



U.S. DEPARTMENT OF
ENERGY

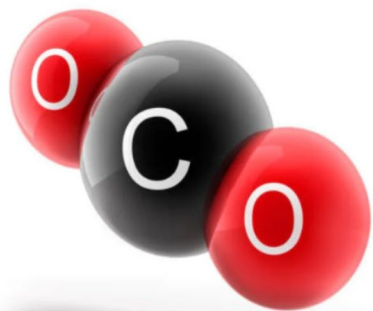
Fossil Energy and
Carbon Management

U.S. / Norway Bilateral Meeting Carbon Transport Slides

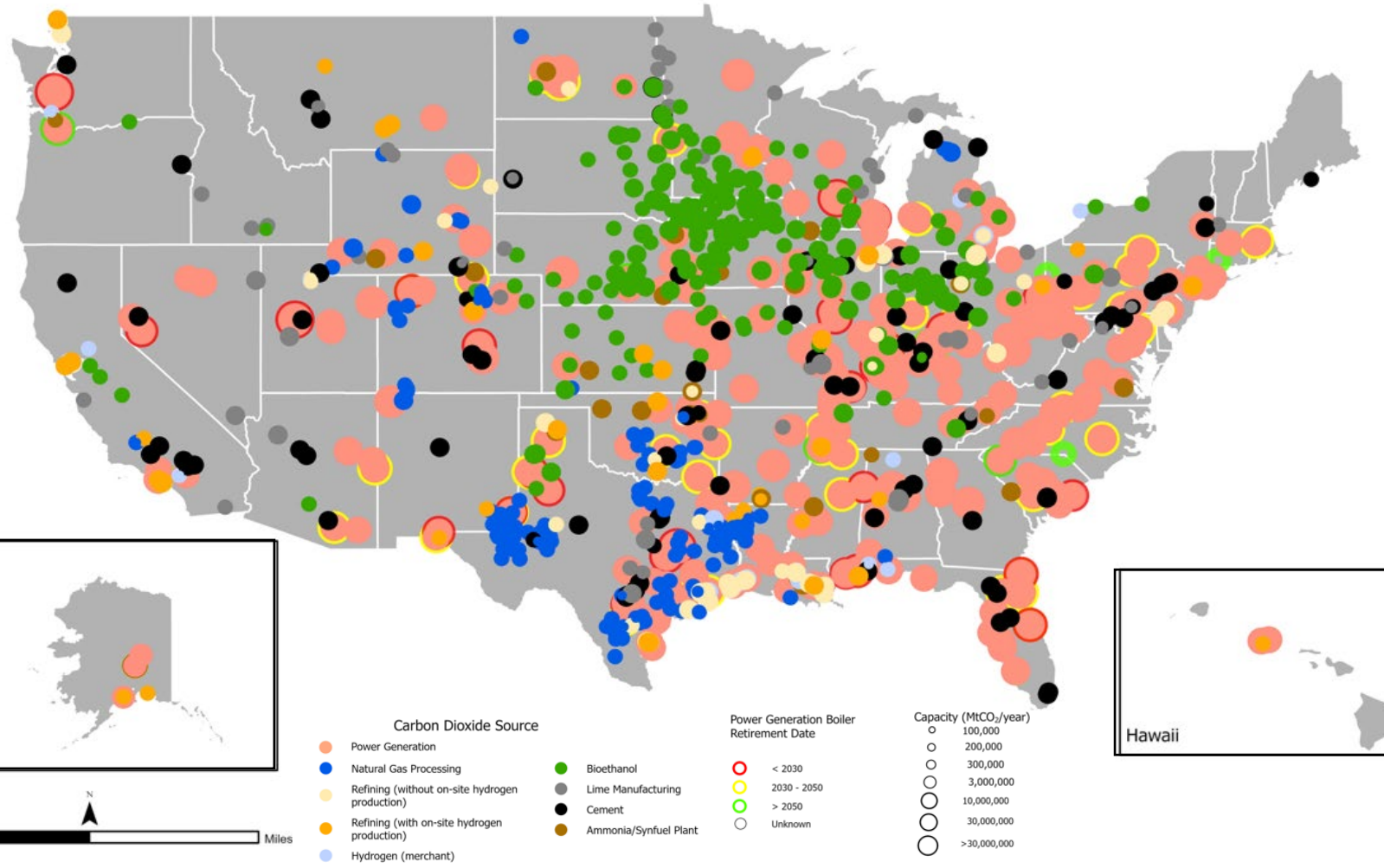
Robert Smith

*Carbon Transport and Storage (CTS) Program
Office of Fossil Energy and Carbon Management*

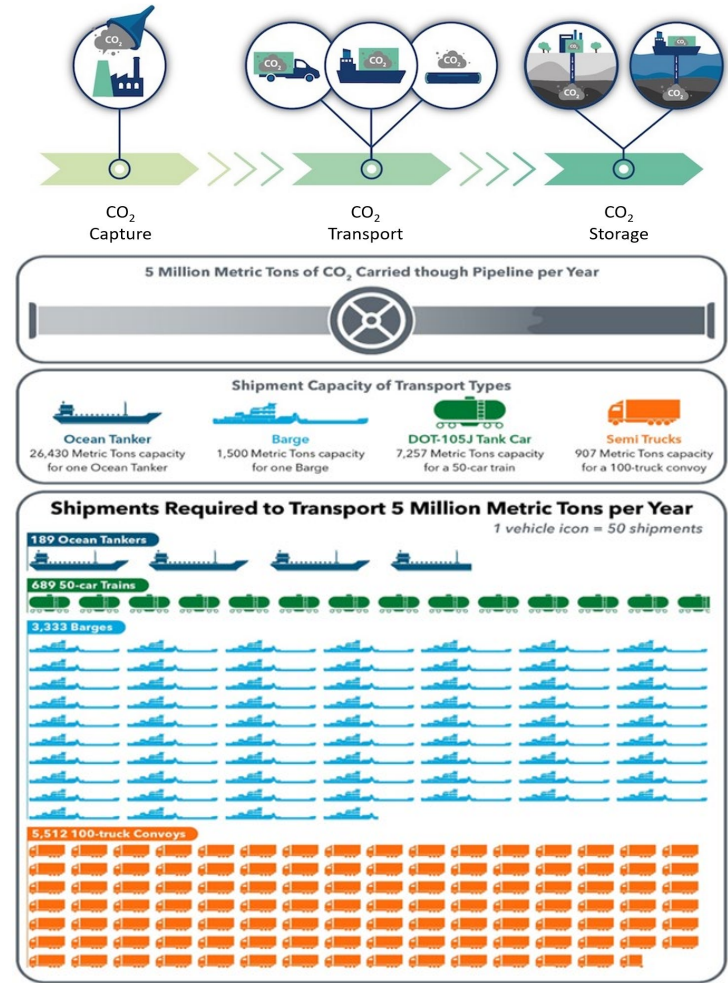
October 31, 2023



Carbon Capture – Sources



Challenge



CO₂ Transport Must Expand Rapidly

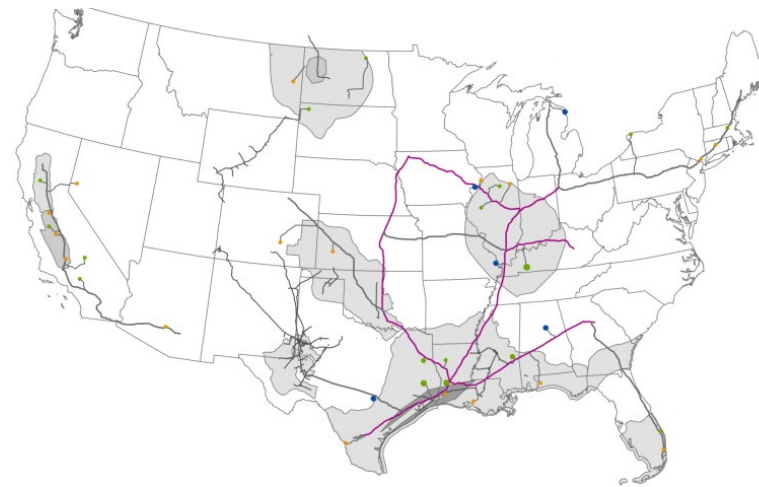
Today



Existing CO₂ Pipeline Mileage (2023)

5,500 miles of pipelines

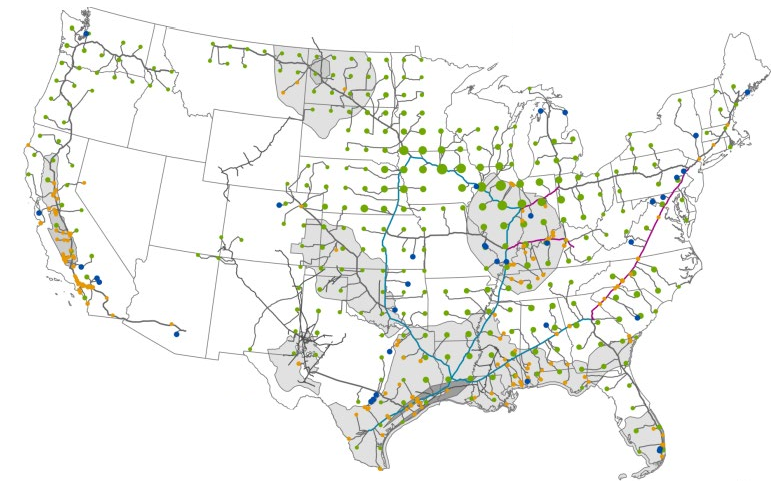
2030



Modeling from Princeton's Net-Zero America Study (2020)

11,000+ miles of pipelines

2050



Modeling from Princeton's Net-Zero America Study (2020)

**13,000+ miles of trunk pipelines
52,000+ miles of spur pipelines**

A network of rail, truck and ship/barge transport with intermodal hubs must also expand in addition to pipelines



U.S. DEPARTMENT OF
ENERGY

Fossil Energy and
Carbon Management

CO₂ Transport FEED Studies & Loans/Grants

Pre-Front-End Engineering Design Studies (FEED):

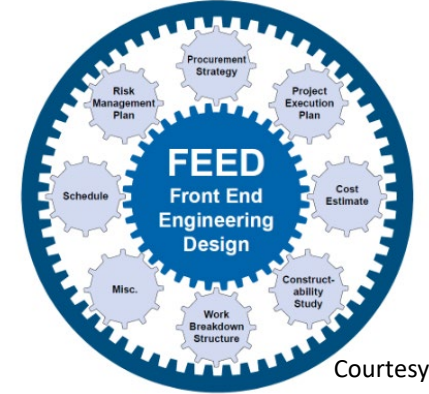
- Supports conceptual design & development of commercial-scale, intermodal CO₂ transport HUBs
- HUB designs may include multiple integrated transportation modes, including but not limited to pipeline, rail, maritime, truck and facilitate offtake of CO₂ streams at various conditions and compositions.

Front End Engineering Design Studies:

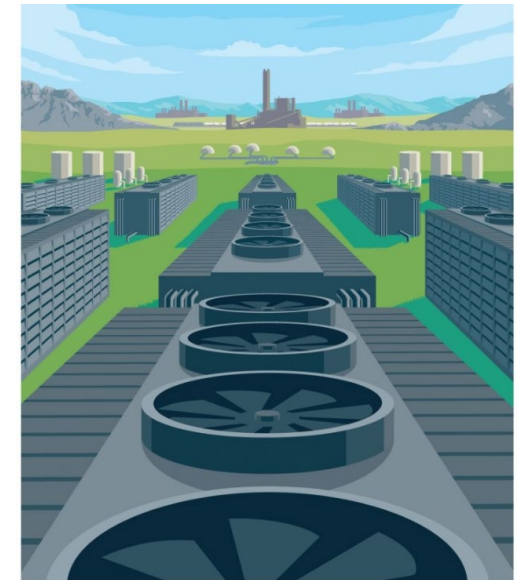
- BIL provides \$100 million for carbon transport infrastructure FEED studies
- Accelerate the planning and development CO₂ transportation infrastructure by a variety of modes, such as through rail, trucks, ships, and pipelines

CO₂ Infrastructure Finance and Innovation (CIFIA):

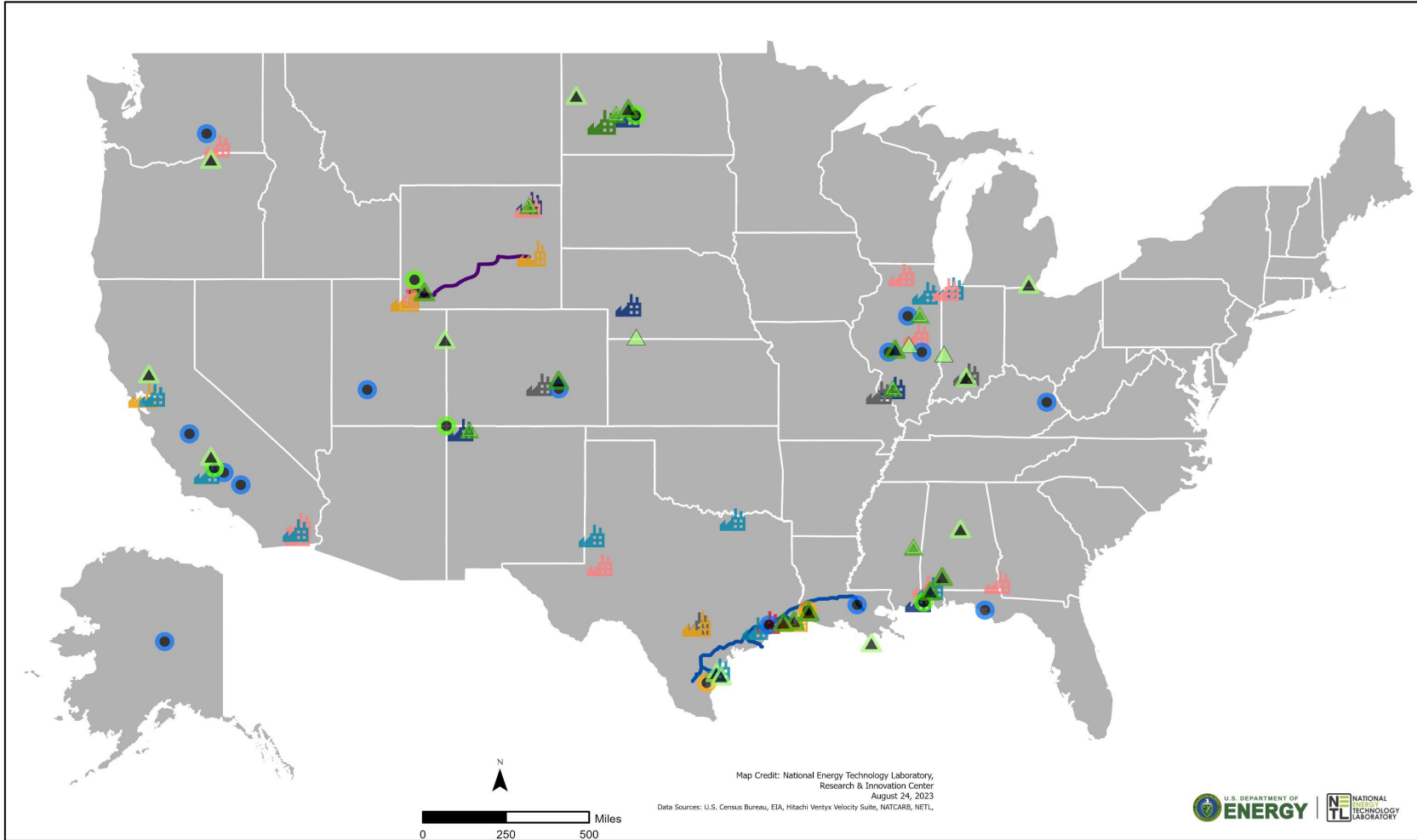
- DOE Loan Program Office financing large scale transport construction
- CIFIA supports CCUS and DAC technology deployment by financing projects that build shared CO₂ transport infrastructure
- BIL provides \$2.1 billion for CO₂ transport infrastructure projects including:
 - Secured loans and loan guarantees (“CIFIA Loans”)
 - Grants for building excess capacity on new and existing CO₂ infrastructure
- Managed via a partnership between DOE’s Fossil Energy and Carbon Management Office, DOE's Loan Programs Office, and the National Energy and Technology Lab



Courtesy: Valency



CarbonSAFE & Transport FEED Locations



LEGEND

- | | | |
|-------------------------------|--------------------------------|-----------------------------|
| CarbonSAFE | Phase II-Existing | Phase III-Selected FOA 2711 |
| | Phase II-Selected FOA 2610 | |
| | Phase III-Existing | |
| PreFEED/FEED Study | Cement | |
| | Chemicals | |
| | Coal-Based | |
| | Direct Air Capture | |
| FEED Pipeline Selected | Carbon Solutions – WyoTCH | |
| | HEP – Gulf Coast Decarb System | |
| DAC Hub | TA1 | |
| | TA2 | |
| | TA3 | |
| | Ethanol | |
| | Natural Gas | |
| | Hydrogen | |

Pipeline FEED Study #1 - Awardee

Awardee: Carbon Solutions LLC

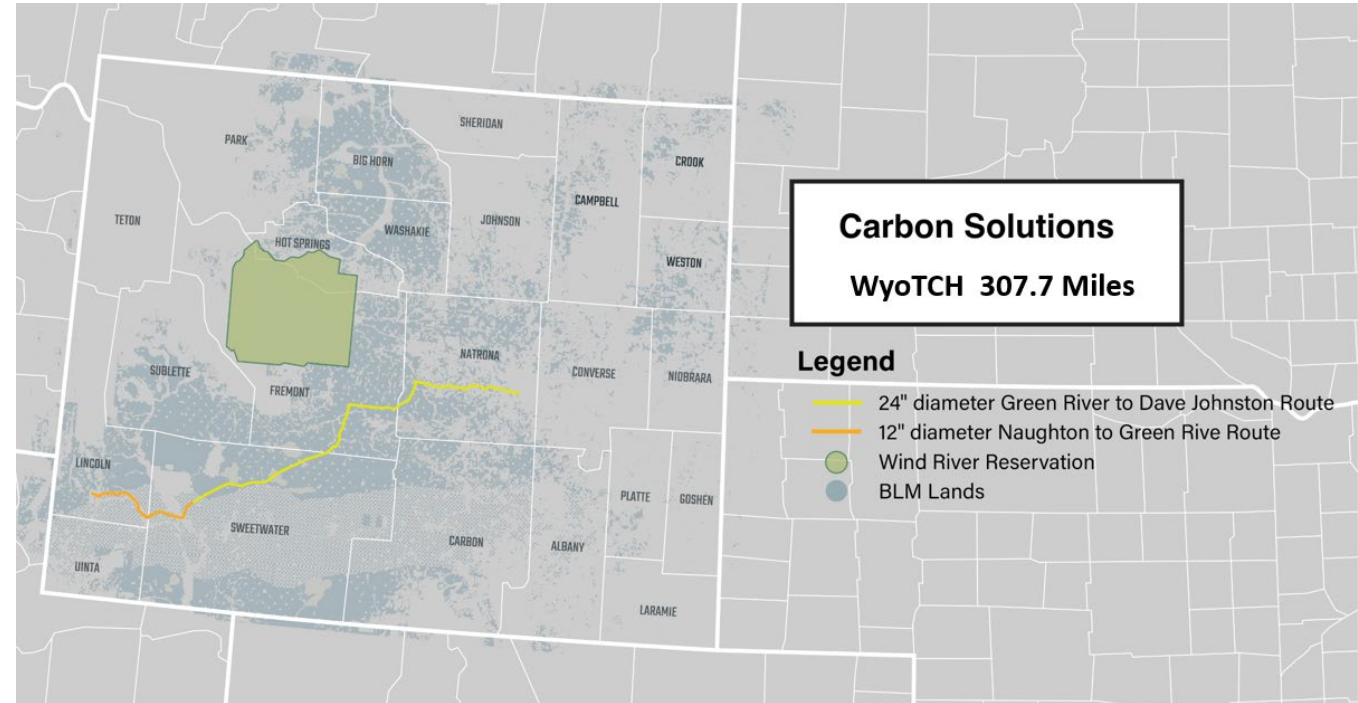
The FEED Study will trigger the development of a commercial-scale pipeline to transport massive quantities of anthropogenic CO₂ in support of the Wyoming Trails Carbon Hub (WyoTCH, pronounced "Watch"). The FEED study enables the planning of a transformative, statewide pipeline system capable of transporting up to 120 million tonnes of CO₂ per year (120 MtCO₂/yr.)

Cost/Cost-Share:

DOE:	\$3,000,000
Non-DOE:	\$1,966,023
Total:	\$4,966,023

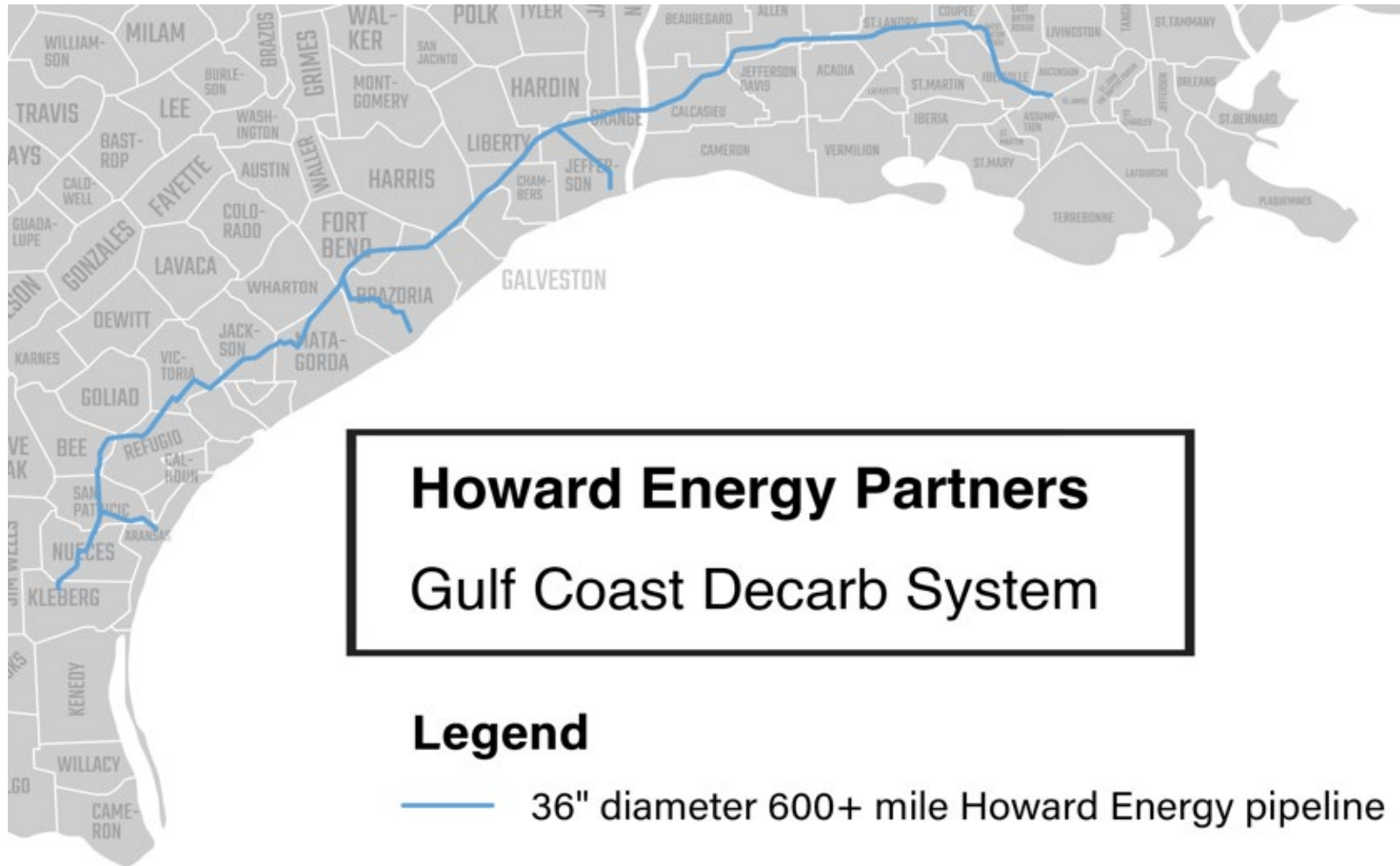
Objectives

This 18-month FEED Study will initiate by de-fining project parameters such as general site characteristics, geological considerations, expected soil conditions. Once defined, the FEED will route a pipeline by optimizing, crossings of waterways, environmental crossings, and other factors to minimize impacts to people and the environment



Proposed Wyoming CO₂ pipeline routes: Orange route 12" Naughton to Green River (74.26 miles). Yellow route 24" Green River to Dave Johnston (233.44 miles) 307.7 miles total

Pipeline FEED Study #2 - Selectee



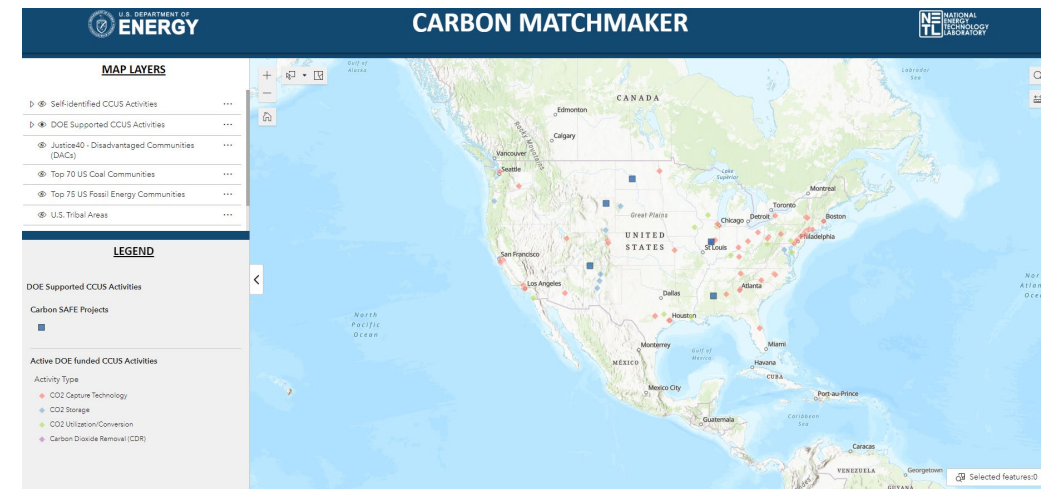
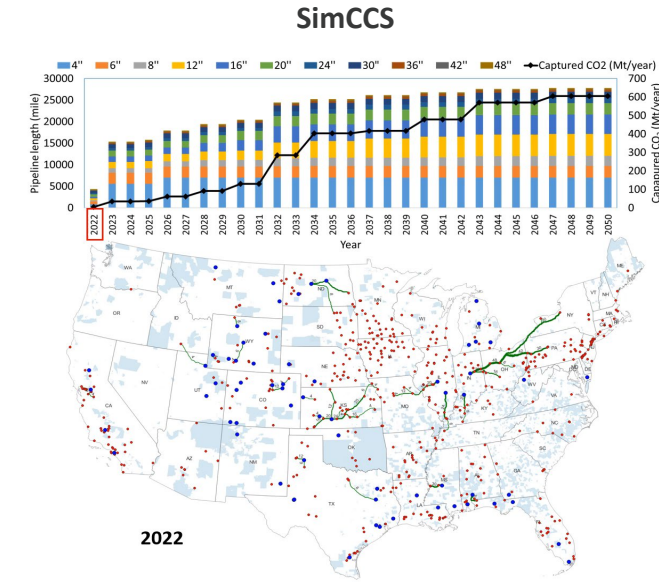
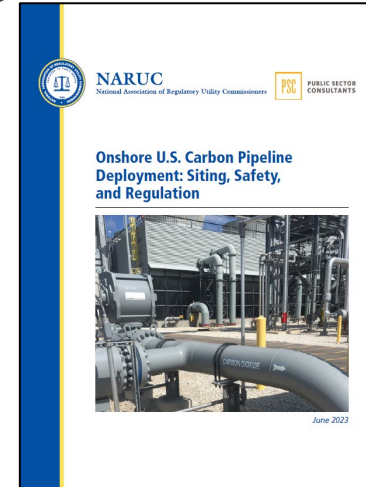
Transport Strategic Studies/Tools

Feasibility/informational studies funded as needed to fill info gaps

- Onshore U.S. Carbon Pipeline Deployment: Siting, Safety, and Regulations authored by NARUC

User friendly models and tools

- SimCCS** – Optimization software for integrated system design that enables researchers, stakeholders, and policy makers to design CCS infrastructure networks
- Carbon Matchmaker** – Online information resource to connect users across the carbon capture, utilization, and storage (CCUS) and carbon dioxide removal (CDR) supply chains
- TEA and LCA Models** – Carbon transport analysis tools to support early concept development and evaluation (in development)



Transport Research, Development & Demonstration

Summary Report: February 2023 Research Workshop

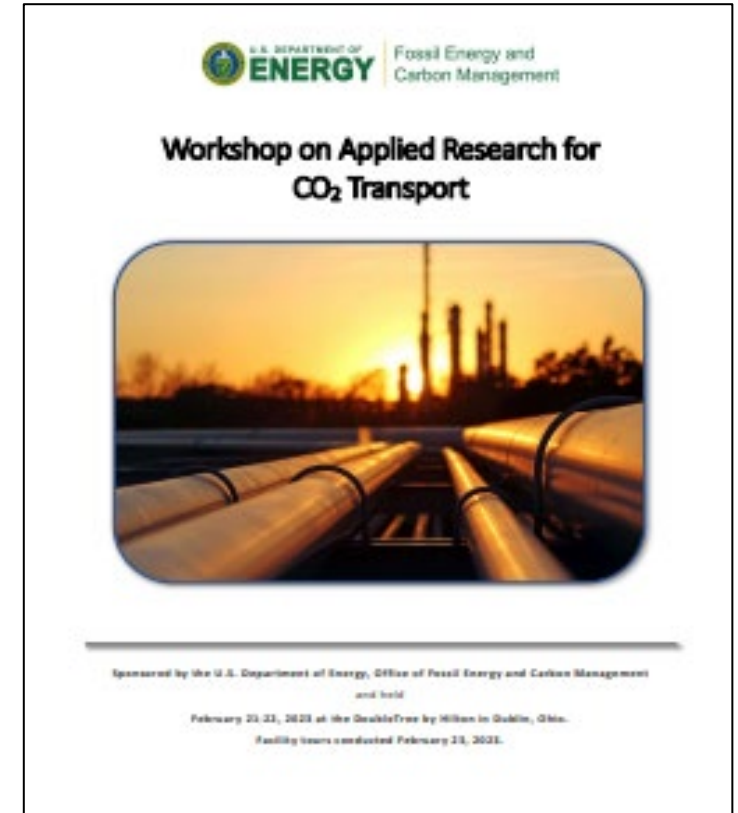
https://www.energy.gov/sites/default/files/2023-08/Workshop-on-Applied-Research-for-CO2-Transport-Summary-Report-2023_1.pdf

Four Areas of Interest identified:

1. Impact of CO2 Impurities on Asset Integrity
2. CO2-Specific Leak Detection and Emergency Response Protocols
3. Repurposing of Existing Infrastructure for CO2 Service
4. Developing & Connecting with Other CO2 Transport & Intermodal Hubs

Key Takeaways:

- Develop a CO2 transport consortium to coordinate RD&D efforts;
- Compile and curate information in an open access platform;
- Accelerate experimental and modeling RD&D efforts to keep pace with at-scale deployment;
- Create pathways to engage and grow the workforce in an equitable, inclusive, and accessible manner; and
- Engage the public in two-way communication.



Interagency Collaboration

Interagency Carbon Transport & Land Use Topic Teams

- **Why Convene?**

- Administration/Congressional drivers - climate goals
- Reduce confusion; expedite statutory implementation
- Members can play a direct role and measure/track project progress

- **Purpose:**

- Share information and agency collected data
- Coordinate efforts on siting/permitting
- Support technical scoping of documents, peer review, and merit review during the pre-award



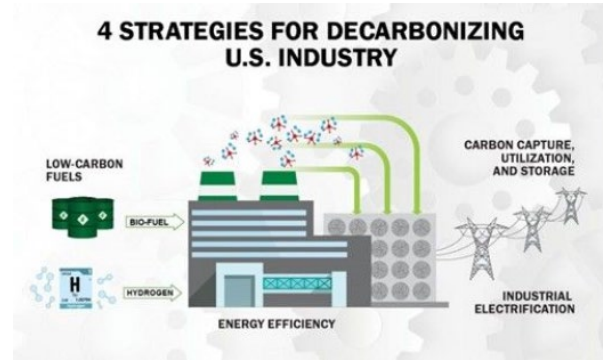
Resources and Engagement Opportunities



[FECM Strategic Vision](#)



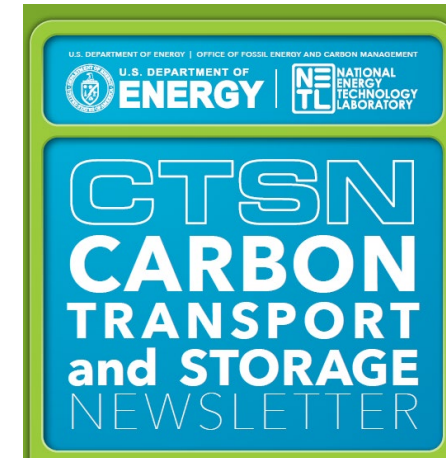
[Justice & Engagement](#)



[Industrial Decarbonization Roadmap](#)



[Workshop R&D Priorities for Repurposing Infrastructure](#)



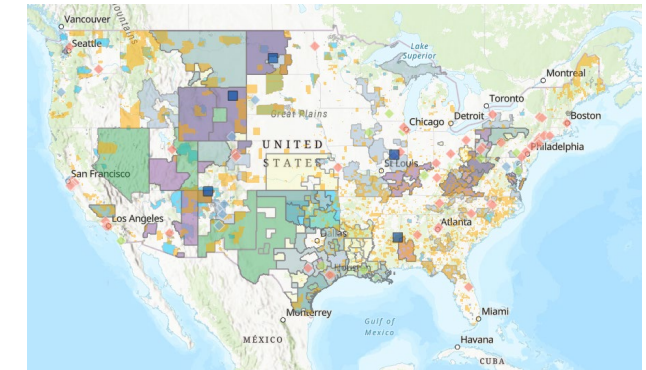
[Program Publications](#)



DOE-funded Carbon Management Projects—held Pittsburgh, PA
Over 1,200 registrants [2023 Conference Proceedings](#)



[EDX 4CCS](#)



[Carbon Matchmaker](#)

Future Outlook

CIFIA Loans/Grants:

- Implement and execute CIFIA loan and grant programs

FEED Studies:

- Implement and expand FEED studies (e.g., Multimodal & Intermodal applications)

Strategic Studies and Tools:

- Continue funding and developing as needed (e.g., LCA/TEA studies in development)

Carbon Transport Consortium:

- Pursue development and connect with stakeholders

Interagency Coordination

- Teams to connect and leverage expertise in land use management & transport



Courtesy NAP



Thank You!



U.S. DEPARTMENT OF
ENERGY

Fossil Energy and
Carbon Management

<https://www.energy.gov/fe/office-fossil-energy>

Sign up to receive DOE FECM's email updates [here](#).

Carbon Transport Team

Robert Smith

Carbon Transport Program Manager

Cell: 202-597-4058

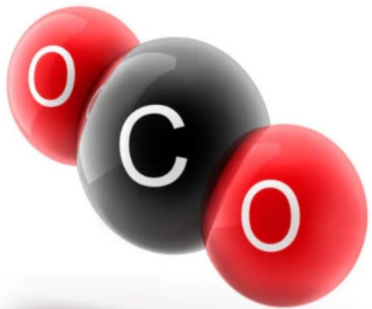
Email: robert.smith8@hq.doe.gov

Kevin Dooley

Carbon Transport Engineer

Cell: 240-243-5999

Email: kevin.dooley@hq.doe.gov

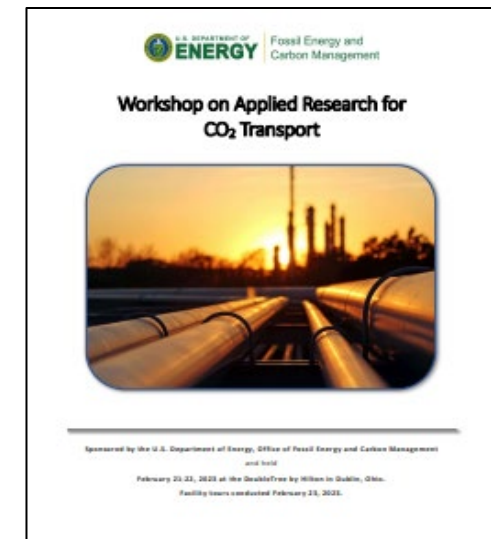
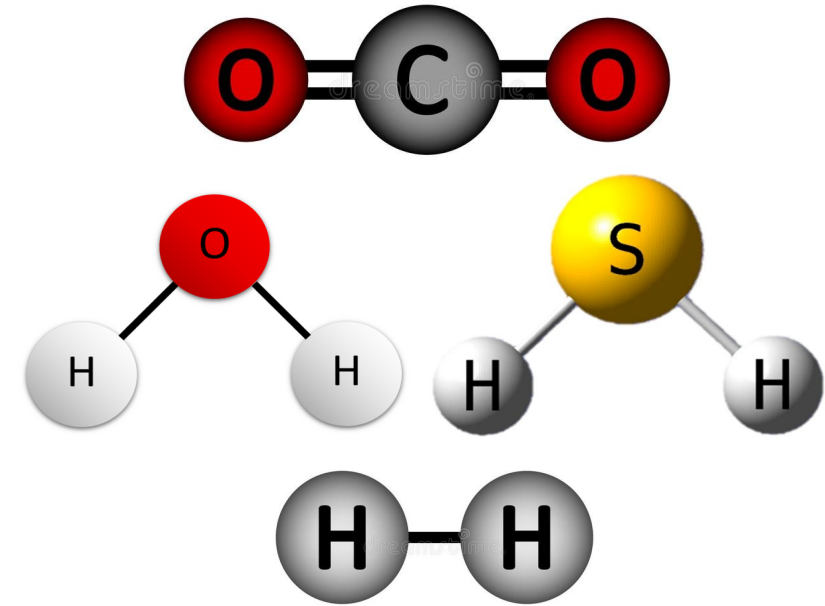


RD&D Area of Interest #1: Impact of CO₂ Impurities on Asset Integrity

CO₂ IMPURITIES MANAGEMENT

- Guide materials selection, standards, and potential regulations by better understanding integrity threats and their evolution over time periods corresponding to asset operational life;
- Determine the effect CO₂ stream impurities has on materials, corrosion, and fluid behavior through testing and modeling;
- Create a testing protocol to complement ongoing work and coordinate experimental and modeling efforts;
- Scale up the size and duration of tests (i.e., small scale to large scale);
- Test odorant additives assess impacts.

https://www.energy.gov/sites/default/files/2023-08/Workshop-on-Applied-Research-for-CO2-Transport-Summary-Report-2023_1.pdf



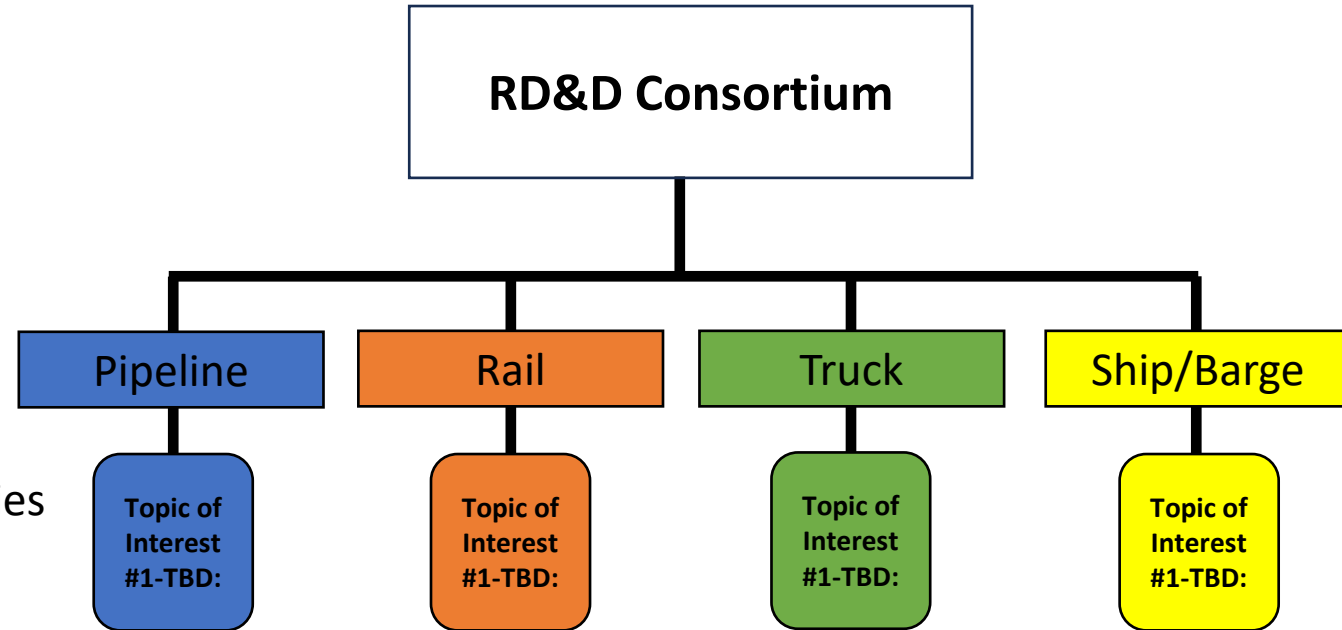
Carbon Transport RD&D Consortium

Benefits

1. Work sharing and reduced costs
2. Increased credibility
3. Improve chances to achieve goals
4. Growing network of knowledge
 - Increased access to experts
 - Increased access to organizations
 - Increased access to peer reviewed knowledge
 - Increased access to intermodal transport companies
5. Access to funding resources

Structure

- Leadership provided by FECM HQ
- Multiple committees for sharing, collating and planning
- Requires logistical support
- Topic of interest for each transport mode



Leave no knowledge behind!

RD&D Area of Interest #3:

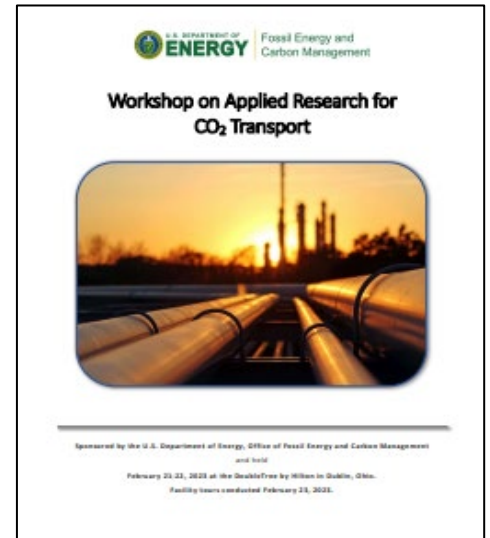
REPURPOSING OF EXISTING INFRASTRUCTURE FOR CO₂ SERVICE

REPURPOSING INFRASTRUCTURE

- Compile and efficiently leverage existing information, especially component materials and lessons learned from industry
- Conduct gap analyses and related RD&D to address materials standards
- Develop LCA and TEA tools to support repurposing infrastructure
- Create checklists of considerations to guide repurposing efforts

https://www.energy.gov/sites/default/files/2023-08/Workshop-on-Applied-Research-for-CO2-Transport-Summary-Report-2023_1.pdf

<https://www.energy.gov/sites/default/files/2022-11/%5BWORKSHOP%5D-Carbon-Transport-and-Storage-R%26D-Priorities-for-Repurposing-Infrastructure.pdf>



Pipeline Repurposing – Operational Considerations

- Pressure capacity limitations
 - Maintaining dense or supercritical phase well over 1,000 psi
- Route length – gaseous vs dense/supercritical phase
 - Long distance favors dense or supercritical phase to reduce frictional forces
- Prior integrity management history
 - Corrosion and other threats
 - Material property suitability
 - Pipe mill and construction paperwork
- CO₂ purity level – Anthropogenic vs pure
 - Uncertainty with role of impurities
- Possible component switch out: pumps/compression, pressure relief/blowdowns, non-metallics, etc.
 - Cost implications

Pipeline Repurposing – Regulatory/Policy

- PHMSA update for CO₂ pipeline safety via 49 CFR Part 195 regulations
 - Focus and issues not fully known
- PHMSA requires a conversion to service plan that outlines requirements on pipeline integrity, inspection, training, and oftentimes a pressure test before repurposing pipelines.
 - May be further impacted due to the unfinished updated rulemaking
- Existing environmental impact statements may need revision/supplement for environmental risk due to change of pipeline service
- Harmonization of federal and state laws, as well as agency coordination, are helpful to resolve issues around pipeline siting, eminent domain
 - Including cross border pipelines – Canada/Mexico

Public Engagement

API RP 1185: Pipeline Public Engagement

RP 1185 Founding Principles

- **Flexible** to accommodate current company programs offering opportunity to fill gaps or upgrade efforts
- **Scalable** to size of company, type of project, and on-the-ground conditions
- **Balance** of industry, government and public stakeholders helps address differing needs to provide greater buy-in
- **Provides** operators a way to demonstrate they are acting in good faith



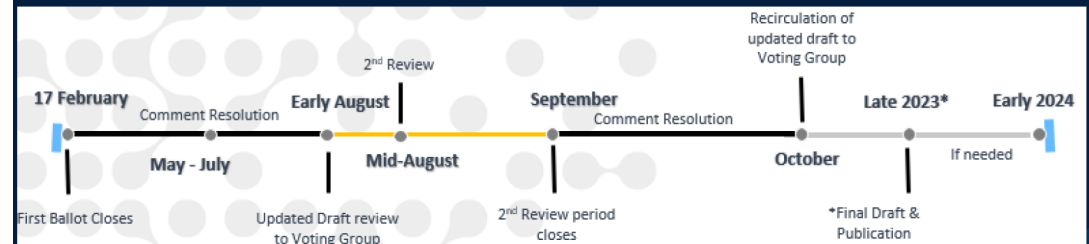
RP 1185 Program Elements

API RP 1185 - ENGAGEMENT

6 ELEMENTS	Yields a cohesive system
VALUES	Underly all elements
COMPONENTS	Stakeholders, lifecycles, tools



Timeline for Completion



At the current rate of comment resolution, it is expected to take until late summer/early fall before starting a second review period.

