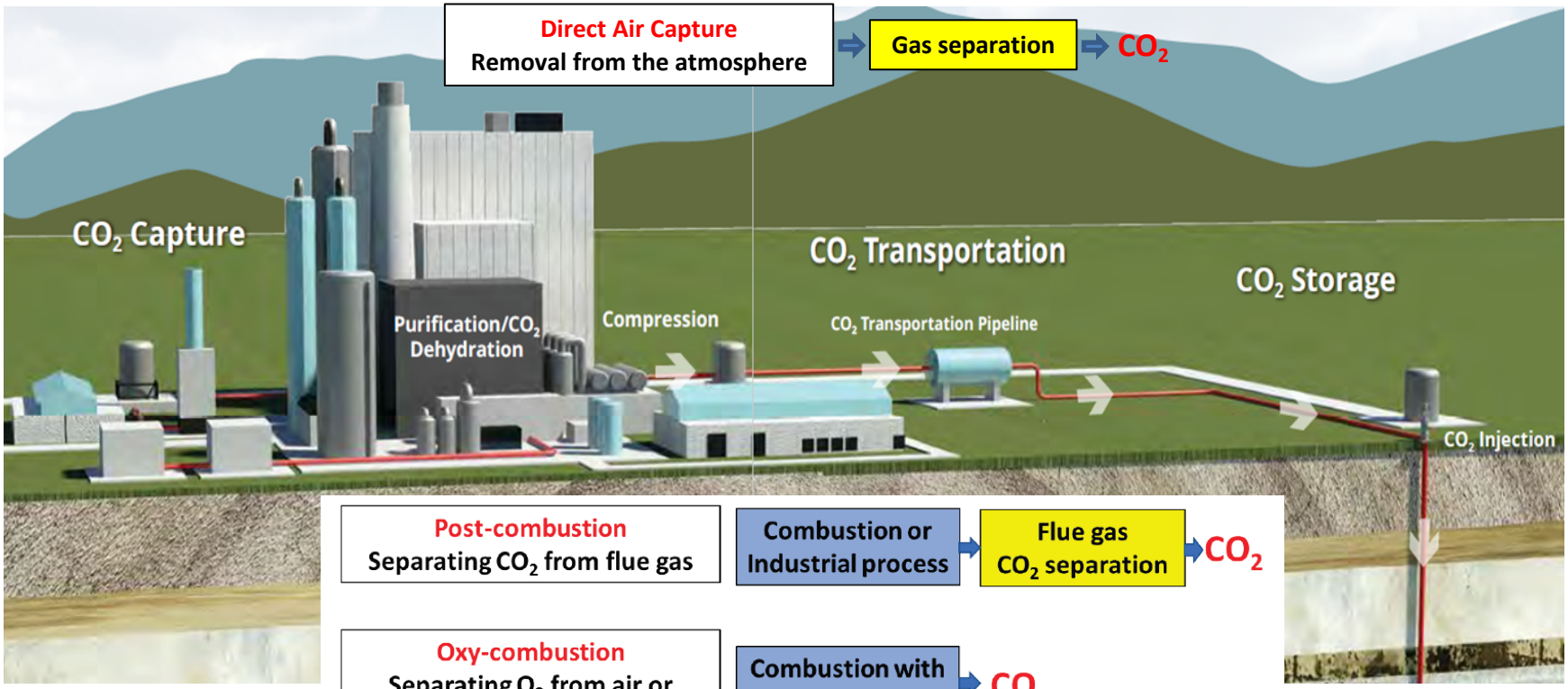


Carbon capture

R&D and scale-up on capture CO_2 technologies for new and existing industrial and power plants



What is Carbon Capture ?



Carbon Storage

Coal FIRST Technologies to Meet Opportunity

Flexible, Innovative, Resilient, Small, Transformative

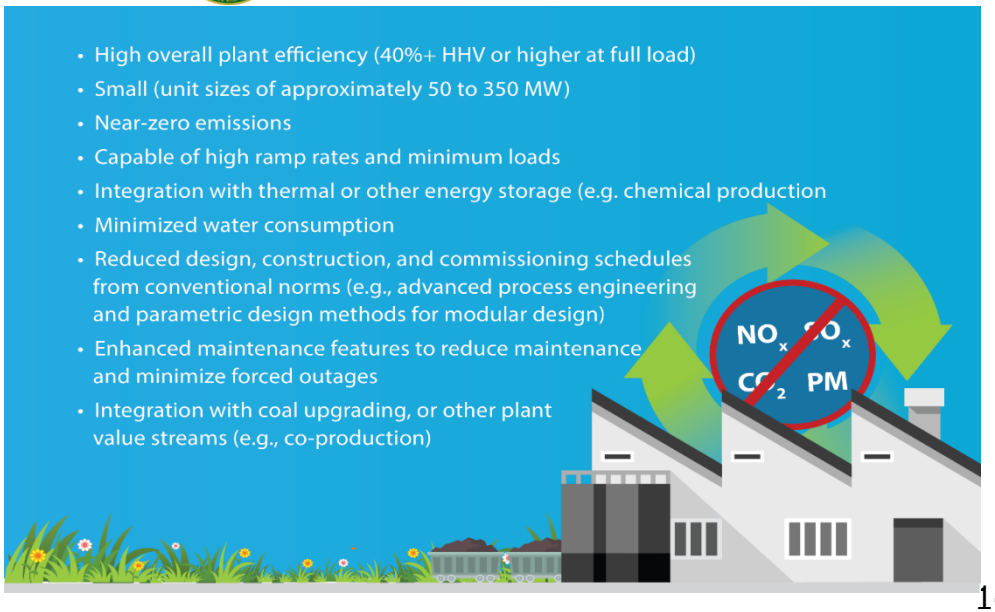
Goal: Develop the coal plant of the future needed to provide secure, stable, and reliable power.

The R&D under the Coal FIRST (Flexible, Innovative, Resilient, Small, Transformative) initiative will support future power plants that:

- Are capable of ***Flexible*** operations to meet the needs of the grid
- Use ***Innovative*** and cutting-edge components that improve efficiency and reduce emissions
- Provide ***Resilient*** power to Americans
- Are ***Small*** compared *to* today's conventional utility-scale coal
- Will ***Transform*** how coal technologies are designed and manufactured.

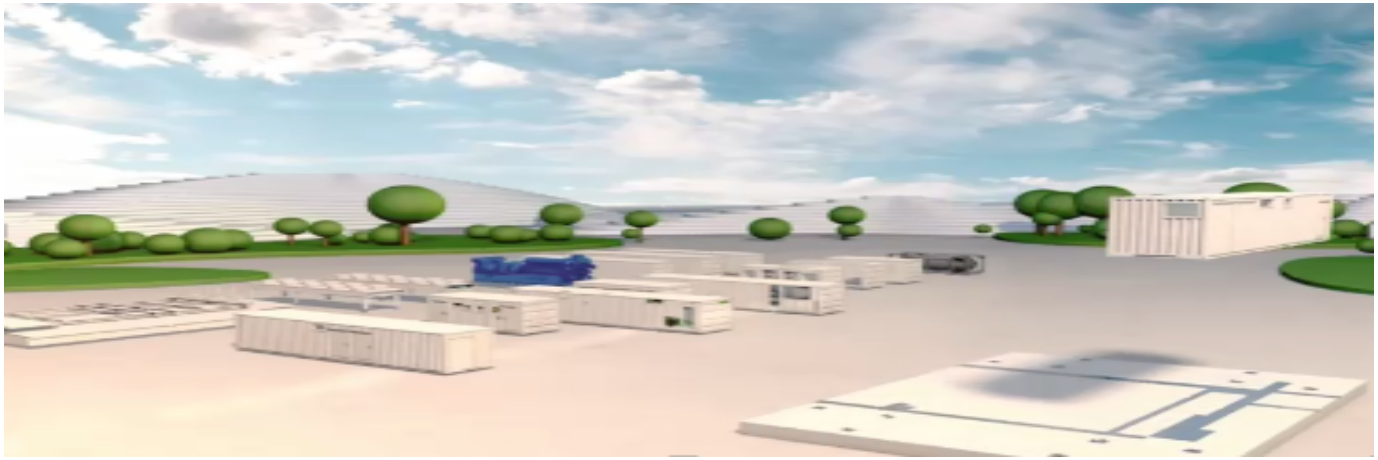
"Carbon Free Fossil Energy"

Coal First will have zero or near zero CO_2 emissions



Coal FIRST Technologies to Meet Opportunity

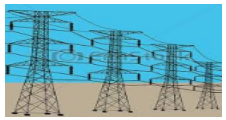
Flexible, Innovative, Resilient, Small, Transformative



The Challenge for Renewable Energy….Reliability and Cost

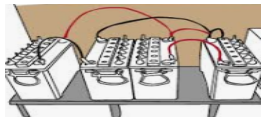
Solar

+



In remote areas

+



4 Hour backup

+

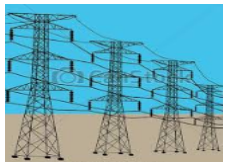
Long term
Back-up + CCS
Grid ancillary services

=

0% GHG

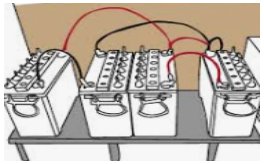
Wind

+



In remote areas

+



4 Hour backup

+

Long term
Back-up + CCS
Grid ancillary services

=

0% GHG

+

Unlikely, generally located near urban areas and existing lines

+

On-site secure fuel

+

NO Need

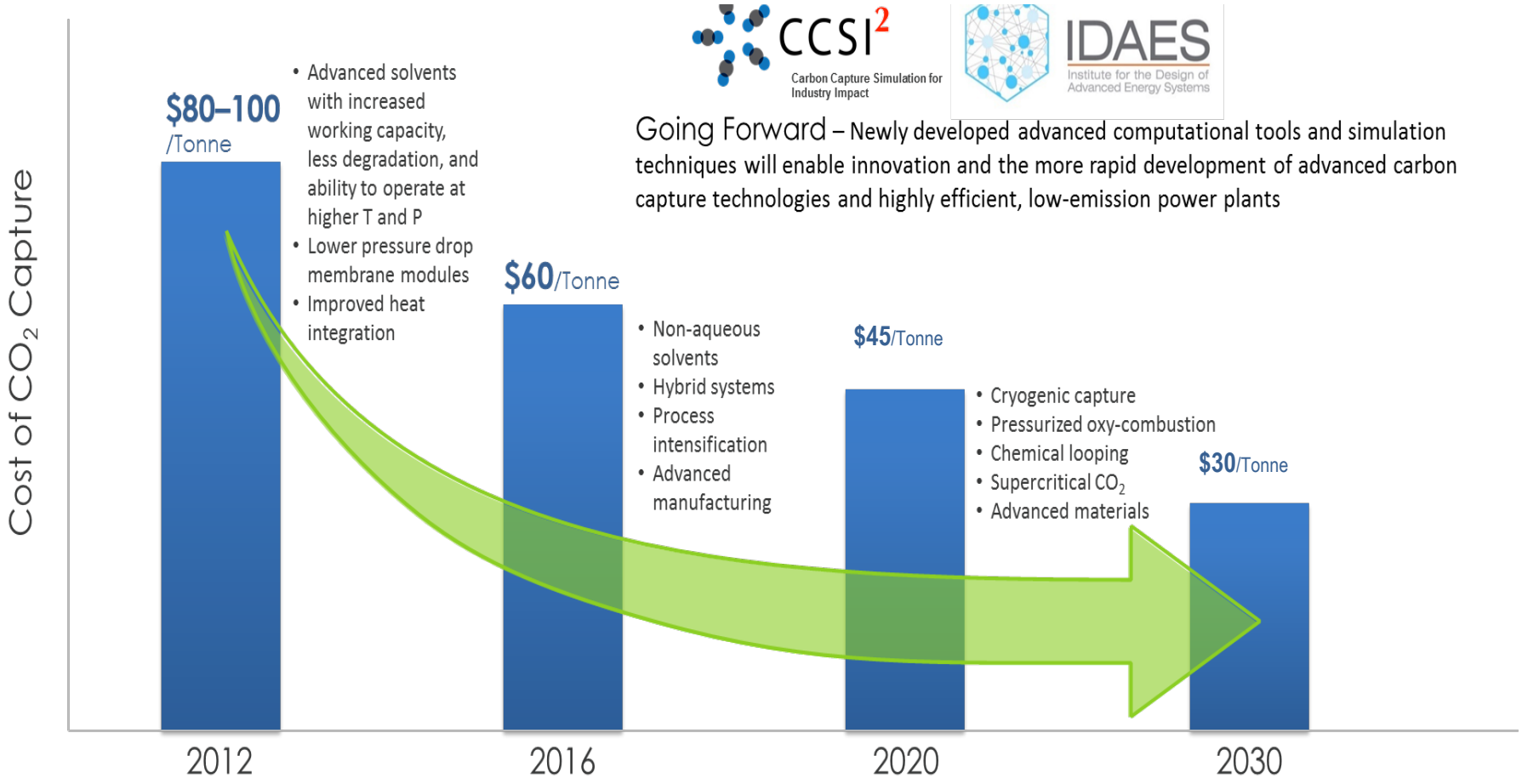
=

0% GHG

Coal First

Coal First Less Expensive Option

Need to Reduce the Cost of CCUS



CCSI² Carbon Capture Simulation for Industry Impact

IDAES Institute for the Design of Advanced Energy Systems

Going Forward – Newly developed advanced computational tools and simulation techniques will enable innovation and the more rapid development of advanced carbon capture technologies and highly efficient, low-emission power plants

Petra Nova-NRG Energy
Advanced Post Combustion CO2 capture

- Project at NRG's W.A. Parish power plant near Houston TX
- Retrofit of Existing Coal Plant to process flue gas from W.A. Parish Unit 8 - Post-Combustion CO_2 capture
- World's largest post-combustion CO_2 capture system
- Project was completed On-Budget and On-Schedule
- Delivering and permanently storing around 1.4 million metric tons of CO_2 per year for EOR.
- 240 MWe slipstream scaled up to improve project economics
- Technology applicable to retrofit of existing coal plants
- EOR at the Hilcorp West Ranch oil field.
- Total Project Cost: ~$1 billion (DOE Cost Share: $190 MM)
  - NRG Equity - $300 million
  - JX Nippon Equity – $300 million
  - JBIC Project Financing - $250 million
  - MHI – Technology Provider

Key Events:

- **Project Awarded: May 2010**
- **Completed Construction (on Schedule and Within Budget): December 2016**
- **Started Operations: January 10, 2017**
- **Ribbon Cutting Ceremony: April 13, 2017**
- **2017 Plant of the Year (Power Magazine)**
- **2017 Coal Project of the Year (Power Engineering Magazine)**
- **First 1 Million Tons of CO_2 Captured: Nov. 2017**
- **2 Million Tons of CO_2 Captured: Oct 2018**

Petra Nova project " …demonstrates that clean coal technologies can have a meaningful and positive impact on the Nation's energy security and economic growth."

U.S. DOE Secretary Rick Perry, April 13, 2017

National Carbon Capture Center (NCCC) Wilsonville, AL

Goal

Develop technologies under realistic conditions that will reduce the cost of advanced coal-fueled power plants with CO_2 capture

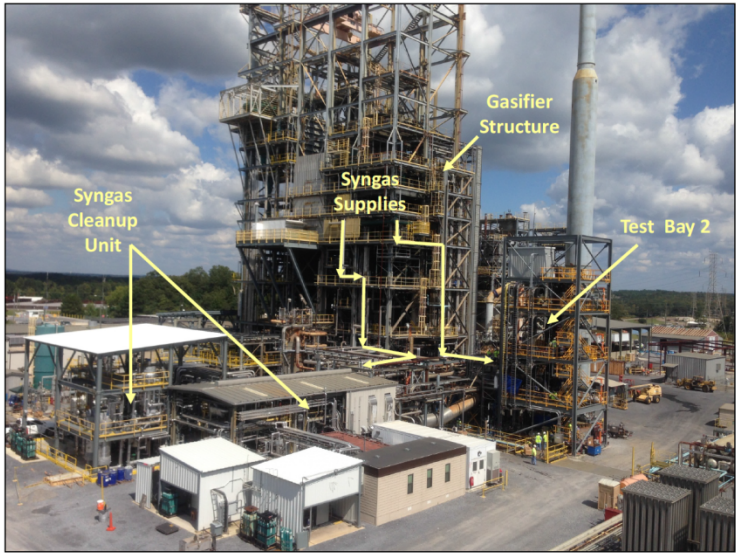
Advantages

- National resource for industry and academia to validate performance and operations of advanced capture
- Consistent testing procedures and data collection allow comparison
- Stellar safety and environmental record

Status

- Over 30 technologies tested from laboratory to small scale pilot
- Hundreds of technologies screened
- Opportunities to test technologies using NG

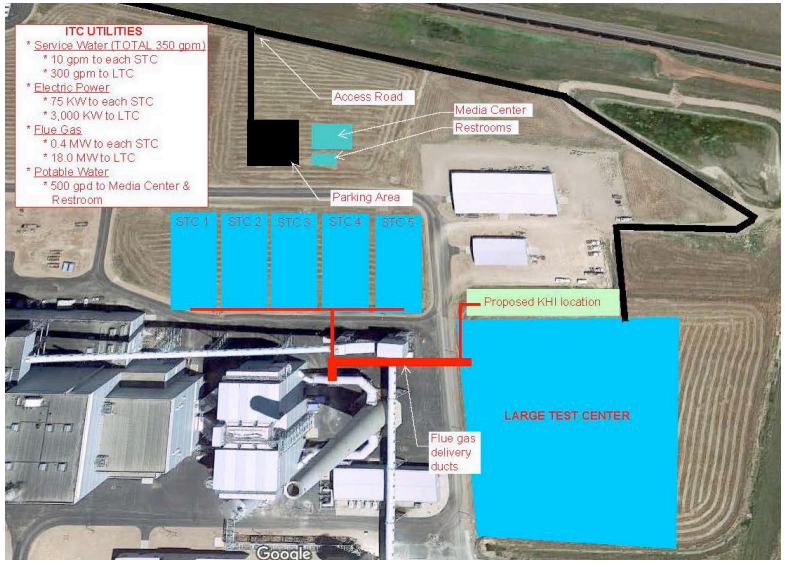
NCCC Pilot Solvent Test Unit (PSTU)



TRIG Pre-combustion Capture Center

Wyoming Integrated Test Facility

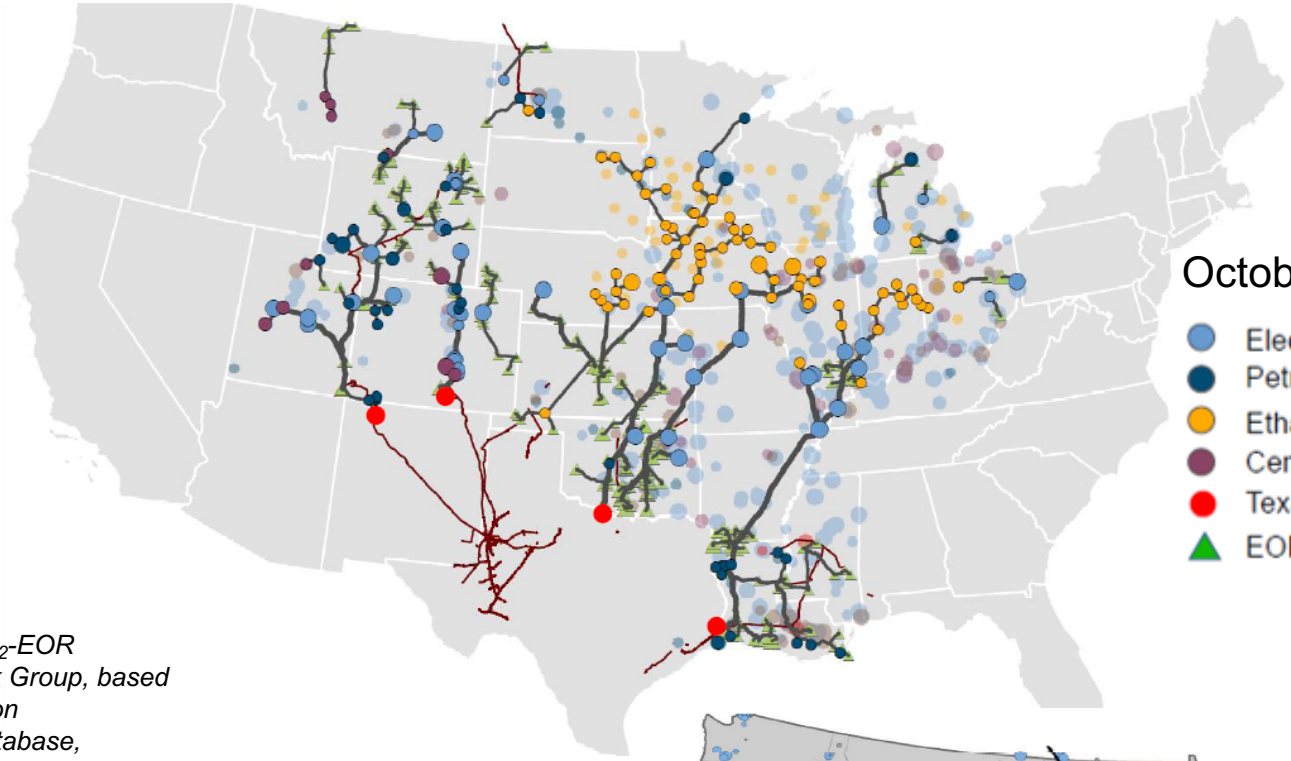
- **Basin Electric and Tri-state Generation owners**
- One of the largest post-combustion demonstration scale test facilities.
- 20+ MW of coal derived flue gas from the Dry Fork Power Station.
- Focused on larger scales to compliment DOE's National Carbon Capture Center and create a space for further scale up
- Capable of hosting multiple vendors
- XPRIZE - 5 teams CO2 utilization offering will produce building materials, polymers, and methanol using various CO2capture technologies.
- KHI and JCOAL - Fixed bed adsorbent optimization testing.



We Need a New West Coast Export Facility

- The US lacks meaningful export port capacity to handle coal off its west coast.
- Existing capacity is limited to small facilities in Long Beach, Stockton and Richmond California.
- Combined, these facilities have an annual capacity of 4.5-5.0 million short tons.
- US coal can be exported through ports in western Canada, however existing capacity, primarily at the Westshore Terminal near Vancouver, is limited because of strong demand from Canadian coal producers.
- Westshore is also logistically difficult for some US coal producers, namely those that produce coal in Utah, Colorado, Arizona and New Mexico.

U.S. CO_2 pipeline infrastructure

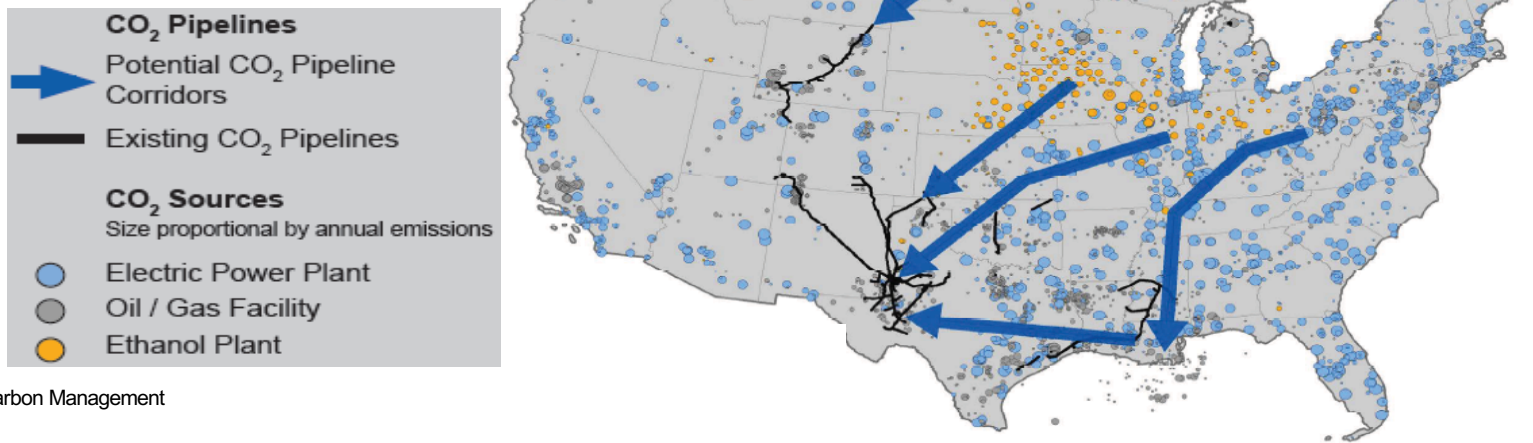


October 2018 scenario

- Electricity
- Petro-chem/NG Refining
- Ethanol
- Cement
- Texas Interconnection
- EOR Sink

Source: State CO_2-EOR Deployment Work Group, based on National Carbon Sequestration Database, accessed February, 2016

2016 scenario



Public Education and Acceptance is Important

Questions?

“Coal…. The 100% Organic Fuel”

Wyoming Coal Power Generation and Mining Overview

- 6 Power Plants in 5 WY Counties
- 6,700 MW Total Generation
- 304,187,000 tons coal produced in 2018
- 5 Counties receive Tax revenue from Coal Mining
- 5 School Districts at risk due to coal plant closures

Coal Mining Earnings v. Average Earnings Statewide

- http://www.wyomingmining.org/wp-content/uploads/2013/10/2018-19-Concise-Guide-to-Wyoming-Coal.pdf

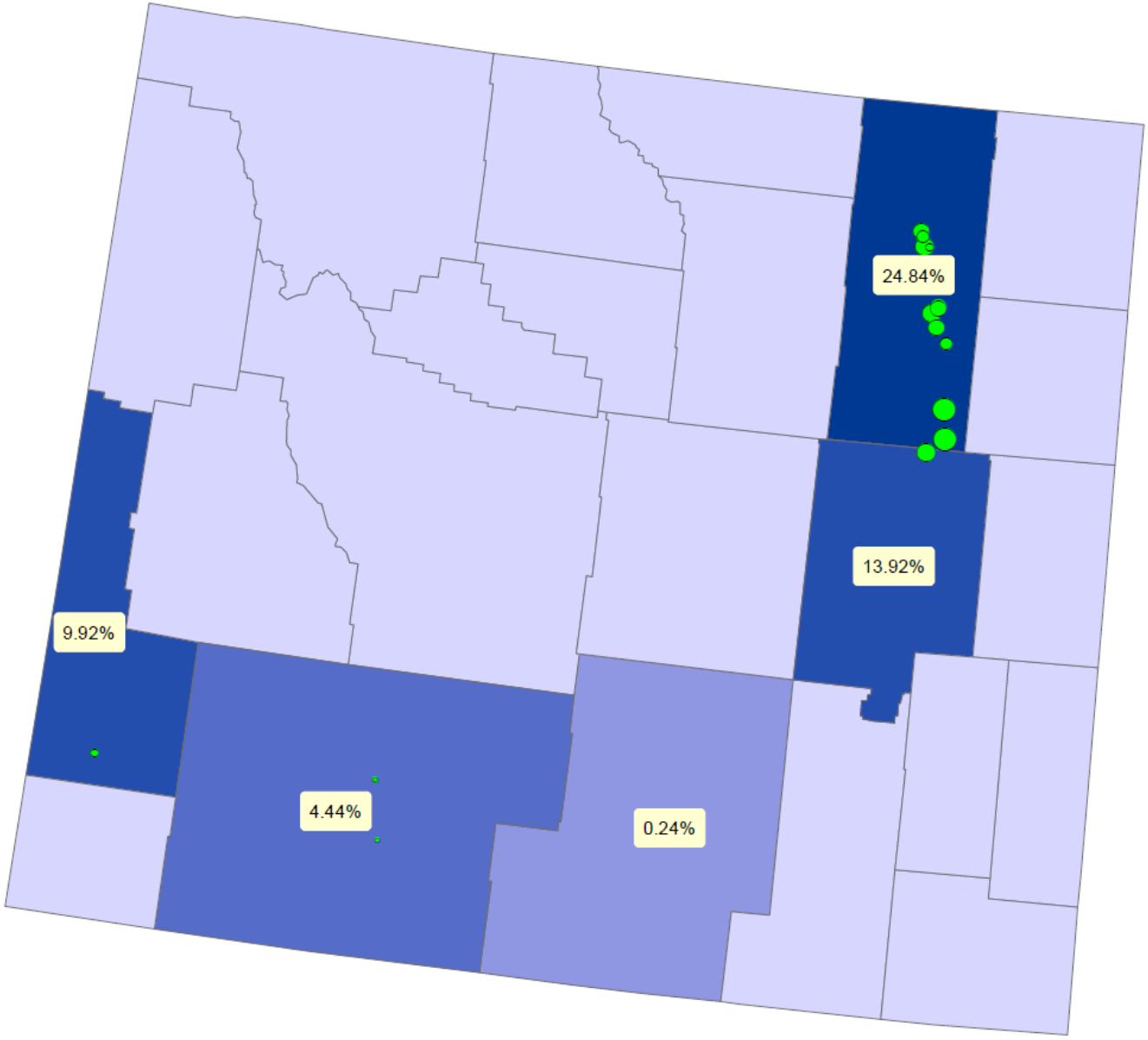
Counties where income from coal mining (NAICS 2121) is a significant portion of overall-level income and coal mines in Wyoming

Coal mining production (short tons)

- 0 - 2499798
- 2499798 - 6304022
- 6304022 - 9504750
- 9504750 - 13508689
- 13508689 - 23155741
- 23155741 - 98315794

% of county payroll from coal mining (NAICS 2121)

- 0%
- 0.01% - 0.24%
- 0.25% - 4.44%
- 4.45% - 13.92%
- 13.93% - 24.84%



School districts at risk from closure of coal-fired plants

School District Name	Coal-fired generation in school district, MW	School District Total 2015 Revenues, $	% of funding from local property taxes
Sweetwater County School District 1	2318	$112,911,000	**42%**
Platte County School District 1	1710	$20,573,000	**23%**
Campbell County School District 1	1225	$161,167,000	**55%**
Converse County School District 2	817	$14,076,000	**60%**
Lincoln County School District 1	707	$13,180,000	**75%**