

**BIA 25 -- TRIBAL PROVIDERS CONFERENCE
CLEAN COAL AND WASTE TO ENERGY SESSION
ANCHORAGE, ALASKA**

John M. Panek
Office Of Strategic Planning and
Global Engagement

DECEMBER 2015

The Energy Challenge

Goals for Energy Systems

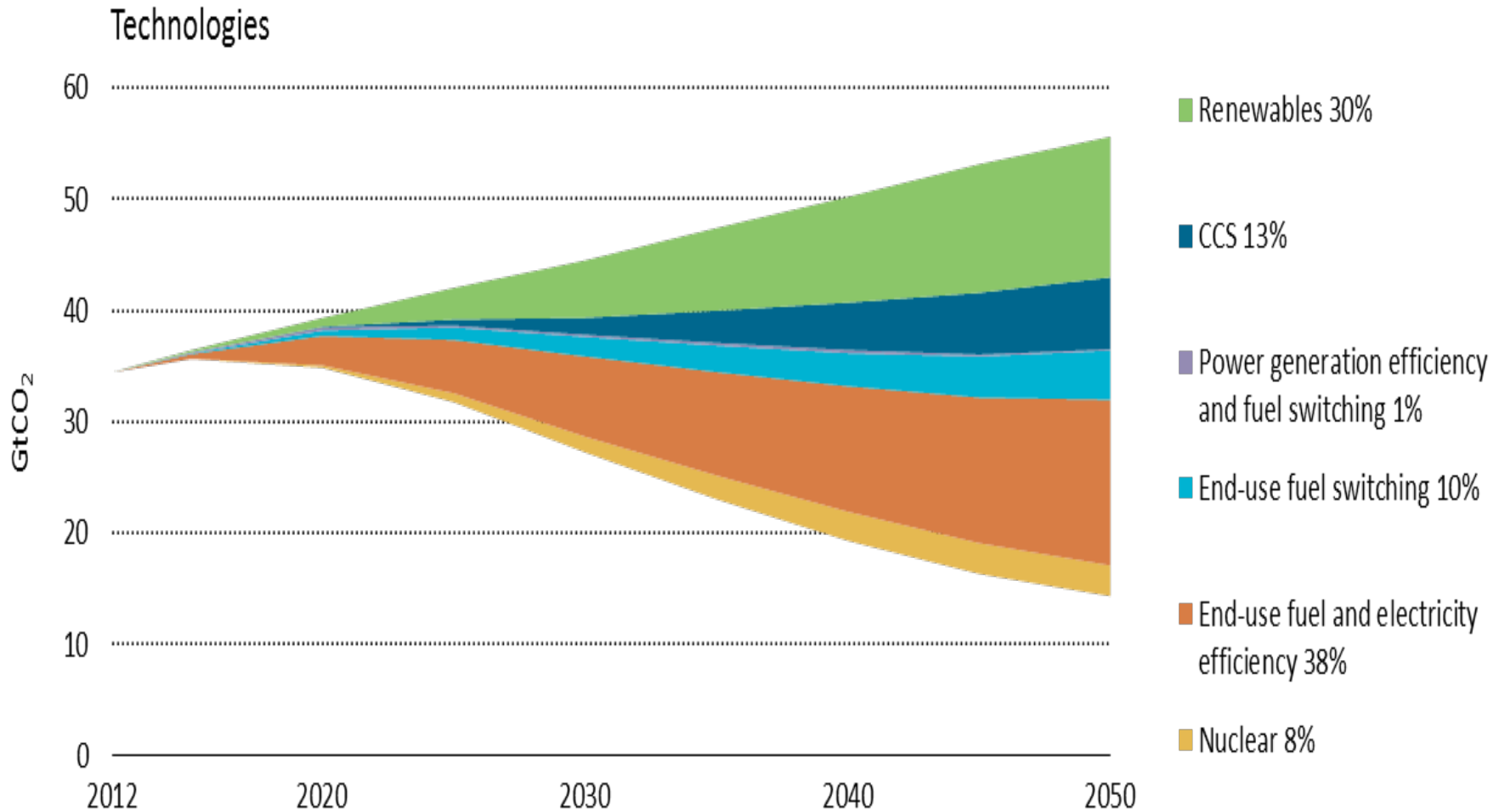
1. Economic security – cost efficient energy systems
2. Energy security – energy systems that have multiple supply options and are robust and resilient
3. Environmental security – much lower emissions of greenhouse gases and other pollutants

Opportunity

Create and manage linked, complex systems that deal with all three challenges

QUADRENNIAL TECHNOLOGY REVIEW

CCS Will Be Required To Meet Our Global Carbon Emission Reduction Goals

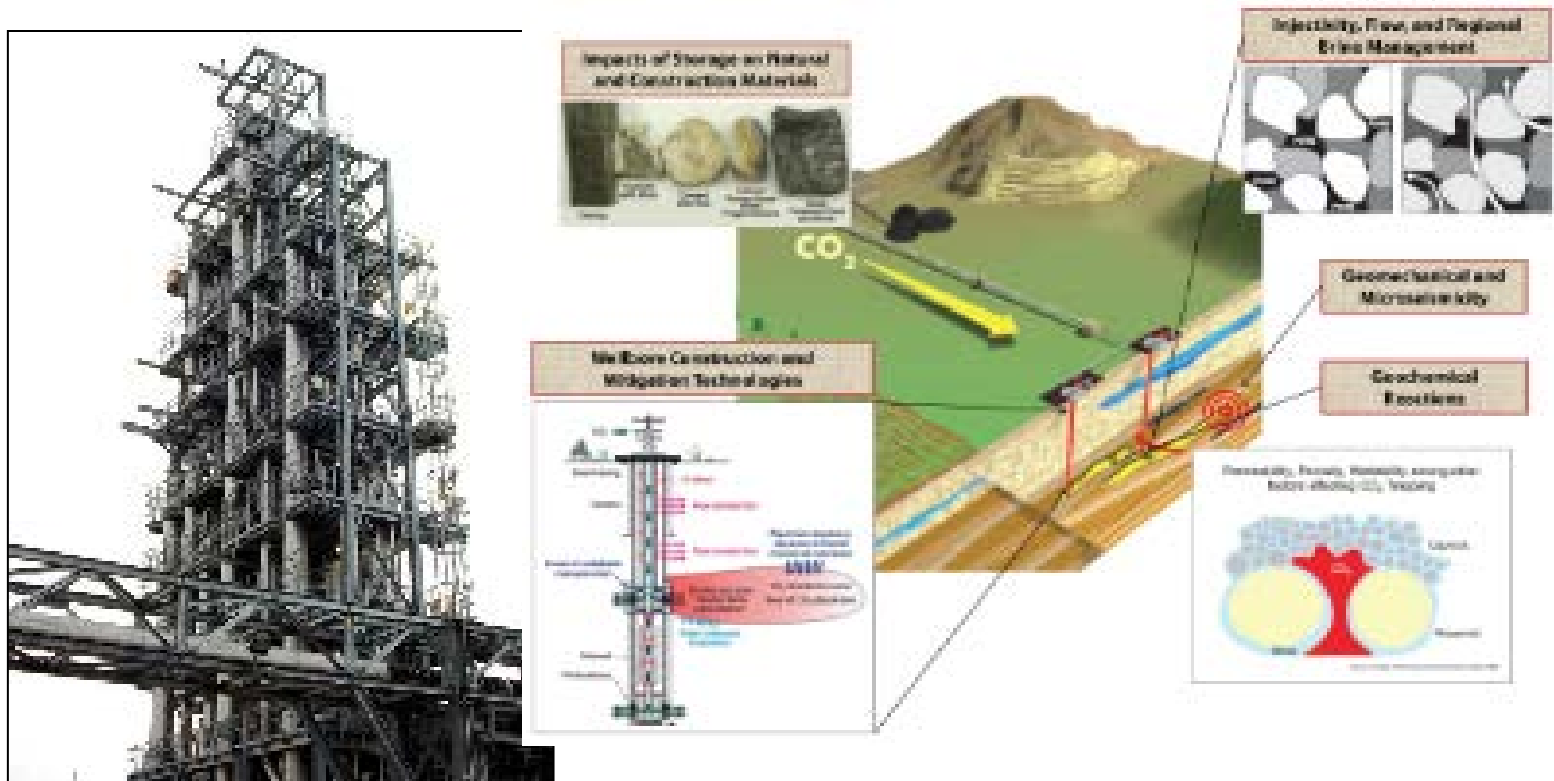


Source: International Energy Agency, ETP 2015



CCS Activities in the U.S. – Focused on Technology Development and Market Mechanisms

Technology Push



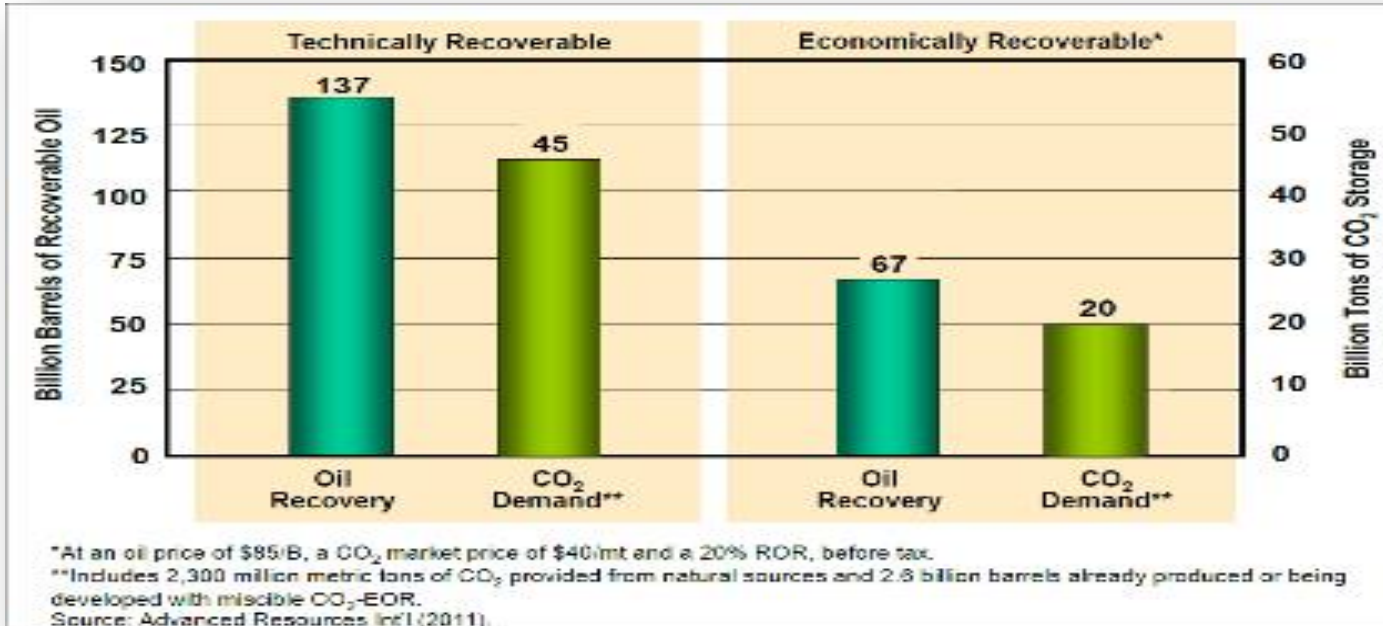
- R&D focused on: cost (capture) and confidence (storage)
- Demos (integration and learning)



CCS Activities in the U.S. – Focused on Technology Development and Market Mechanisms

Market Pull

Domestic Oil Supplies and CO₂ Demand (Storage) Volumes from “Next Generation” CO₂-EOR Technology**



- Existing Market Mechanisms: Enhanced Oil Recovery (EOR)
65 million tons per year of CO₂ to produce nearly 300,000 barrels of oil per day.
- Regulatory Framework
- Financing



Early CCS Projects



Sleipner
(Source: Statoil)



Great Plains Synfuels
(Source: Dakota Gasification)



Boundary Dam
(Source: SaskPower)



Kemper
(Source: IEA)



Decatur
(Source: US DOE)



Port Arthur
(Source: Air Products)



Peterhead
(Source: Shell)



Gorgon (Source: Chevron)



Scofford Upgrader
(Source: Shell)



REALIZING THE PROMISE OF CLEAN COAL



- Clean Coal Research
- Carbon Capture and Storage Research



- Petroleum Reserves
- Heating Oil Reserves



- Oil and Gas Research



- Natural Gas Regulation

(The Office of Fossil Energy regulates natural gas and LNG imports and exports under Section 3 of the Natural Gas Act of 1938.)



FE is Advancing Coal Towards a Low-Carbon Future



Making Coal Plants More Efficient

Gasification, Advanced Turbines, Advanced Combustion, CBTL, and Fuel Cells



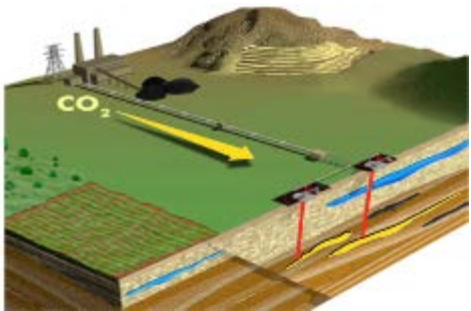
Capturing More CO₂

Cost-effective carbon capture for new and existing power plants



Turning CO₂ into Valuable Products

New pathways to utilize captured CO₂



Storing CO₂ Underground

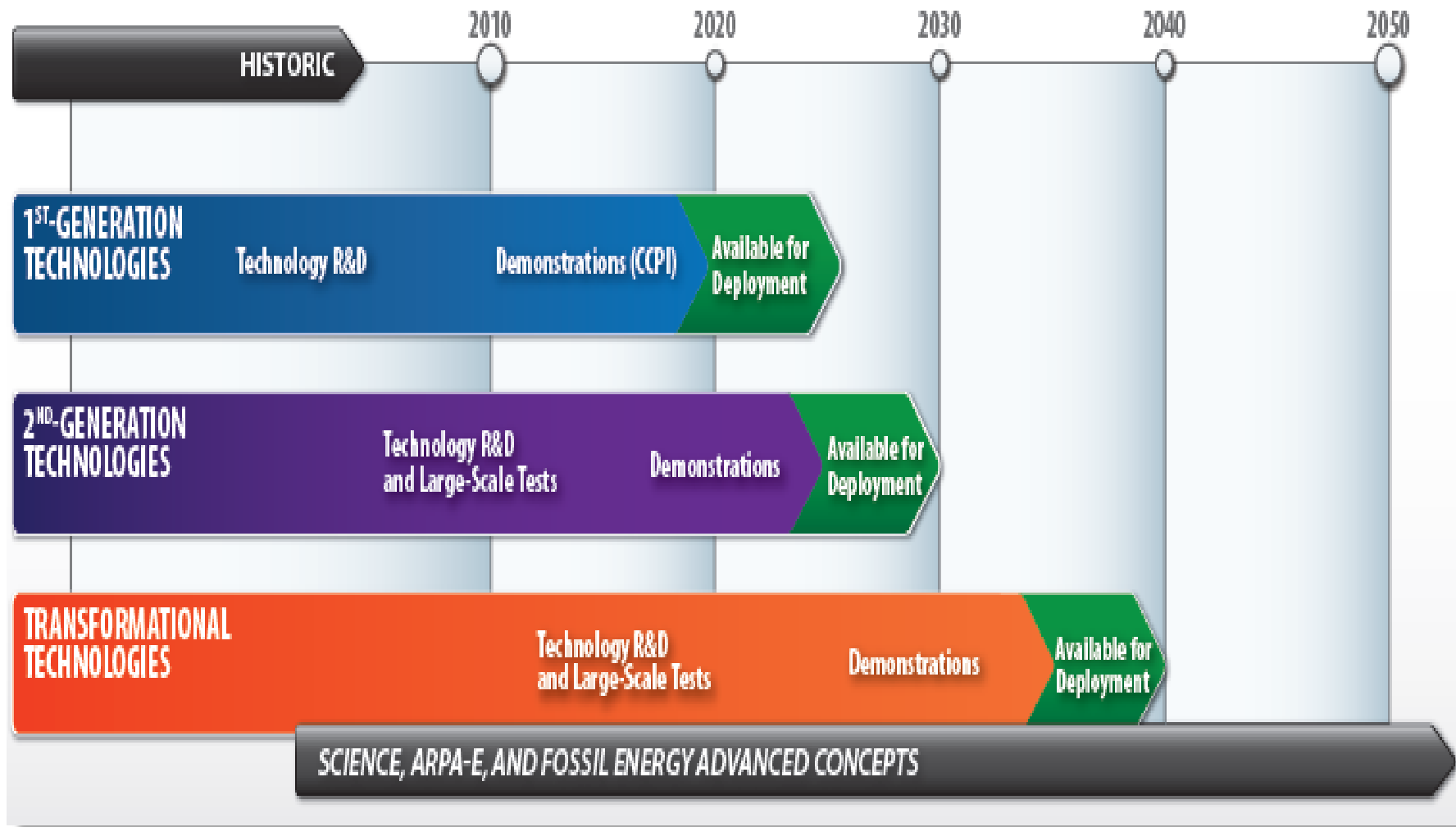
Safe, permanent storage of CO₂ from power generation and industry



Bringing it All Together

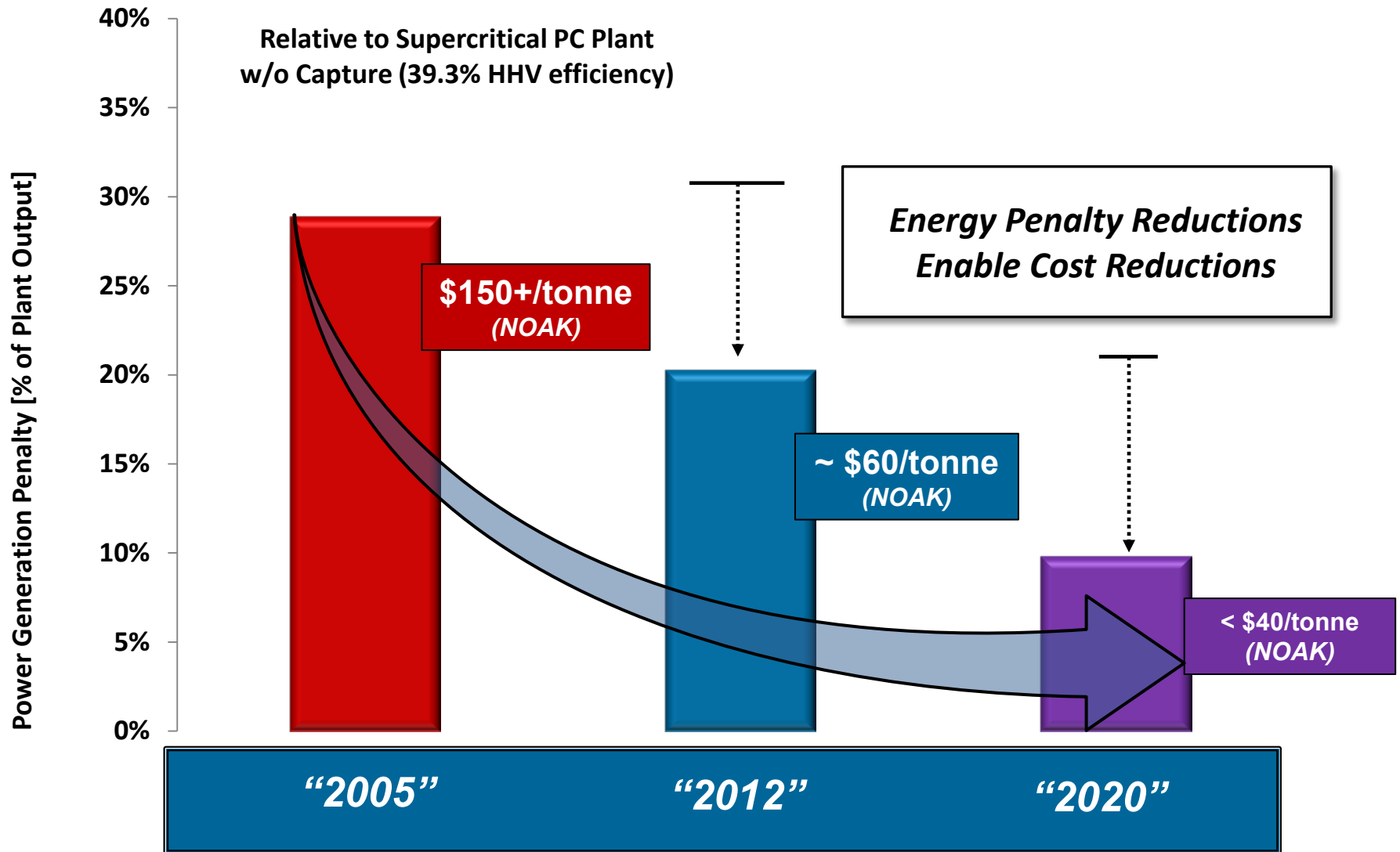
Crosscutting technology development program

A technology pipeline for affordable CCS



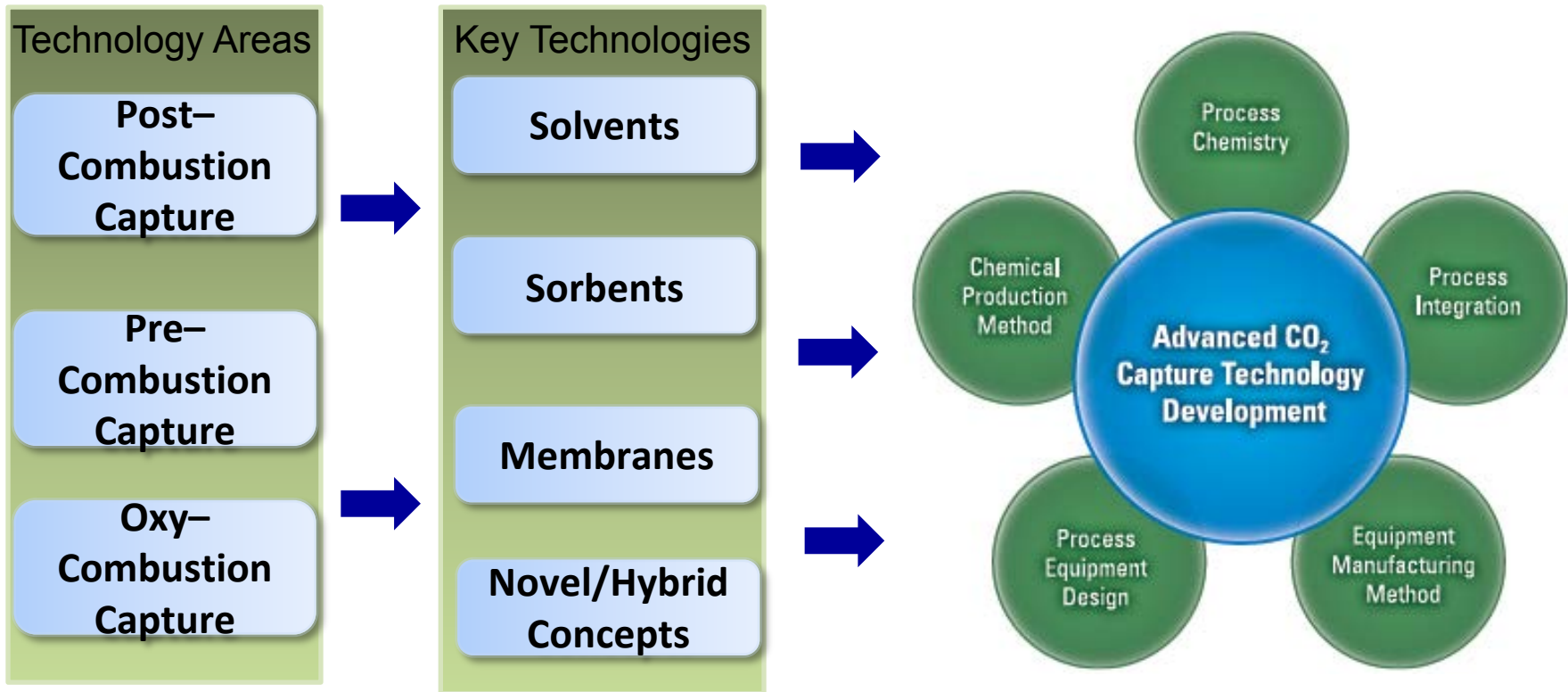
Clean Coal RD&D Progress

Performance Improvement is Driving Cost Reductions



CO₂ Capture

Requires Multiple Technologies and Multiple Scientific and Engineering Disciplines



Primary pathway to steep cost reductions



CO₂ Capture from Industrial Sources

- Globally, industry accounts for 40% of energy-related CO₂ emissions -
- mostly in developing countries
- Many industrial facilities are large point sources
- In some plants, CO₂ is already being captured in order to produce the desired product (e.g., H₂/Ammonia), and additional capture cost is minimal
- CO₂ concentration in treated stream may be high or nearly pure
- Often located near potential storage sites
- ICCS technology is applicable to coal-fired power generation



Hanson Permanente Cement Kiln, Los Altos, CA, 2008

Subsurface Activities

Discovering, Characterizing, and Predicting

Efficiently and accurately locate target geophysical and geochemical responses, finding more viable and low-risk resource, and quantitatively infer their evolution under future engineered conditions

Accessing

Safe and cost-effective drilling, with reservoir integrity

Engineering

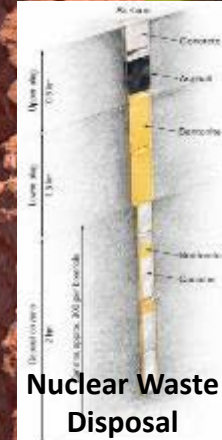
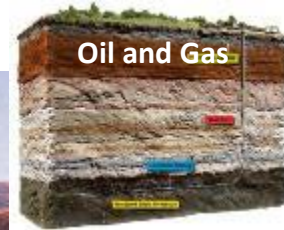
Create/construct desired subsurface conditions in challenging high-pressure/high-temperature environments

Sustaining

Maintain optimal subsurface conditions over multi-decadal or longer time frames through complex system evolution

Monitoring

Improve observational methods and advance understanding of multi-scale complexities through system lifetimes

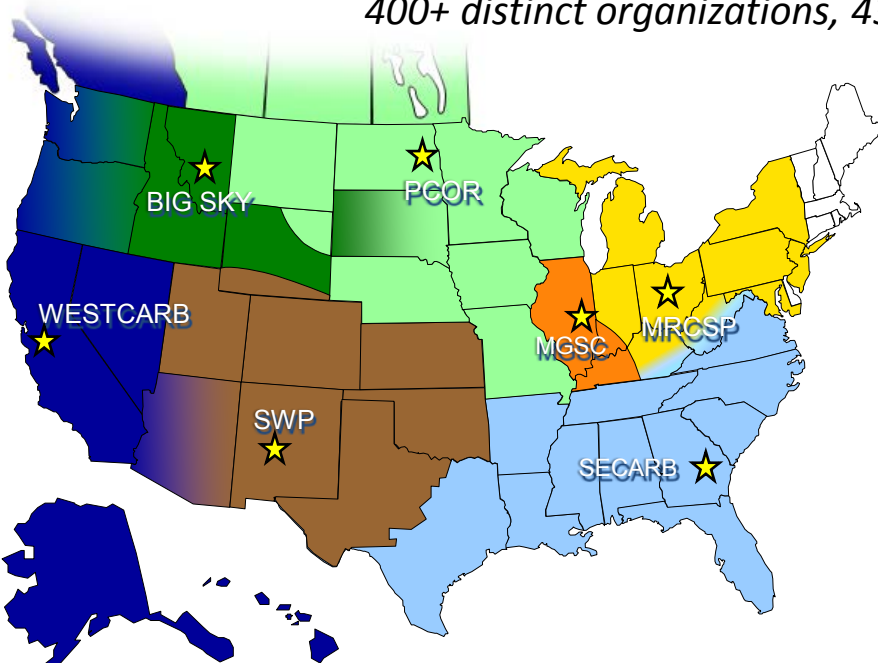


Regional Carbon Sequestration Partnerships

Developing the Infrastructure for Wide Scale Deployment

Seven Regional Partnerships

400+ distinct organizations, 43 states, 4 Canadian Provinces



- Engage regional, state, and local governments
- Determine regional sequestration benefits
- Baseline region for sources and sinks
- Establish monitoring and verification protocols
- Validate sequestration technology and infrastructure

Characterization Phase (2003-2005)

Search of potential storage locations and CO₂ sources

Found potential for 100s of years of storage

Validation Phase (2005-2011)

20 injection tests in saline formations, depleted oil, unmineable coal seams, and basalt

Development Phase (2008-2018+)

8 large scale injections (over 1 million tons each)

Commercial scale understanding and validation

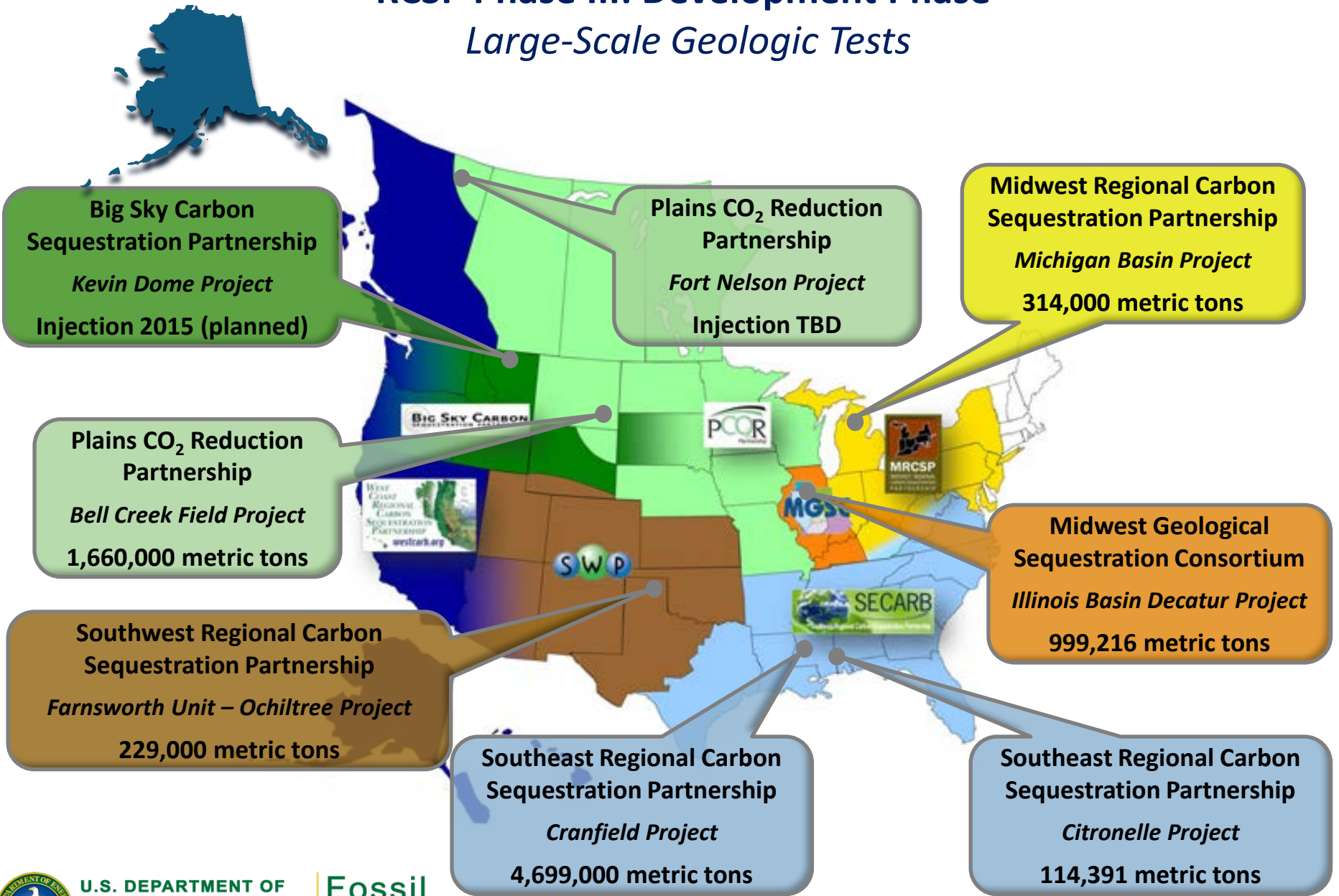


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RCSP Phase III: Development Phase

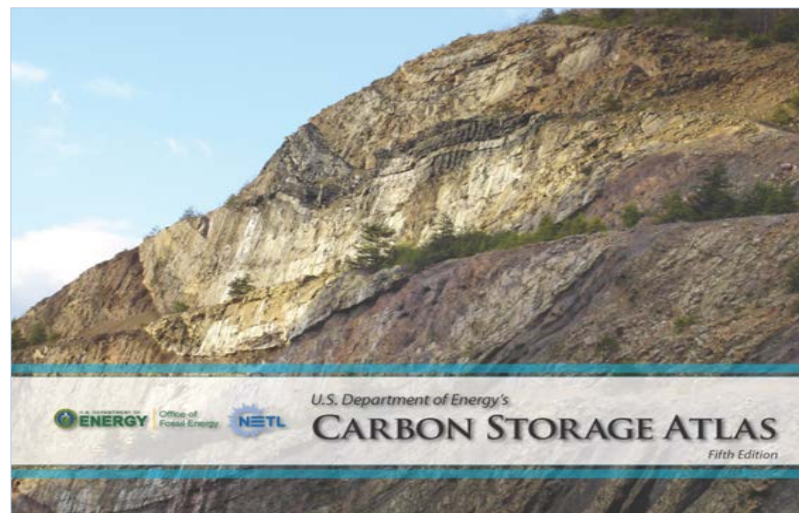
Large-Scale Geologic Tests



North American Carbon Storage Atlas

V

- Provides overview of DOE's Carbon Capture and Storage Activities
- Highlights from carbon storage research and analyses conducted at the National Energy Technology Laboratory
- Summarizes knowledge sharing efforts to Stakeholders



www.netl.doe.gov/research/coal/carbon-storage/natcarb-atlas



Capturing and Sharing Knowledge



Best Practices Manual	Version 1 (P--II)	Version 2 (P--III)	Final Version (Post-Injection)
Monitoring, Verification and Accounting	2012	2016	2020
Public Outreach and Education	2009	2016	2020
Site Characterization	2010	2016	2020
Geologic Storage Formation Classification	2010	2016	2020
Simulation and Risk Assessment	2010	2016	2020
Carbon Storage Systems and Well Management Activities	2011	2016	2020



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Carbon Capture and Storage

- Capture with solvents well demonstrated
- 2nd generation demonstrations
- Reduce energy penalties and costs of components, materials, chemistries, separations, integrated plant designs
- Storage in a variety of subsurface geologic settings
- Demonstrate for post-combustion retrofits, natural gas generation



Southern Company Kemper Project, IGCC + CC + EOR
Credit: Mississippi Power

Major CCS 1st Gen Demonstration Projects

Project Locations & Cost Share

 Clean Coal Power Initiative
 ICCS Area 1

Summit TX Clean Energy
 Commercial Demo of Advanced IGCC w/ Full Carbon Capture
 ~\$1.7B – Total, \$450M – DOE
 EOR – ~2.2M MTPY 2018 start

Archer Daniels Midland
 CO₂ Capture from Ethanol Plant
 CO₂ Stored in Saline Reservoir
 \$208M – Total, \$141M – DOE
 SALINE – ~0.9M MTPY 2015 start

Southern Company
 Kemper County IGCC Project
 Transport Gasifier w/ Carbon Capture
 ~\$4.12B – Total, \$270M – DOE
 EOR – ~3.0M MTPY 2015/2016 start

HECA
 Commercial Demo of Advanced IGCC w/ Full Carbon Capture
 ~\$4B – Total, \$408M – DOE
 EOR – ~2.6M MTPY 2019 start

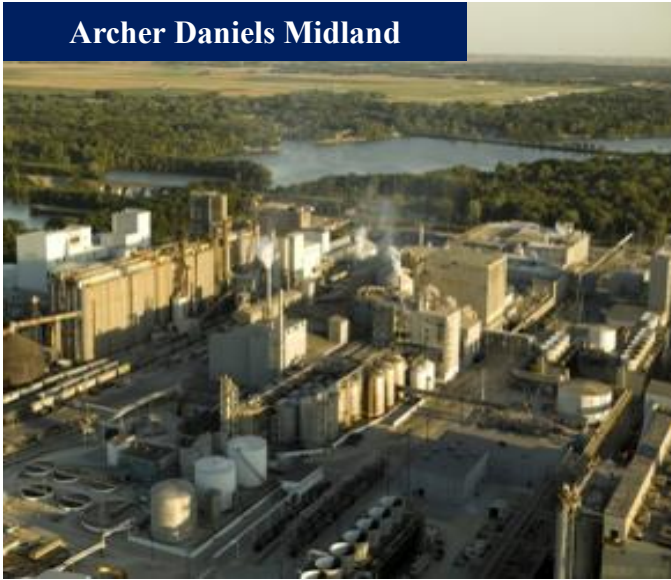
Petra Nova (formerly NRG)
 W.A. Parish Generating Station
 Post Combustion CO₂ Capture
 \$775 M – Total
 \$167M – DOE
 EOR – ~1.4M MTPY 2017 start

Air Products and Chemicals, Inc.
 CO₂ Capture from Steam Methane Reformers
 EOR in Eastern TX Oilfields
 \$431M – Total, \$284M – DOE
 EOR – ~0.93M MTPY 2012 start



Archer Daniels Midland (ADM) ICCS Demonstration

Archer Daniels Midland



Project Background

- Decatur, IL
- Corn to Ethanol Biofuel plant with CO₂ Geologic Storage
- CO₂ >99% purity from fermentation reactors (dehydration & compression); ~900,000 tonnes CO₂/year
- Total Project: \$208 million; DOE share: \$141 million

Current Project Status

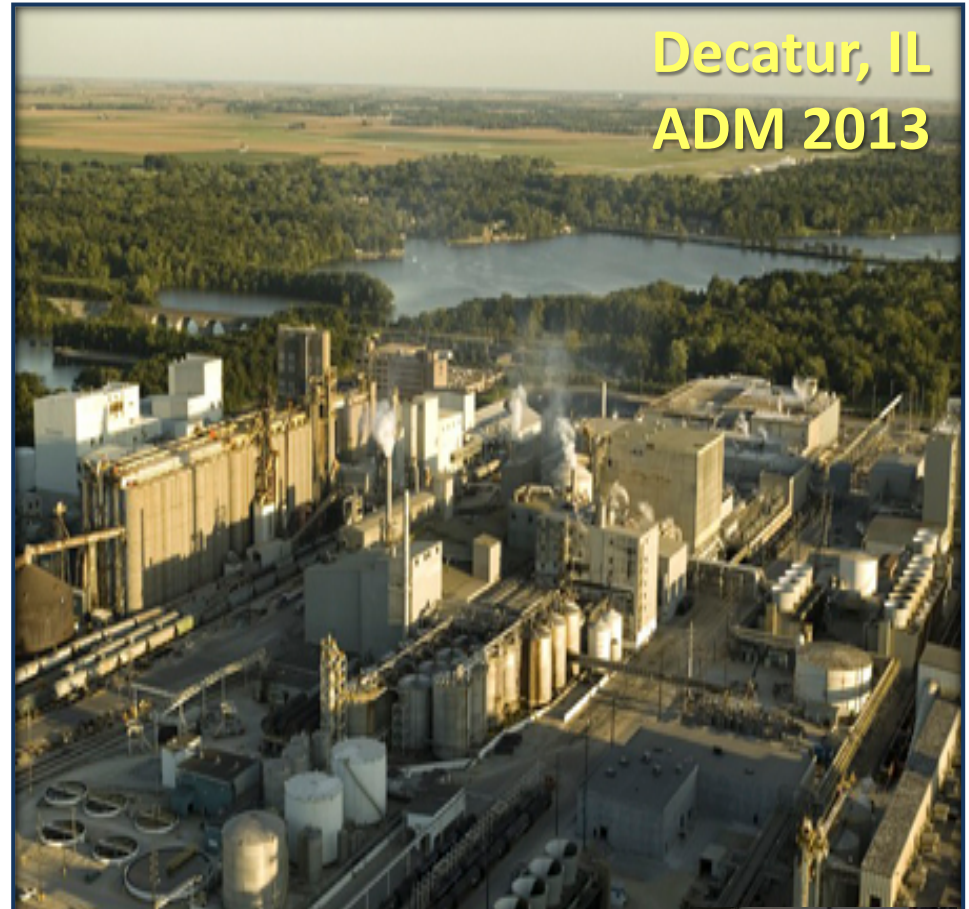
- Drilled the monitoring and geophysical wells (Nov 2012)
- Injection well was drilled to a total depth of 7192 feet (May 28, 2015)
- Working towards
- EPA authorization for injection and begin CO₂ sequestration (Nov 2015)
- CCS in operation Apr/May 2016



Archer Daniels Midland (ADM) Ethanol Facility



- A Dehydration/compression facility location
- B Pipeline route
- C Injection well site
- D Verification well site
- E Geophone well



CO₂ Pipe to Injection Well

Compression Facility



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Air Products ICCS Demonstration

Air Products – Port Arthur



Project Background

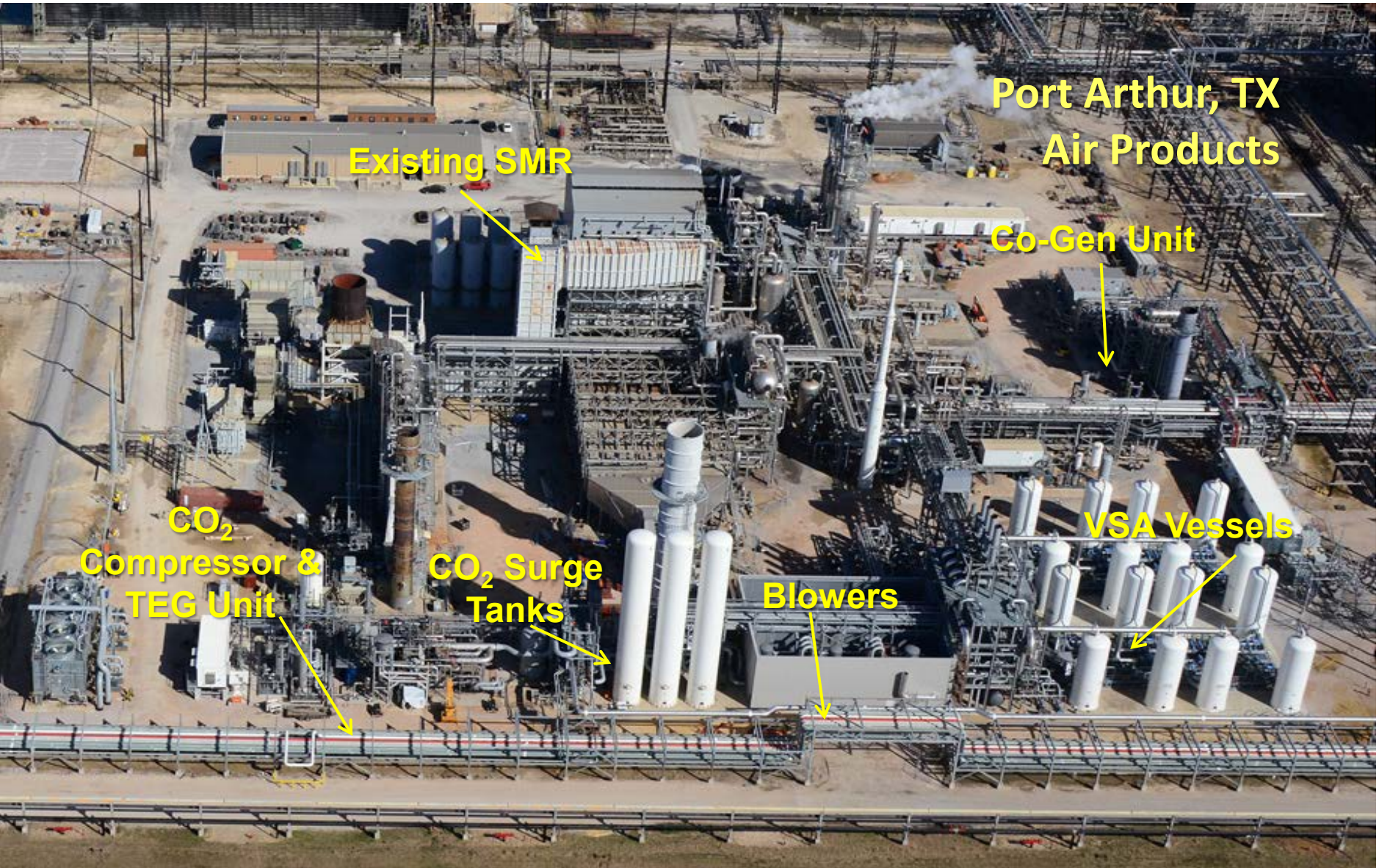
- Port Arthur, TX
- Hydrogen production plant at Valero Refinery
- 90%+ CO₂ capture (Vacuum Swing Adsorption) ~925,000 tonnes CO₂/year sent through Denbury “Green” pipeline to West Hastings oil field
- Total Project: \$431 million; DOE share: \$284 million

Current Project Status

- In operation since December 2012
- Successfully captured and delivered over 2,000,000 metric tons of CO₂
- Project has been a successful demonstration of ICCS for EOR in production for over two years



Air Products ICCS Demonstration



PetraNova Project – W.A. Parrish, TX



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Wide-Ranging Partnerships At Home and Around the World

Cooperation and Collaboration is Critically Important



Shale Gas Risk Analysis



CCS Knowledge Sharing

Strategic Petroleum Security

NPC



Multi-lateral Collaboration

Bilateral Agreements



Unconventional Oil & Gas Exploration

Geologic Research & Modeling



Fossil Energy

International partnerships required

Many platforms (WEC, APEC, etc.)

CSLF: Multinational platform

- 22 countries + E.C.
- 12 years in practice
- Productive technical and policy working groups
- Potential to showcase global large scale CCS projects

Partnerships in Commerce

- Joint ventures
- International investment
- “Showcase” projects

Accelerated Deployment

- Data sharing
- International Science Projects



Carbon Sequestration Leadership Forum

www.cslforum.org



Mission

An international initiative focused on improved cost-effective technologies for the separation and capture of carbon dioxide for its utilization and long-term safe storage

Purpose

Make technologies broadly available internationally;
Identify and address wider issues

23 members



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The Next Decade of Projects: Policy Infrastructure



Pure CO₂ Sources >95%
(kT CO₂ per year)

- 0 - 250
- 250 - 500
- 500 - 1000



Technology Informs Policy

- **Technology Development**

- Informs state, industry, regulatory, and governmental leaders on the current technical “state of the art” fossil based technologies.
- Provide high-level information on the general direction of R&D initiatives on many fossil energy component technologies.

- **EPA’s Clean Power Plan (111(d))**

- Fossil Energy, through its National Laboratory, has access to tools and analysis capabilities that can help States examine their options on Greenhouse Gas mitigation and fossil resource use.
- Provide technical expertise and speakers at meetings to discuss energy technologies and policies that can be used to help States mitigate Greenhouse Gas emissions.

- **Education/Information**

- FE has access to significant amounts of information and educational material on a variety of coal and fossil issues ranging from electricity to fuels. These include topics like: Carbon Capture & Storage (CCS), Turbines, Gasification, Fuel Cells, Fuels, Crosscutting Research, Major Demonstration projects, etc.



The next decade of projects = policy infrastructure



Pure CO₂ Sources >95%
(kT CO₂ per year)

- 0 - 250
- 250 - 500
- ◻ 500 - 1000



Key unit of innovation – global engines of discovery



For More Information...

www.fossil.energy.gov 



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twitter.com/fossilenergygov