Smart CO_2 Transport-Route Planning Tool

Providing Data and Insights for Accelerating Carbon Transport & Storage Deployment

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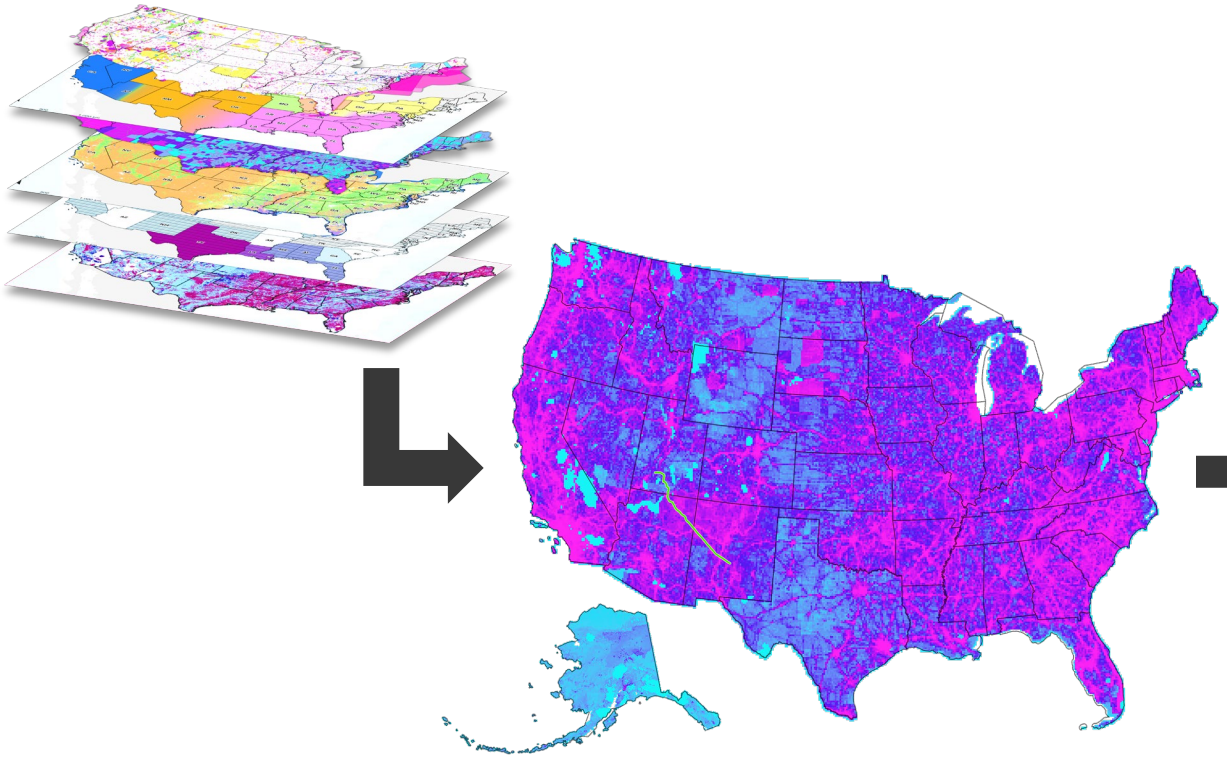
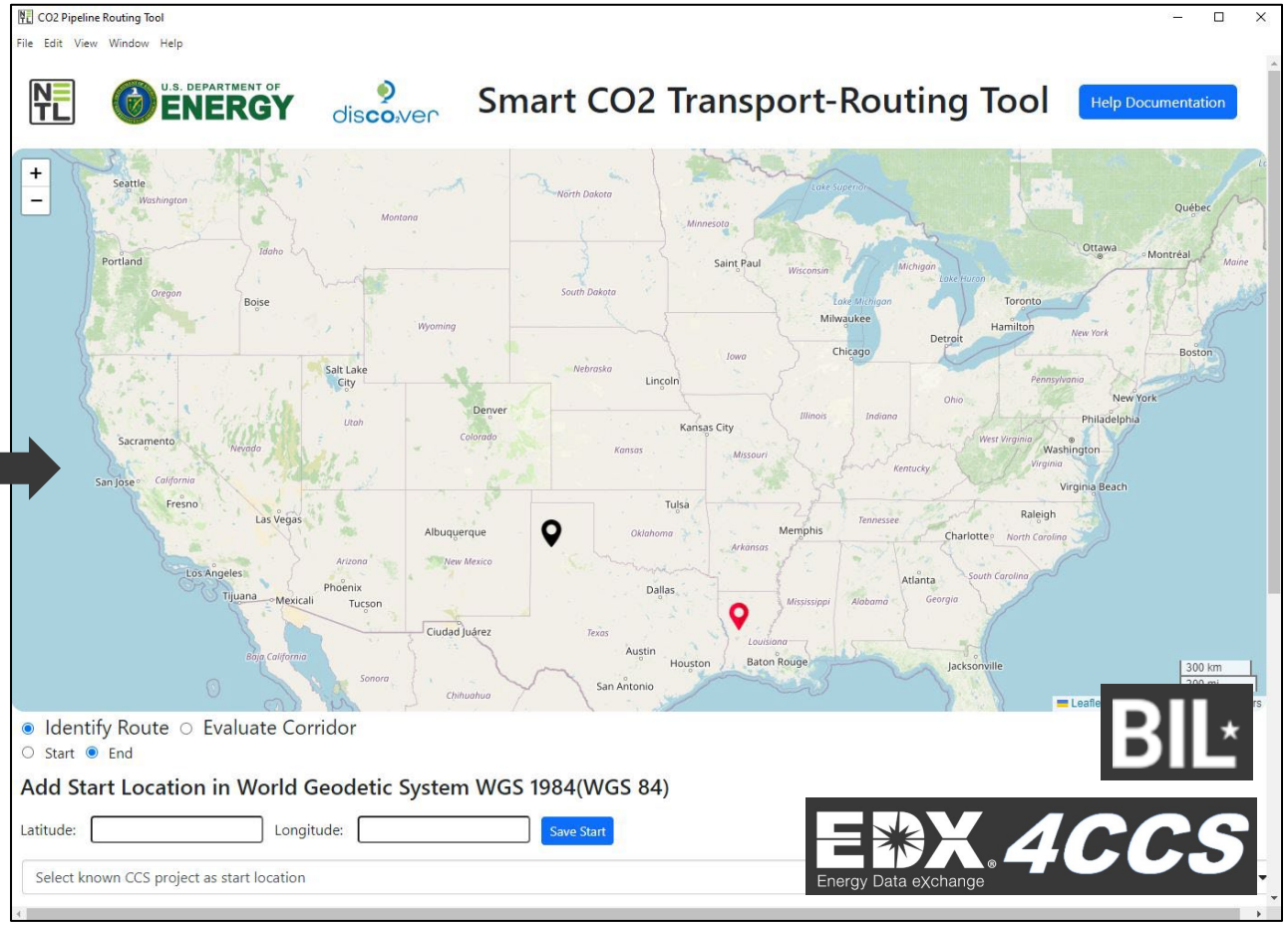
NATIONAL ENERGY TECHNOLOGY LABORATORY

2024 FECM/NETL Carbon Management Research Project Review Meeting

Aug. 7, 2024





U.S. DEPARTMENT OF ENERGY

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Meeting CTS Challenges with Smart and Spatial Solutions

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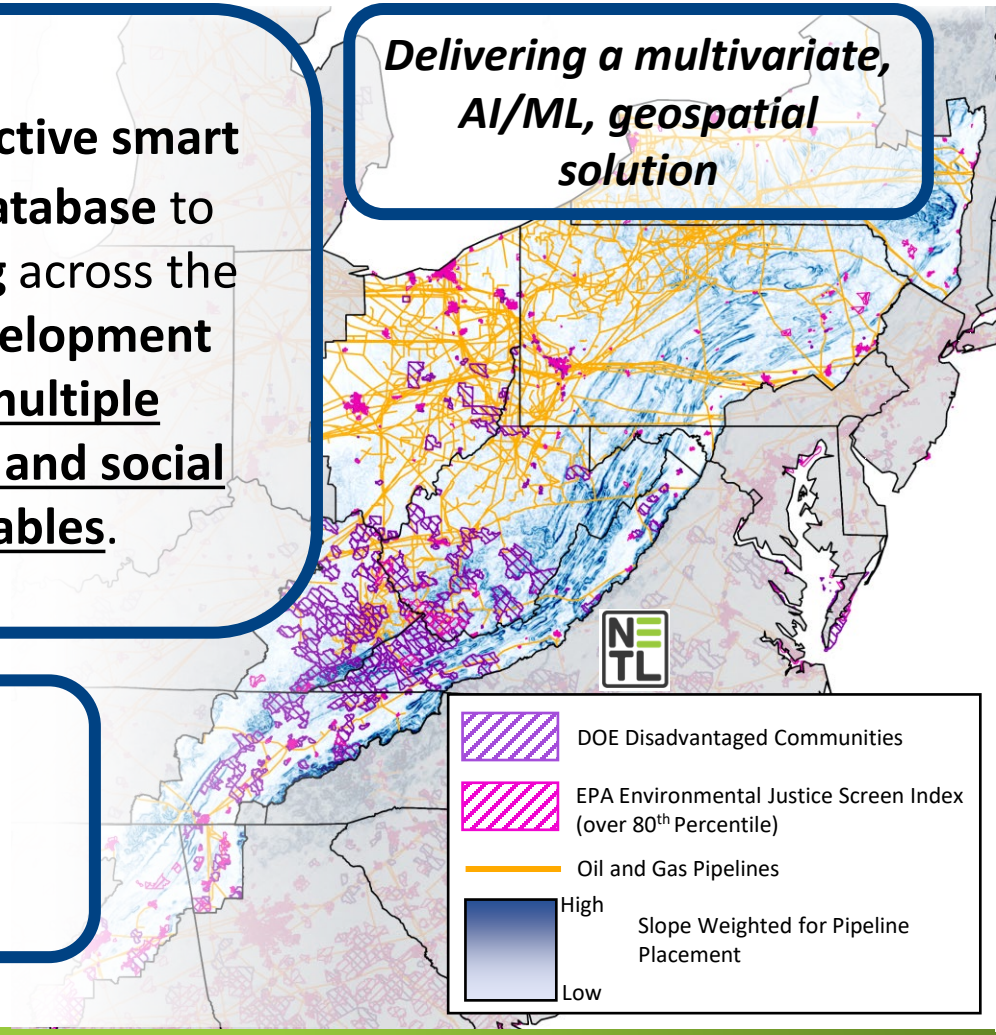
Need & Overview

Challenge: CTS pipeline models ***fail to integrate complex social, economic, and environmental variables*** that can greatly affect the success of developing new pipelines and increase project costs.

\+ Need for evaluation of existing transport corridors for reuse

Solution: An **interactive smart tool** and **geospatial database** to assist in **route planning** across the U.S. to **accelerate development** while **considering multiple environmental justice and social justice (EJSJ) variables**.

Delivering a multivariate, AI/ML, geospatial solution



Stakeholders

Industry
Regulators
Researchers

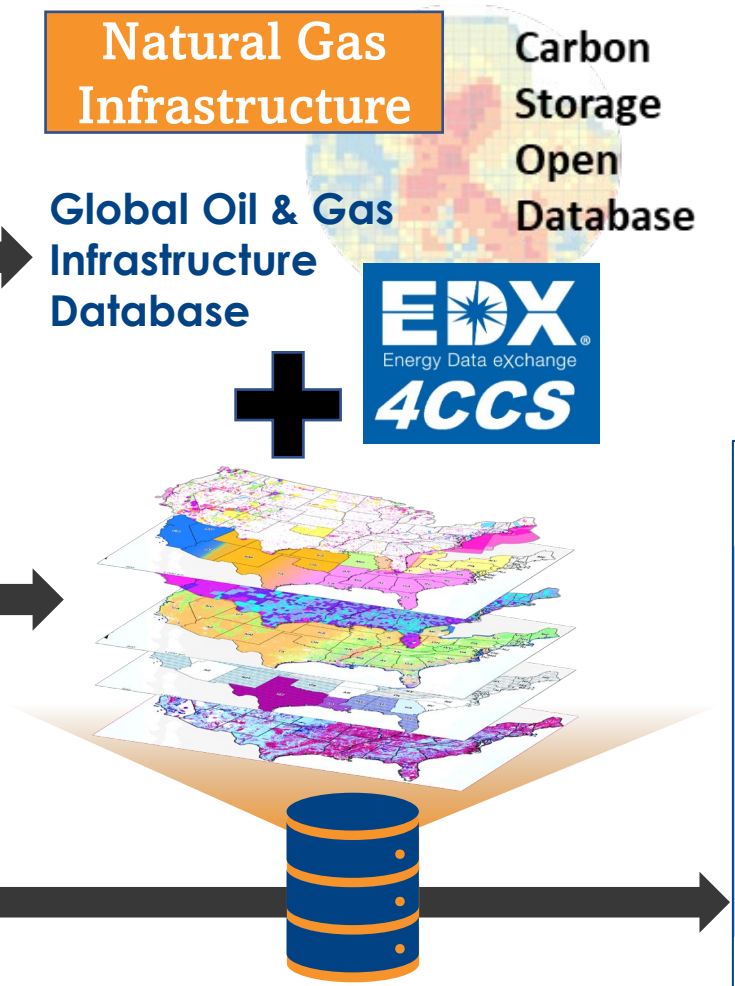
Delivering Transformative Resources

NATIONAL ENERGY TECHNOLOGY LABORATORY

Objectives & Outcomes

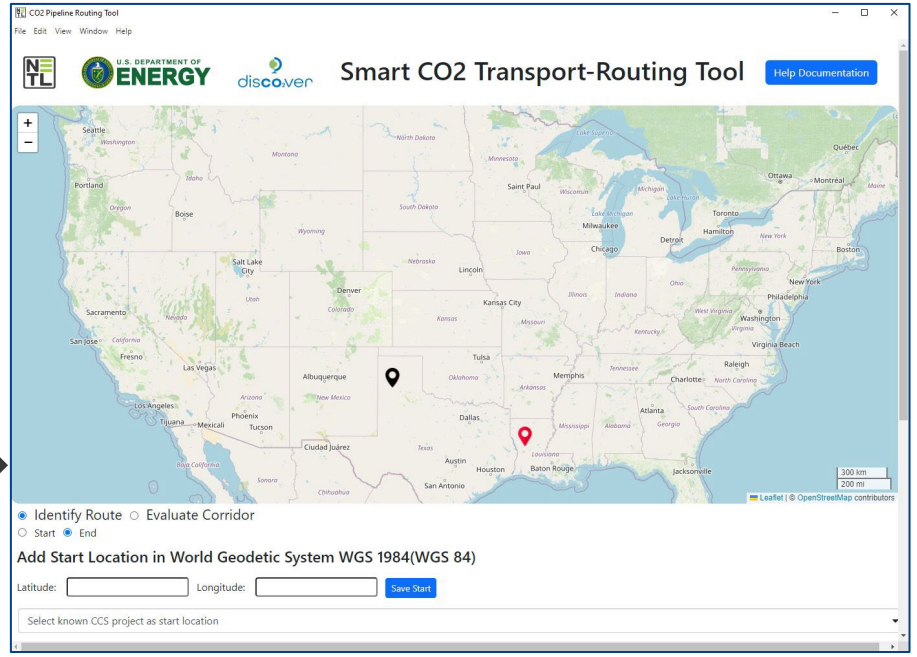
Objectives:

1. Build-off **existing resources** to provide a national **comprehensive spatial database**
2. **Integrate data** and **critical qualitative governance** to support safe **transport planning**
3. Enable stakeholders to **identify potential routes AND evaluate existing corridors**



Advancing DOE Program Goals

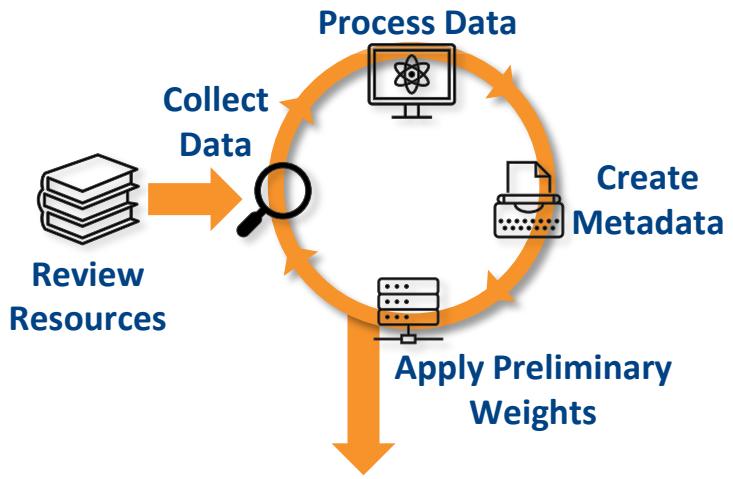
by developing of ***scientific***, ***smart***, and ***geospatial technologies*** to **accelerate** the **economically**, **socially**, and **environmentally prudent planning** and **development** of ***carbon transport***



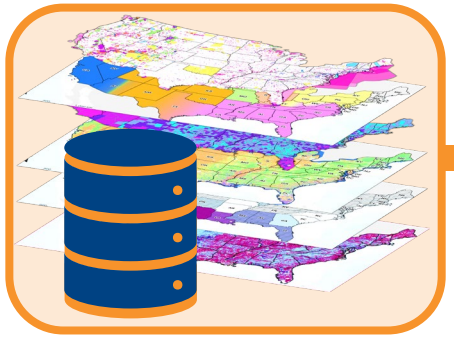
Multivariate, AI/ML, & Geospatial Method

Technical Approach to Inform CTS Planning & Development

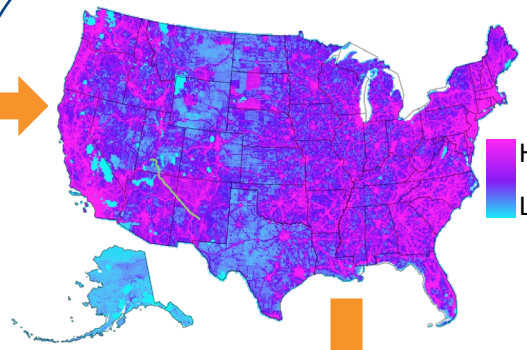
Geospatial Database



Publish Database



Smart CO2 Transport-Route Planning Tool



Build Multivariate, Weighted Grid

User Inputs

Identify Route → Select Start & End Location

or

Evaluate Route → Upload Area or Line of Interest

Model-based Reinforcement Learning using Monte Carlo Tree Search (MCTS)

Outputs

- Identified Route Layer
- Evaluation Report

Spatially Assess Intersects to Database by 10km area & Census Tract

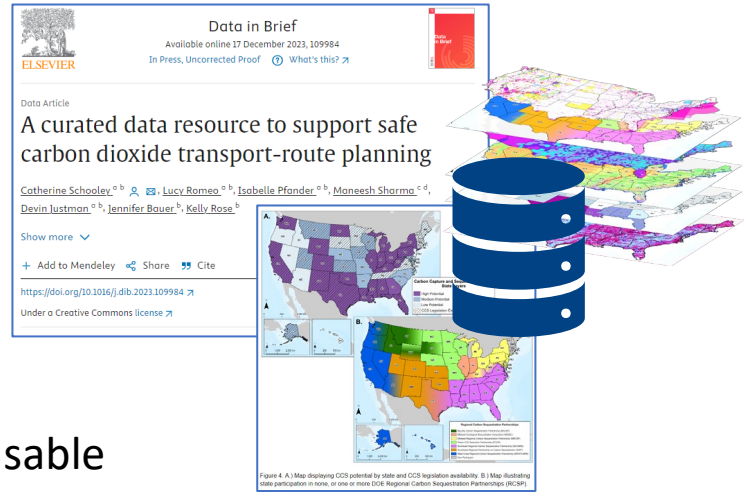
Output

- Evaluation Report

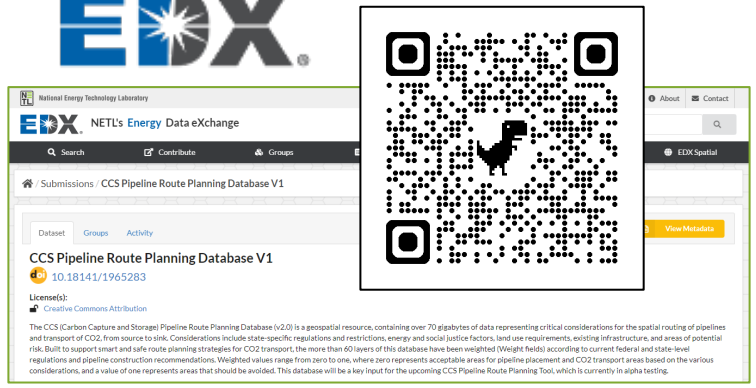
Published and Utilized Data Resource

Database Accomplishments *(March 2022 to present)*

- Paper published *(Schooley et al. 2024)*
- **550+** downloads
- Geospatial database *(v. 2),* March 2024
  - **60+ weighted layers**
  - **Metadata** and **weight definitions**
  - **F**indable, **A**ccessible, **I**nteroperable, **R**eusable



Available on



Category	Layer Examples
CCS by State	Restrictions & regulations
Boundaries	Protected areas, urban areas, land cover, buildings
Infrastructure	Pipelines, wells, roads
EJSJ	Social Vulnerability Index, Environmental Justice Screen
Natural Hazards	Floodplains, earthquake, wildfire, slope, landslides
Hydrology	Lakes, rivers, aquifers, groundwater

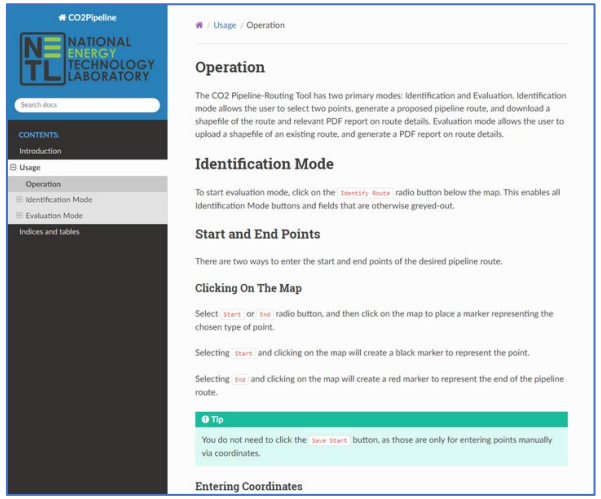
Led to an increase of ***collaboration*** *&* ***coordination*** *with stakeholders and researchers*

Smart CO_2 Transport-Route Planning Tool

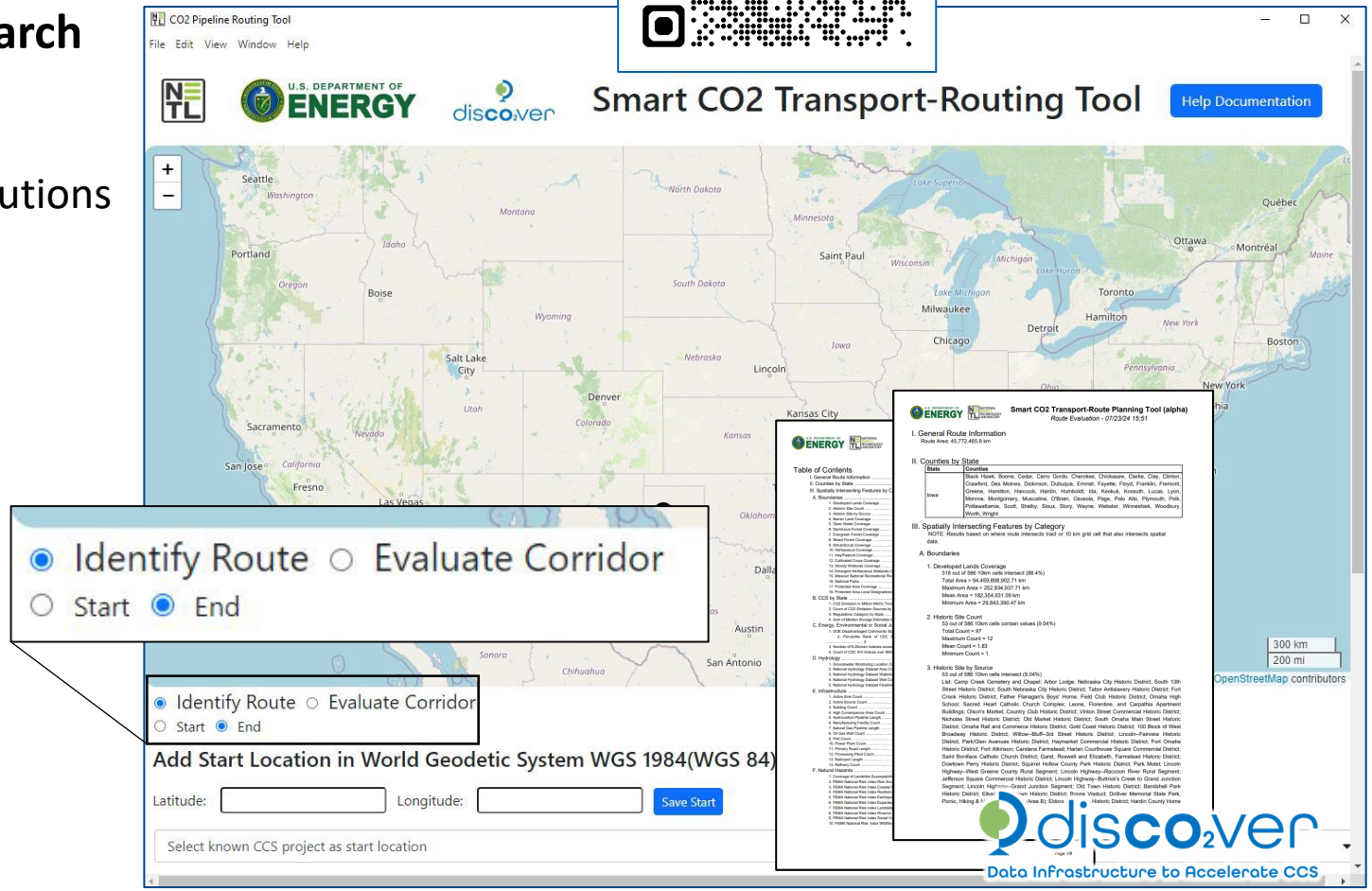
Tool Accomplishments *(March 2022 to present)*

Available on

- Open-source & stand-alone
- *Identifies Routes* using **Monte Carlo Tree Search**
  - Model-based **Reinforcement Learning** (RL)
  - Heuristic algorithm finding 'near optimal' solutions
  - Relatively simple → explainable
- Updated user-interface



- Added *Evaluate Route* option
  - Reporting functionality
- Revised help documentation

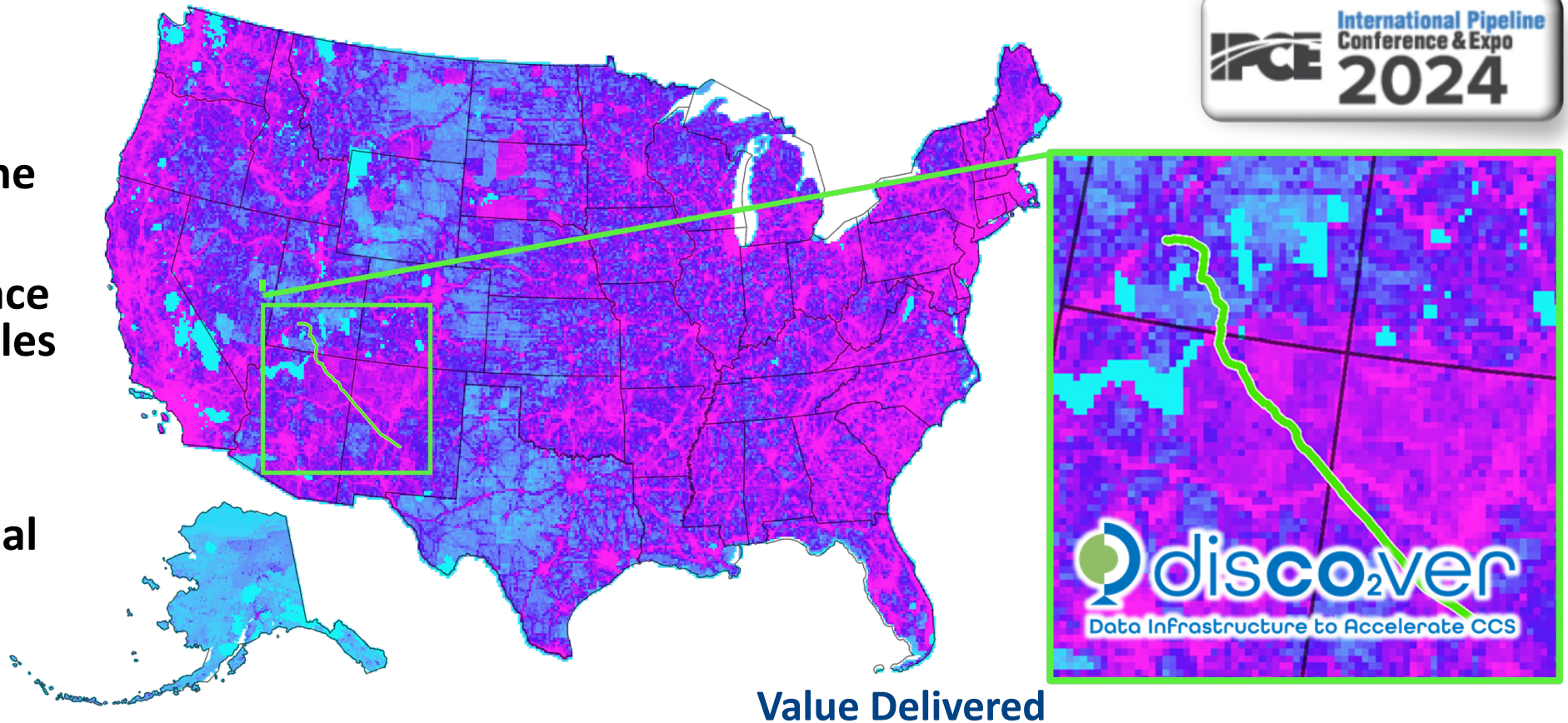


Increasing **Useability & Usefulness**

Communication & Collaboration is Key

Next Steps

- **International Pipeline Conference**
- Enable **direct interface** with **mapped variables**
- Support **dynamic weighting**
- Integrate **multi-modal functionality**
- Decrease **run times**
- **Publication**
- **Version 2**, Spring 2025



Value Delivered

Interactive, **stand-alone**, **geospatial tool** designed to **accelerate safe route planning for CO_2 transport** that accounts for **state and Federal regulations**, **best practices**, **EJSJ** considerations, and is **complementary to related capabilities**

DOE CO_2 Transport Technologies

Scope – Filling a Technology Niche & Supporting Model Validation

	Stakeholders	Supports	Tool is…				Analytics apply…					Variables include…						Baseline Data Published	Outputs Include
			Open-Source	Stand-alone	Spatial	Temporal	AI/ML	Multi-scale	Multi-modal	Multi-stops	Phase-based	Environmental	Energy infrastructure	Public infrastructure	Economic	EJSJ	Risk Likelihood		
FECM/NETL CO_2 Transport Cost Model (CO2_T_COM)	Researchers (i.e., government, academic, non-profit), industry	Estimating the cost of new CO_2 pipelines	X	X	X	X	–	X	–	–	–	–	X	X	X	–	/	–	Pipeline diameter, number of pumps, cash flows, NPV, break-even CO2 price
SimCCS (LANL)	Industry, researchers (i.e., government, academic, non-profit)	Transport network modeling and cost analysis	X	–	X	X	–	X	X	X	X	X	X	X	X	X	–	–	Optimal network; costs for capture, transport, and storage
Smart CO_2 Transport-Route Planning Tool & Database (NETL)	Regulators, industry, researchers (i.e., government, academic, non-profit)	Inform planning, development, and repurposing; risk assessments	X	X	X	–	X	X	/	–	–	X	X	X	X	X	X	X	Optimal network as spatial layer; report of route evaluation against variables

X Currently supports / In progress – Not in planned scope

the stats

54 RIC PRESENTATIONS

22 POSTERS

30 TOOL DEMOS

MONDAY

Presentations
(10:30AM - 5:25PM)

- 16 disCO2ver presentations

TUESDAY

Presentations
(10:30AM - 5:45PM)

- 17 SMART presentations
- 2 disCO2ver presentations
- 2 Geographic focus/tool presentations

Posters
(5:45PM - 7:45PM)

- 18 CTS Posters
- 2 PSCC Posters
- 1 CDR Poster
- 1 MLEF Poster

Tool Demos
(5:45PM - 7:45PM)

- 30 Tool Demos
  - SMART
  - NRAP
  - EDX
  - EDX4CCS

WEDNESDAY

Presentations
(2:10PM - 4:30PM)

- 3 transport, research, development, and demonstration activities presentations
- 1 transport modeling presentation
- 1 secure storage (basalts/mafic) presentation

THURSDAY

Presentations
(10:30AM - 5:20PM)

- 8 NRAP presentations
- 2 NETL RIC Presentations
- 2 Offshore presentations

NETL Research · Carbon Storage Program

NRAP National Risk Assessment Partnership

SMART

EDX disco2ver

https://edx.netl.doe.gov/disco2ver

NETL Carbon Storage Outreach Example

2024 FECM/NETL Carbon Management Research Project Review Meeting

100+ DOE-sponsored CTS presentations

Presentations on EY23 CTS work:

- Advanced Storage FWP
- Carbon Storage Data FWP
- Carbon Storage Analysis FWP
- Multi-Modal Transportation FWP
- EDX4CCS
- NRAP
- SMART

Open to the public

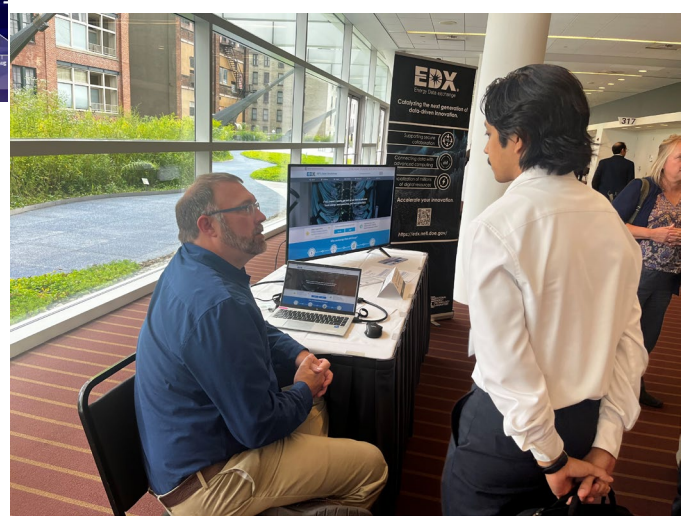
Attendees from government agencies, utilities, research, universities, industry

Poster and tool/app demo session – Tuesday Aug. 6th evening

Carbon Storage Timeline summarizing field, lab and computational contributions to CTS' digital future
Live, interactive demo at the booth!
Source: NETL

Aug. 5-9, 2024
Pittsburgh Convention Center

Stop by the CTS booth in the exhibit hall to learn more! Take-aways, information, expertise in one stop shop



Multiple tool demos will be hosted
Source: NETL

Acknowledgments

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NETL RESOURCES

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Thank you!

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