Welcome to the 129th Meeting

of the

National Petroleum Council

Washington, D.C.

December 12, 2019

National Petroleum Council

Dynamic Delivery –
America's Evolving Oil and Natural Gas Transportation Infrastructure

December 12, 2019

Secretary's Request

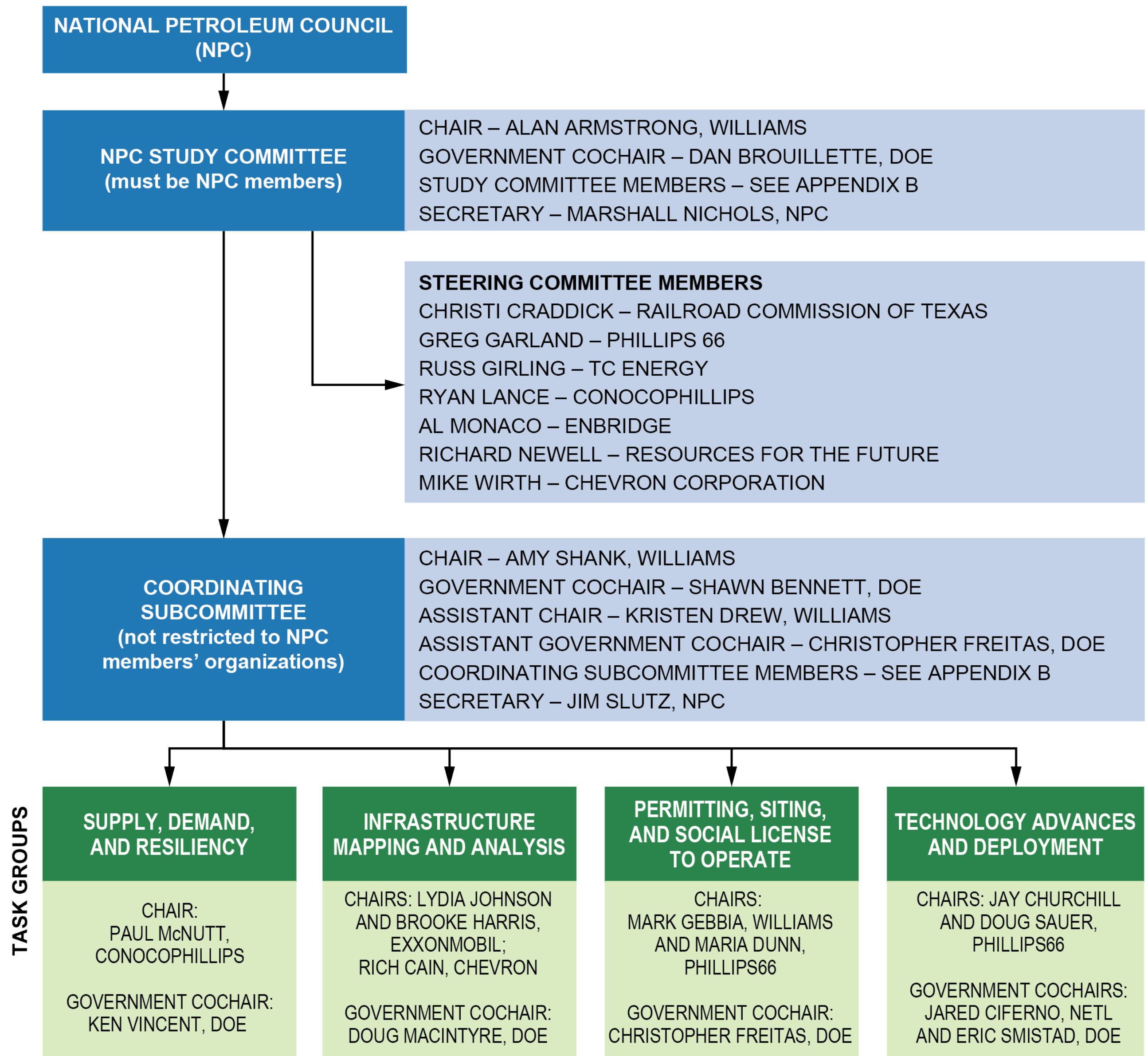
A study that would:

- Explain the extent of the transportation infrastructure today and the United States' infrastructure needs under varying demand assumptions.
- Include a review of any constraints to growing domestic oil and natural gas production caused by infrastructure limitations that reduce domestic demand or energy exports.
- Evaluate technology and policy options for improving infrastructure siting and related permitting processes, and which in turn could improve safety, environmental performance, and resilience of the system.

Key Questions:

- What are the important changes in future supply and demand patterns, and what transportation infrastructure improvements are required to leverage the regional and national opportunities offered by these changes?
- What advances in technology could improve the U.S. oil and natural gas transportation system, in terms of safety, reliability, efficiency, and environmental performance? In what new technology areas should research be progressed?
- How can state and federal governments leverage efforts to support U.S. petroleum and natural gas supply and transportation infrastructure capacity improvements?
- Are there regulatory requirements or policies that may be causing unintended consequences on energy system resilience? If so, what solutions can accomplish the regulatory objective more effectively?
- What emerging issues should policy makers be aware of and what actions should be considered to address these issues?

Infrastructure Study Organization



Study Team Diversity

STUDY COMMITTEE
55 team members

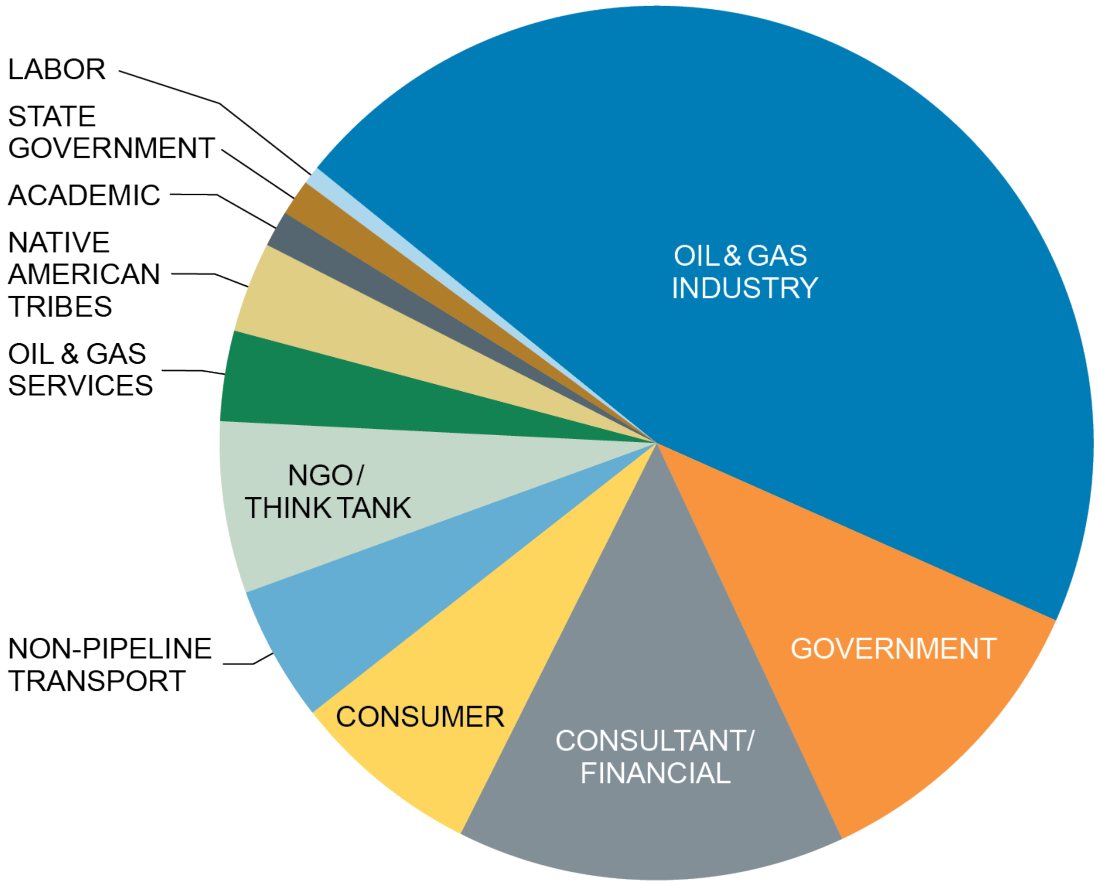
COORDINATING SUBCOMMITTEE
41 team members

SUPPLY, DEMAND, AND RESILIENCY TASK GROUP
49 team members

INFRASTRUCTURE MAPPING AND ANALYSIS TASK GROUP
32 team members

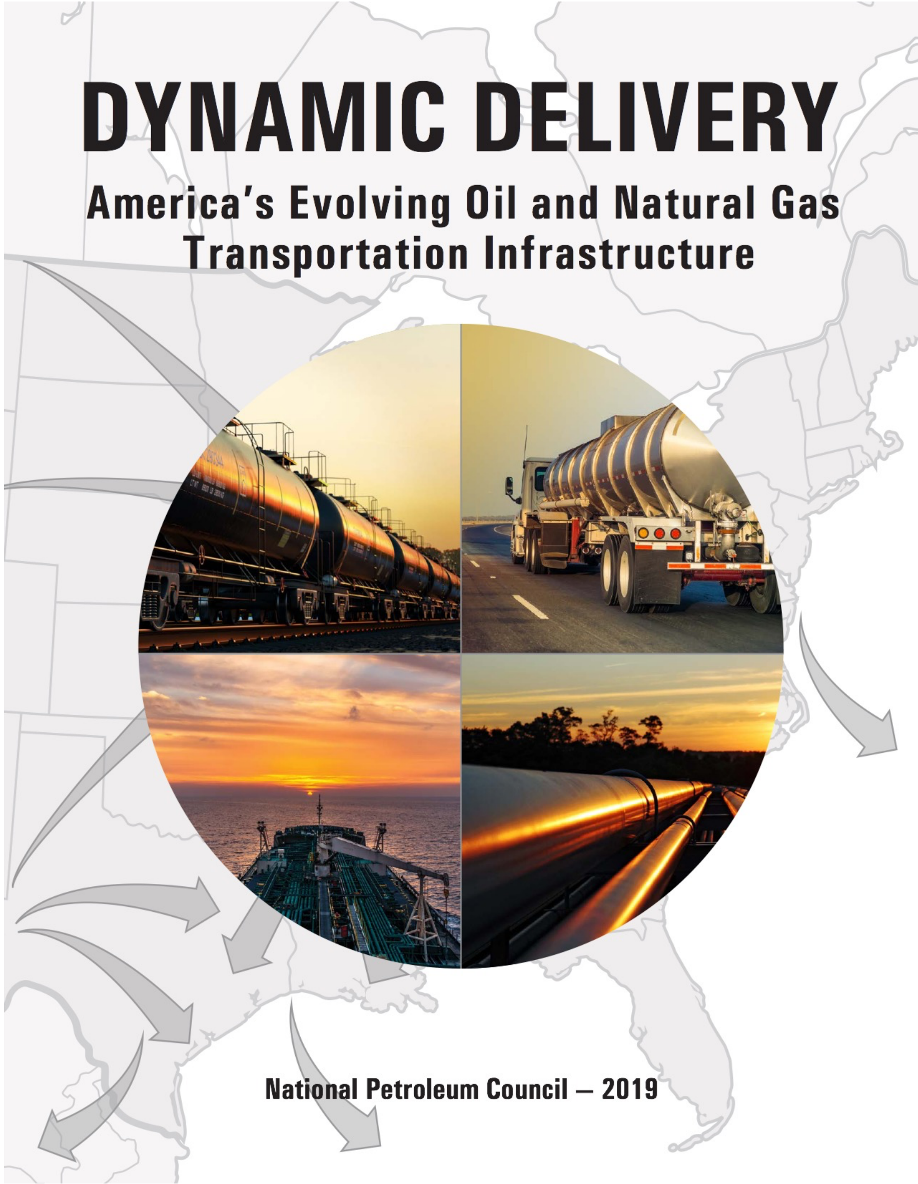
PERMITTING, SITING, AND SOCIAL LICENSE TO OPERATE TASK GROUP
45 team members

TECHNOLOGY ADVANCES AND DEPLOYMENT TASK GROUP
126 team members



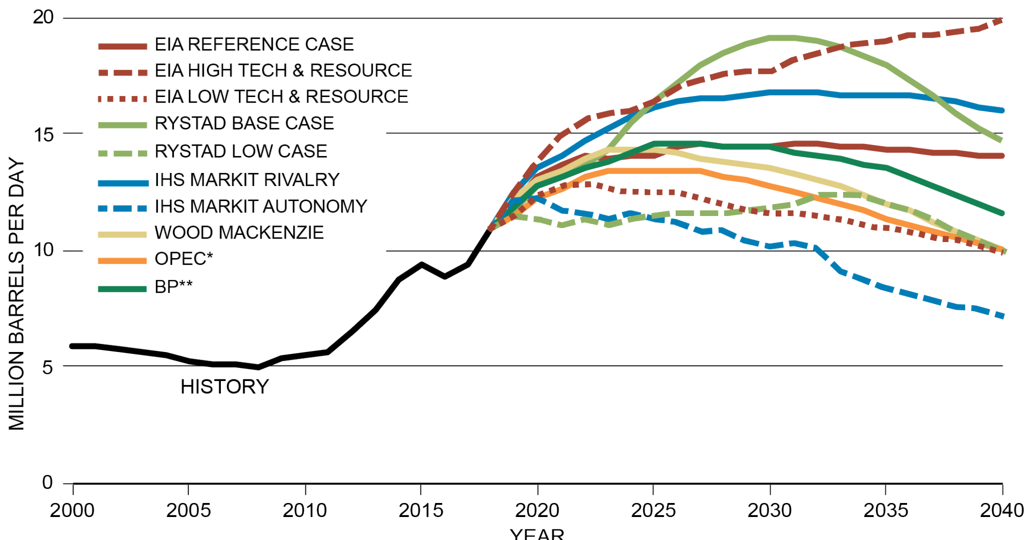
Report Structure

- Transmittal Letter
- Preface
- Executive Summary
- Chapter 1 – Supply and Demand
- Chapter 2 – Infrastructure Resiliency, Mapping, and Analysis
- Chapter 3 – Permitting, Siting, and Community Engagement
- Chapter 4 – Technology Advancement and Deployment
- Appendix A – Request Letter and Council Membership
- Appendix B – Roster of Study Participants
- Appendix C – List of Topic Papers

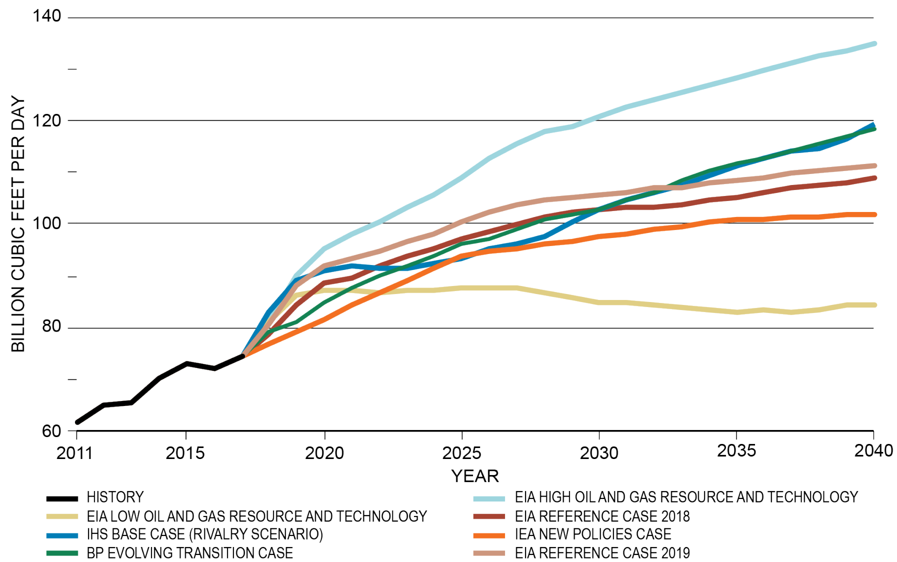

DYNAMIC DELIVERY
America's Evolving Oil and Natural Gas
Transportation Infrastructure
National Petroleum Council – 2019

Supply and Demand

Key Finding 1: The United States has become the largest producer of both oil and natural gas in the world, which has provided the nation with increased employment and economic growth, reduced energy imports, and reduced greenhouse gas emissions. Increased natural gas use replacing coal to generate electricity has been the single largest contributor to reducing U.S. CO_2 emissions by 15% since 2005.



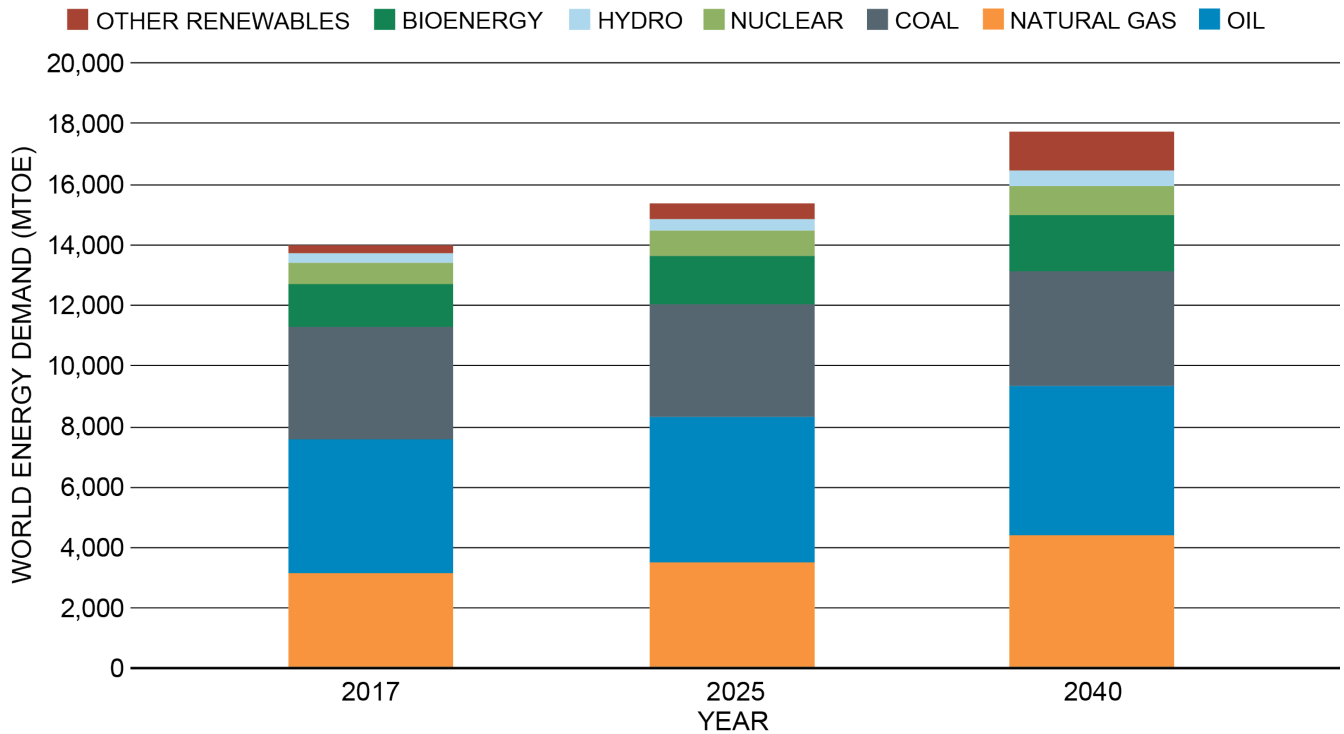
Sources: As noted in legend.
* OPEC outlook released in 2018. Other outlooks from 2019. ** BP 2019 Energy Outlook, Evolving Transitions scenario.



Sources: EIA *Annual Energy Outlook* 2018 and 2019; IHS Markit; and *BP Energy Outlook* 2019.

Supply and Demand

Key Finding 2: Even in energy forecasts designed to meet climate change targets, the largest energy sources continue to be oil and natural gas through at least 2040 to provide reliable and affordable energy.



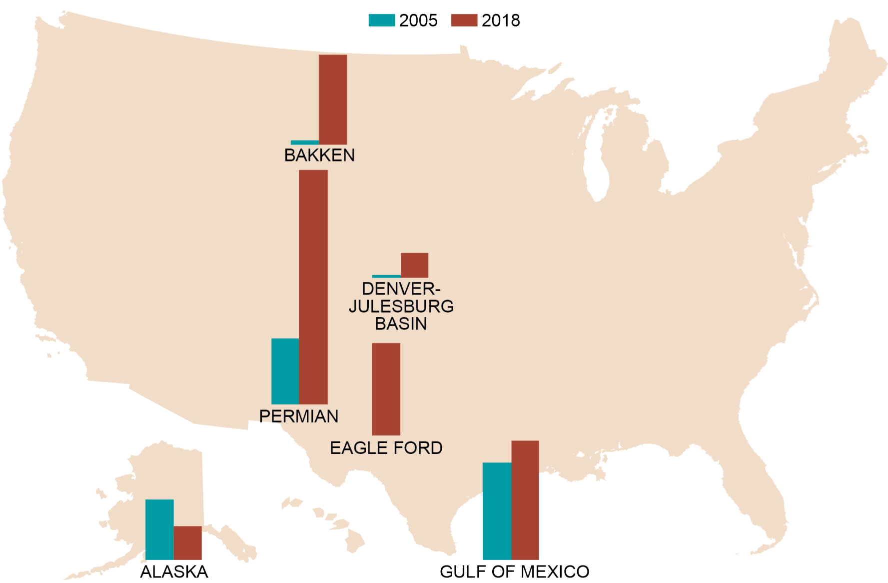
Source: The IEA New Policy Scenario is based on IEA data from IEA (2018) *World Energy Outlook,* all rights reserved; as modified by the National Petroleum Council.

IEA New Policies Scenario – Incorporates existing energy policies as well as an assessment of the results likely to stem from the implementation of announced policy intentions. These policies include the Nationally Determined Contributions countries agreed to under the Paris Agreement.

Infrastructure Analysis

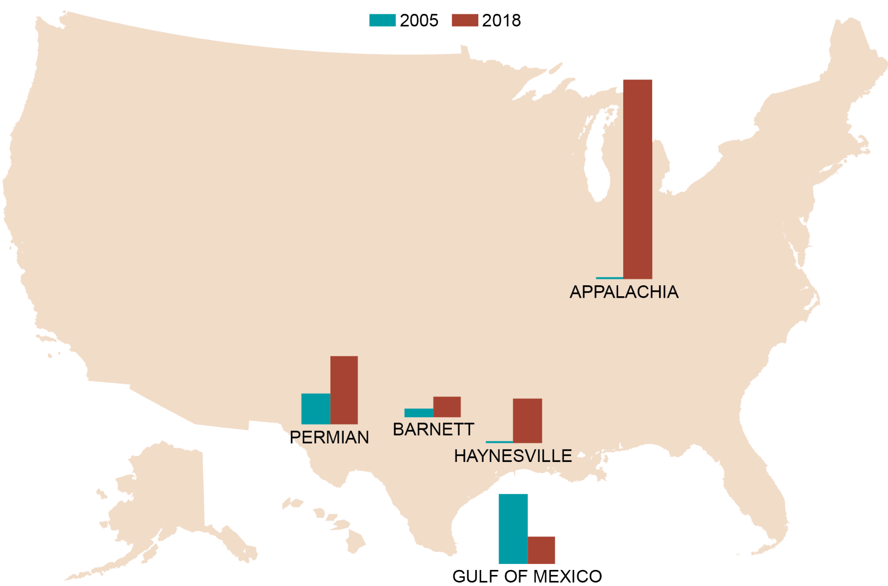
Key Finding 3: The benefits of the unprecedented increase in oil and natural gas production could not have come about without the significant expansion and adaptation of transportation infrastructure capacity.

Oil and Natural Gas Production Shifts



Source: U.S. Energy Information Administration.

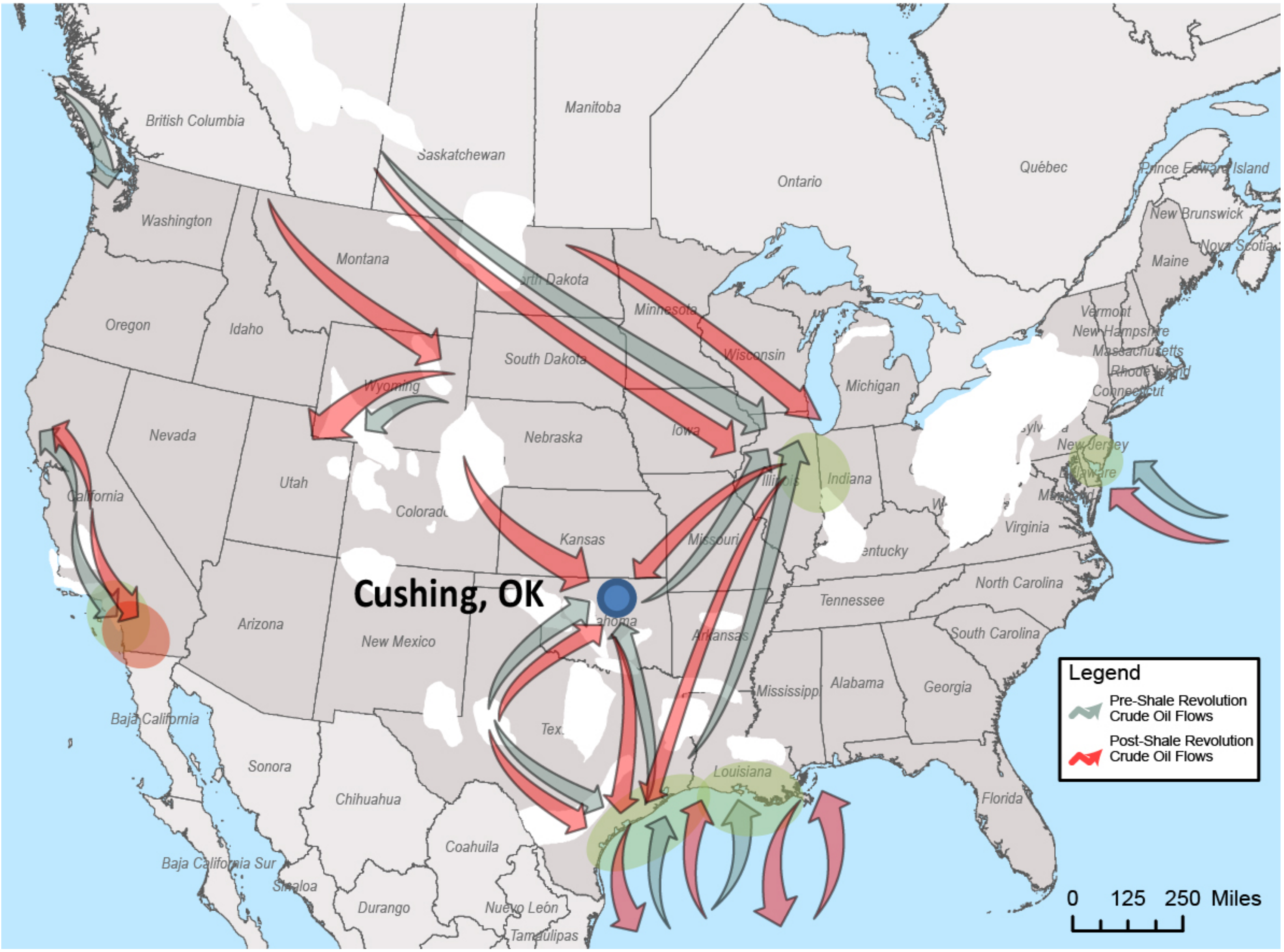
Crude Oil



Source: U.S. Energy Information Administration.

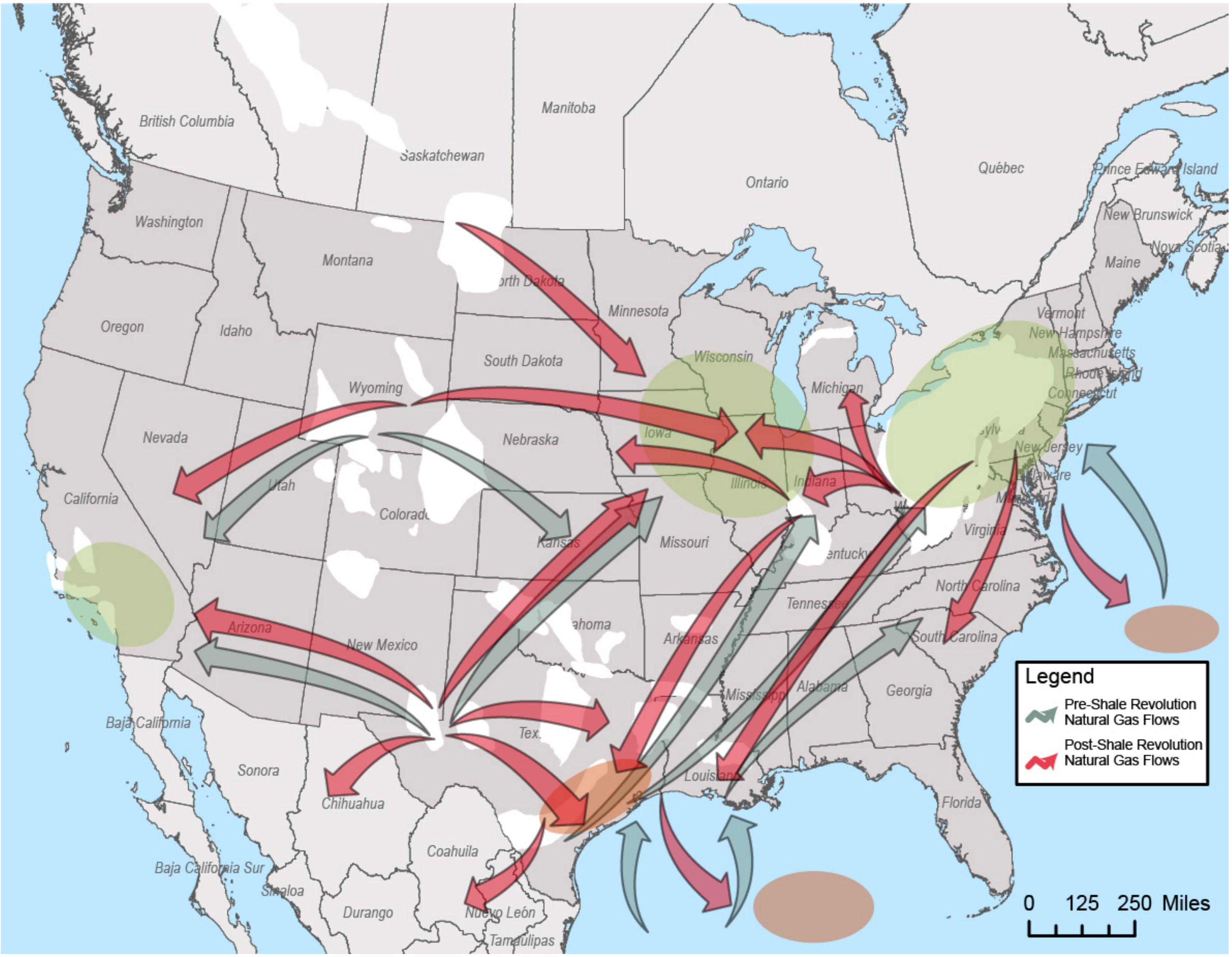
Natural Gas

Crude Oil Flows Pre- and Post-Shale



Source: RBN Energy and Hart Energy

Natural Gas Flows Pre- and Post-Shale



Source: RBN Energy and Hart Energy

Infrastructure Analysis

Key Finding 4: The U.S. economy can benefit even further from increased export of oil and natural gas.

Key Finding 5: Existing infrastructure has been modified and adapted to near-maximum capacity. To connect America's abundant energy supplies with domestic and global demand, significant public and private investment in new and existing pipelines, ports, rail facilities, and inland waterways will be essential.

Key Finding 6: Several critical infrastructure bottlenecks exist: natural gas pipeline access to New England/New York, Port of Houston capacity, and oil and natural gas export capability.

Key Finding 7: It is becoming increasingly challenging to keep pace with hiring and developing a well-qualified workforce to build and maintain existing and future infrastructure. A skilled labor shortage exists in the United States and will continue to grow as the current workforce continues to retire.

Value of Oil and Natural Gas Infrastructure

Economic Contributions of Oil and Natural Gas

JOBS
10.3 Million

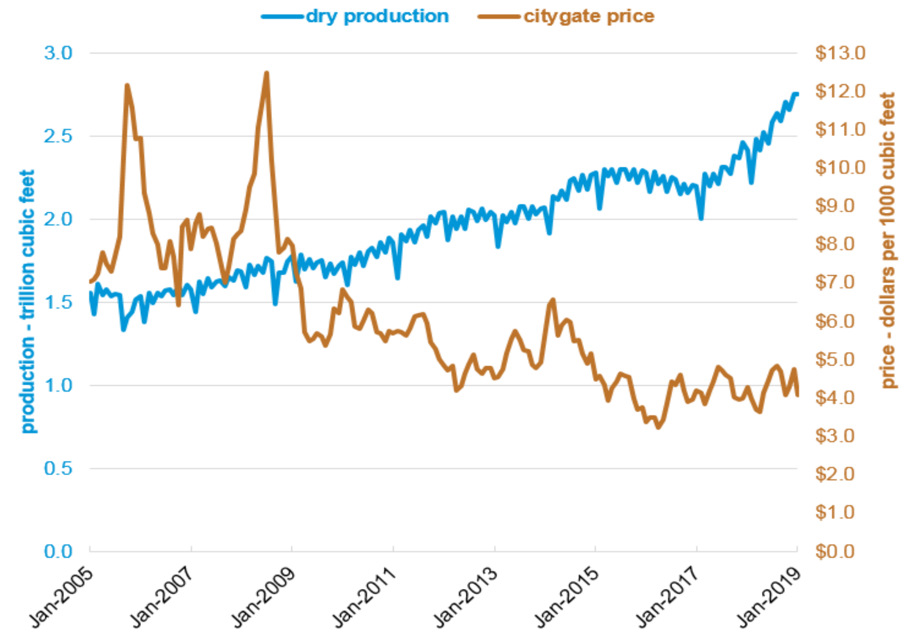
INCOME
$714 Billion

ECONOMIC BENEFIT
$1.3 Trillion

PriceWaterhouseCoopers, “Impacts of the Oil and Natural Gas Industry on the US Economy in 2015,” July 2017.

Lower Energy Costs Benefit Consumers

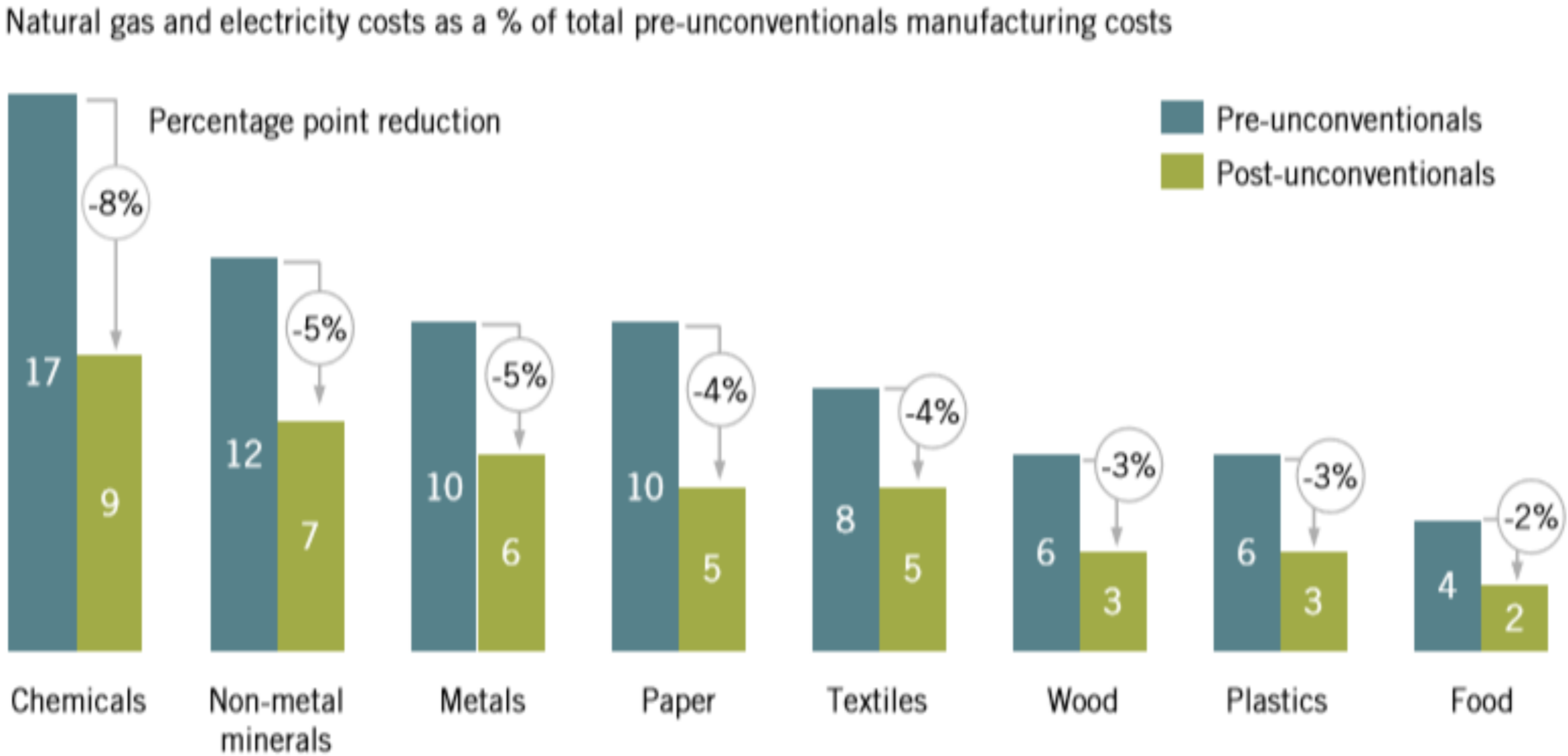
U.S. monthly dry natural gas production and monthly average citygate price, January 2005–January 2019



Note: Citygate is a point or measuring station at which a natural gas distribution utility receives gas from a pipeline company or transmission system.
Source: U.S. Energy Information Administration, *Natural Gas Monthly*, June 2019

Source: EIA, Natural Gas Monthly, June 2019.

Value of Oil and Natural Gas Infrastructure



Note: Manufacturing costs include all raw materials through all production processes with overhead included.

Source: Harold L. Sirkin, Michael Zinser, and Justin Rose, "The U.S. as One of the Developed World's Lowest-Cost Manufacturers: Behind the American Export Surge," The Boston Consulting Group, August 20, 2013, https://www.bcgperspectives.com/content/articles/lean_manufacturing_sourcing_procurement_behind_american_export_surge, accessed May 2015.

Natural Gas and Electricity Costs as a Percentage of Total Pre-Unconventional Oil and Natural Gas Manufacturing Costs

Improving Infrastructure Investment

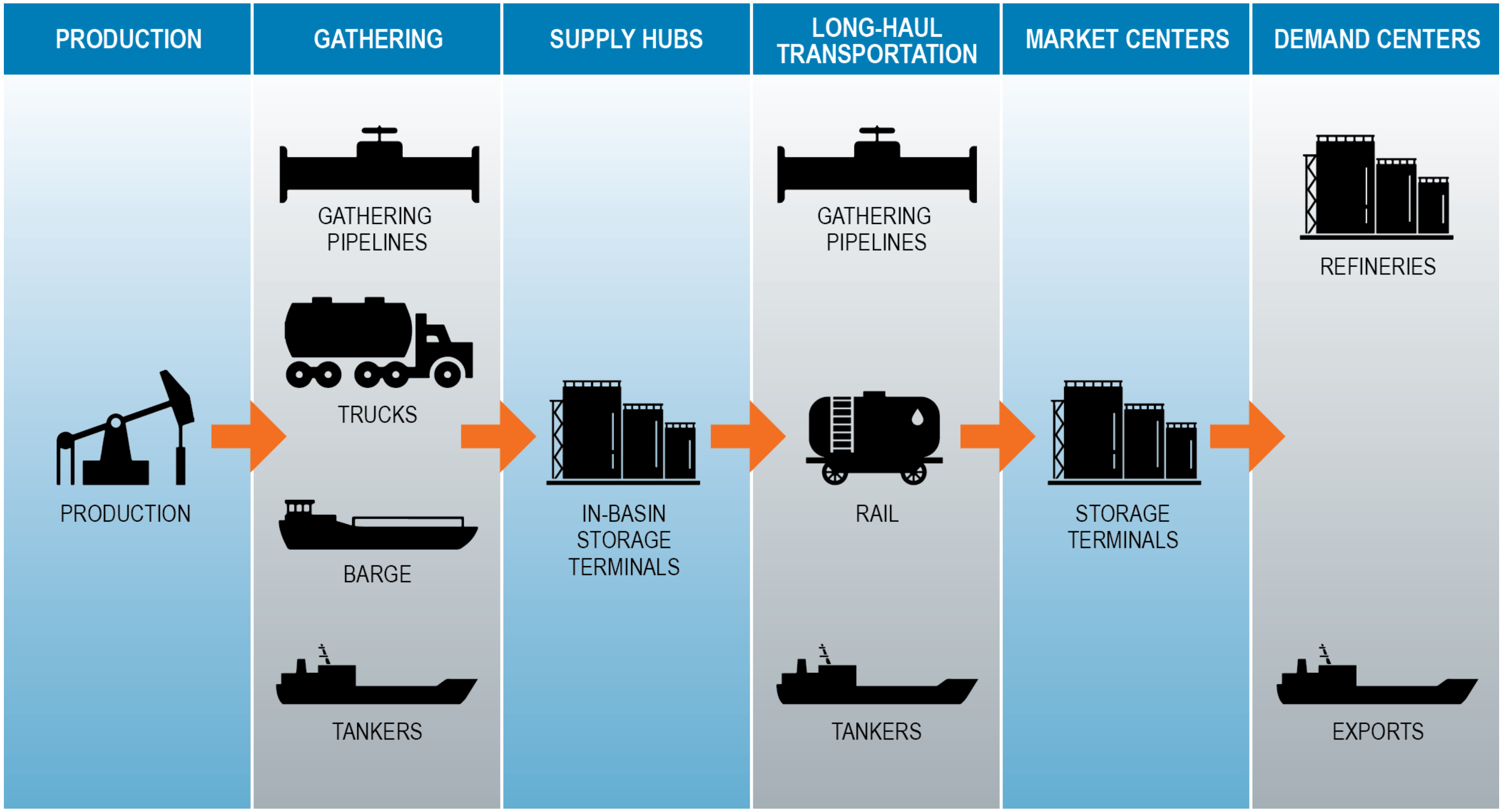
The NPC recommends:

- To mitigate negative impacts on interstate commerce, all levels of government should have constructive dialogue about the overall economic benefits from the nation's energy resources and effectively engaging stakeholders and minimizing local impacts and risks.
- Congress should fully appropriate the revenue coming into the Harbor Maintenance Trust Fund and the Inland Waterways Trust Fund funds to restore and fully maintain all U.S port and waterways infrastructure at their authorized dimensions.
- The U.S. government, states, local communities, secondary schools, and industry should promote vocational career education and technical training of their constituents, members, and communities.
- Industry, along with secondary and technical schools, should advocate for and support registered and accredited apprenticeship programs to ensure an adequate supply of skilled industrial construction, operations, and maintenance workers.

Resiliency

Key Finding 8: An interdependent infrastructure system of pipeline, truck, rail, and marine transport working together with storage ensures the delivery of reliable and affordable energy.

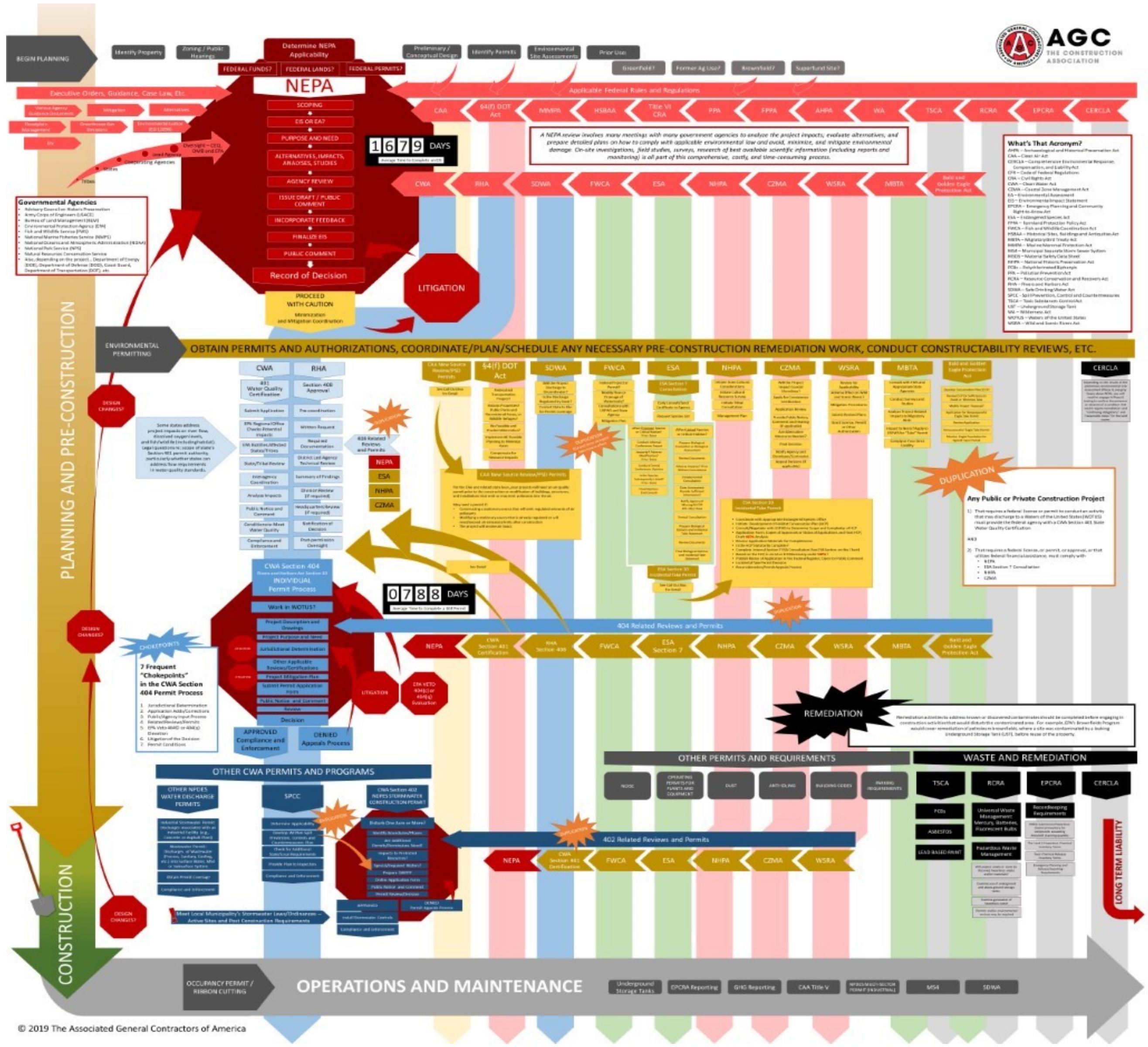
Crude Oil Supply Chain Example



Source: Plains All American.

Permitting

Key Finding 9:
Overlapping and duplicative regulatory requirements, inconsistencies across multiple federal and state agencies, and unnecessarily lengthy administrative procedures have created a complex and unpredictable permitting process.



Permitting

The NPC recommends:

- States should consider utilizing the Environmental Council of the States' relationships with state officials and knowledge of the federal process, to facilitate a common agreement between federal and state jurisdictions when there are potential conflicts between a NEPA review and a SEPA review to avoid delay, confusion, and legal vulnerability.
- A national organization made up of state regulatory agencies, such as the Interstate Oil and Gas Compact Commission or the Environmental Council of the States, and representatives of local governments, communities, interested nongovernmental organizations (NGOs), and industry should collaborate to develop a model master structure for state permitting and coordination of approvals for infrastructure, to provide for efficient collaboration with operators and better coordination with federal agencies.
- States should adopt a single point of contact for permit coordination.

Permitting

The NPC recommends: The U.S. Army Corps of Engineers should:

- Implement rulemaking to provide procedural consistency among nationwide permit programs, potentially requiring pre-application to identify Lead Districts, points of contact, and variations in requirements across watershed and political boundaries.
- Continue working and implementing One Federal Decision process initiatives to improve the efficiencies of the USACE regulatory processes, including a lead district for projects crossing multiple districts and a single point of contact for One Federal Decision and any project crossing District boundaries.
- Clarify when the pre-construction notifications requirements for use of NWP12 are required, e.g., when there are public water supply intakes downstream of the activity, or when the activity may affect listed species or officially designated critical habitat.
- Implement consistent approaches to permit interpretation among its field offices to minimize variation of nationwide permit programs.

Permitting

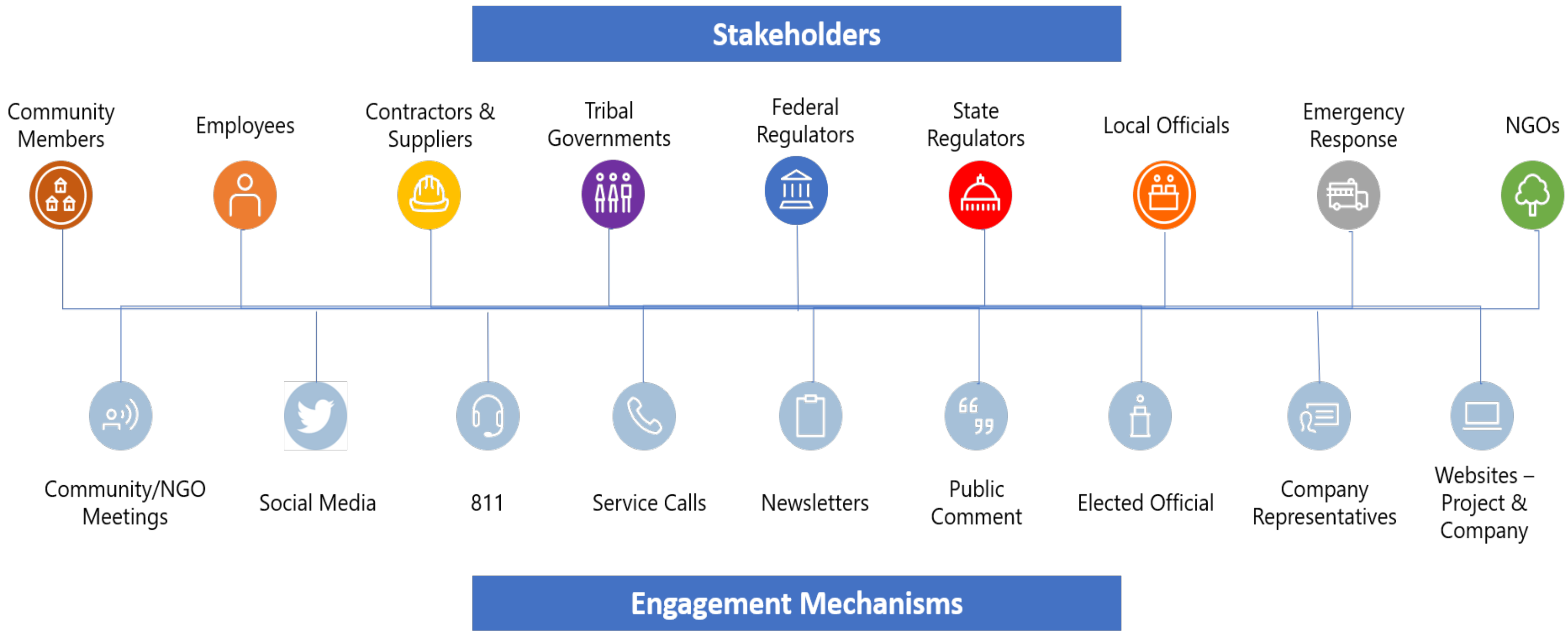
Key Finding 10: Bipartisan actions by Congress and the Executive Branch, including mechanisms to expedite the permitting process for large infrastructure projects, represent positive steps; however, further improvements are necessary.

The NPC recommends:

- A federal agency should consult with FAST-41 project sponsors and other stakeholders to obtain feedback to improve FAST-41 before reauthorization.
- Congress should reauthorize FAST-41 for an additional 7 years and include the following improvements:
  - Expand FAST-41 to include eligibility for all federal energy infrastructure projects and continuing staffing of FPISC.
  - For federal permits or decisions delegated to the states (CZMA, CWA, CAA), states should be incentivized to comply with FAST-41 and One Federal Decision and make decisions in conjunction with federal NEPA process timeline.
  - FPISC should be leveraged to drive concurrent review by the states during federal permitting processes.
- Further reauthorizations by Congress of FAST-41 should consider eliminating sunset provisions.

Stakeholder Engagement

Key Finding 11: Successful infrastructure projects depend upon early, effective, and continuous stakeholder engagement and collaboration.



Stakeholder Engagement

The NPC recommends: Infrastructure companies should:

- Implement existing best practices (e.g. FERC, INGAA, API, AOPL) for early and effective engagement with local governments, communities, private citizens, public interest groups, and American Indian and Alaska Native Tribes to understand and address stakeholder concerns. Infrastructure companies should strive to incorporate stakeholder input into a proposed action wherever practicable and collaborate on finding solutions or conveying reasons in those circumstances where an interest is difficult to accommodate.
- Engage in educational and awareness efforts with communities and stakeholders to increase understanding of the need for infrastructure, the steps to be taken to construct and operate it safely, and how they will be engaged throughout the siting and development process.
- Work collectively towards more effective engagement practices regarding energy, environmental, and related public policies that encourage responsible energy development and transport.

Permitting and Climate Change

Key Finding 12: The nation faces the dual challenge of providing affordable energy to support economic growth and human prosperity while addressing the environmental effects including the risks of climate change. Industry shares the public's concerns that climate change is a serious issue that must be addressed. Litigation of individual projects to address climate concerns is an ineffective approach.

The NPC recommends:

- All infrastructure companies should strive for an outstanding environmental compliance record and to reduce the intensity of greenhouse gas emissions from their operations. Emissions reduction programs, such as One Future, The Methane Challenge, The Environmental Partnership, and EPA's Natural Gas Star Program are all means of demonstrating a company's efforts to reduce methane emissions.

Permitting and Climate Change

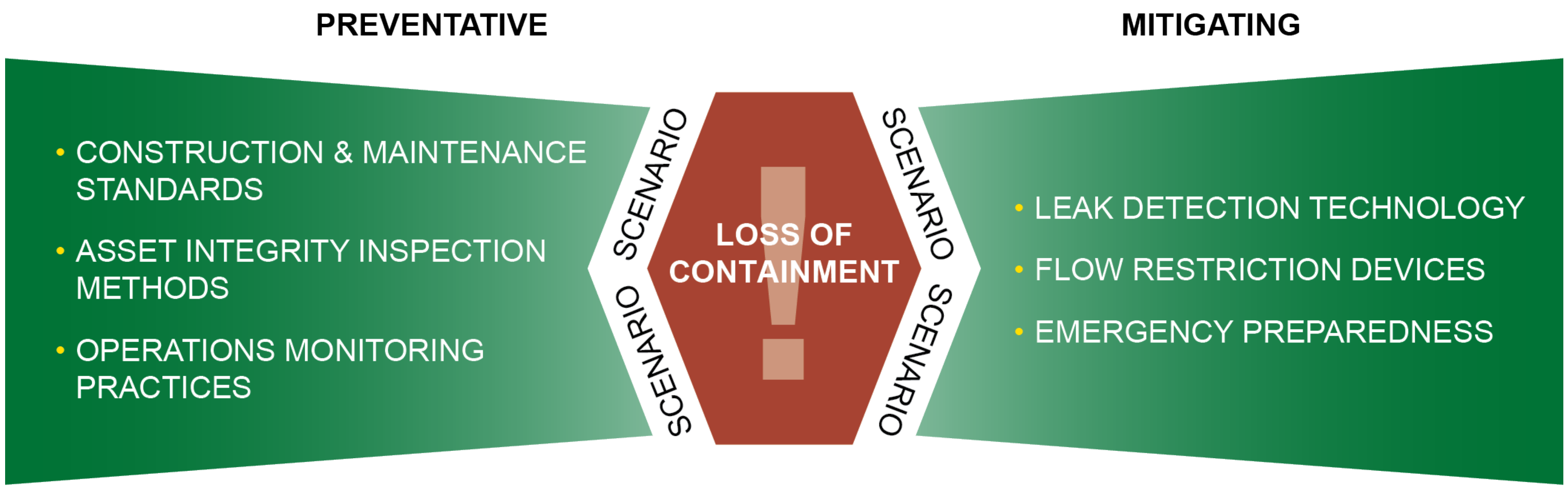
Key Finding 13: The permitting and construction of some energy infrastructure projects has been challenged, delayed, or stopped as a result of litigation by stakeholders concerned about climate change and the associated policy debate.

The NPC recommends: Congress should:

- Clarify that greenhouse gas assessments under NEPA, for oil and natural gas infrastructure projects, are confined to emissions that are (1) proximately caused by the federal action (see Dep't. of Transportation v. Public Citizen, 541 U.S. 752 (2004)), and (2) are reasonably foreseeable.
- Enact a comprehensive national policy to reduce greenhouse gas emissions and seek to harmonize federal, state, and sectoral policies to enhance efficiency and effectiveness. Congress should ensure that the enacted national policy is economy wide, applicable to all sources of emissions, market-based, transparent, predictable, technology agnostic, and internationally competitive.

Technology Advancements – Safety

Key Finding 14: Crude oil, petroleum products, and natural gas moved by the nation's infrastructure reach their destinations with a high degree of safety, resiliency, and environmental performance. However, incidents have occurred, and oil and gas companies are committed to continuous improvement.



Technology Deployment

Key Finding 15: Advancements in new technologies have been an important contributor to industry's safety, reliability, and environmental performance. Overcoming challenges and barriers to new technology development and deployment would accelerate these improvements.

The NPC recommends:

- While working with DOE, EPA, and the U.S. Coast Guard, DOT should lead creation of an agile pathway for evaluation and regulatory acceptance of new technologies that can improve transportation safety and shorten the research, deployment, and adoption cycle time.
- Congress should authorize DOT to lead a collaborative effort, with support from industry, to develop and prioritize pilot programs that can accelerate pipeline, storage, and LNG technology adoption based on performance-based rules with a goal of enhancing public safety. Upon successful completion of pilot programs, regulators should promptly update regulations to allow use of new technology.
- Oil and natural gas transportation companies should establish a collaborative effort with participation from DOT, DOE, EPA, and industry research consortiums to prioritize promising, risk-based research opportunities, establish consistent technical readiness processes, and prioritize field validation testing needs.
- FERC and state regulatory agencies should work with DOT, DOE, and others to promote laws, regulations, and public-private partnerships that support cost recovery for natural gas and oil pipeline safety research.

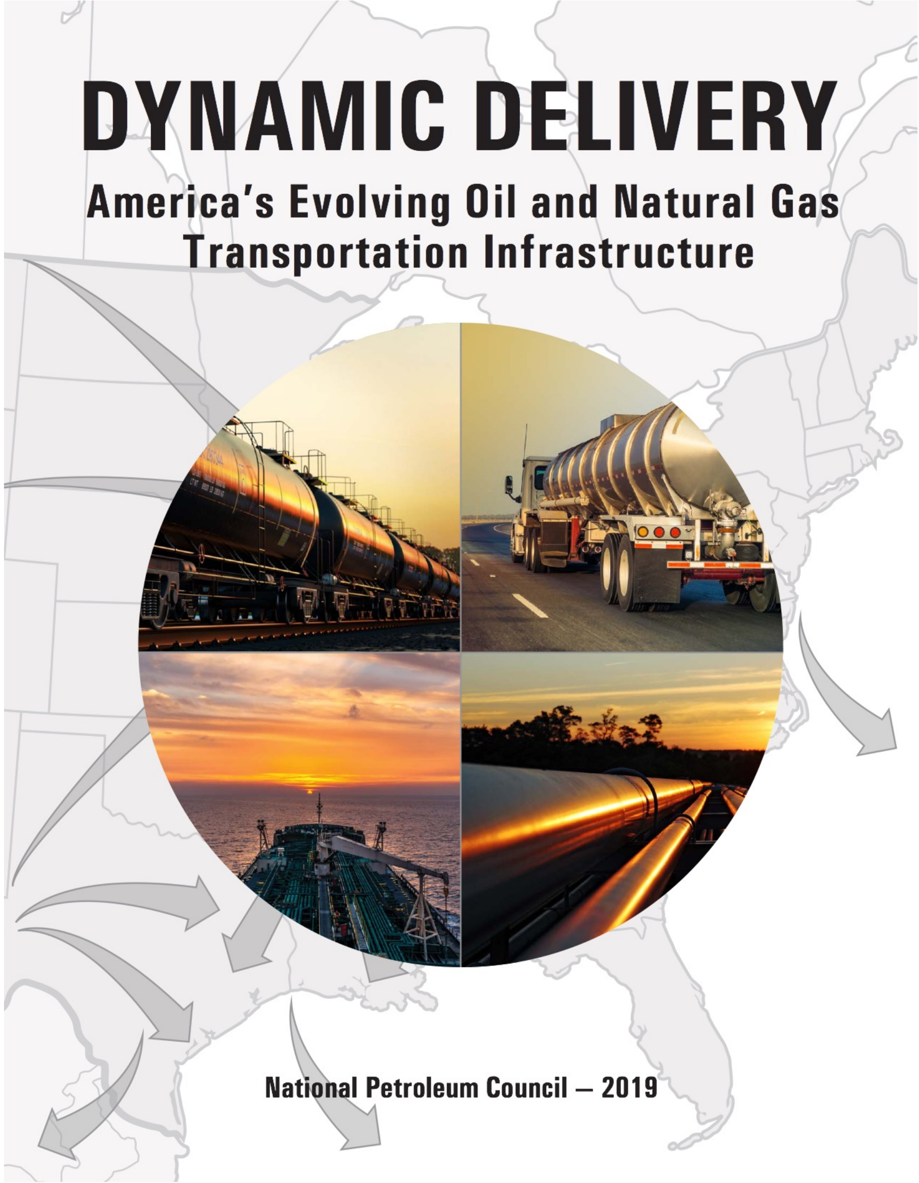
Cybersecurity

Key Finding 16: Cyber threats to energy infrastructure control systems are increasing and security protections are being challenged due to increasing connectivity and growing malicious cyber activity.

The NPC recommends: Cybersecurity protections should be advanced through:

- Industry, in collaboration with trade associations and federal government agencies, should adopt and maintain up-to-date performance-based Cyber Security Management Standards.
- Increased DHS and DOE capabilities and resources to support independent and secure cyber security assessments and audits prioritized on critical infrastructure.
- DOE, working with industry, DOD, DHS, and DOT, to establish a collaborative process to identify and prioritize research and development aimed at sector-wide protection against nation-state and advanced persistent threat actors.

Discussion



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National Petroleum Council – 2019

National Petroleum Council

Washington, D.C.

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

December 12, 2019

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 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?

Comprehensive report covering:

CCUS Energy and Emission Landscape

- Understanding the dual challenge and the role of CCUS

Economics

- Detailed CCUS cost and economic analyses

Enabling Factors

- Existing policy and regulatory landscape
- Current barriers and prioritized, actionable recommendations

Technology

- Well written technology chapters covering entire supply chain
- Aggressive research and development recommendations

Roadmap

- Prioritized based on economics and ease of implementation
- Three phases of deployment
- Detailed plan – who, what, when, and why over 25 years

Study organization

National Petroleum Council (NPC)

NPC Study Committee (NPC Members)

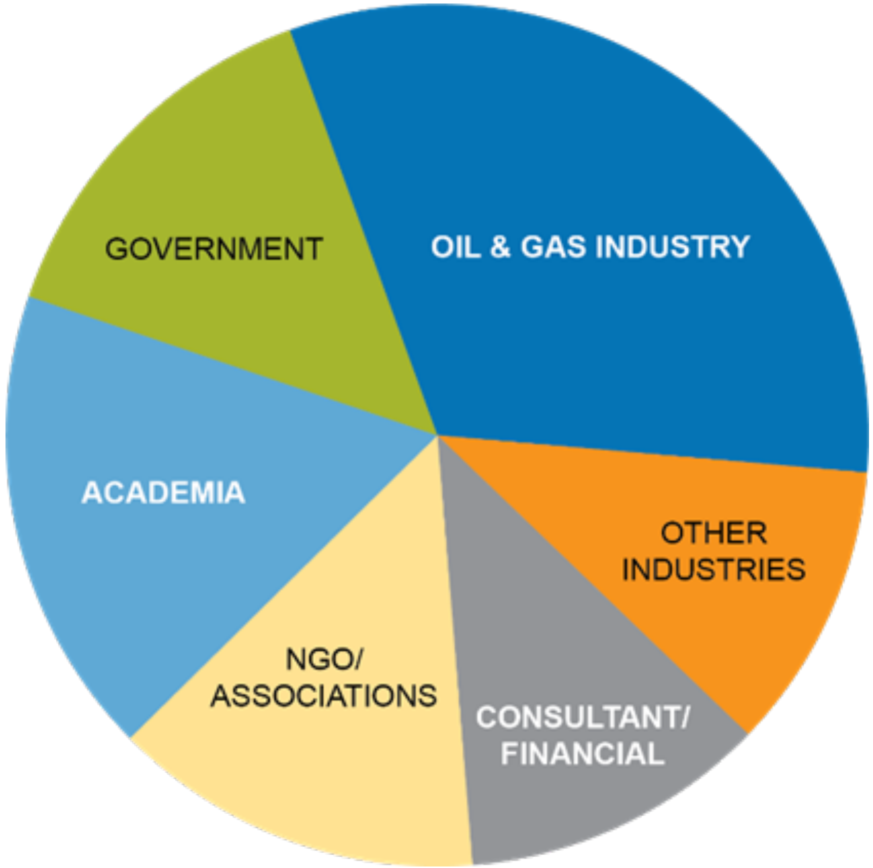
Steering Committee

Coordinating Subcommittee (CSC)

- Energy & Emissions Landscape Task Group
- CCUS Technologies Task Group
- Enabling Factors for Deployment Task Group
- Roadmap to Deployment Team
- Integrative Economics Team

Study participation

- The CSC 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.



CCUS deployment at scale

Will mean:

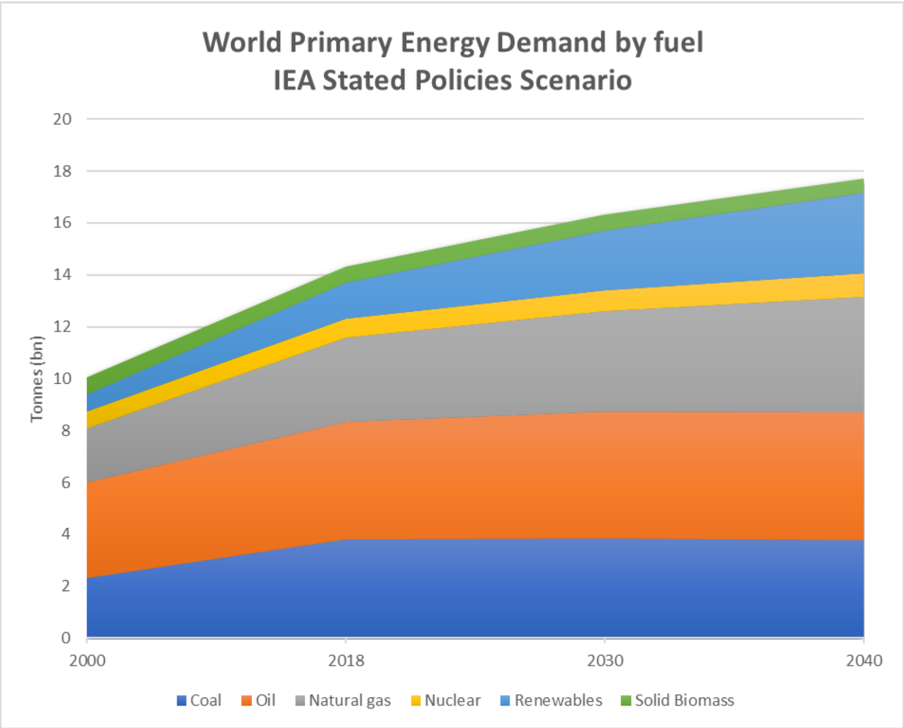
- Moving from 25 to **500 Million tonnes per annum** of CCUS capacity
- Infrastructure buildout equivalent of **13 million barrels per day** capacity
- Incremental investment of **$680 billion**
- Support for **236,000 U.S. jobs** and **GDP of $21 billion** annually

Will require:

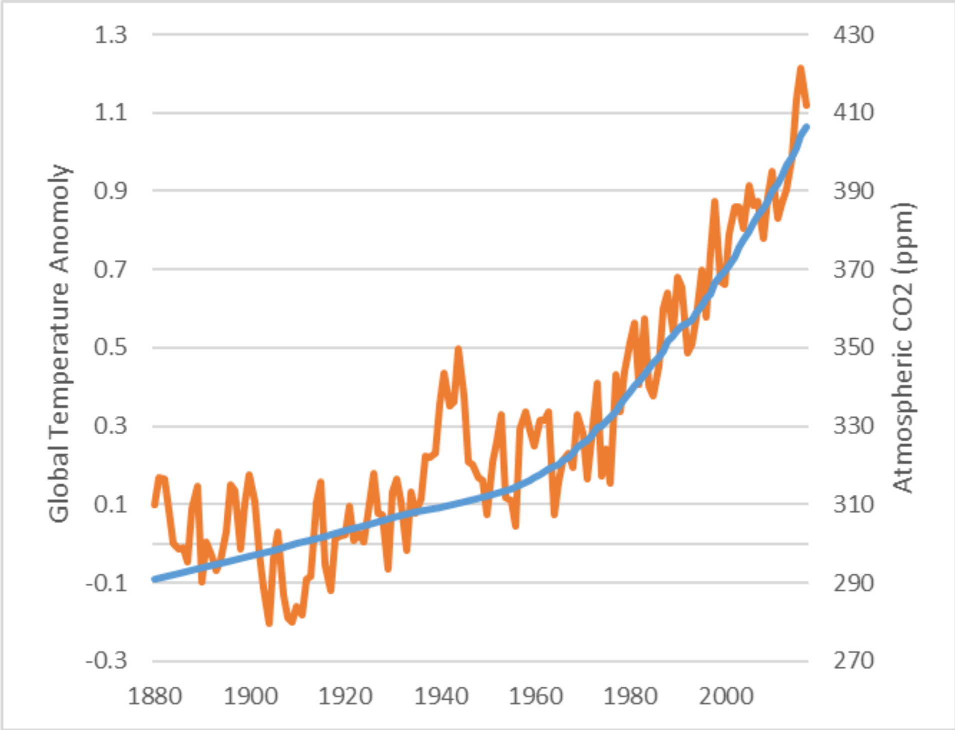
- Improved **policies**, **incentives**, **regulations** and **legislation**
- Broad-based **innovation** and **technology** development
- Strong **collaboration** between **industry** and **government**
- Increased **understanding** and **confidence** in CCUS

Understanding the dual challenge

The world faces a dual challenge of providing affordable, reliable energy while addressing the risks of climate change.



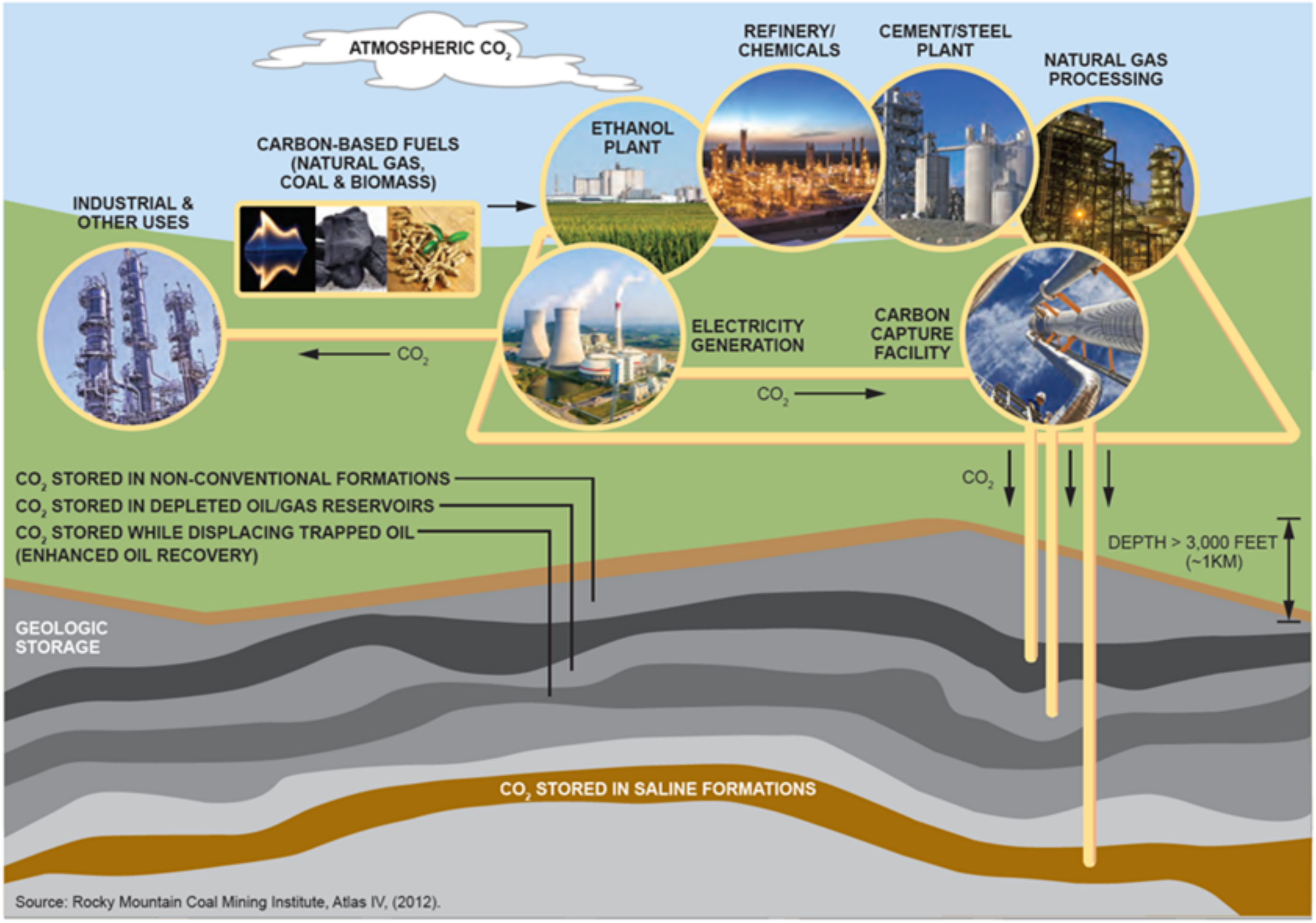
Over the next two decades, global population and GPD growth will drive continued increase in global energy demand



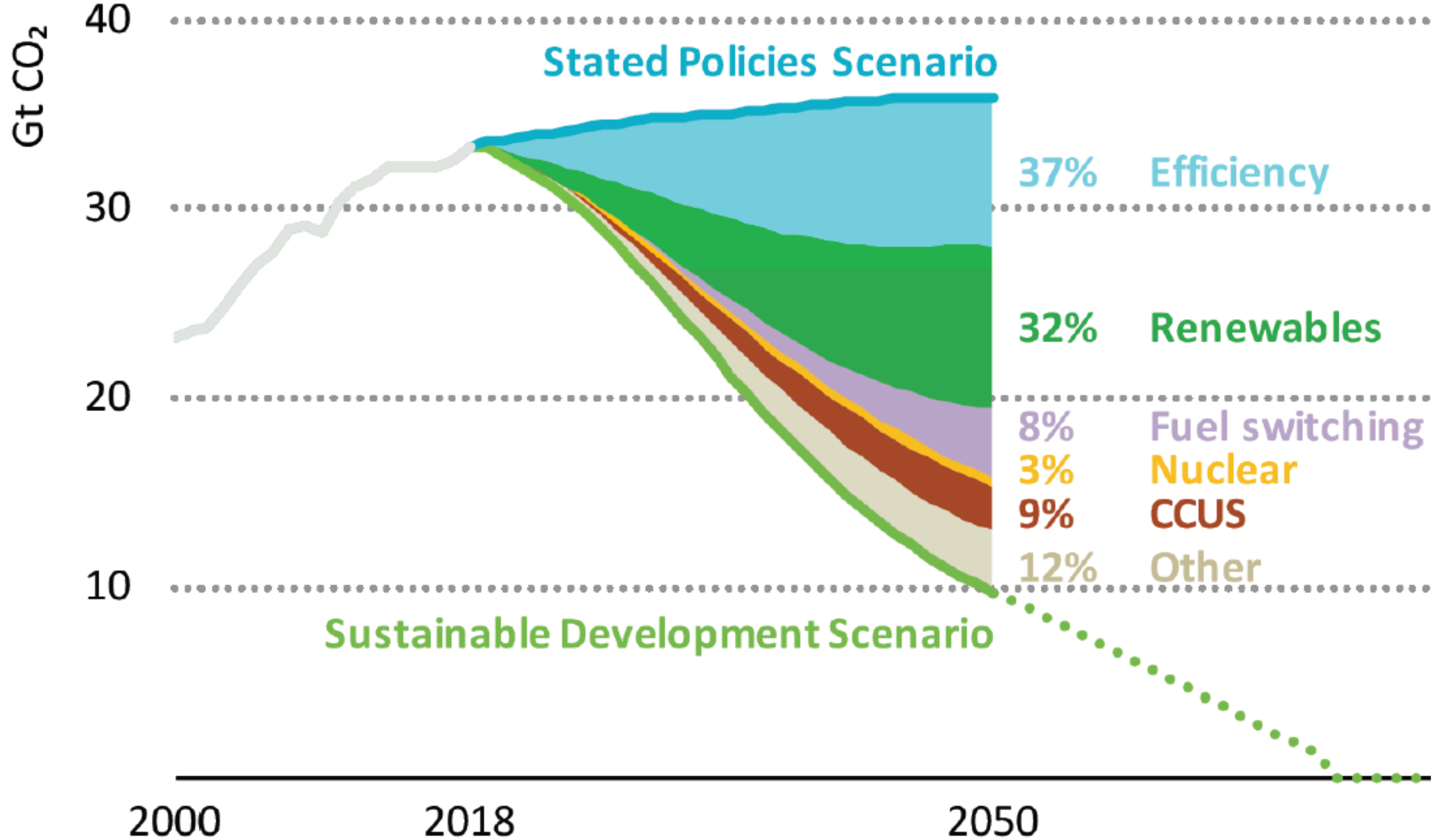
At the same time, the need to address rising carbon dioxide (CO_2) emissions continues to grow

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.



CCUS as part of a clean energy portfolio



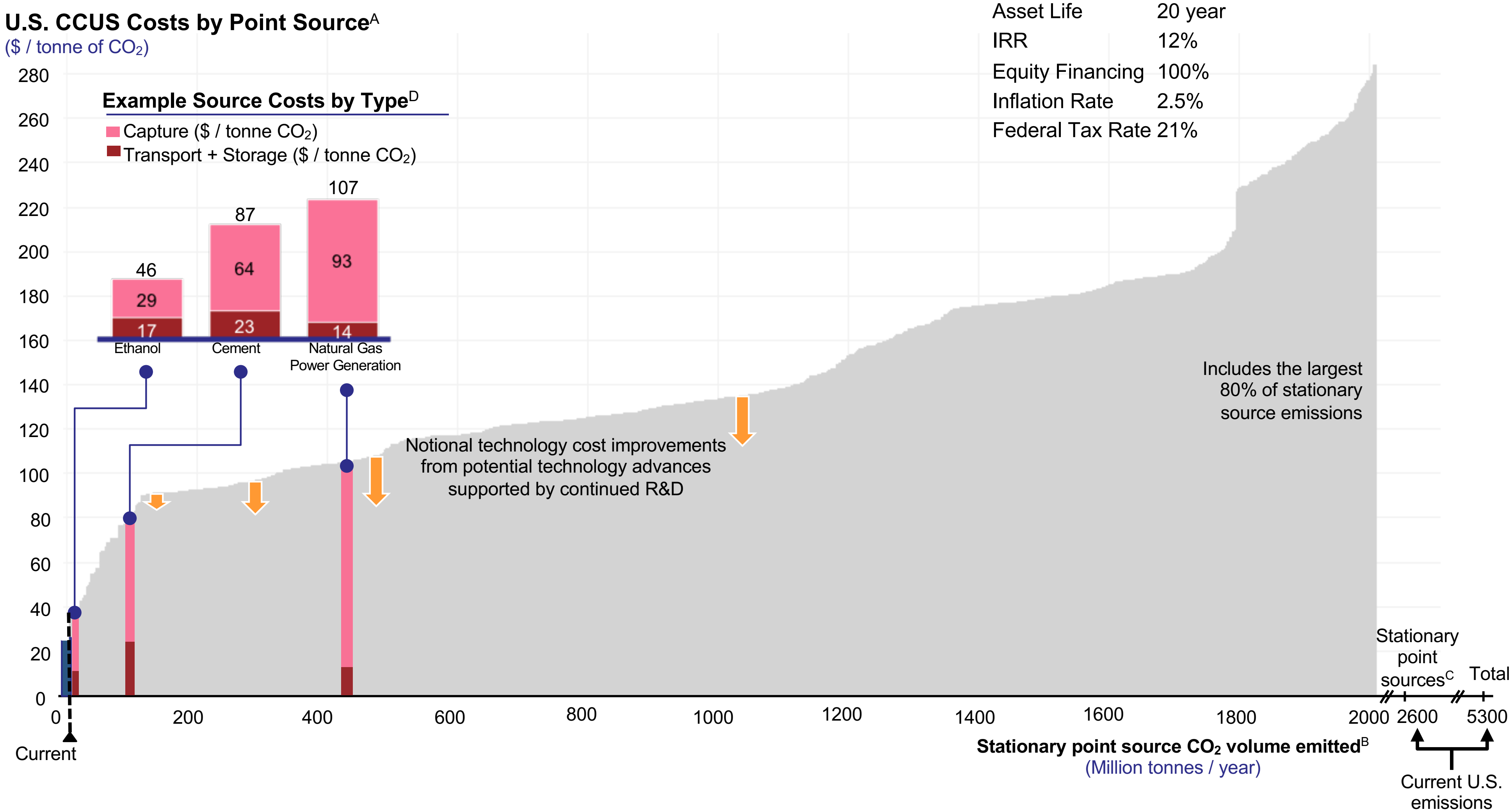
IEA analysis demonstrates the critical role of CCUS in a clean energy technology portfolio (IEA, 2019)

CCUS cost assessment

Study has 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 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
- Builds the case for ongoing RD&D across entire CCUS supply chain
- Economic impacts assessment (e.g., jobs, GDP)

CCUS cost assessment: methodology

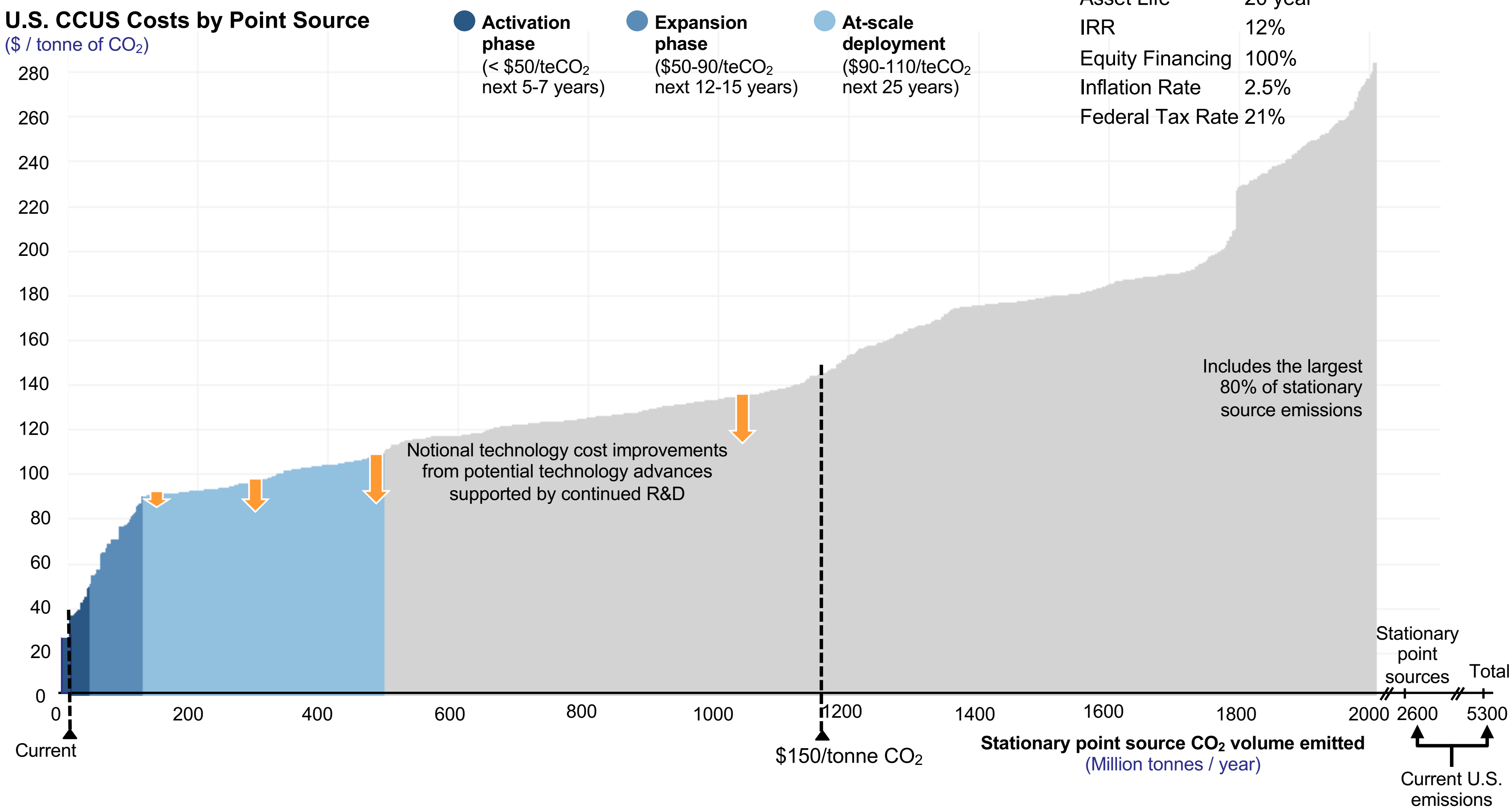


Assumptions

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

CCUS cost assessment: phases of deployment



Assumptions

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

Findings 1 - 4: CCUS landscape and outlooks

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 CO_2 intensive energy system.
4. The United States is uniquely positioned as the world leader in CCUS and has substantial capability to drive widespread deployment:
   - ~80% of the world's CCUS capacity (10 of 19 projects) is deployed in the U.S.
   - ~85% of global CO_2 pipeline infrastructure is in the U.S.
   - Cutting edge RD&D - $4.5bn DOE investment over last 20 years
   - Supportive policy framework – but insufficient for widescale deployment

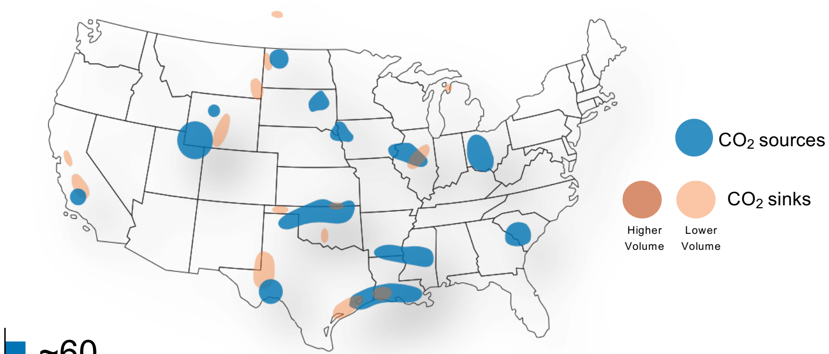
Finding 5: activation phase

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.

<u>Recommendations</u>

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



~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

* note: 25-40 mtpa 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.

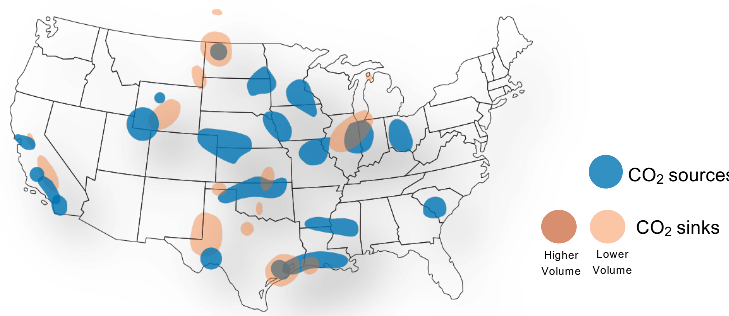
<u>Recommendations</u>

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 CO_2 sources

Agencies to:

- DOE & DOI to implement process for pore space access
- DOE to create CO_2 pipeline working group for development of large scale CO_2 pipeline infrastructure
- DOE to convene stakeholder forum to address geologic storage long-term liabilities
- State policymakers enable access to pore space on private lands



~150 Mtpa — Cumulative annual CCUS Volume

~$175 B investment (cumulative)

~$9 B pipeline infrastructure investment (cumulative)

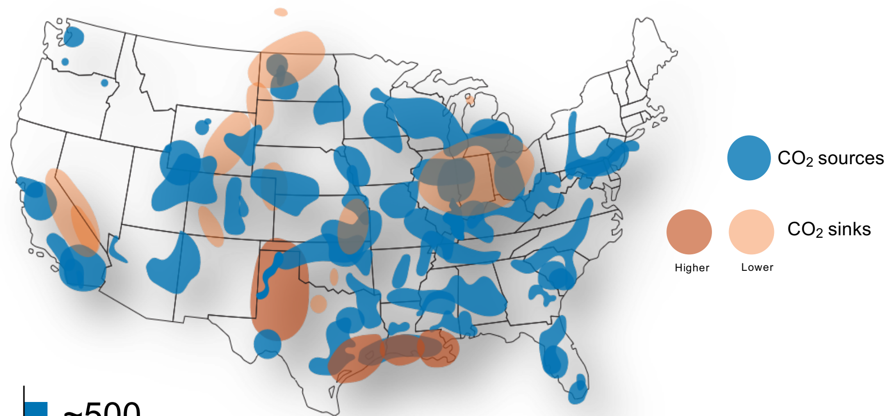
~40K annual jobs (cumulative)

23% of US oil system by volume

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.

<u>Recommendation</u>:
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.



~500 Mtpa — Cumulative annual CCUS Volume

~$680 B investment (cumulative)

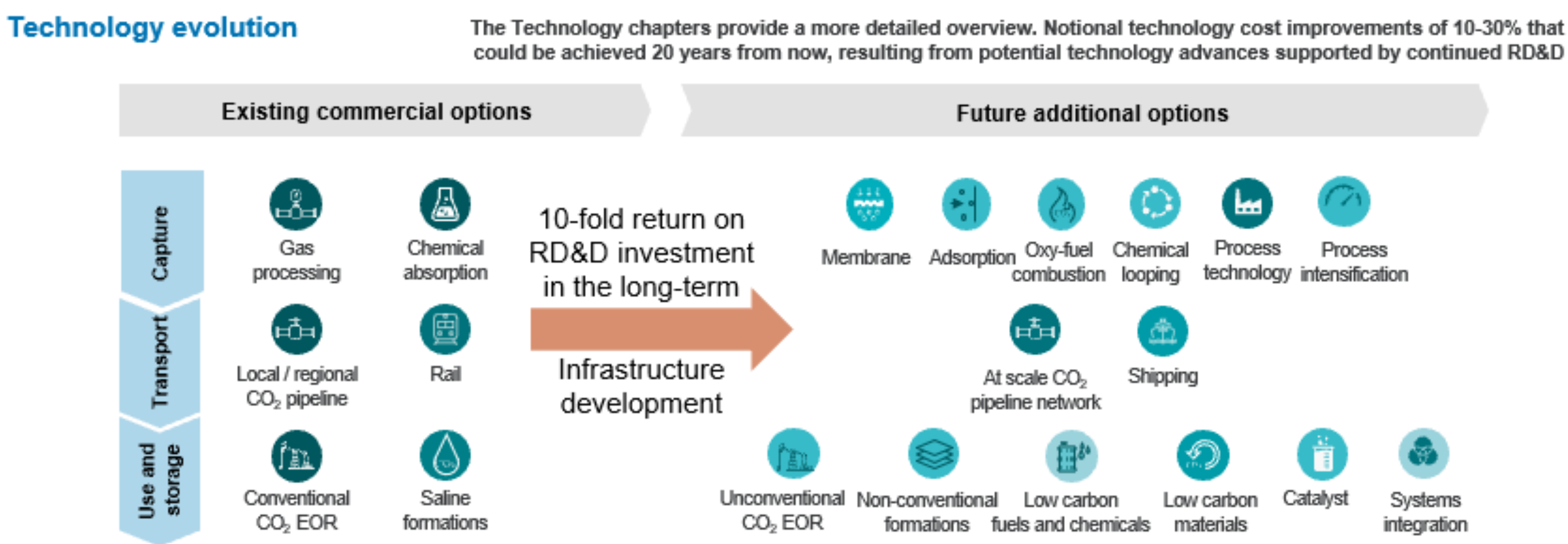
~$28 B pipeline infrastructure investment (cumulative)

~230K annual jobs (cumulative)

76% of US oil system by volume

Critical role of RD&D investment

Study describes the evolution of CCUS technologies across the supply chain and builds the case for continued investment in research and development to achieve long-term cost and performance improvements.



Finding 8: research and development

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.

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**

Findings 9 and 10: public and industry engagement

9. Increasing understanding and confidence in CCUS as a safe and reliable technology is essential for public and policy stakeholder support.

Recommendations:

- Simplify terminology and build confidence that CCUS is safe, secure, and critical to managing emissions.
- Oil and natural gas industry remain committed to improving its environmental performance.

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

Recommendation:

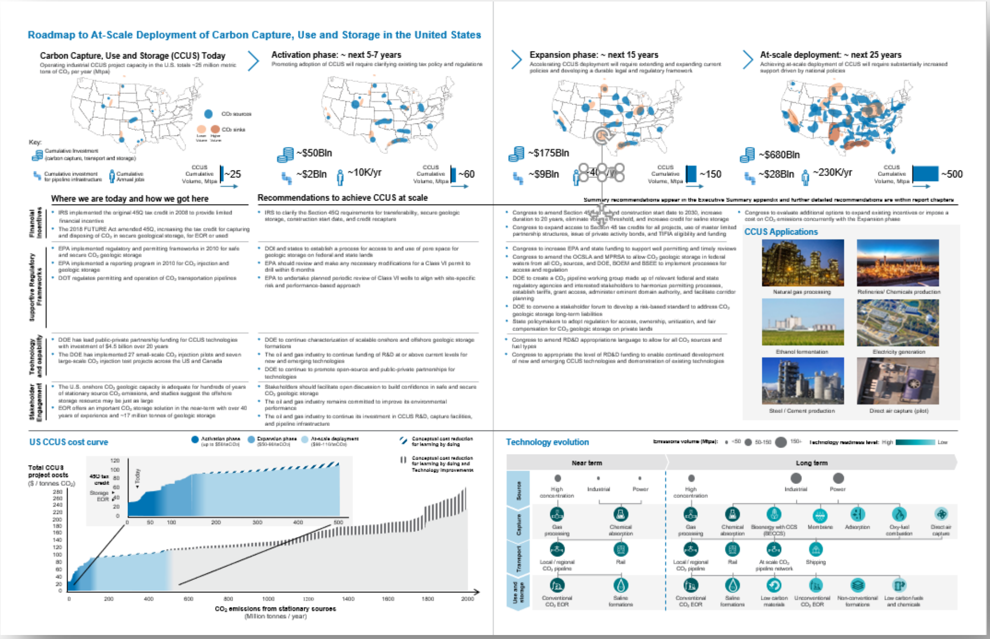
- The oil and natural gas industry continue investment in CCUS, specifically:
  - Current and next generation capture facilities
  - Development of new technologies
  - CO_2 pipeline infrastructure needed for EOR and saline storage
  - R&D for advancing CCUS technologies

Key messages

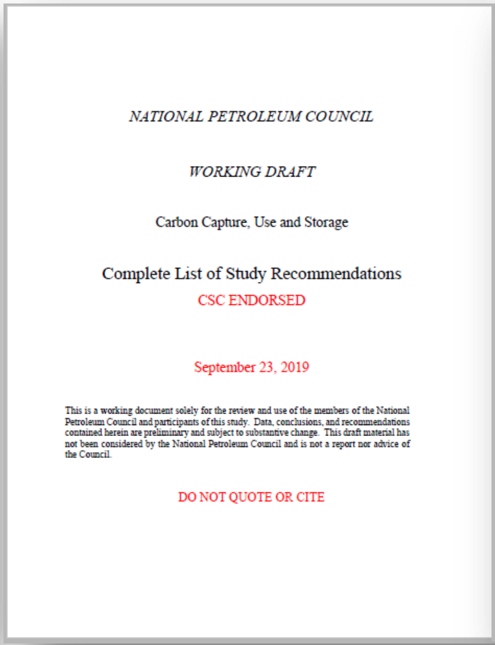
- CCUS refers to the complete supply chain needed to capture, transport and permanently use or store CO_2, eliminating it from the atmosphere.
- CCUS is essential to addressing the dual challenge of providing affordable, reliable energy to meet the world's growing demand while addressing the risks of 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.

Roadmap and full list of recommendations

Roadmap to At-Scale CCUS Deployment



All Study Recommendations



NATIONAL PETROLEUM COUNCIL

WORKING DRAFT

Carbon Capture, Use and Storage

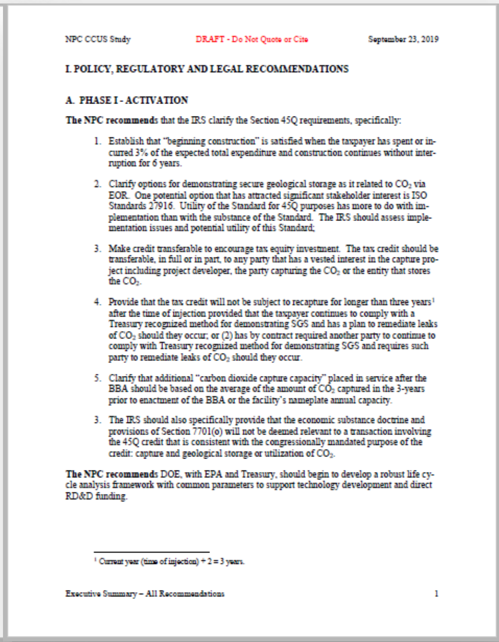
Complete List of Study Recommendations

CSC ENDORSED

September 23, 2019

This is a working document solely for the review and use of the members of the National Petroleum Council and participants of this study. Data, conclusions, and recommendations contained herein are preliminary and subject to substantive change. This draft material has not been considered by the National Petroleum Council and is not a report nor advice of the Council.

DO NOT QUOTE OR CITE



NPC CCUS Study DRAFT - Do Not Quote or Cite September 23, 2019

I. POLICY, REGULATORY AND LEGAL RECOMMENDATIONS

A. PHASE I - ACTIVATION

The NPC recommends that the IRS clarify the Section 45Q requirements, specifically:

1. Establish that "beginning construction" is satisfied when the taxpayer has spent or incurred 3% of the expected total expenditure and construction continues without interruption for 6 years.
2. Clarify options for demonstrating secure geological storage as it related to CO_2 via EOR. One potential option that has attracted significant stakeholder interest is ISO Standards 27916. Utility of the Standard for 45Q purposes has more to do with implementation than with the substance of the Standard. The IRS should assess implementation issues and potential utility of this Standard;
3. Make credit transferable to encourage tax equity investment. The tax credit should be transferable, in full or in part, to any party that has a vested interest in the capture project including project developer, the party capturing the CO_2 or the entity that stores the CO_2.
4. Provide that the tax credit will not be subject to recapture for longer than three years[1] after the time of injection provided that the taxpayer continues to comply with a Treasury recognized method for demonstrating SGS and has a plan to remediate leaks of CO_2 should they occur; or (2) has by contract required another party to continue to comply with Treasury recognized method for demonstrating SGS and requires such party to remediate leaks of CO_2 should they occur.
5. Clarify that additional "carbon dioxide capture capacity" placed in service after the BBA should be based on the average of the amount of CO_2 captured in the 3-years prior to enactment of the BBA or the facility's nameplate annual capacity.

3. The IRS should also specifically provide that the economic substance doctrine and provisions of Section 7701(o) will not be deemed relevant to a transaction involving the 45Q credit that is consistent with the congressionally mandated purpose of the credit: capture and geological storage or utilization of CO_2.

The NPC recommends DOE, with EPA and Treasury, should begin to develop a robust life cycle analysis framework with common parameters to support technology development and direct RD&D funding.

[1] Current year (time of injection) + 2 = 3 years.

Executive Summary – All Recommendations 1

NPC study report

Executive Summary

- 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 1)

- **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
H. Integrated Economic Analysis (ERM Memo)

CCUS Technologies (Volume 2)

- **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

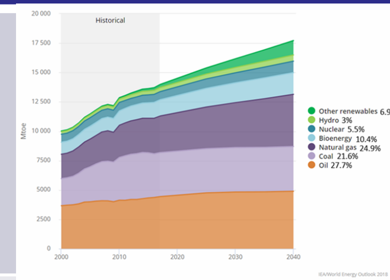
Appendices

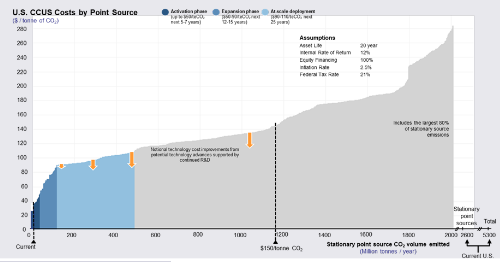
D. Mature CO_2 Capture Technologies
E. Emerging CO_2 Capture Technologies
F. CO_2 EOR Case Studies
G. CO_2 EOR Economic Factors and Considerations
List of Topic Papers
Abbreviations, Units, Glossary

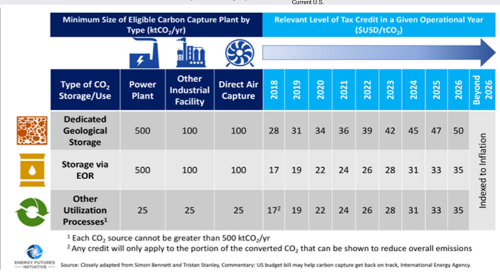
Findings and Recommendations — *Full Report*

CCUS deployment at-scale: chapters 1 - 4

Title	Lead Authors	Key Sections
The Role of CCUS in a Future Energy Mix	Jason Bordoff Julio Friedmann	• Global & U.S. energy demand forecasts • Role of CCUS • U.S. CO_2 emissions profile • Benefits of CCUS – environmental, economic, US leadership
CCUS Supply Chains and Economics	Nigel Jenvey Guy Powell Rick Callahan	• Complexity of supply chain • Description of existing projects • Supply chain enablers • Cost to deploy CCUS • Enablers for future projects
Policy, Regulatory and Legal Enablers	Leslie Savage Susan Blevins	• Existing policy and regulatory framework • Activation phase actions • Expansion phase actions • At-Scale phase actions • Research and development priorities
Building Stakeholder Confidence	Sallie Greenberg	• Spheres of public engagement • Public perception of CCUS • Defining and understanding stakeholders • Strategic engagement





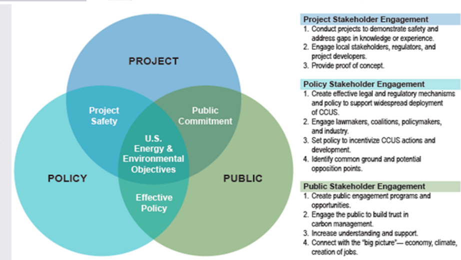


Type of CO_2 Storage/Use	Power Plant	Other Industrial Facility	Direct Air Capture	2018	2019	2020	2021	2022	2023	2024	2025	2026	Beyond 2026
Dedicated Geological Storage	500	100	100	28	31	34	36	39	42	45	47	50	Indexed to Inflation
Storage via EOR	500	100	100	17	19	22	24	26	28	31	33	35	
Other Utilization Processes[1]	25	25	25	17[2]	19	22	24	26	28	31	33	35	

Minimum Size of Eligible Carbon Capture Plant by Type ($ktCO_2/yr$) — Relevant Level of Tax Credit in a Given Operational Year ($\$USD/tCO_2$)

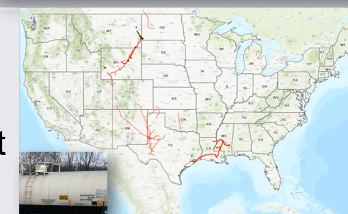
[1] Each CO_2 source cannot be greater than 500 $ktCO_2/yr$
[2] Any credit will only apply to the portion of the converted CO_2 that can be shown to reduce overall emissions

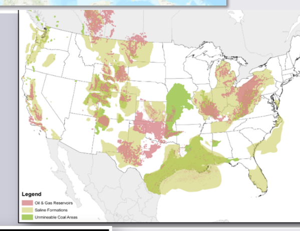
Energy Futures Initiative. Source: Closely adapted from Simon Bennett and Tristan Stanley, Commentary: US budget bill may help carbon capture get back on track, International Energy Agency.

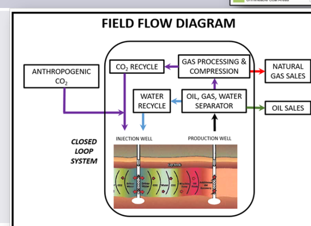


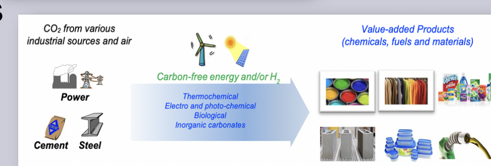
CCUS technologies: chapters 5 – 9

Title	Lead Authors	Key Sections
CO_2 Capture	John Northington Jennifer Wilcox	• Capture process • Technology types and maturity • Opportunities by sector • Capture cost drivers • Research and development priorities
CO_2 Transport	Dan Cole	• Current transport technologies • Existing U.S. CO_2 pipeline network • Role of transport in widespread CCUS deployment
CO_2 Geologic Storage	Richard Esposito Sally Benson	• Description of CO_2 geologic storage • Commercial scale experience and enablers • Options for CO_2 storage and capacity potential • Research and development priorities
CO_2 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
CO_2 Use	Will Morris Alissa Park	• CO_2 use technologies, pathways and products • Relative experience and maturity • Opportunities and challenges • Research and development priorities









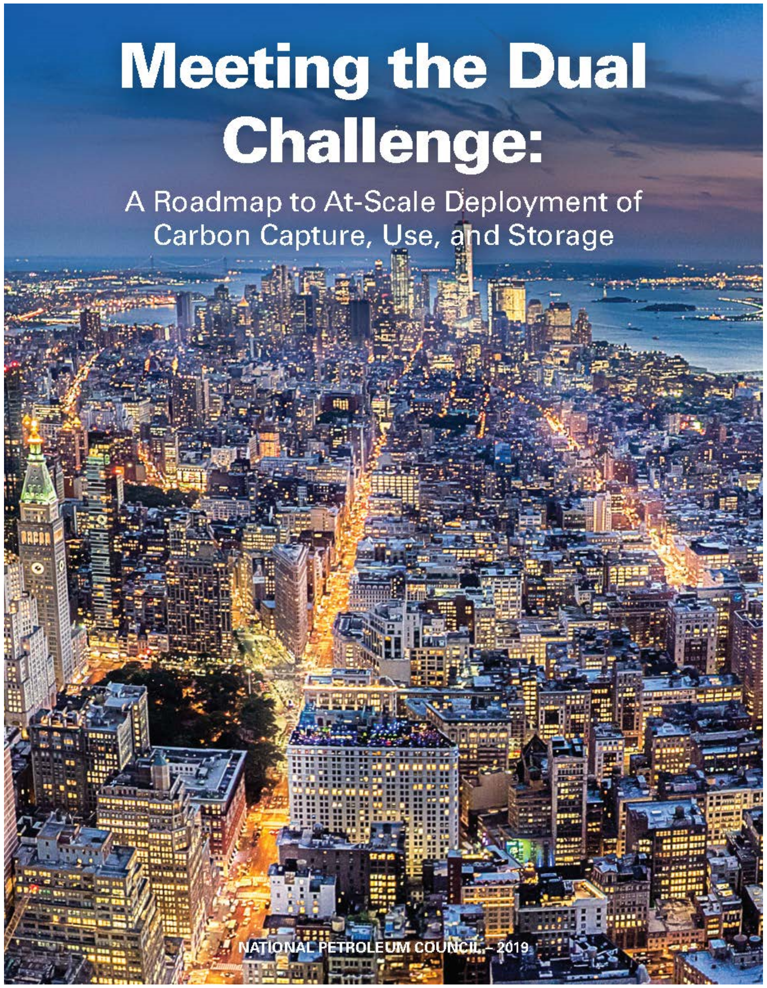
Forward plans

Digital publications and communications

- Report website will go live this afternoon
- Digital copy of executive summary and related materials
- Council webcast
- Social media friendly
- Other useful links

Printed Report Publication

- Executive Summary volume available mid-January
- Full report available end 1Q 2020



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Communications

Communications

- The study will be communicated in 2020 as requested by policymakers, governments, academia, research organizations, trade associations, technical societies and other interested groups.
- To request a presentation, please contact the National Petroleum Council

Protocol for ongoing communications

- Any individual or organization may use the NPC CCUS report in expressing their own views, provided that it is properly cited
- If the request did not originate from the NPC, please inform the NPC staff, and provide the name of the presenter, the audience, and a copy of the presentation or report
- Presenters are to be mindful of the purpose of the Council, and the prohibition against lobbying

Acknowledgements

- U.S. Department of Energy
- The National Petroleum Council leadership and staff
- Members of the National Petroleum Council
- The NPC Infrastructure Study leadership and team

… and to the 300^+ participants who helped to develop and deliver this comprehensive study on Carbon Capture, Use, and Storage, thank you for your contributions over the last 18 months.

National Petroleum Council

Washington, D.C.

December 12, 2019

Thank you for attending

the 129th Meeting

of the

National Petroleum Council

Washington, D.C.

December 12, 2019

For study information and a copy of this presentation, please visit the NPC website

https://www.npc.org