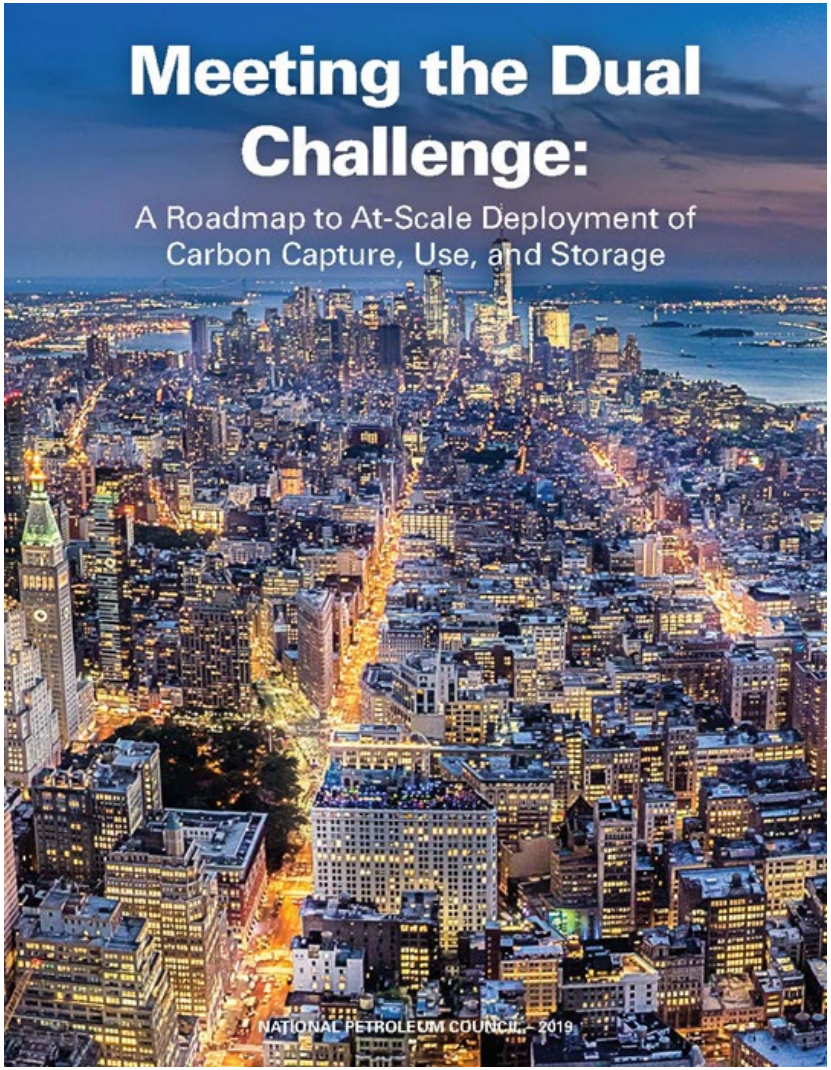
National Petroleum Council

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

www.dualchallenge.npc.org



University of Texas
5th Conference on Carbon Capture and Storage
January 28-29, 2020

Susan Blevins, ExxonMobil
Jane Stricker, BP
On behalf of the National Petroleum Council

What is the National Petroleum Council (NPC)

Origins	Continuation of WWI government / industry cooperation
Purpose	Sole purpose is to advise U.S. Secretary of Energy and Executive Branch by conducting studies at their request
Organization	A federally chartered, self-funded Advisory Committee; not an advocacy group, does not lobby
Membership	Broad and balanced. Approximately 200 members from all segments of the oil and gas industries and many outside interests
Study Participants	Diverse interests and expertise relating to the topic being addressed
Study Reports	All NPC advice is provided in reports approved by its members and is available to the public. Reports can be viewed and downloaded at not cost from the NPC website – www.npc.org

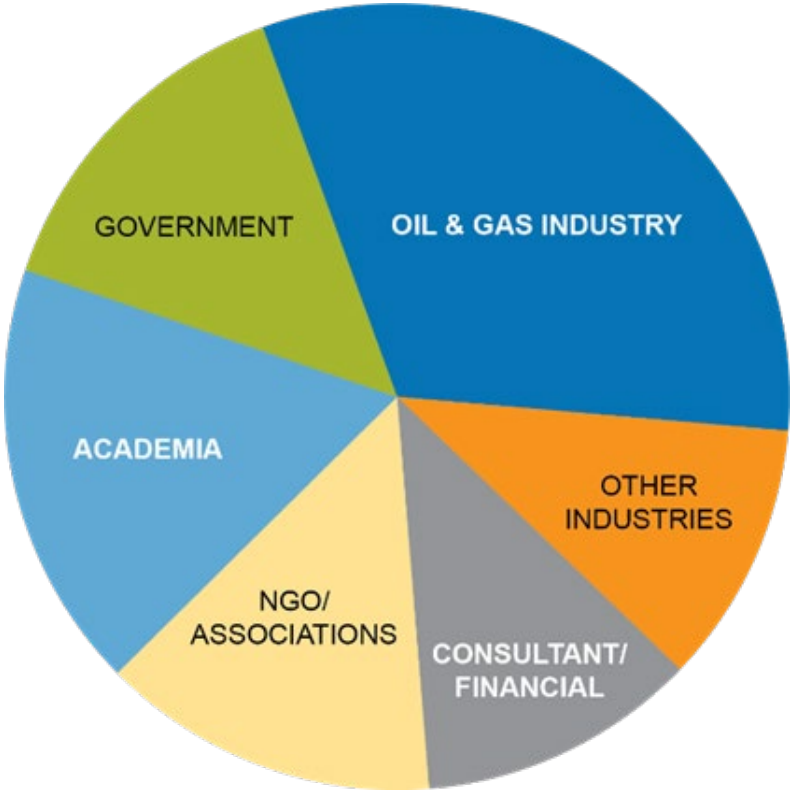
In September 2017

The Secretary of Energy requested the NPC conduct a study

- Define the potential pathways for integrating CCUS at scale into the U.S. energy and industrial marketplace.
- The request included five key questions:
  - What are U.S. and global future energy demand outlooks, and the environmental benefits from the application of CCUS technologies?
  - What R&D, technology, infrastructure, and economic barriers must be overcome to deploy CCUS at scale?
  - How should success be defined?
  - What actions can be taken to establish a framework that guides public policy and stimulates private-sector investment to advance the deployment of CCUS?
  - 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

- Over two-thirds of study participants came from outside the oil and gas industry.
- The Coordinating Subcommittee membership was 22 individuals representing upstream and downstream oil & gas, LNG, biofuels, power, NGO, and state and federal governments.
- Overall study team included over 300 participants representing more than 110 US and international organizations.



CCUS deployment at scale

Will mean:

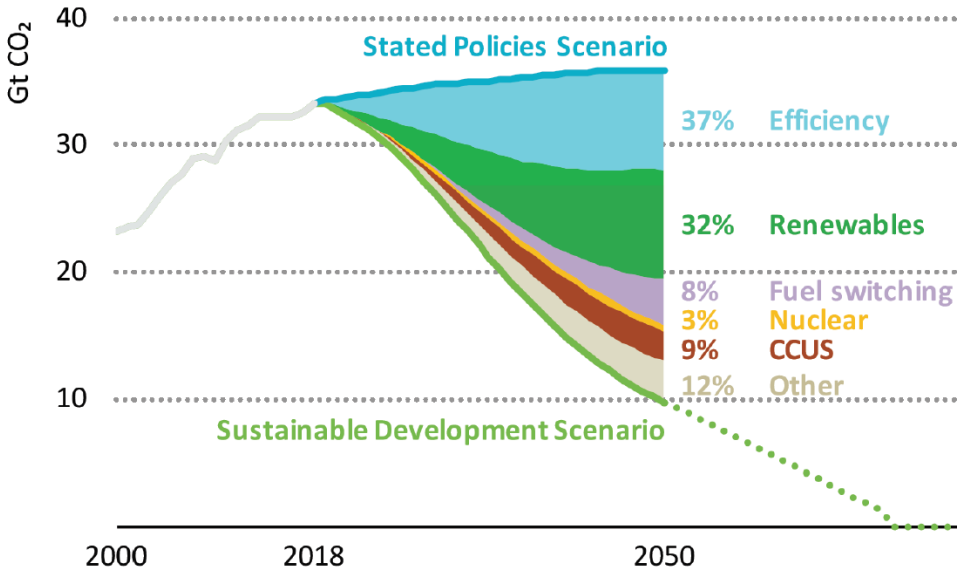
- Moving from 25 to **500 Million tonnes per annum** of CCUS capacity
- Infrastructure buildout equivalent of **13 million barrels per day** capacity
- Incremental investment of **$680 billion**
- Support for **236,000 U.S. jobs** and **GDP of $21 billion** annually

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

CCUS is a critical element of a clean energy portfolio

IEA analysis demonstrates the critical role of CCUS in a clean energy technology portfolio (IEA, 2019)



"Carbon capture, use and storage holds enormous potential to enable economic growth and create jobs, while ensuring the environment is protected."

-- Jim Carr, Canada's Minister of Natural Resources, June 6, 2017

"Without CCUS as part of the solution, reaching our climate goals is almost impossible."

-- Fatih Birol, Executive Director of IEA, Twitter on Nov 26, 2018

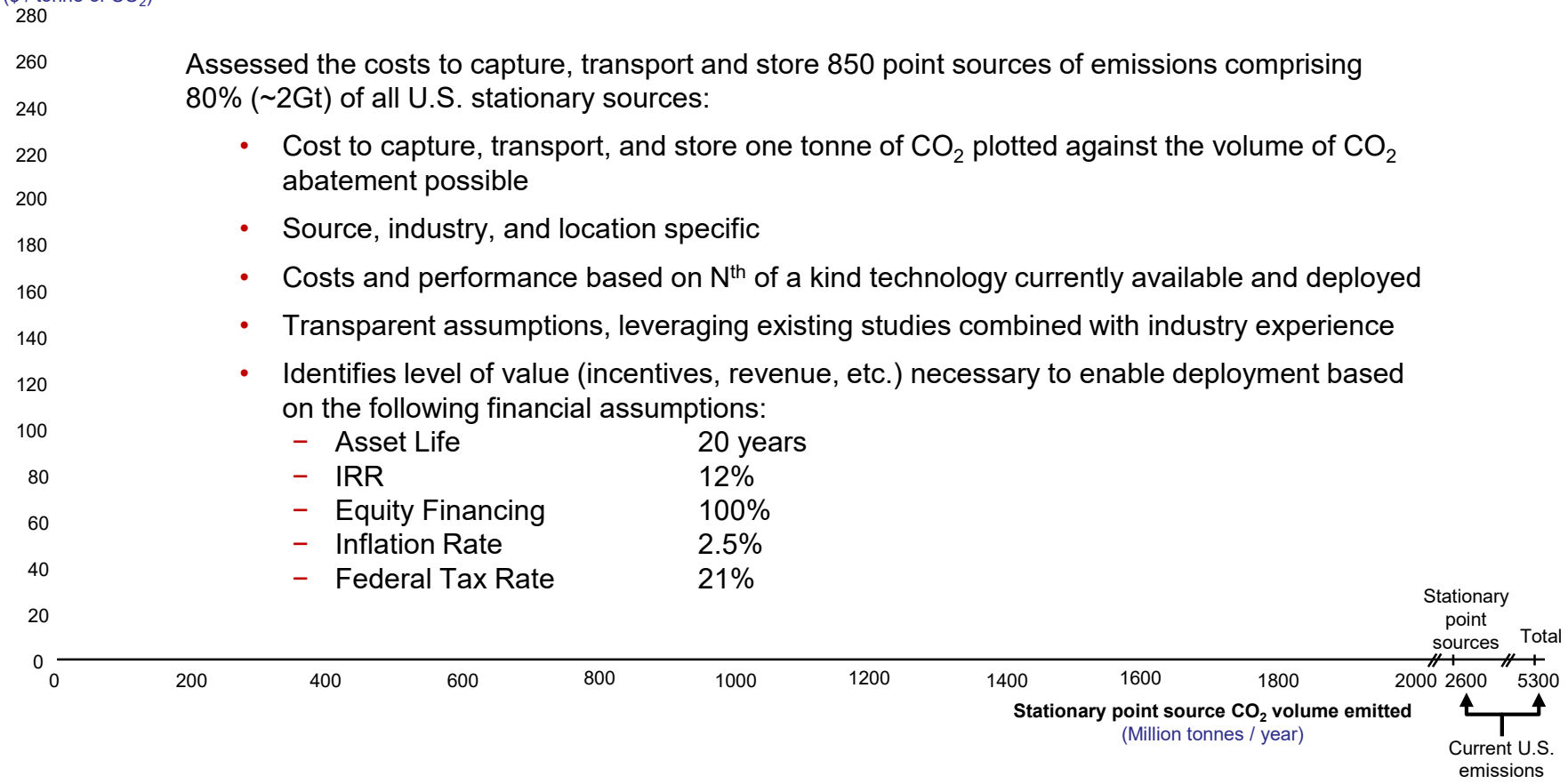
"CCUS is a critical part of a complete clean energy technology portfolio that provides a sustainable path for mitigating greenhouse gas emissions while ensuring energy security."

-- International Energy Agency, June 7, 2017

CCUS cost assessment: methodology

U.S. CCUS Costs by Point Source

($ / tonne of CO_2)



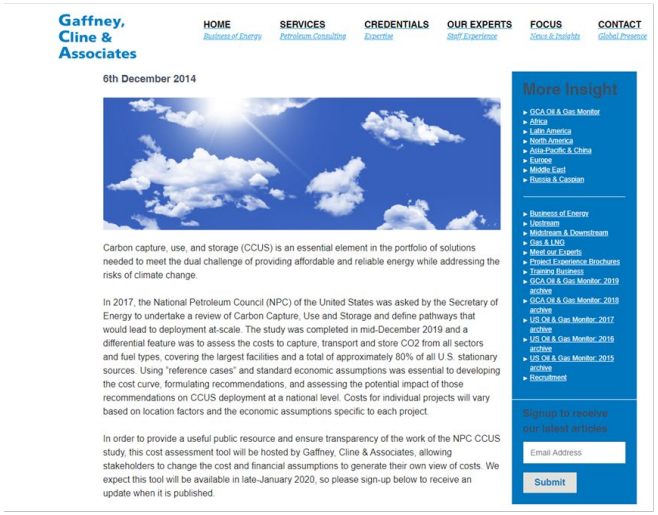
Assessed the costs to capture, transport and store 850 point sources of emissions comprising 80% (~2Gt) of all U.S. stationary sources:

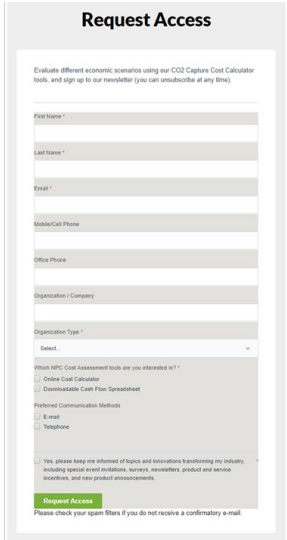
- Cost to capture, transport, and store one tonne of CO_2 plotted against the volume of CO_2 abatement possible
- Source, industry, and location specific
- Costs and performance based on N^{th} of a kind technology currently available and deployed
- Transparent assumptions, leveraging existing studies 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%

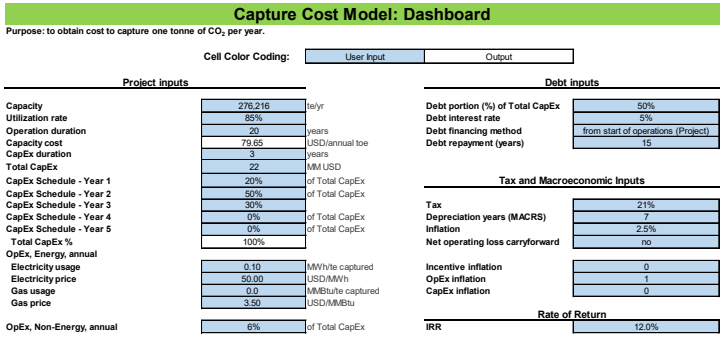
CCUS cost assessment: public online tool

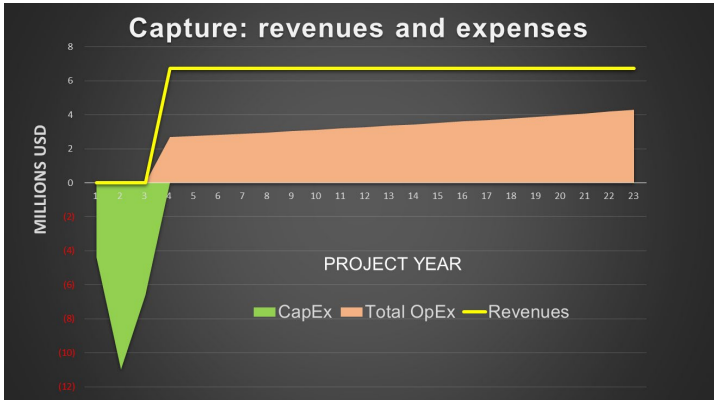
To provide a useful public resource and ensure transparency of the work, a cost assessment tool hosted by Gaffney, Cline & Associates will be available in late January/early February.

- Registration page www.gaffney-cline-focus.com/npc-ccus-cost-assessment-tool

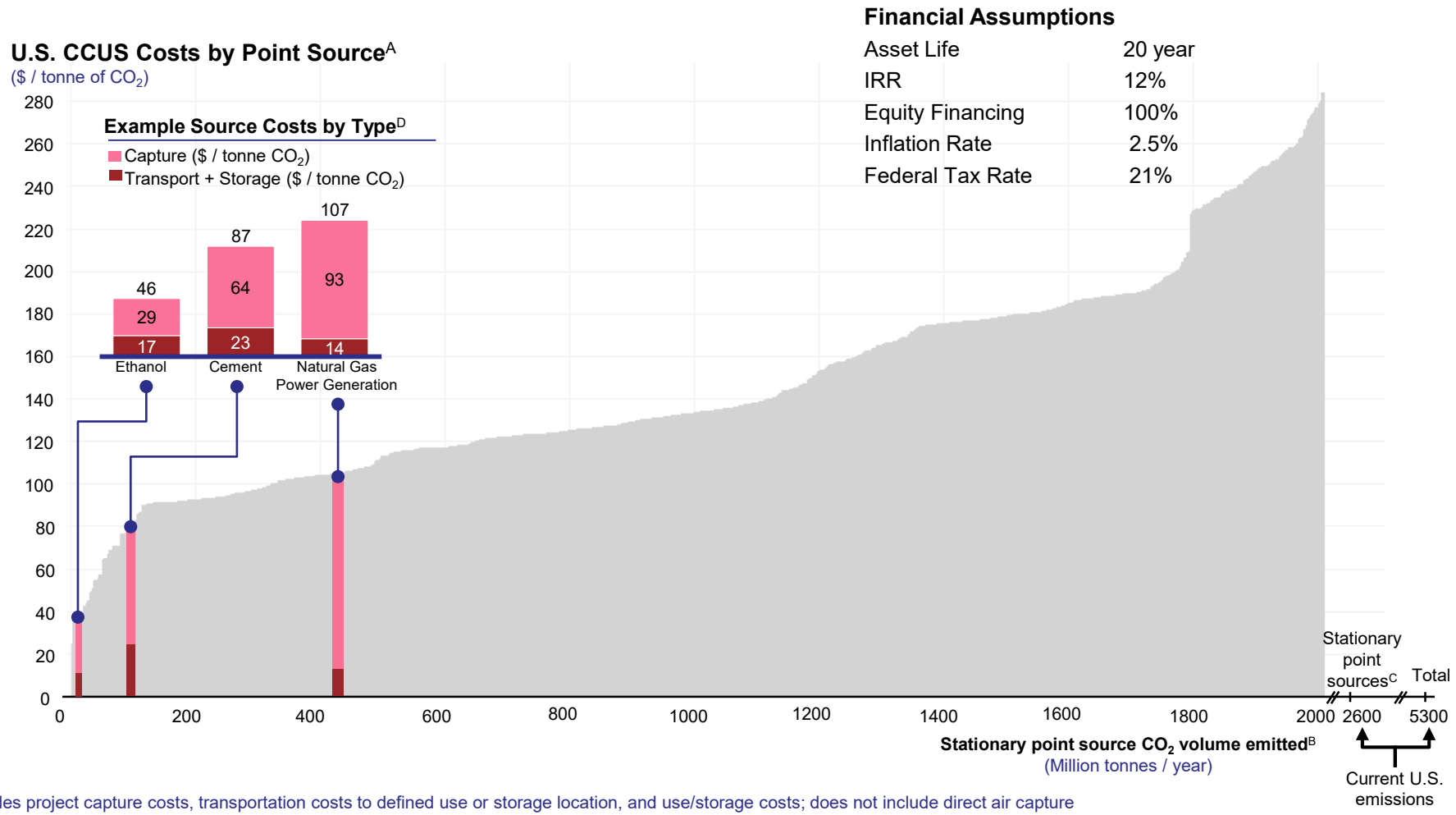








CCUS cost assessment: methodology

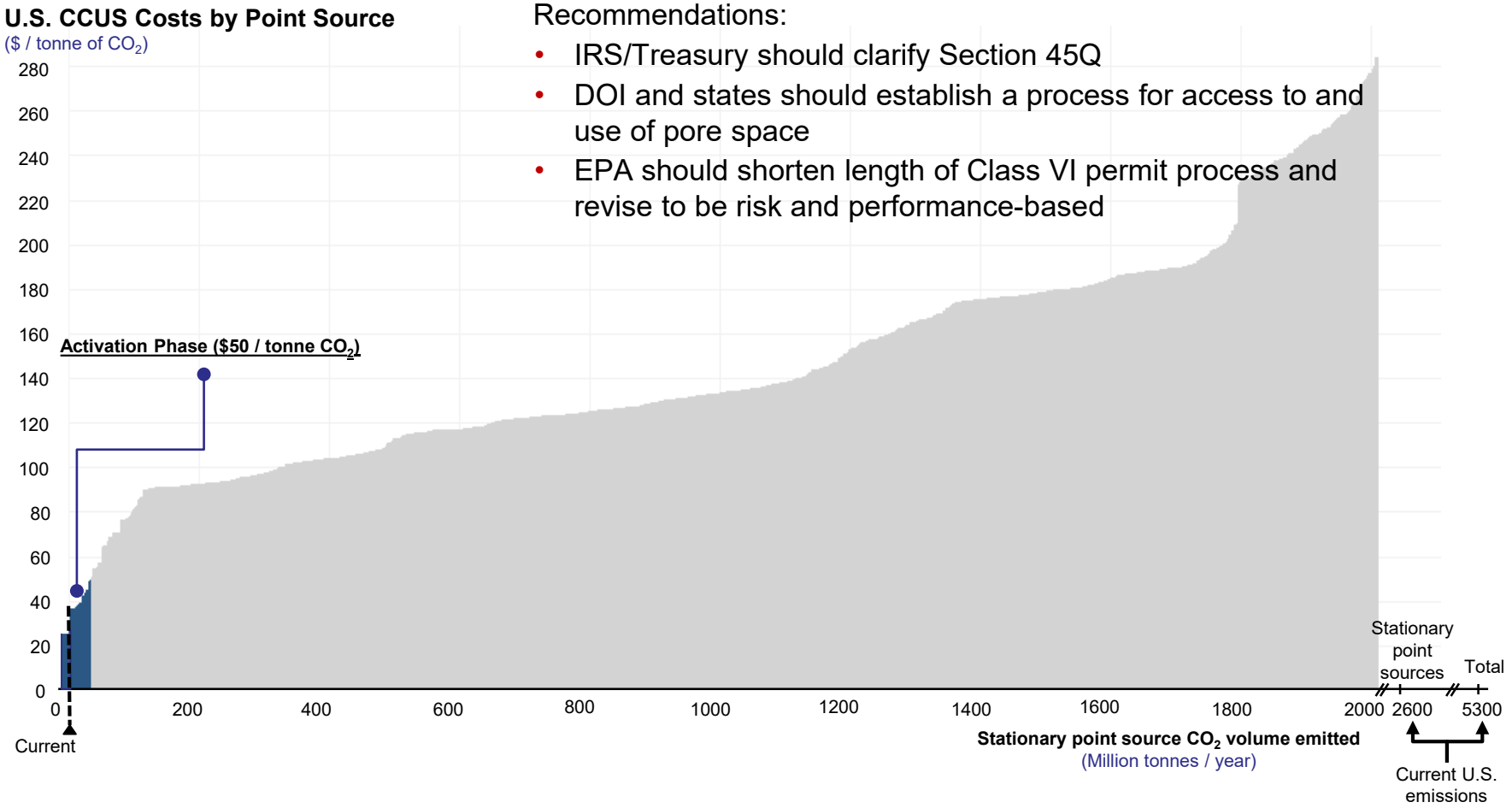


Financial Assumptions

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

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 CO_2 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

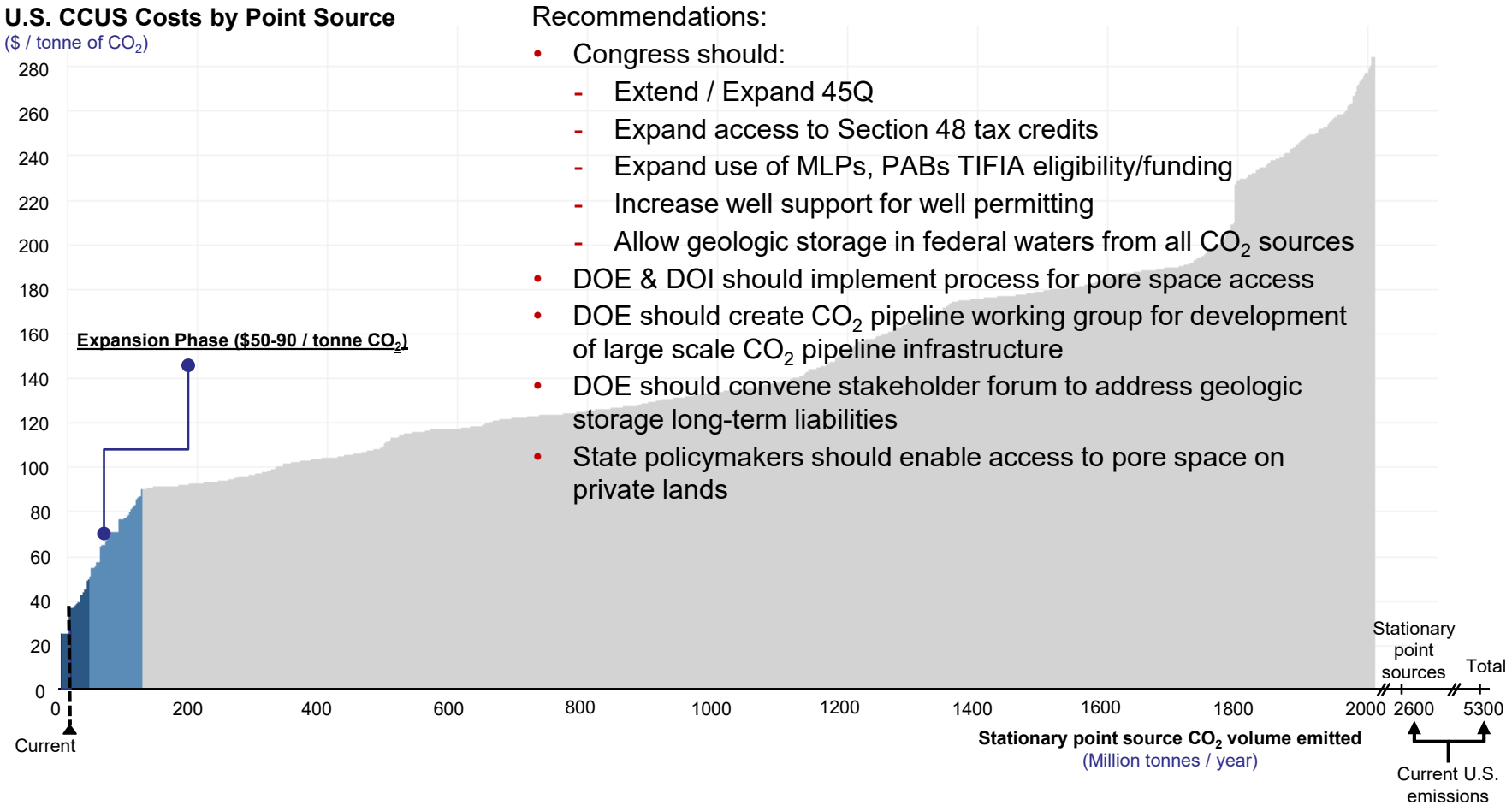
Activation phase



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 length of Class VI permit process and revise to be risk and performance-based

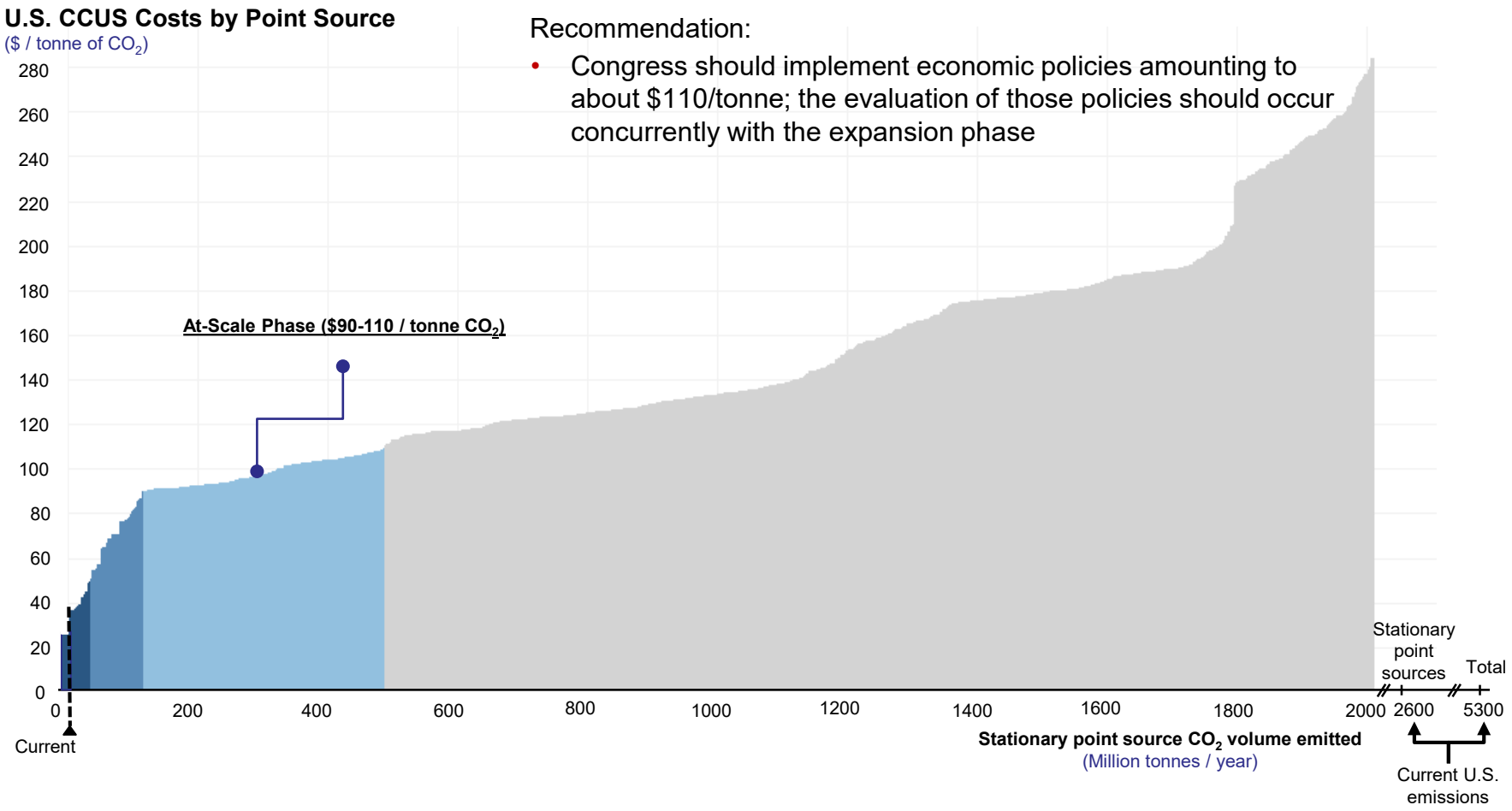
Expansion phase



Recommendations:

- Congress should:
  - Extend / Expand 45Q
  - Expand access to Section 48 tax credits
  - Expand use of MLPs, PABs TIFIA eligibility/funding
  - Increase well support for well permitting
  - Allow geologic storage in federal waters from all CO_2 sources
- DOE & DOI should implement process for pore space access
- DOE should create CO_2 pipeline working group for development of large scale CO_2 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



Recommendation:

- Congress should implement economic policies amounting to about $110/tonne; the evaluation of those policies should occur concurrently with the expansion phase

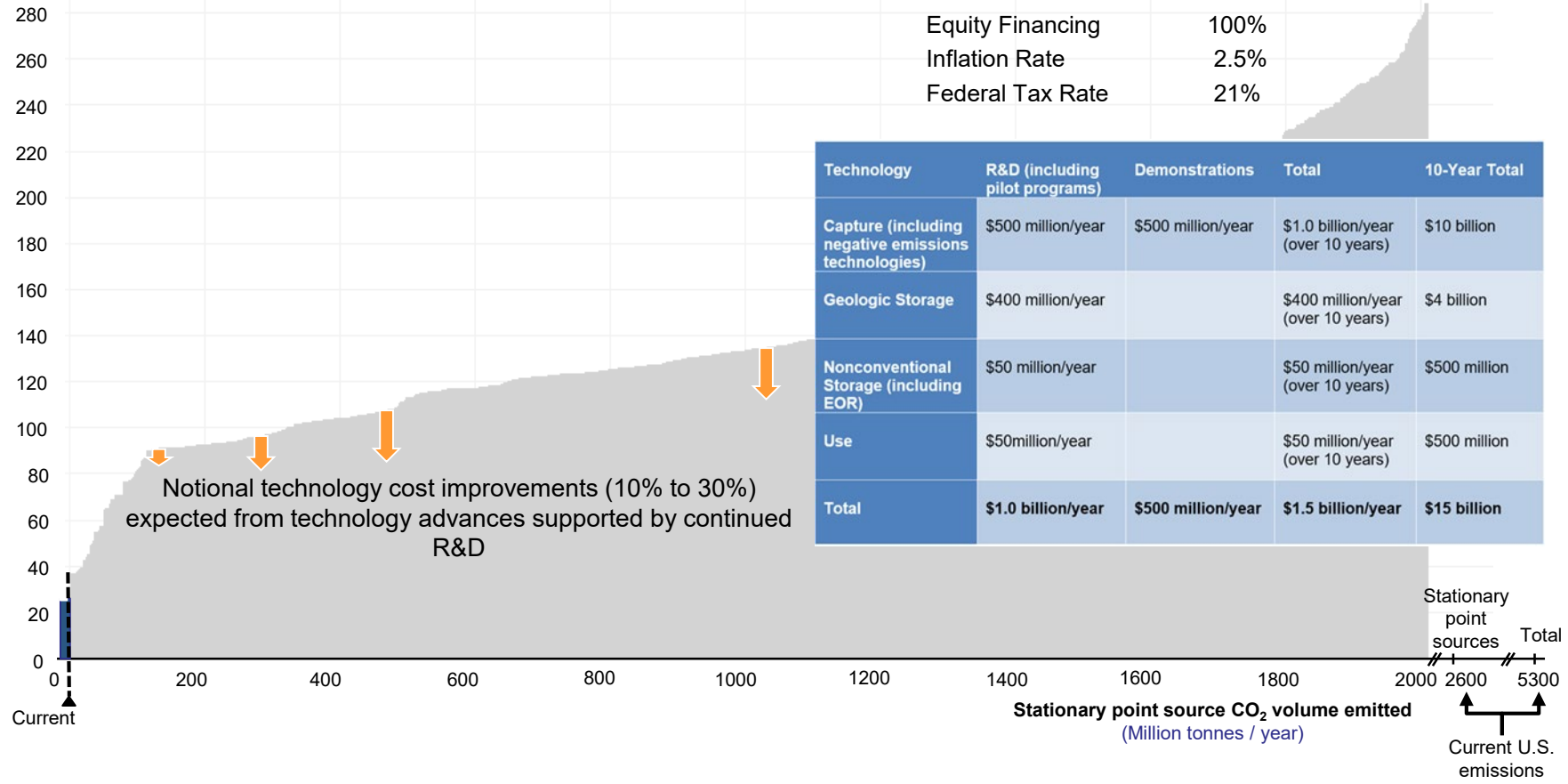
CCUS costs: role of R&D

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

($ / tonne of CO_2)



Technology	R&D (including pilot programs)	Demonstrations	Total	10-Year Total
Capture (including negative emissions technologies)	$500 million/year	$500 million/year	$1.0 billion/year (over 10 years)	$10 billion
Geologic Storage	$400 million/year		$400 million/year (over 10 years)	$4 billion
Nonconventional Storage (including EOR)	$50 million/year		$50 million/year (over 10 years)	$500 million
Use	$50million/year		$50 million/year (over 10 years)	$500 million
Total	**$1.0 billion/year**	**$500 million/year**	**$1.5 billion/year**	**$15 billion**

Key messages

- CCUS refers to the complete supply chain needed to capture, transport and permanently use or store CO_2, 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.

Back-up

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)

CCUS Technologies (Volume 3)

- **Technology Introduction**
- **Chapter 5:** CO_2 Capture
- **Chapter 6:** CO_2 Transport
- **Chapter 7:** CO_2 Geologic Storage
- **Chapter 8:** Enhanced Oil Recovery
- **Chapter 9:** CO_2 Use

Appendices

E. Mature CO_2 Capture Technologies

F. Emerging CO_2 Capture Technologies

G. CO_2 EOR Case Studies

H. CO_2 EOR Economic Factors and Considerations

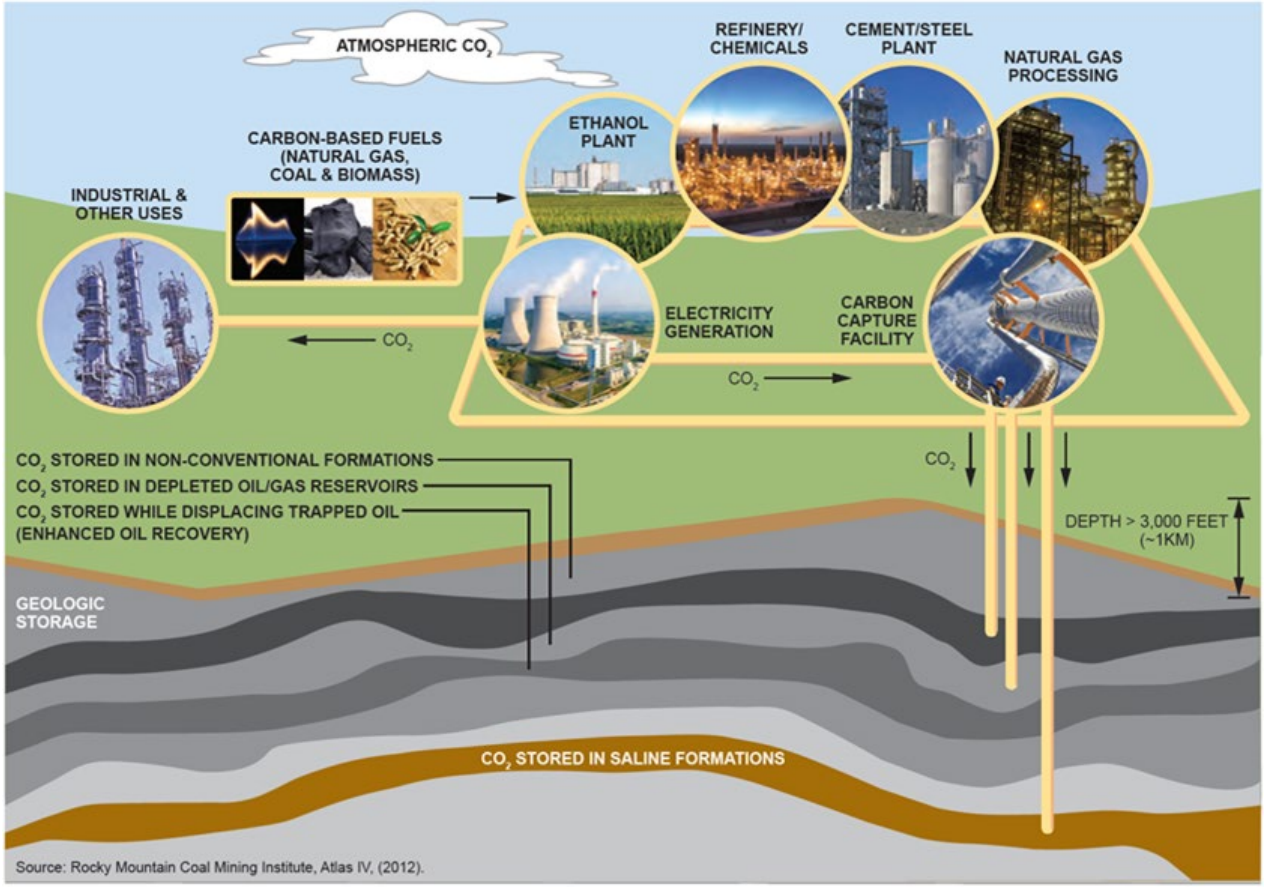
List of Topic Papers
Abbreviations, Units, Glossary

Findings and Recommendations

Full Report

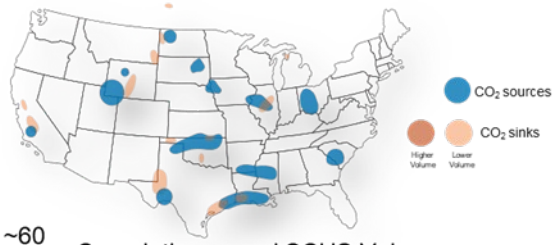
The CCUS supply chain

CCUS technologies combine to reduce the level of CO_2 emitted to or remove CO_2 from the atmosphere to be transported to and converted into useful products or injected underground for safe, secure and permanent storage.



Economic impacts of each phase of deployment

Activation



~60 Mtpa Cumulative annual CCUS Volume

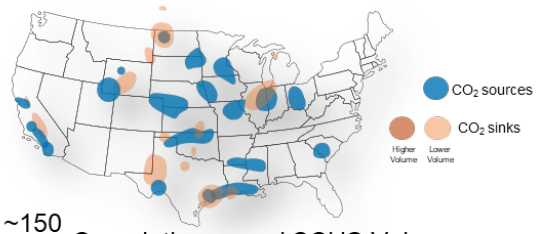
~$50 B investment (cumulative)

~$2 B pipeline infrastructure investment

~10K annual jobs

9% of US oil system by volume

Expansion



~150 Mtpa Cumulative annual CCUS Volume

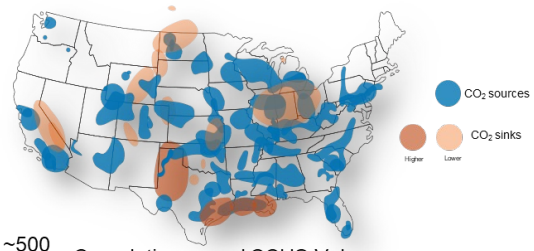
~$175 B investment (cumulative)

~$9 B pipeline infrastructure investment (cumulative)

~40K annual jobs (cumulative)

23% of US oil system by volume

At-scale



~500 Mtpa Cumulative annual CCUS Volume

~$680 B investment (cumulative)

~$28 B pipeline infrastructure investment (cumulative)

~230K annual jobs (cumulative)

76% of US oil system by volume