Meeting the Dual Challenge: A Roadmap to At-Scale Deployment of Carbon Capture, Use, and Storage

www.dualchallenge.npc.org

Ground Water Protection Council
UIC Conference
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On behalf of the National Petroleum Council

NPC: Meeting the Dual Challenge
In September 2017

The Secretary of Energy requested the NPC conduct a study

- Define the potential pathways for integrating CCUS at scale into the energy and industrial marketplace.

- The request included five key questions:
  1. What are U.S. and global future energy demand outlooks, and the environmental benefits from the application of CCUS technologies?
  2. What R&D, technology, infrastructure, and economic barriers must be overcome to deploy CCUS at scale?
  3. How should success be defined?
  4. What actions can be taken to establish a framework that guides public policy and stimulates private-sector investment to advance the deployment of CCUS?
  5. What regulatory, legal, liability or other issues should be addressed to progress CCUS investment and to enable the U.S. to be global technology leaders?
• Over two-thirds of study participants came from outside the oil and gas industry.

• The Coordinating Subcommittee has membership of 22 individuals representing upstream and downstream oil & gas, LNG, biofuels, power, NGO, and state and federal governments.

• Overall study team included over 300 participants from more than 110 different organizations and 17 international members.
Findings 1-4

1. As global economies and populations continue to grow and prosper, the world faces the dual challenge to provide affordable, reliable energy while addressing the risks of climate change.

2. Widespread CCUS deployment is essential to meeting the dual challenge at the lowest cost.

3. Increasing deployment of CCUS can deliver benefits and favorably position the United States to participate in new market opportunities as the world transitions to a lower CO₂ intensive energy system.

4. The United States is uniquely positioned as the world leader in CCUS and has substantial capability to drive widespread deployment.
Finding 5: Activation Phase

5. Clarifying existing tax policy and regulations could activate an additional 25 to 40 million tons per annum (Mtpa) of CCUS, doubling existing U.S. capacity within the next 5 to 7 years. (No congressional action required)

Recommendations

- IRS to clarify Section 45Q requirements for transferability, secure geologic storage, construction start date, and credit recapture
- DOI and states to establish a process for access to and use of pore space for geologic storage on federal and state lands
- EPA should issue a Class VI permit to drill within six months
- EPA, upon receipt of a completed well report, should review and make any necessary modifications, and issue a Class VI permit to inject within six months
- EPA to undertake planned periodic review of Class VI regulations to align with site-specific risk and performance-based approach

* note: 35mtpa is likely overstated based on current 12 year life of 45Q tax credit – the increase to 20 years does not come until Expansion phase
Finding 6: Expansion Phase

6. Extending and expanding current policies and developing a durable legal and regulatory framework could enable the next phase of CCUS projects (an additional 75-85 Mtpa) within the next 15 years.

Recommendations

Congress to:
• Amend 45Q to extend construction start date to 2030, increase duration to 20 years, lower volume threshold, and increase credit for saline storage
• Expand access to Section 48 tax credits for all projects
• Expand access to MLPs, private activity bonds, and TIFIA eligibility/funding for all projects
• Increase EPA and state regulatory funding to support well permitting and timely reviews
• Amend OCSLA and MPRSA to allow geologic storage in federal waters from all CO₂ sources

Agencies to:
• DOE & DOI to implement process for access and regulation
• DOE to create CO₂ pipeline working group made up of relevant agencies and stakeholders to harmonize permitting processes, establish tariffs, grant access, administer eminent domain authority, and facilitate corridor planning
• DOE to convene stakeholder forum to develop a risk-based standard to address geologic storage long-term liabilities
• State policymakers adopt regulation for access, ownership, unitization & fair compensation for storage on private lands
Finding 7: At-Scale Deployment Phase

7. Achieving CCUS deployment at scale, an additional 350-400 Mtpa, in the next 25 years will require substantially increased support driven by national policies.

Recommendation:
To achieve at-scale deployment, congressional action should be taken to implement economic policies amounting to about $110/tonne. The evaluation of those policies should occur concurrently with the expansion phase.
Finding 8: Research, Development and Demonstration

8. Increased government and private research, development, and demonstration is needed to improve performance, reduce costs, and advance alternatives beyond currently deployed technology.

Recommendation: Congress should appropriate $15 billion of RD&D funding over the next 10 years to enable the continued development of new and emerging CCUS technologies and demonstration of existing technologies.

<table>
<thead>
<tr>
<th>Technology</th>
<th>R&amp;D (including pilot programs)</th>
<th>Demonstrations</th>
<th>Total</th>
<th>10-Year Total</th>
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<tbody>
<tr>
<td>Capture (including negative emissions technologies)</td>
<td>$500 million/year</td>
<td>$500 million/year</td>
<td>$1.0 billion/year (over 10 years)</td>
<td>$10 billion</td>
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<tr>
<td>Geologic Storage</td>
<td>$400 million/year</td>
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<td>$400 million/year (over 10 years)</td>
<td>$4 billion</td>
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<tr>
<td>Nonconventional Storage (including EOR)</td>
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<td>$50 million/year (over 10 years)</td>
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<tr>
<td>Use</td>
<td>$50 million/year</td>
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<td>$50 million/year (over 10 years)</td>
<td>$500 million</td>
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<tr>
<td>Total</td>
<td>$1.0 billion/year</td>
<td>$500 million/year</td>
<td>$1.5 billion/year</td>
<td>$15 billion</td>
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9. Increasing understanding and confidence in CCUS as a safe and reliable technology is essential for public and policy stakeholder support.

Recommendations:
- Government, industry, and associated coalitions design policy and public engagement opportunities to facilitate open discussion, simplify terminology & build confidence that CCUS is a safe, secure means of managing emissions.
- Oil and natural gas industry remain committed to improving its environmental performance and the continued development of environmental safeguards.

10. The oil and natural gas industry is uniquely positioned to lead CCUS deployment due to its relevant expertise, capability, and resources.

Recommendation:
- The oil and natural gas industry continue investment in CCUS, specifically:
  - Current and next generation capture facilities
  - Development of new technologies
  - CO₂ pipeline infrastructure needed for EOR and saline storage
  - R&D for advancing CCUS technologies
The Secretary requested a roadmap of actions needed to drive widespread deployment of CCUS in the U.S. over the next 25 years.

To develop the roadmap, a CCUS cost curve was developed:

- Assessed the costs to capture, transport and store the largest 80% of U.S. stationary source CO₂ emissions – source, industry, and location specific and use transparent assumptions.
- Plotted the cost to capture, store and transport one tonne of CO2 against the volume of CO2 abatement possible – identifies the level of value (incentives, revenue, etc.) needed to enable deployment.

The roadmap details recommendations in four pathways – financial incentives, regulatory frameworks, technology and capability, and stakeholder engagement and across three phases – activation, expansion and at-scale, designed to achieve widespread deployment.
CCUS deployment at scale

Will mean:

• Moving from 25 to 500 Million tonnes per annum of CCUS capacity

• Infrastructure buildout equivalent of 13 million barrels per day capacity

• Incremental investment of $680 billion

• Support for 236,000 U.S. jobs and GDP of $21 billion annually

Will require:

• Improved policies, incentives, regulations and legislation

• Broad-based innovation and technology development

• Strong collaboration between industry and government

• Increased understanding and confidence in CCUS
NPC study report

Executive Summary (Volume 1)

- Transmittal letter
- Report outline
- Preface
- Executive Summary, Roadmap and Recommendations

Appendices
A. Request Letter and NPC Description
B. Study Group Rosters

CCUS Deployment At-Scale (Volume 2)

- Chapter 1: The Role of CCUS in Future Energy Mix
- Chapter 2: CCUS Supply Chains & Economics
- Chapter 3: Policy, Regulatory & Legal Enablers
- Chapter 4: Stakeholder Engagement

Appendices
C. CCUS Project Summaries
D. Integrated Economic Analysis (ERM Memo)

Findings and Recommendations

CCUS Technologies (Volume 3)

- Technology Introduction
- Chapter 5: CO₂ Capture
- Chapter 6: CO₂ Transport
- Chapter 7: CO₂ Geologic Storage
- Chapter 8: Enhanced Oil Recovery
- Chapter 9: CO₂ Use

Appendices
E. Mature CO₂ Capture Technologies
F. Emerging CO₂ Capture Technologies
G. CO₂ EOR Case Studies
H. CO₂ EOR Economic Factors and Considerations

List of Topic Papers
Abbreviations, Units, Glossary

Full Report

NPC: Meeting the Dual Challenge
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<th>Title</th>
<th>Lead Authors</th>
<th>Key Sections</th>
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<tr>
<td>The Role of CCUS in a Future Energy Mix</td>
<td>Jason Bordoff, Julio Friedmann</td>
<td>• Global &amp; U.S. energy demand forecasts</td>
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<td>• Role of CCUS</td>
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<td>• U.S. CO₂ emissions profile</td>
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<td></td>
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<td>• Benefits of CCUS - environmental, economic, US leadership</td>
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<tr>
<td>CCUS Supply Chains and Economics</td>
<td>Nigel Jenvey, Guy Powell</td>
<td>• Complexity of supply chain</td>
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<td></td>
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<td>• Description of existing projects</td>
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<td>• Supply chain enablers</td>
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<td>• Cost to deploy CCUS</td>
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<td>• Enablers for future projects</td>
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<td>Policy, Regulatory and Legal Enablers</td>
<td>Leslie Savage, Susan Blevins</td>
<td>• Existing policy and regulatory framework</td>
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<td>• Activation phase actions</td>
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<td>• Research and development priorities</td>
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<td>Stakeholder Engagement</td>
<td>Sallie Greenberg</td>
<td>• Spheres of public engagement</td>
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<td>• Public perception of CCUS</td>
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<td>• Defining and understanding stakeholders</td>
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<td>• Strategic engagement</td>
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## CCUS Technologies (Volume 3)

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| CO₂ Capture               | John Northington, Jennifer Wilcox | • Capture process  
                               • Technology types and maturity  
                               • Opportunities by sector  
                               • Capture cost drivers  
                               • Research and development priorities |
| CO₂ Transport             | Dan Cole                  | • Current transport technologies  
                               • Existing U.S. CO₂ pipeline network  
                               • Role of transport in widespread CCUS deployment |
| CO₂ Geologic Storage      | Richard Esposito, Sally Benson | • Description of CO₂ geologic storage  
                               • Commercial scale experience and enablers  
                               • Options for CO₂ storage and capacity potential  
                               • Research and development priorities |
| CO₂ Enhanced Oil Recovery | William Barrett           | • EOR technology experience and maturity  
                               • Conventional vs. non-conventional EOR  
                               • EOR capacity potential, near- and long-term  
                               • Research and development priorities |
| CO₂ Use                   | Will Morris, Alissa Park  | • CO₂ use technologies, pathways and products  
                               • Relative experience and maturity  
                               • Opportunities and challenges  
                               • Research and development priorities |