The Path Forward for Coal
The Role of Technology Innovation

Janet Gellici, National Coal Council

Power Plant Management & Generation Summit

Houston, TX – October 24, 2016

National Coal Council

Celebrating 32 years ~ 1984|2016

The National Coal Council provides advice and recommendations to the Secretary of Energy on general policy matters relating to coal and the coal industry.

NCC is a Federal Advisory Committee organized under FACA legislation

National Coal Council

Members

Appointed to serve
by Secretary of Energy
125-150 members

Reports

~ 35 reports prepared by NCC members at no cost to DOE

- **Industry –**
  coal suppliers, utility & industrial consumers & coal transportation
- **Support Services –**
  engineering firms, vendors, consultants & attorneys
- **Academics**
- **NGOs –**
  environmental & trade association reps
- **Government –**
  PUC & state energy officials

Extensive Range of Topics

Carbon Management
Clean Coal Technologies
Coal & Coal Technology Exports
Coal Conversion
Utility Deregulation
Climate & Clean Air Regulations
Building New Coal Power Plants
Industrial Coal Use
CCUS for EOR
Value of Existing Coal Fleet
Fossil Forward: CCS Technologies
Policy Parity for CCS
CO_2 Building Blocks: CO_2 Utilization

Presentation Overview

- Trending in Energy
- Policy Parity for Coal Technologies
- The Path Forward

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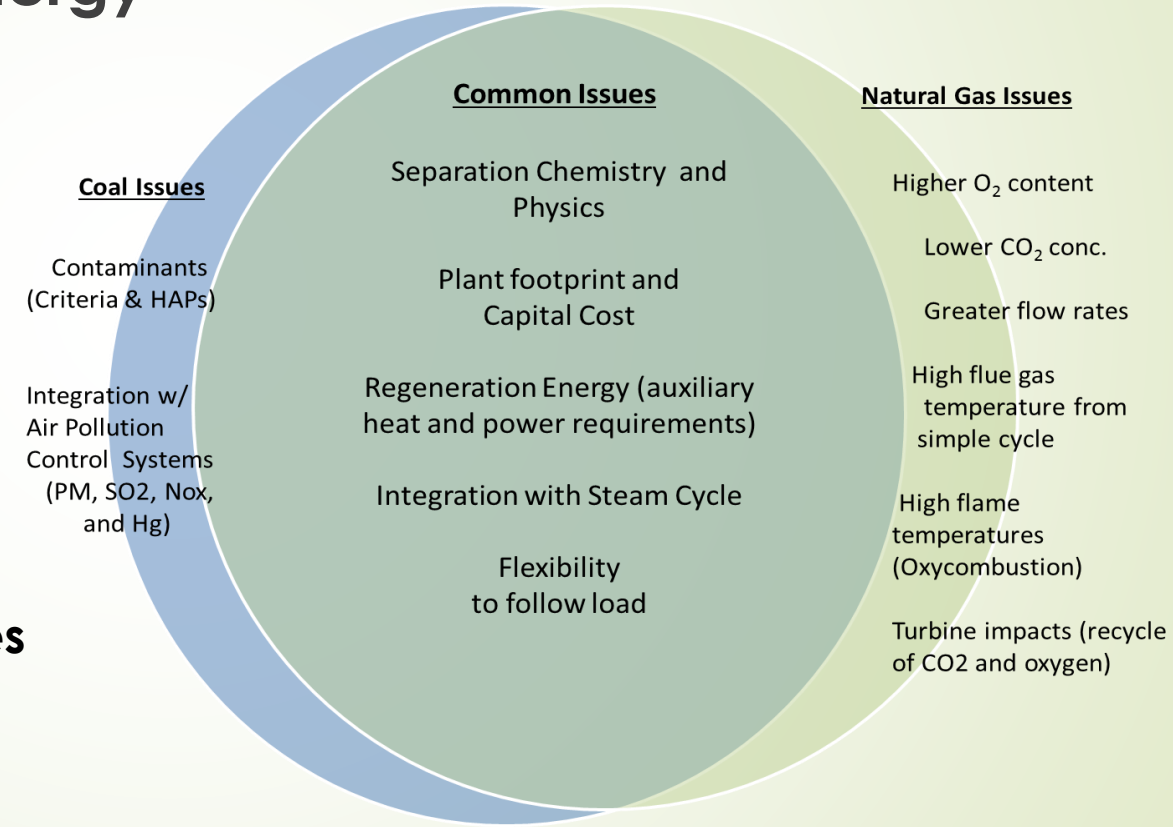
Trending in Energy

- Integration of Fossil Energy
- "Expanding the Tent"



Common & Distinct Challenges of Carbon Capture for Coal & Natural Gas

Source: U.S. Department of Energy

Trending in Energy

- Technology Innovation Push
- International Partnerships

MISSION INNOVATION
Accelerating the Clean Energy Revolution

nrg | cosia CARBON XPRIZE
Reimagine CO_2

U.S.–China Clean Energy Research Center
中美清洁能源联合研究中心

INTRODUCING THE
BREAKTHROUGH ENERGY COALITION

The world needs widely available energy that is reliable, affordable and does not produce carbon.

Trending in Energy

- Energy Security
- Value of Diversity

"A **diverse portfolio** of energy resources is **critical to U.S. energy and national security**. A diverse energy system has the inherent benefits of being **more robust and resilient** in comparison to a system that is heavily dependent on a limited set of energy resources. A system that is diverse helps insulate the economy from certain risks, including **price volatility** and risks from **supply disruptions** that can affect the availability of particular energy resources or infrastructure."

U.S. Department of Energy – August 2016
Carbon Capture, Utilization, and Storage:
Climate Change, Economic Competitiveness, and Energy Security

Trending in Energy

- Consensus on Need for CCUS
- Recognition of Need for Policy Parity for CCS

"There is a growing consensus among industry, the environmental community and governments that future carbon dioxide (CO_2) emission reduction goals cannot be met by renewable energy sources alone and that carbon capture, utilization and storage (CCUS) technologies for all fossil fuels will have to be deployed to achieve climate objectives in the U.S. and globally."

National Coal Council – August 2016
CO_2 Building Blocks: Assessing CO_2 Utilization Options

"In order to achieve CCS deployment at commercial scale, policy parity for CCS with other low carbon technologies and options is required."

National Coal Council – January 2015
Fossil Forward – Revitalizing CCS: Bringing Scale & Speed to CCS Deployment

NCC Report - January 2015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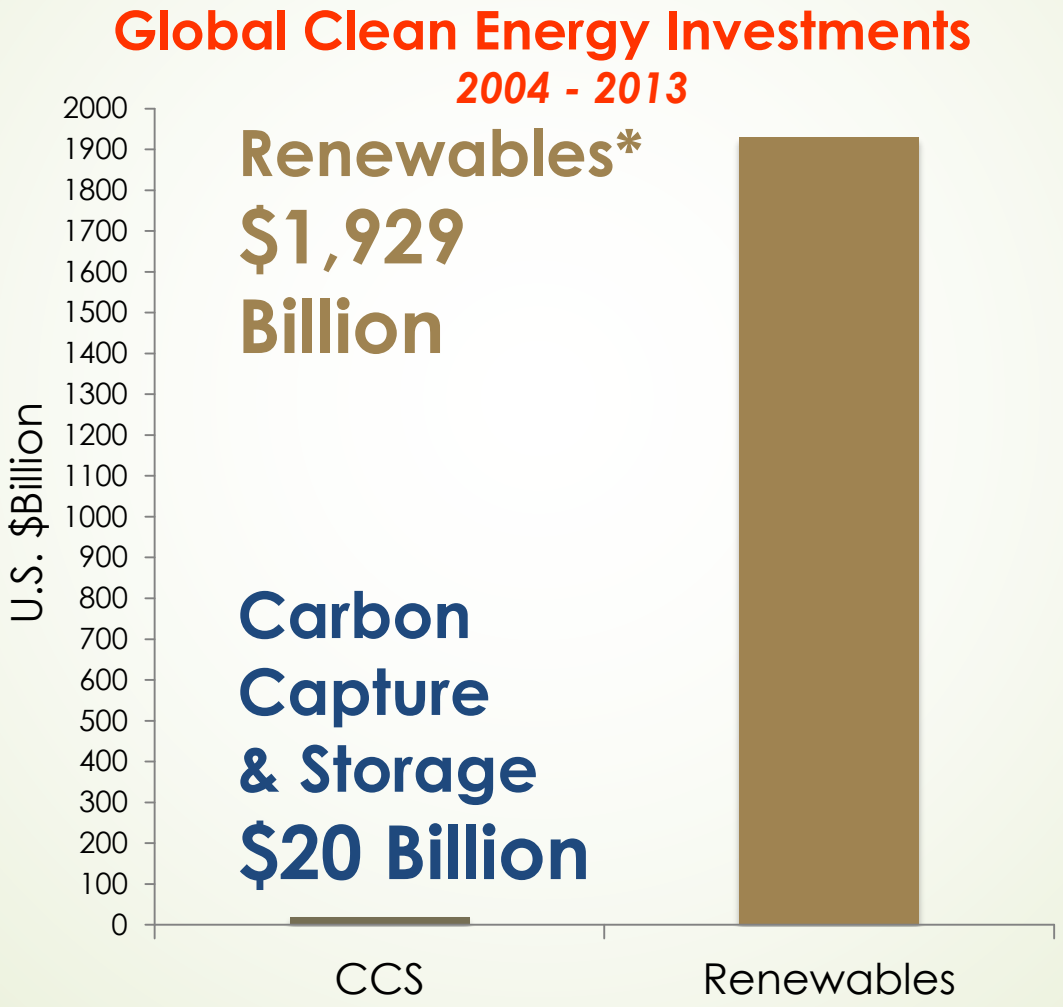
LEVELING THE PLAYING FIELD
Policy Parity for Carbon Capture and Storage Technologies
NCC White Paper – November 2015

Dis-Parity CCS vis-a-vis Renewables



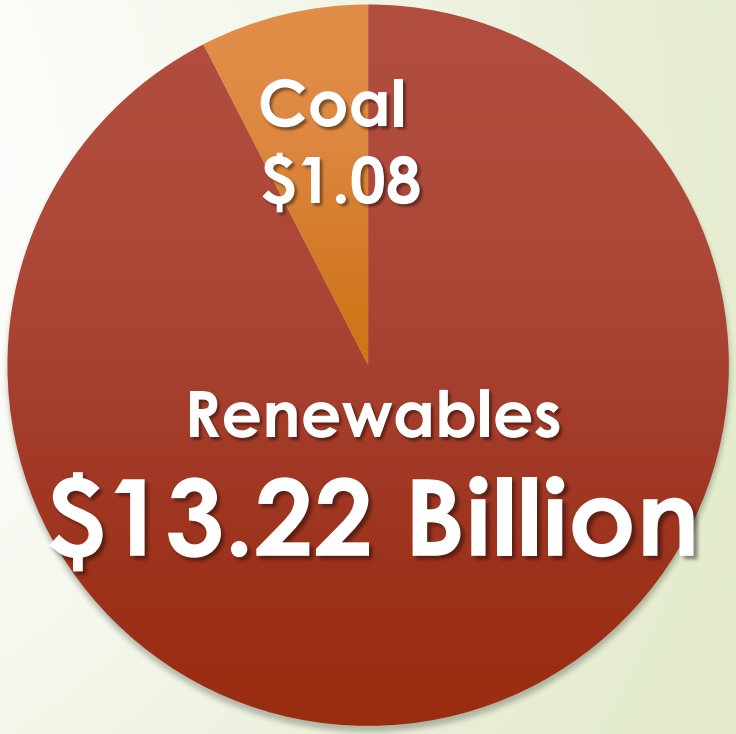
Source: International Energy Agency. *Includes technology development , projects, M&A. Source: BNEF.

U.S. Renewables Received 12X Federal Incentives Versus Coal in 2013

Renewables Receive 72% of Total Incentives
Coal Just 6%

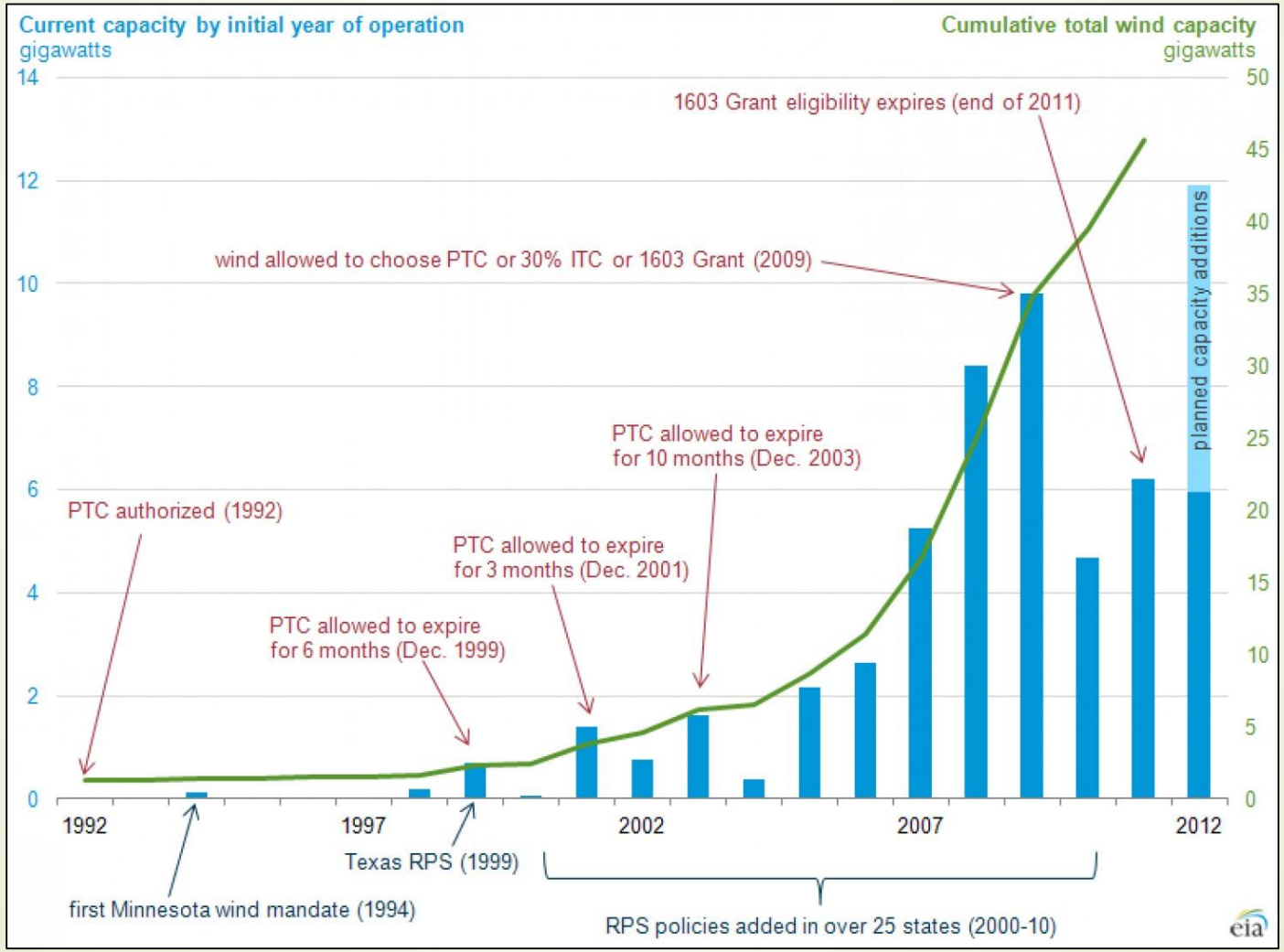
- Fossil fuels produced 78.5% of U.S. energy; renewables 11.4%, nuclear 10.1% in 2013
- Renewable subsidies increased from ~15% in 2007 to 72% in 2013
- Funding for coal declined from 12.7% in 2007 to 6% in 2013

U.S. Energy Incentives in 2013

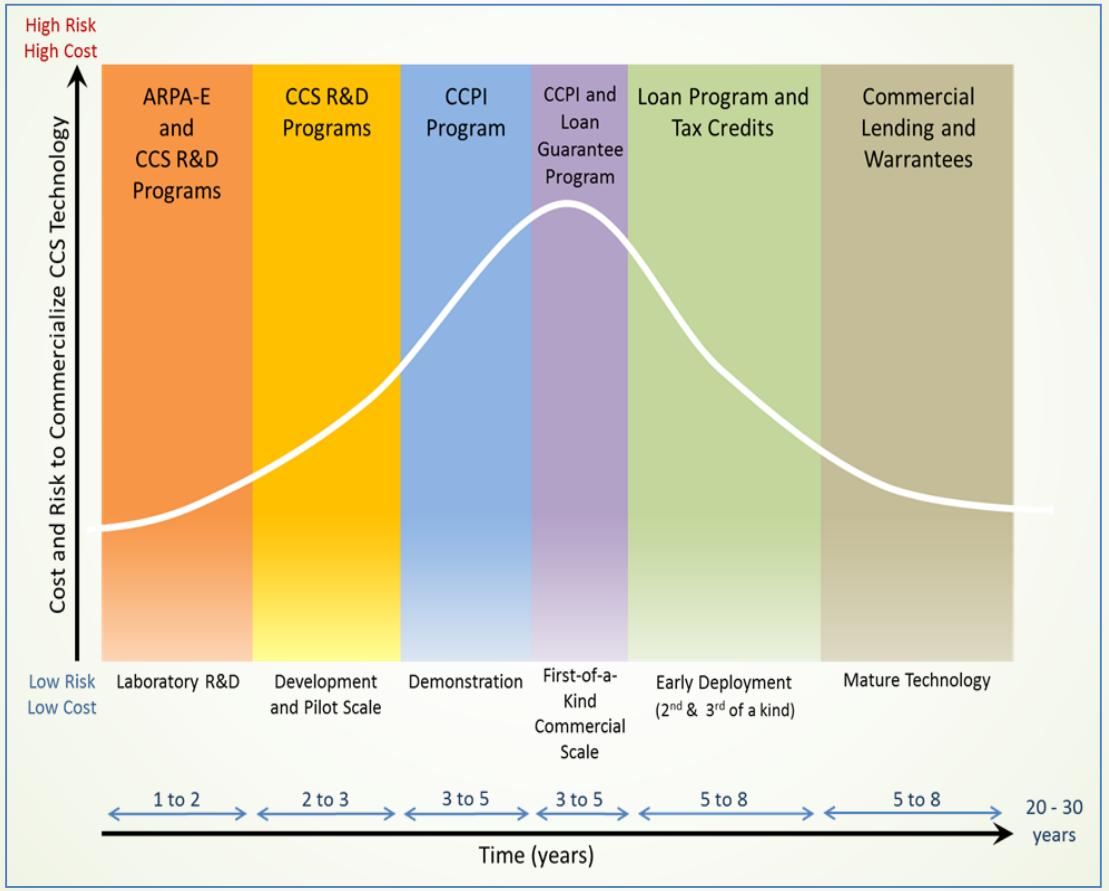


Source: Energy Information Administration, March 2015.

Policy & Financial Incentives Work



Energy Technology Development Spectrum to Commercialize CCS



Capital and operating costs for projects with CCS are more expensive than conventional technologies, carrying greater commercial risk.

The Path Forward - Leveling the Playing Field

Financial Incentives

- Broaden to include incentives available to other clean energy sources

Regulatory Improvements

- Regulatory blueprint needed to remove barriers to construction and development of CCS projects

Research Development and Demonstration

- U.S. Dept. of Energy must be a catalyst for commercial scale demonstrations to start immediately

Communications and Collaboration

- U.S. Dept. of Energy must assure policymakers that fossil fuels will continue to be used & CCS is essential

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Recommendations for Leveling the Playing Field

Foundational Financial Structure: Contracts for Differences

- Establish a "contracts for differences" structure enabling greater competitiveness
- Allow developers to propose a menu of government incentives – e.g., CCPI grants to reduce capital, loan guarantees to reduce borrowing costs, tax credits to reduce cost of power over time
- Provide CFD structure for first 5-10 GW of projects with CCS on a competitive basis
- Use to create commercial demonstrations and large-scale pilot projects

Recommendations for Leveling the Playing Field

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Financial Incentives

- **Limited Guaranteed Purchase Agreements**: Offer a limited number of pioneering CCS facilities to receive a guarantee that their output will be purchased in order to obtain financing
- **Market Set Aside:** Establish a market set-aside to provide parity with state RES requirements
- **Clean Energy Credits:** Allow CCS projects to receive credit under applicable programs for 100% of CO_2 emissions avoided

Recommendations for Leveling the Playing Field

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Financial Incentives

- **Tax Credits and Price Interventions**: In addition to guaranteed purchase agreements and the ability to attract financing, offer other support through:
  - Production Tax Credit
  - Revised CO_2 Injection Credit
  - Electricity Price Stabilization
  - CO_2 Price Stabilization
- **Tax-Preferred Bonds**: Provide financing with tax-preferred and tax exempt bonds under Section 54 or Section 142 of Internal Revenue Code

Recommendations for Leveling the Playing Field

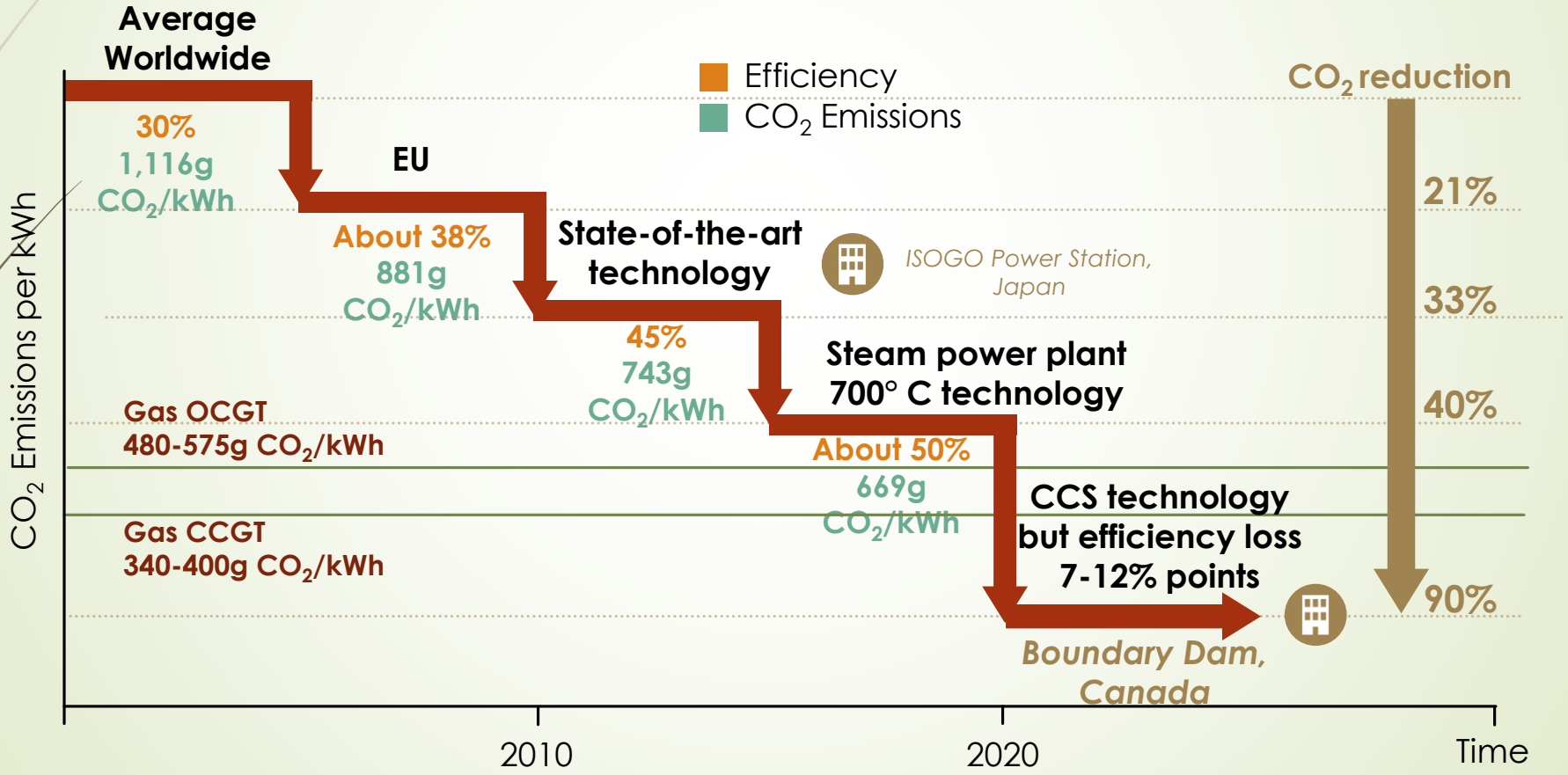
Financial Incentives

- **Master Limited Partnerships:** Provide MLP structure for projects with CCS so qualifying income is taxed at the individual level
- **Loan Guarantees:** Put in place a mechanism to pay the credit subsidy cost of loan guarantees similar to the Section 1705 program that helped renewables

The Path Forward – HELE Technologies

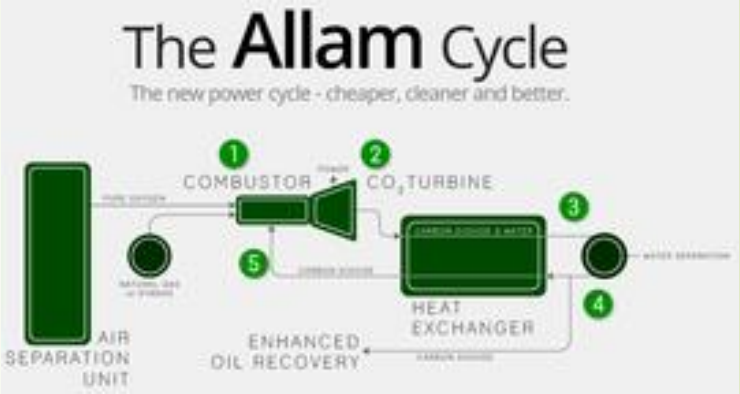
CO_2 Reduction Glidepath

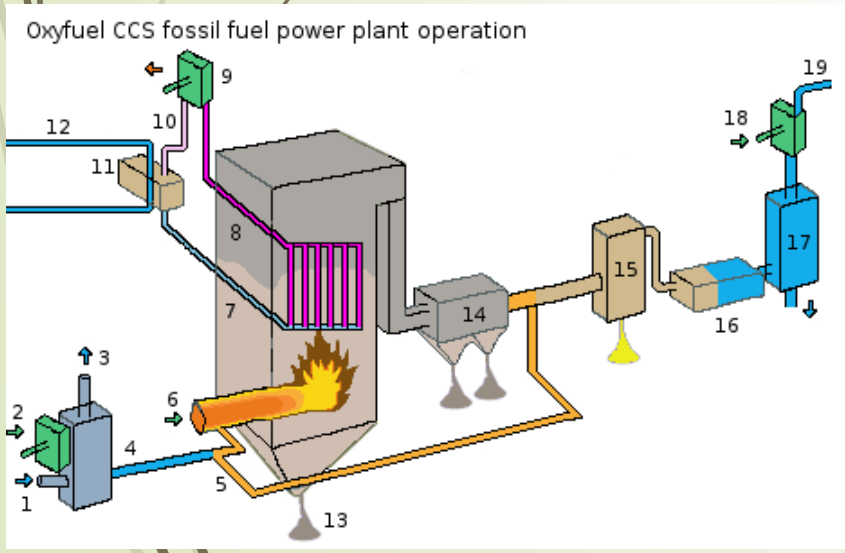
Increasing Efficiency of Coal Plants by 1% Reduces CO_2 2-3%



Source: VGB PowerTech 2013, Word Coal Association.

Horizon Technologies

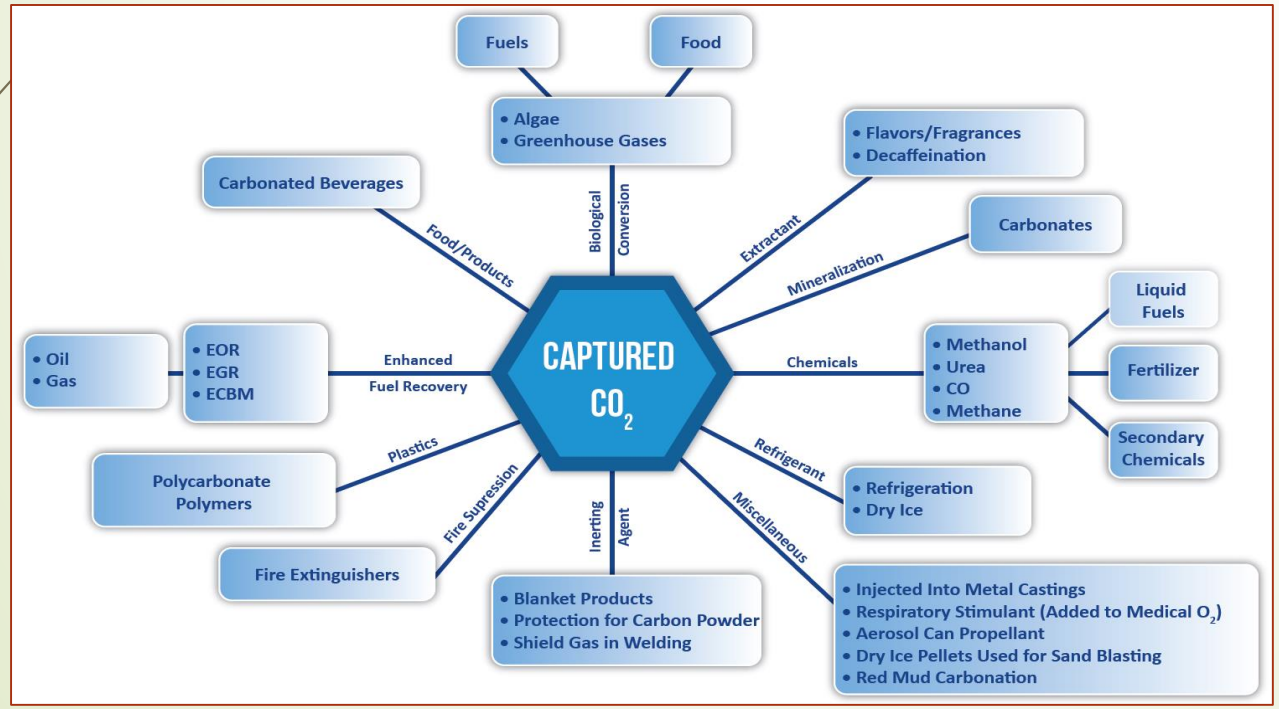


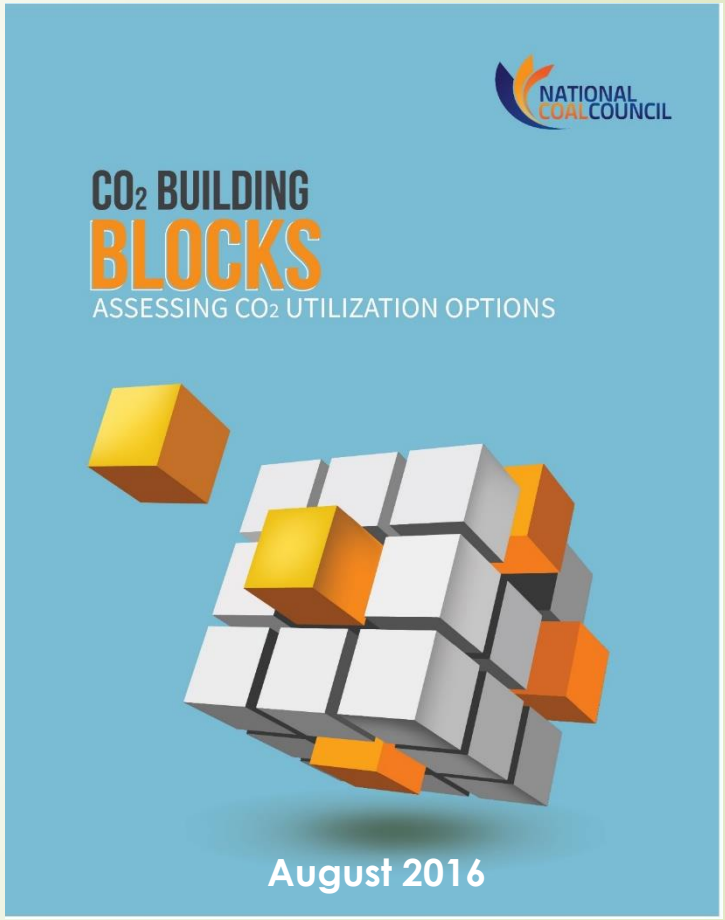


The Path Forward – CO_2 Utilization

"One of the greatest challenges we face and a potential game changer is how we can develop technologies for very, very, very large-scale utilization of CO_2."

Secretary Moniz – House Testimony – September 15, 2016





Technically Recoverable Domestic Oil and CO_2 Storage Capacity, State of Art and "Next Generation" CO_2-EOR Technology

Basin/Area	Technically Recoverable Oil (Billion Barrels)		Technical CO2 Demand/Storage (Million Metric Tons)	
	SOA	"Next Generation"	SOA	"Next Generation"
1. Main Pay Zone CO2-EOR				
Lower-48 Onshore	55.6	105.5	22,270	33,050
Alaska	5.8	8.8	3,320	4,110
Offshore GOM	23.5	52.9	12,640	15,060
Sub-Total	**84.9**	**167.2**	**38,230**	**52,220**
2. Residual Oil Zone CO2-EOR				
ROZ Fairways*	n/a	25.7	n/a	17,100
Below Oil Fields	n/a	16.3	n/a	8,200
Sub-Total	**n/a**	**42.0**	**n/a**	**25,300**
Total	**84.9**	**209.2**	**38,230**	**77,520**

*Four County Permian Basin San Andres ROZ fairway.

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CO_2 Building Blocks

Assessing CO_2 Utilization Options

Key Finding

CO_2-EOR still represents the most immediate, highest value opportunity to utilize the greatest volume of anthropogenic CO_2.

CO_2 Geologic Markets

- **SHALE GAS:** Shale gas formations offer potential to storage large amounts of CO_2 while increasing recoverable reserves of natural gas.
- **ENHANCED COAL BED METHANE:** ECBM has potential to store CO_2 and recovered methane can be used as a fuel that could supplement coal and oil with far lower CO_2 emissions when combusted.
- **ENHANCED WATER RECOVERY:** EWR presents a major opportunity for new sources of water in an increasingly water-scarce world.
- **GEOTHERMAL STORAGE:** Potential to use heat in geological brine to generate electricity by harnessing geothermal energy.

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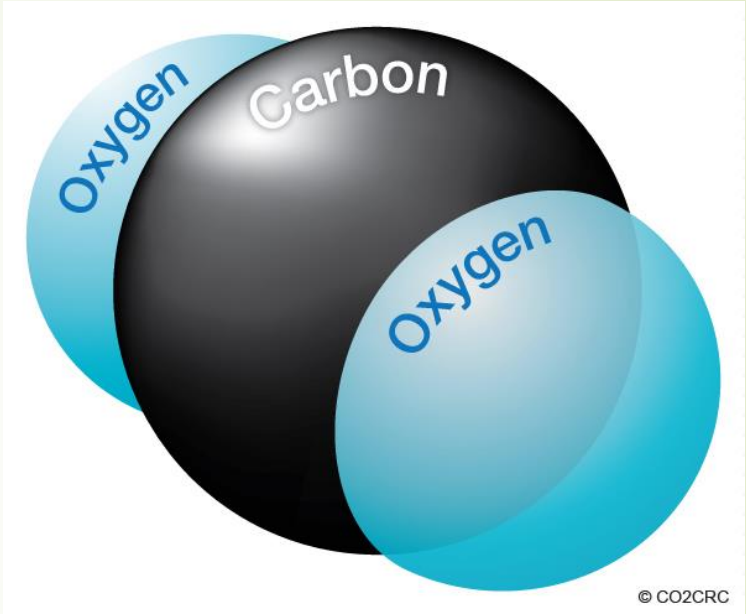
CO_2 Building Blocks

Assessing CO_2 Utilization Options

Key Finding

Geological CO_2 utilization options have the greatest potential to incentivize and advance CCUS by creating market demand for CO_2.

CO_2 Markets – Non-Geologic



Two Pathways to
CO_2 Non-Geologic Utilization

- Cleaving - Breaking down the CO_2 molecule by cleaving C=O bond(s)
- Intact/Fixed – Incorporating the entire CO_2 molecule into other chemical structures

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CO_2 Non-Geologic Markets

- **INORGANIC CARBONATES & BICARBONATES:** Includes carbon products (carbon black, activated carbon, nanofilters, graphene); cement & aggregates; buffers & other chemical products (baking soda, potassium bicarbonate)
- **PLASTICS & POLYMERS:** Includes polymers and fine chemicals.
- **ORGANIC & SPECIALTY CHEMICALS:** Includes urea, ethylene & propylene, DMC, acrylic acid and solvents.
- **AGRICULTURAL FERTILIZERS:** A source of high efficiency carbon and oxygen food for plants and trees with ability to balance nitrogen.

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CO_2 Building Blocks

Assessing CO_2 Utilization Options

Key Finding

Some non-geological CO_2 utilization options are promising in that they tend to "fix" CO_2.

CO_2 Non-Geologic Markets

- **FOOD & BEVERAGE:** Includes beverage carbonation and production of dry ice.
- **FUELS:** Includes methanol, hydrocarbon fuels and biological processes (algae/microrganisms).

Order of Magnitude Estimates for the Worldwide Capacity of CO_2 Utilization

Option of CO_2 Utilization	Worldwide Capacity (Order of Magnitude in Giga Ton Carbon)
Non-chemical Utilization	0.01 – 0.1 GtC per year
Chemicals & Materials	0.1 – 1 GtC per year
Synthetic Liquid Fuels	1 – 10 GtC per year

Source: Song, 2002

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CO_2 Building Blocks

Assessing CO_2 Utilization Options

Key Finding

All non-geological CO_2 utilization options should be lifecycle analyzed and assessed for their potential to store CO_2 on a permanent basis.

CO_2 Markets as Incentives for CCUS

- U.S. law recognizes CO_2–EOR and other geologic storage technologies for compliance purposes.
- Non-geologic storage technologies may be used only if EPA determines they are as effective as geologic storage.
- U.S. climate goals and non-binding international climate goals require CCUS technology deployment at scale in the near future.
- CO_2 utilization in non-geologic contexts face the following hurdles:
  - Cost of capture
  - Insufficient scope of market/supply
  - Nearly all non-geologic CO_2 utilization technologies are not yet commercialized
  - Geographic/infrastructure considerations
  - Legal and regulatory considerations

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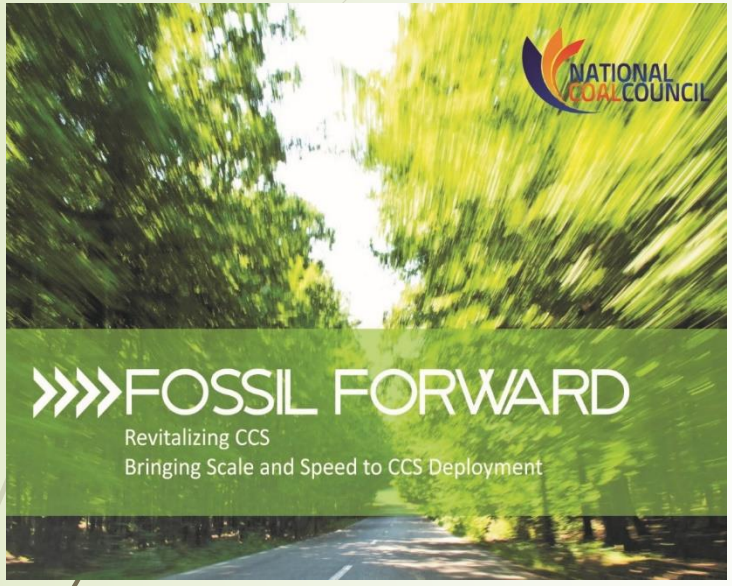
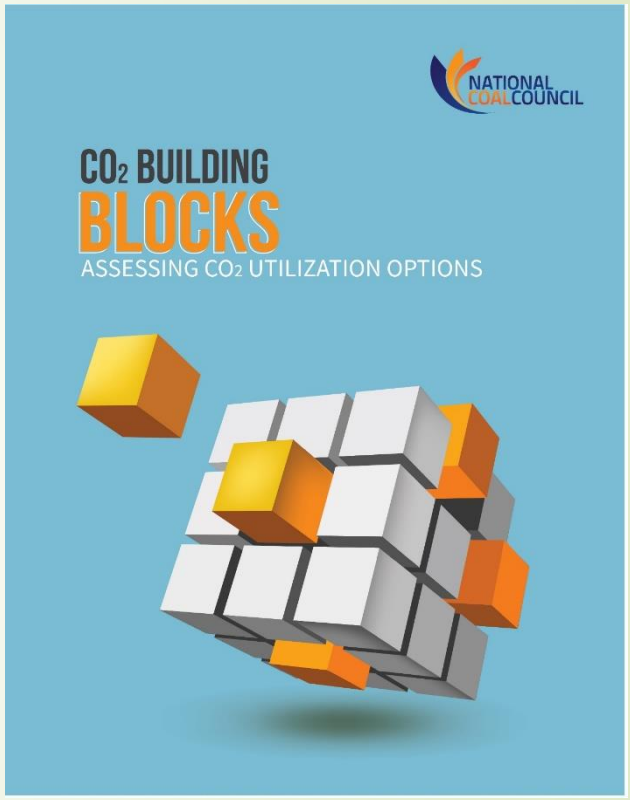
CO_2 Building Blocks

Assessing CO_2 Utilization Options

Key Finding

Non-geologic CO_2 utilization options are unlikely to significantly incentivize CCUS in the near- to intermediate-term because of technical, GHG LCA considerations, challenges regarding scalability and related reasons.





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