

AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

Clean Energy Ministerial CCUS Initiative Webinar

A Roadmap to At-Scale Deployment of Carbon Capture, Use, and Storage

Tuesday 21 January 2020
08:00 EST | 14:00 CET

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AGENDA

1

Welcome & Introductory Remarks

2

Presentation

- **Jarad Daniels**
Director, Office of Strategic Planning, Analysis, and Engagement
U.S. Department of Energy
- **Guy Powell**
Carbon Capture and Storage Venture Executive
Exxon Mobil Corporation
- **Nigel Jenvey**
Global Head of Carbon Management
Gaffney, Cline & Associates

3

Question and Answer Session



Jarad Daniels

*Director, Office of Strategic Planning,
Analysis, and Engagement*
US Department of Energy

Jarad Daniels leads the Office of Strategic Planning, Analysis, and Engagement within the Department of Energy (DOE) Office of Fossil Energy, including domestic programs and international engagements conducted in close collaboration with industry, academia, and multi-lateral organizations.

Mr. Daniels has twenty-five years of experience with the DOE, managing advanced technology programs and working in several national laboratories throughout the United States. His expertise includes domestic and global energy and environmental technologies, policies, and programs.

Mr. Daniels holds a Master of Science degree in Chemical Engineering from the University of California at Berkeley.



Guy Powell

*Carbon Capture and Storage Venture
Executive*

Exxon Mobil Corporation

Guy received his Bachelor of Science degree in Electrical Engineering from Mississippi State University in 1990 and joined Exxon Company U.S.A. as a Project Engineer at the Baton Rouge Refinery in Louisiana. Guy has subsequently worked in a variety of technical, refinery operations, planning and business development roles of increasing responsibility for the Corporation's downstream businesses in the U.S.A. and Europe.

In 2014 Guy joined ExxonMobil's Corporate Strategic Planning organization in Irving, TX as the Corporation's Greenhouse Gas Manager. In 2018 he assumed his current position as ExxonMobil's Carbon Capture and Storage (CCS) Venture Executive, responsible for oversight of strategy, policy, advocacy, technology, and business development for ExxonMobil's global CCS activities.

Guy is married, has two daughters and is now based in Houston TX.



Nigel Jenvey

Global Head of Carbon Management
Gaffney, Cline & Associates

Nigel has over 23 years of global oil and gas industry experience in technology, exploration, development and production operations with major oil and gas operating companies. He is an industry leader in Carbon Management and expert in Carbon Capture, Use and Storage (CCUS) having previously held roles such as the chair of the CO₂ Capture Project, chair of the North American CCS Association, and program chair of the Society of Petroleum Engineers CCUS Technical Section.

At Gaffney, Cline & Associates, Nigel leads the new global Carbon Management practice to help customers understand the wide variety of options available that will ensure continued business success through the energy transition.

Nigel graduated from Imperial College, London with a Master's degree in Petroleum Engineering, and from The University of Leeds, UK with a Bachelor's degree with honors in Mining Engineering. Nigel now lives in Houston, Texas with his wife and 2 children.

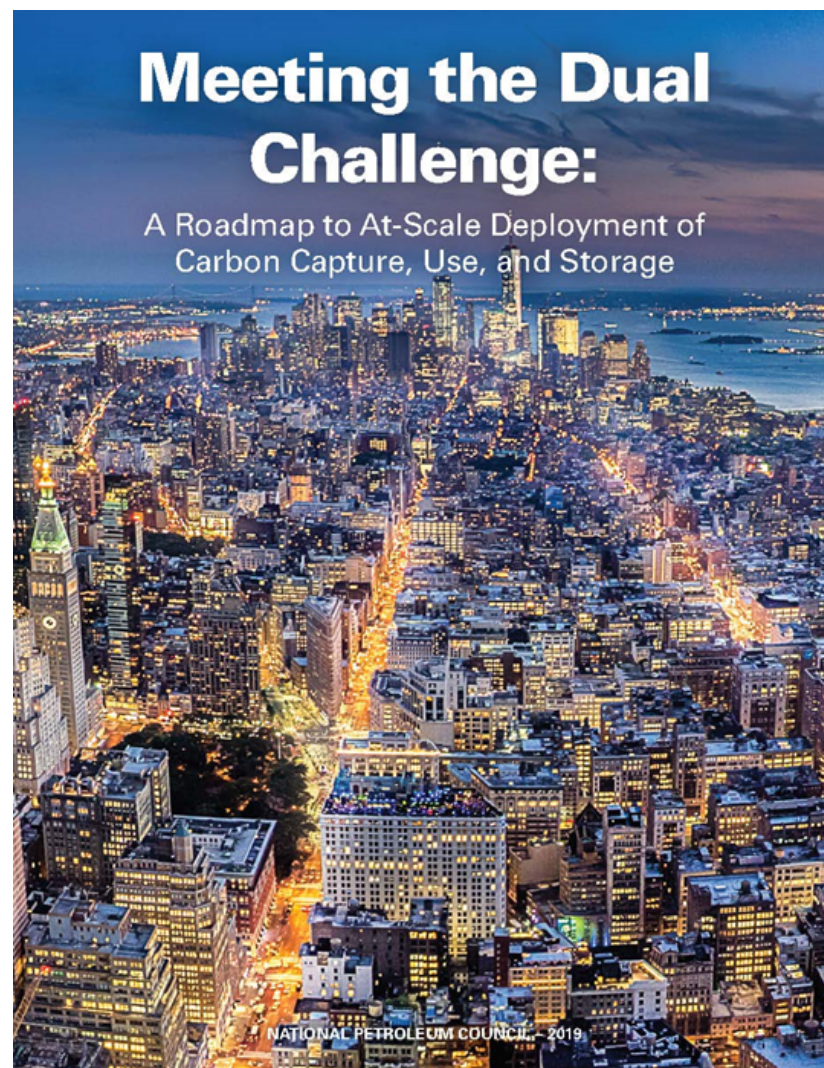
National Petroleum Council

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

www.dualchallenge.npc.org

Clean Energy Ministerial
January 21, 2020

Guy Powell, ExxonMobil
Nigel Jenvey, Gaffney-Cline



The Secretary of Energy requested the NPC conduct a study

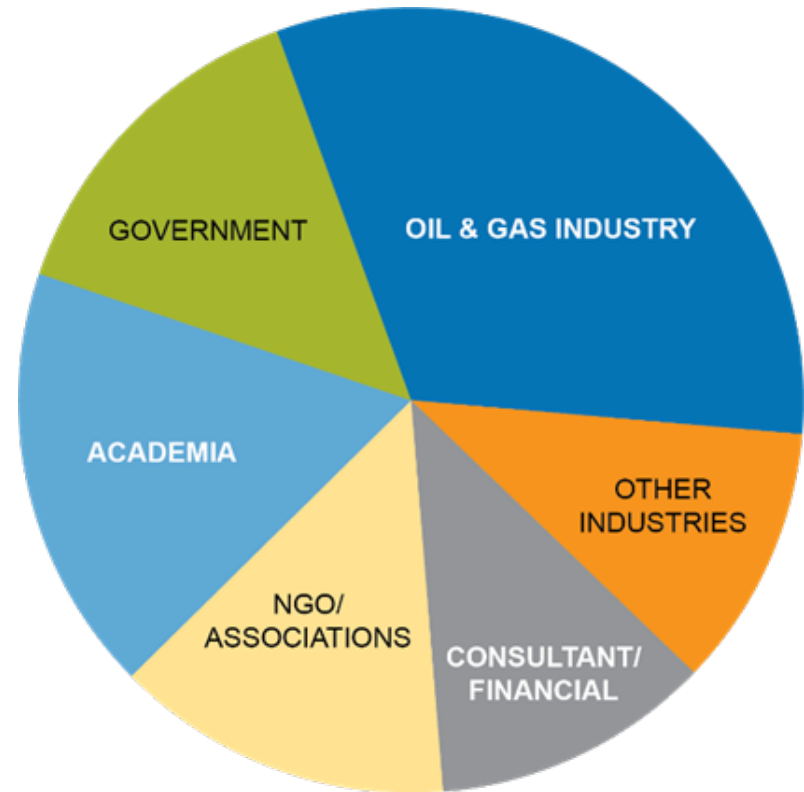
- **Define the potential pathways for integrating CCUS at scale into the energy and industrial marketplace.**
- **The Secretary asked the Council to consider:**
 - Technology options and readiness
 - Market dynamics, economics and financing
 - Cross-industry integration and infrastructure
 - Policy, legal and regulatory issues
 - Environmental footprint
 - Public acceptance

The request asked 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?

Study participation

- The Coordinating Subcommittee has membership of 22 individuals representing upstream and downstream oil & gas, LNG, biofuels, power, EPC, NGO, and state and federal governments.
- The overall study team is currently composed of over 300 participants from more than 110 different organizations and includes 17 international members.
- National Coal Council participation is represented through overlap of 21 organizations.



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

Findings and Recommendations

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

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

CCUS cost assessment: methodology

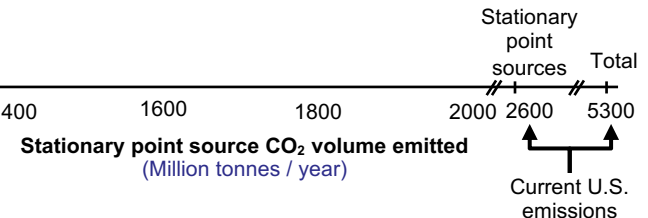
U.S. CCUS Costs by Point Source

(\$ / tonne of CO₂)
280

260
240
220
200
180
160
140
120
100
80
60
40
20
0

Assessed the costs to capture, transport and store 850 point sources of emissions comprising 80% (~2Gt) of all U.S. stationary sources:

- Cost to capture, transport, and store one tonne of CO₂ plotted against the volume of CO₂ abatement possible
- Source, industry, and location specific
- Costs and performance based on Nth of a kind technology currently available and deployed
- Transparent assumptions, leveraging existing studies combined with industry experience
- Identifies level of value (incentives, revenue, etc.) necessary to enable deployment based on the following financial assumptions:
 - Asset Life 20 years
 - IRR 12%
 - Equity Financing 100%
 - Inflation Rate 2.5%
 - Federal Tax Rate 21%



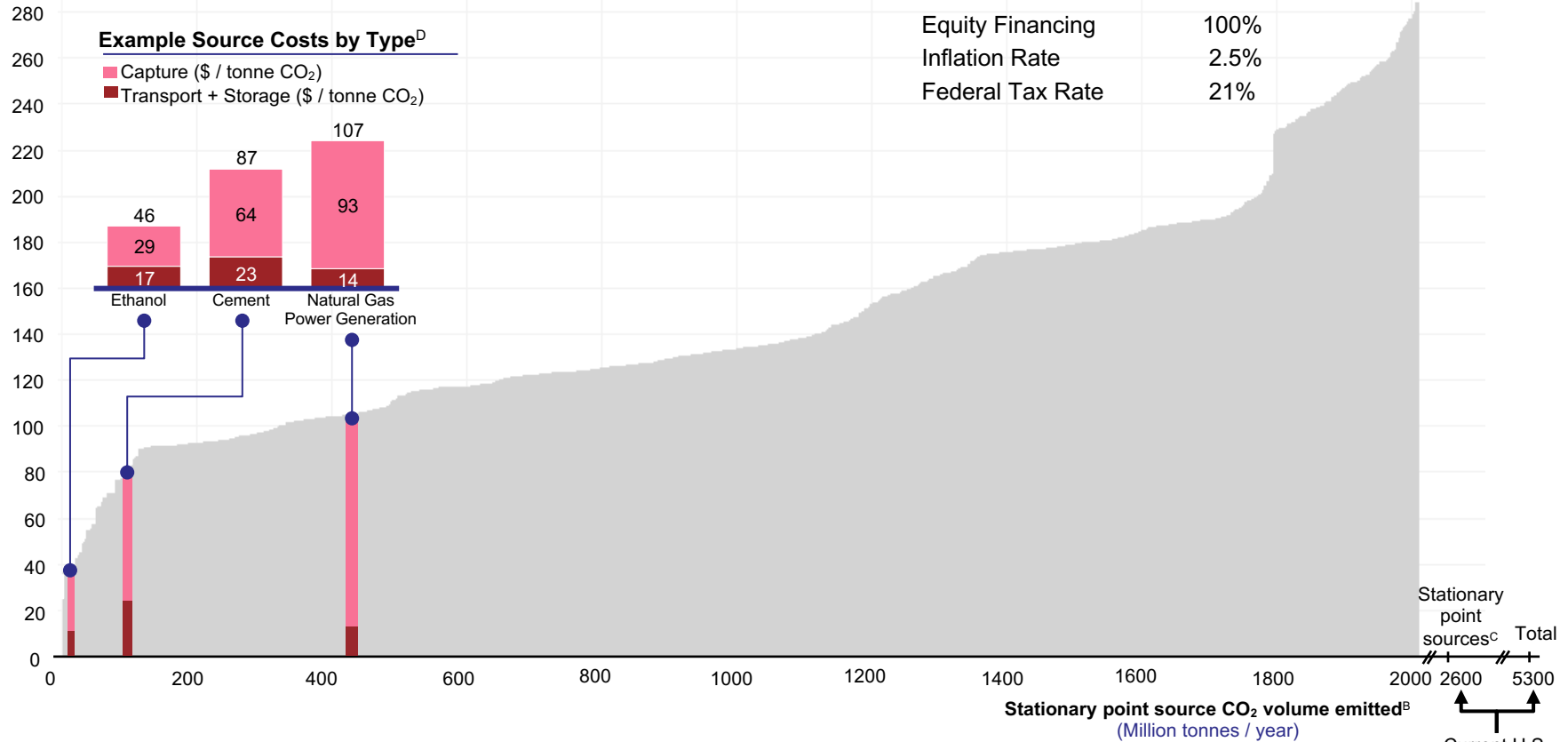
CCUS cost assessment: methodology

Financial Assumptions

Asset Life	20 year
IRR	12%
Equity Financing	100%
Inflation Rate	2.5%
Federal Tax Rate	21%

U.S. CCUS Costs by Point Source^A

(\$ / tonne of CO₂)

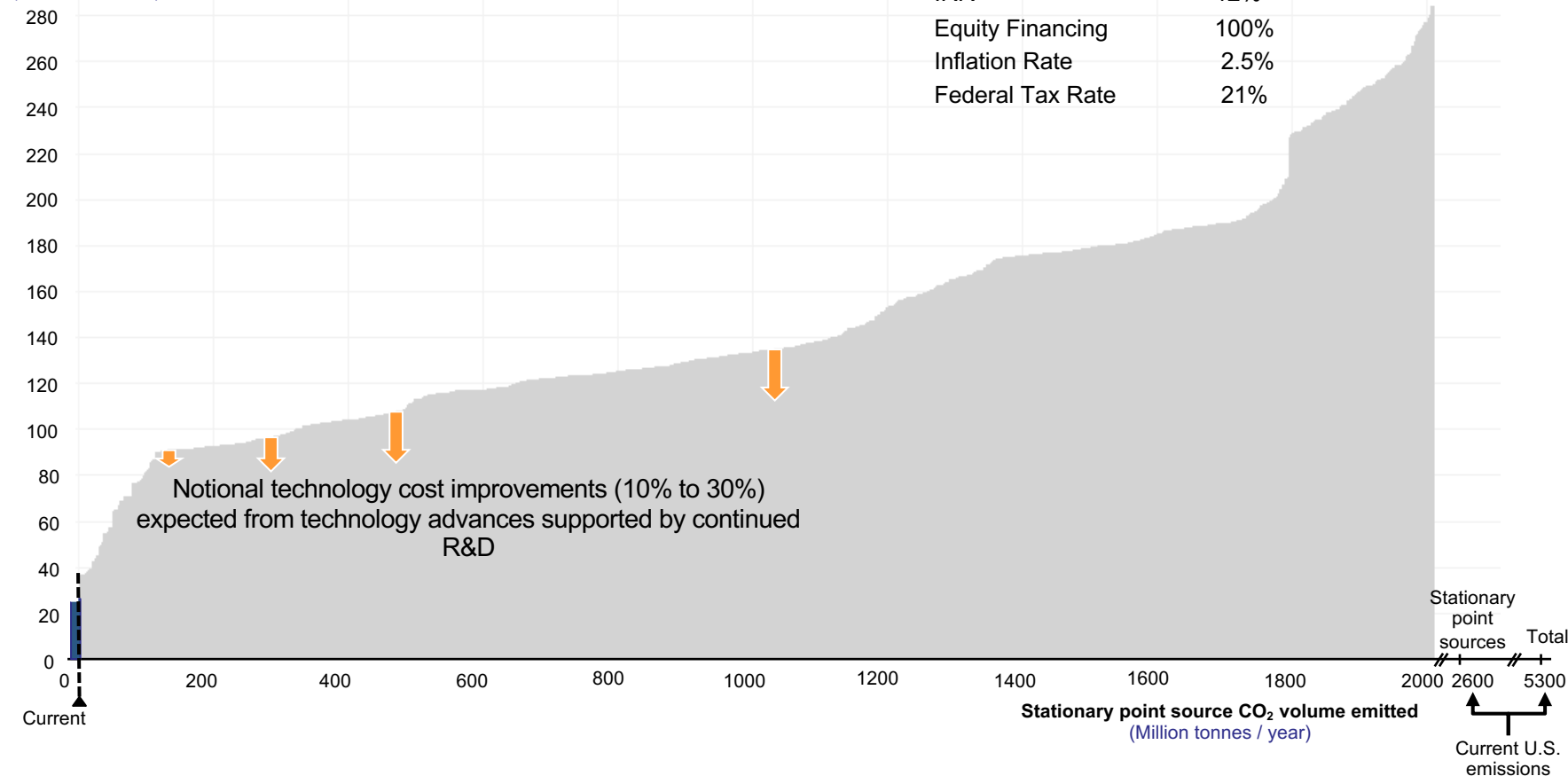


- A Includes project capture costs, transportation costs to defined use or storage location, and use/storage costs; does not include direct air capture
- B This curve is built from bars that each represent an individual point source with a width corresponding to the total CO₂ emitted from that individual source
- C Total point sources include ~600 MTPA of point sources emissions without characterized CCUS costs
- D Widths of bars are illustrative and not indicative of volumes associated with each source

CCUS cost assessment: role of R&D

U.S. CCUS Costs by Point Source

(\$ / tonne of CO₂)



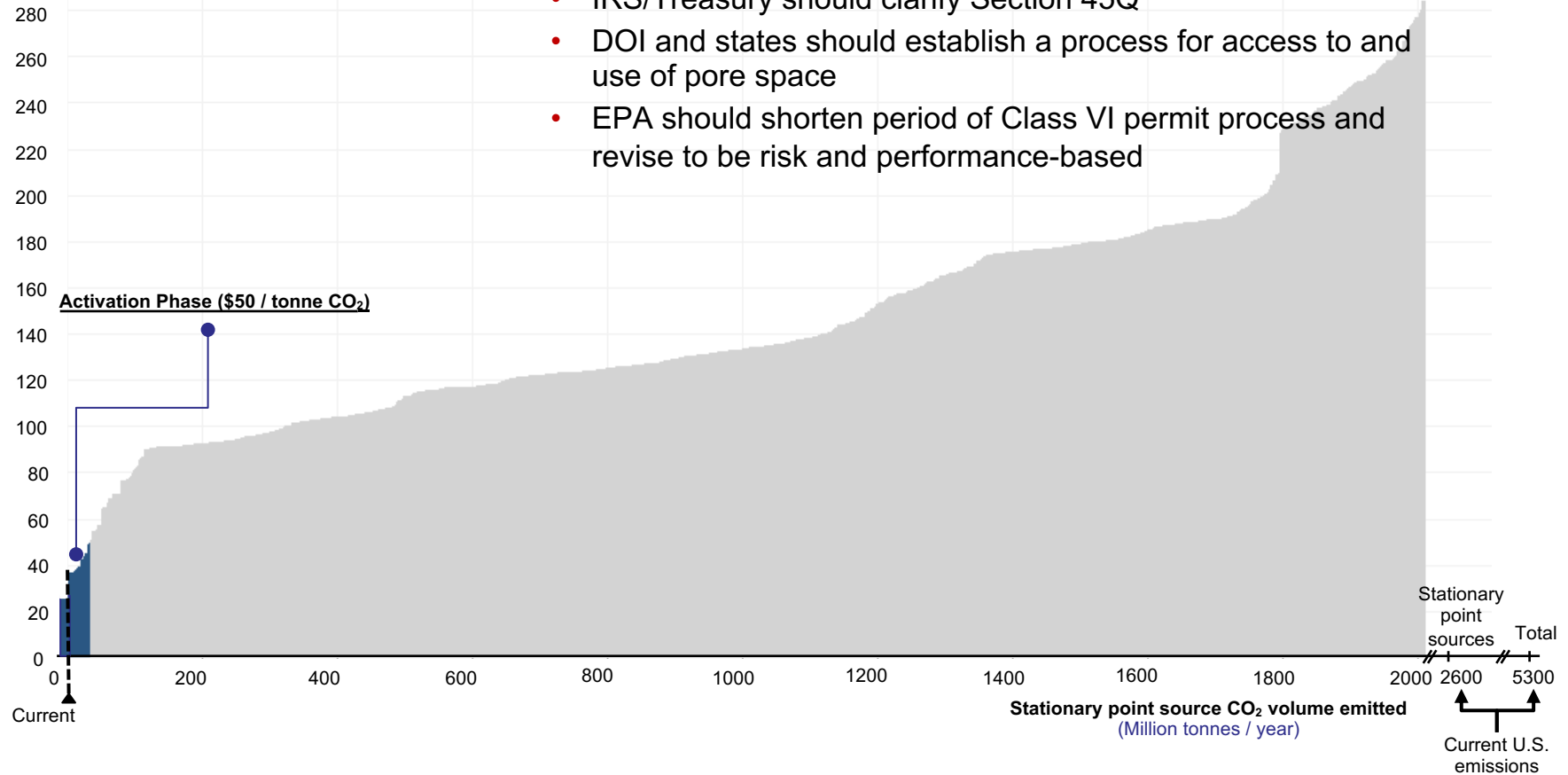
Financial Assumptions

Asset Life	20 year
IRR	12%
Equity Financing	100%
Inflation Rate	2.5%
Federal Tax Rate	21%

Activation phase

U.S. CCUS Costs by Point Source

(\$ / tonne of CO₂)



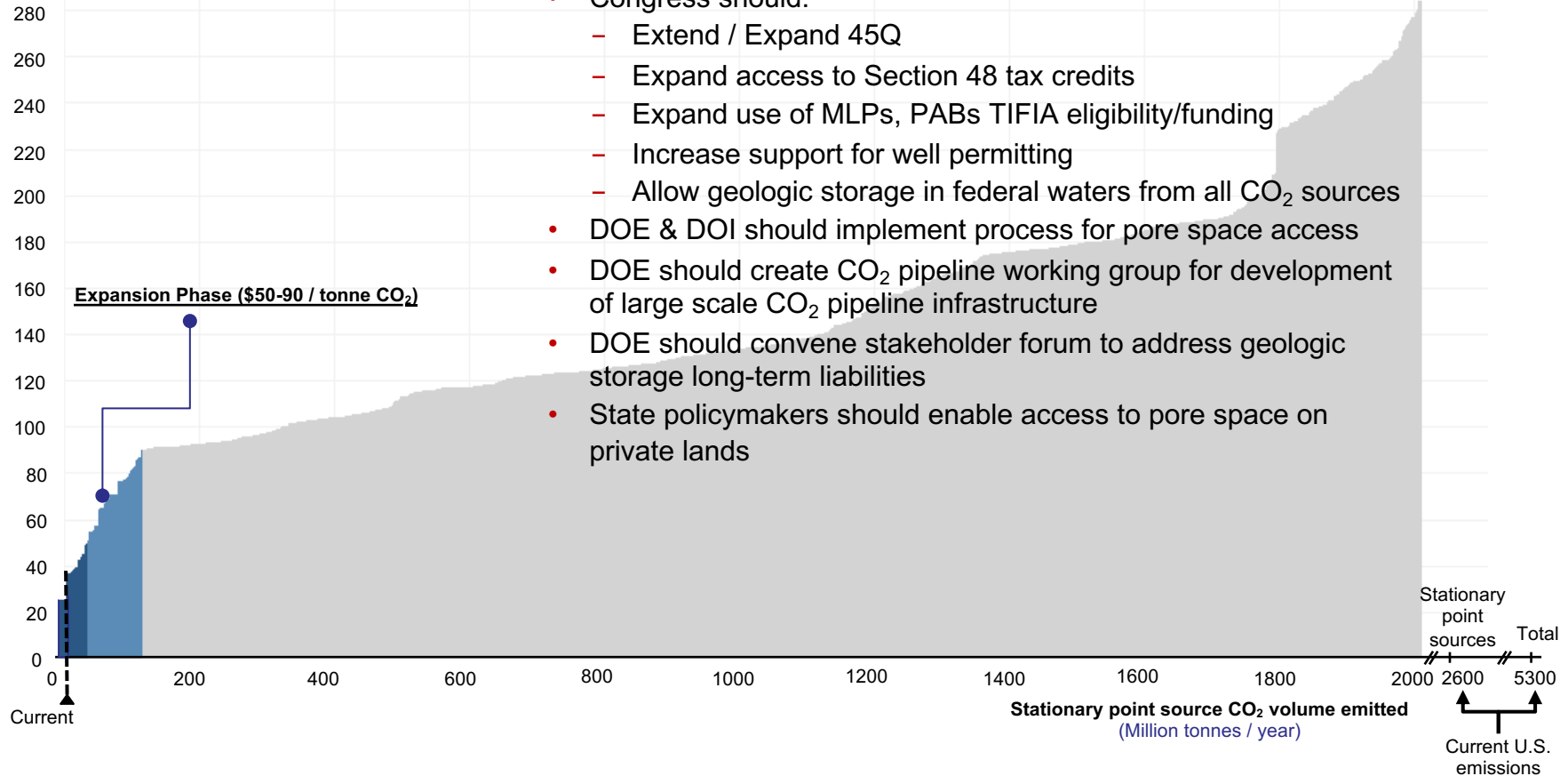
Recommendations:

- IRS/Treasury should clarify Section 45Q
- DOI and states should establish a process for access to and use of pore space
- EPA should shorten period of Class VI permit process and revise to be risk and performance-based

Expansion phase

U.S. CCUS Costs by Point Source

(\$ / tonne of CO₂)



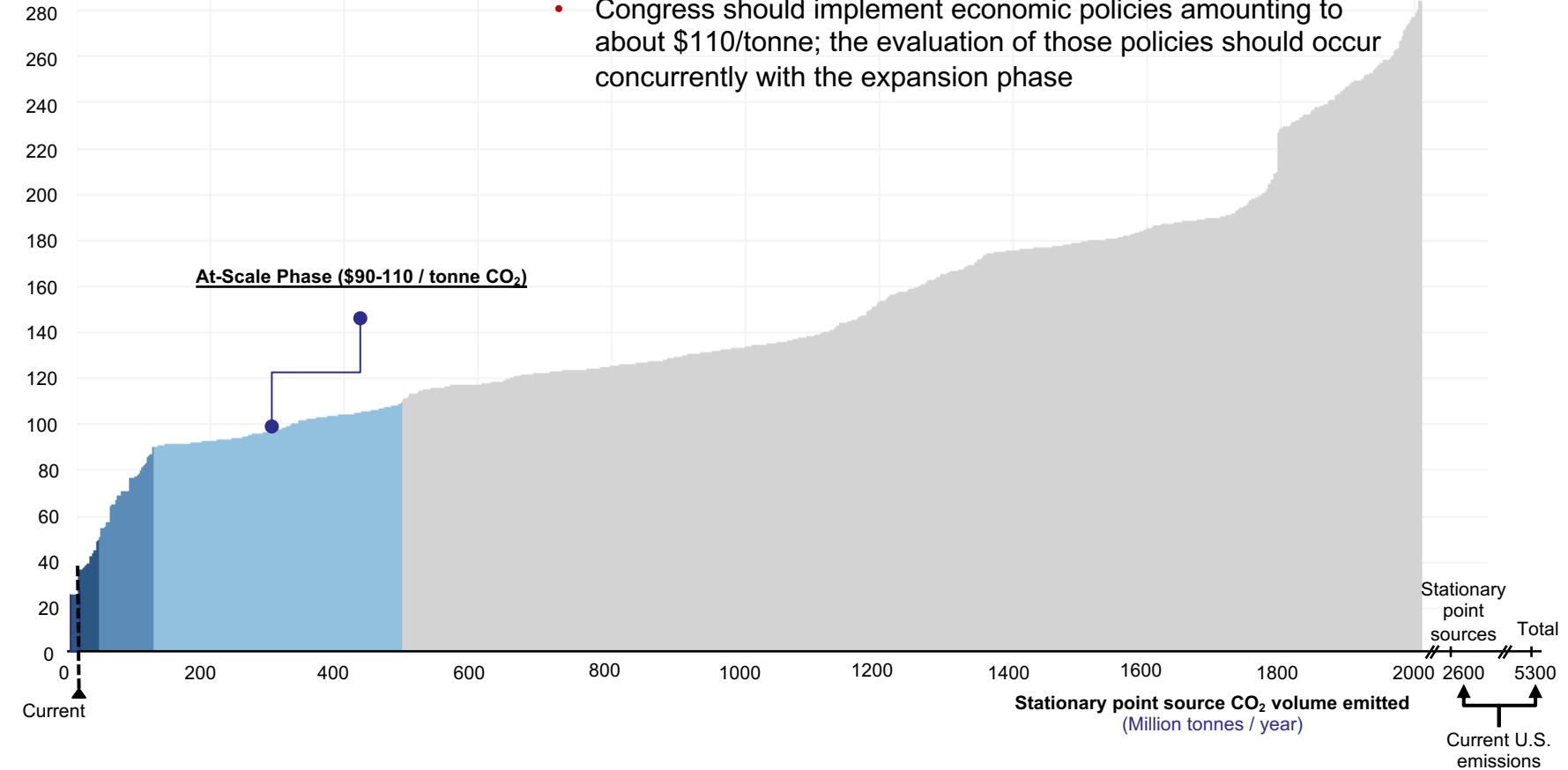
Recommendations:

- Congress should:
 - Extend / Expand 45Q
 - Expand access to Section 48 tax credits
 - Expand use of MLPs, PABs TIFIA eligibility/funding
 - Increase support for well permitting
 - Allow geologic storage in federal waters from all CO₂ sources
- DOE & DOI should implement process for pore space access
- DOE should create CO₂ pipeline working group for development of large scale CO₂ pipeline infrastructure
- DOE should convene stakeholder forum to address geologic storage long-term liabilities
- State policymakers should enable access to pore space on private lands

At-scale phase

U.S. CCUS Costs by Point Source

(\$ / tonne of CO₂)



Public and industry engagement

Increasing understanding and confidence in CCUS as a safe and reliable technology is essential for public and policy stakeholder support. The oil and natural gas industry is uniquely positioned to lead CCUS deployment due to its relevant expertise, capability, and resources.

Recommendations:

- Industry, governments and NGOs should work together to build confidence that CCUS is safe, secure, and critical to managing emissions.
- The oil and natural gas industry should remain committed to improving its environmental performance.
- The oil and natural gas industry should continue to 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

Key messages

- CCUS refers to the complete supply chain needed to capture, transport and permanently use or store CO₂, eliminating it from the atmosphere.
- All credible future energy scenarios recognize that fossil fuels will remain part of the total energy mix for the next several decades.
- CCUS is essential to addressing the dual challenge of providing affordable, reliable energy to meet the world's growing demand while addressing the risks of climate change.
- The United States is the world leader in CCUS and uniquely positioned to deploy the technologies at scale.
- To achieve CCUS deployment at scale, the U.S. government will need to reduce uncertainty on existing incentives, establish adequate additional incentives, and implement a durable regulatory and legal environment that drives industry investment.
- A commitment to CCUS must include a commitment to continued research, development, and demonstration.
- At-scale CCUS deployment could create a new industry, driving job creation and economic growth across the nation.
- Increasing understanding and confidence in CCUS as safe and reliable is essential for public and policy stakeholder support.

QUESTION AND ANSWER SESSION



Jarad Daniels

*Director, Office
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Our next webinar:



“Carbon Capture, Utilization and Storage in China”

Thursday 5 March 2020
08:00 EST / 14:00 CET / 21:00 CST



CARBON CAPTURE, UTILIZATION & STORAGE

ACCELERATING CCUS TOGETHER

AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

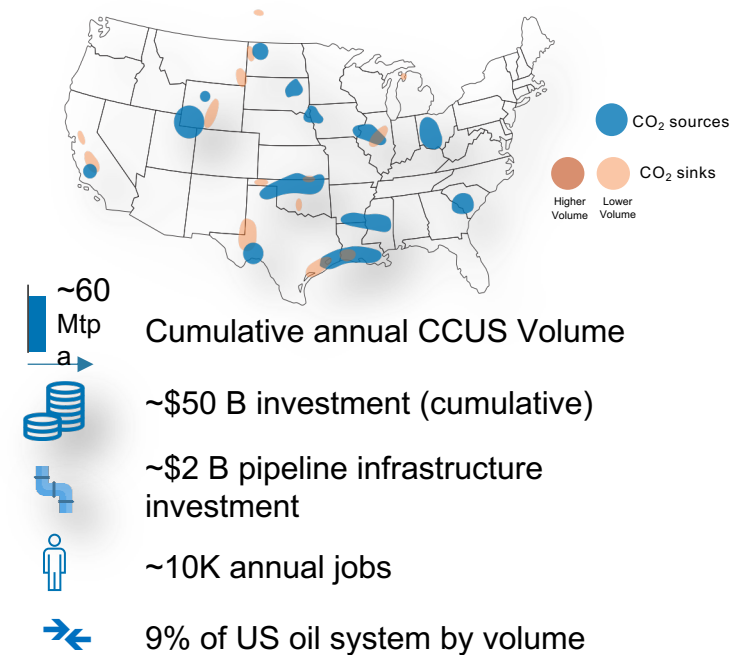
Activation phase – recommendations and impact

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.

Recommendations

Agency Action & Rulemaking:

- IRS/Treasury to clarify Section 45Q
- DOI and states to establish a process for access to and use of pore space
- EPA should shorten period of Class VI permit process
- EPA to review Class VI permit process to be site-specific risk and performance-based



Expansion phase – recommendations and impact

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.

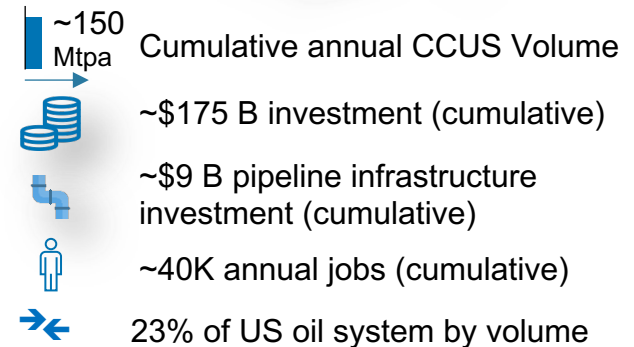
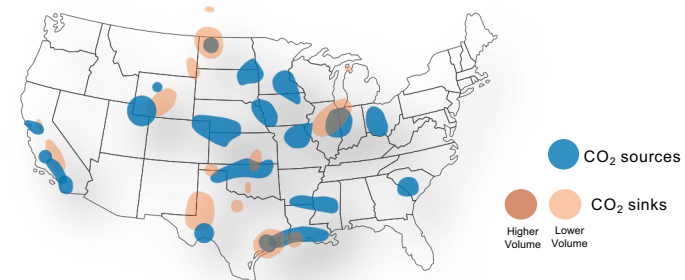
Recommendations

Congress to:

- Amend 45Q
- Expand access to Section 48 tax credits
- Expand use of MLPs, private activity bonds, and TIFIA eligibility/funding
- Increase funding to support well permitting and timely reviews
- Allow geologic storage in federal waters from all CO₂ sources

Agencies to:

- DOE & DOI to implement process for pore space access
- DOE to create CO₂ pipeline working group for development of large scale CO₂ pipeline infrastructure
- DOE to convene stakeholder forum to address geologic storage long-term liabilities
- State policymakers enable access to pore space on private lands



At-scale phase – recommendation and impact

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.

