Smart CO_2 Transport-Route Planning Tool

Providing Data and Insights for Accelerating Carbon Transport & Storage Deployment

Lucy Romeo
GeoData Research Scientist, NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

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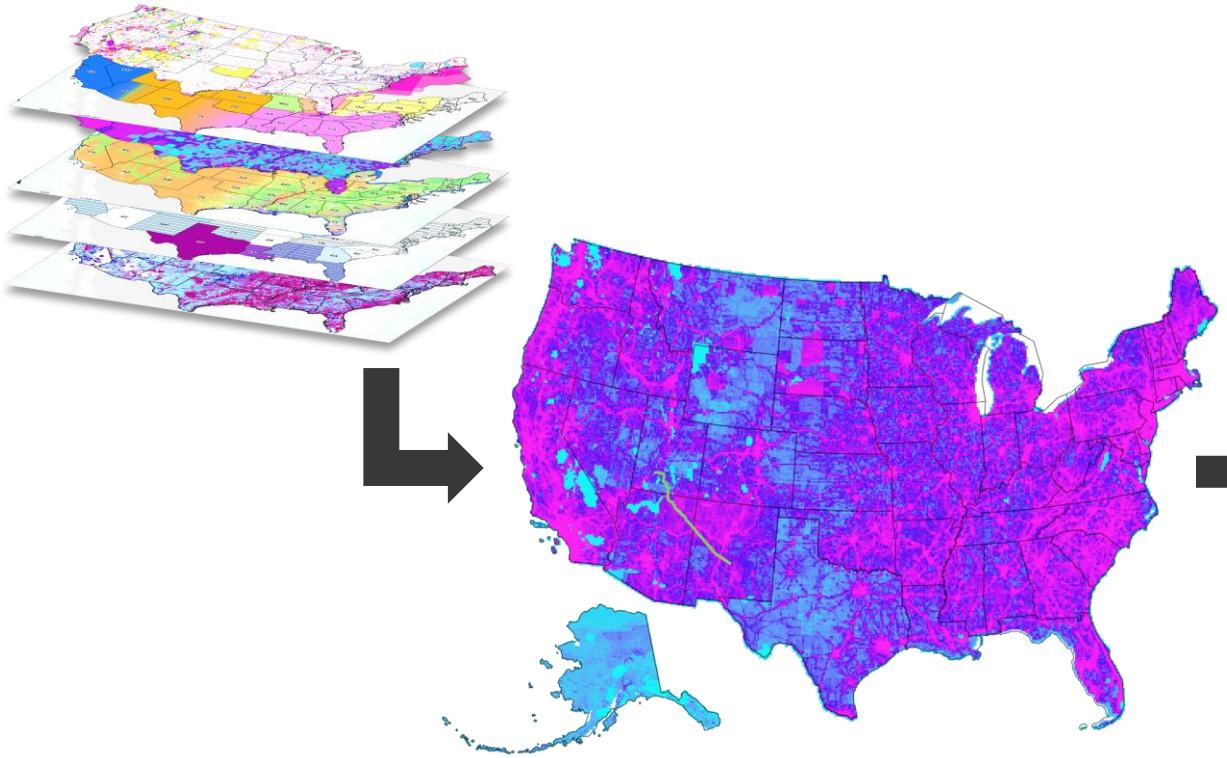

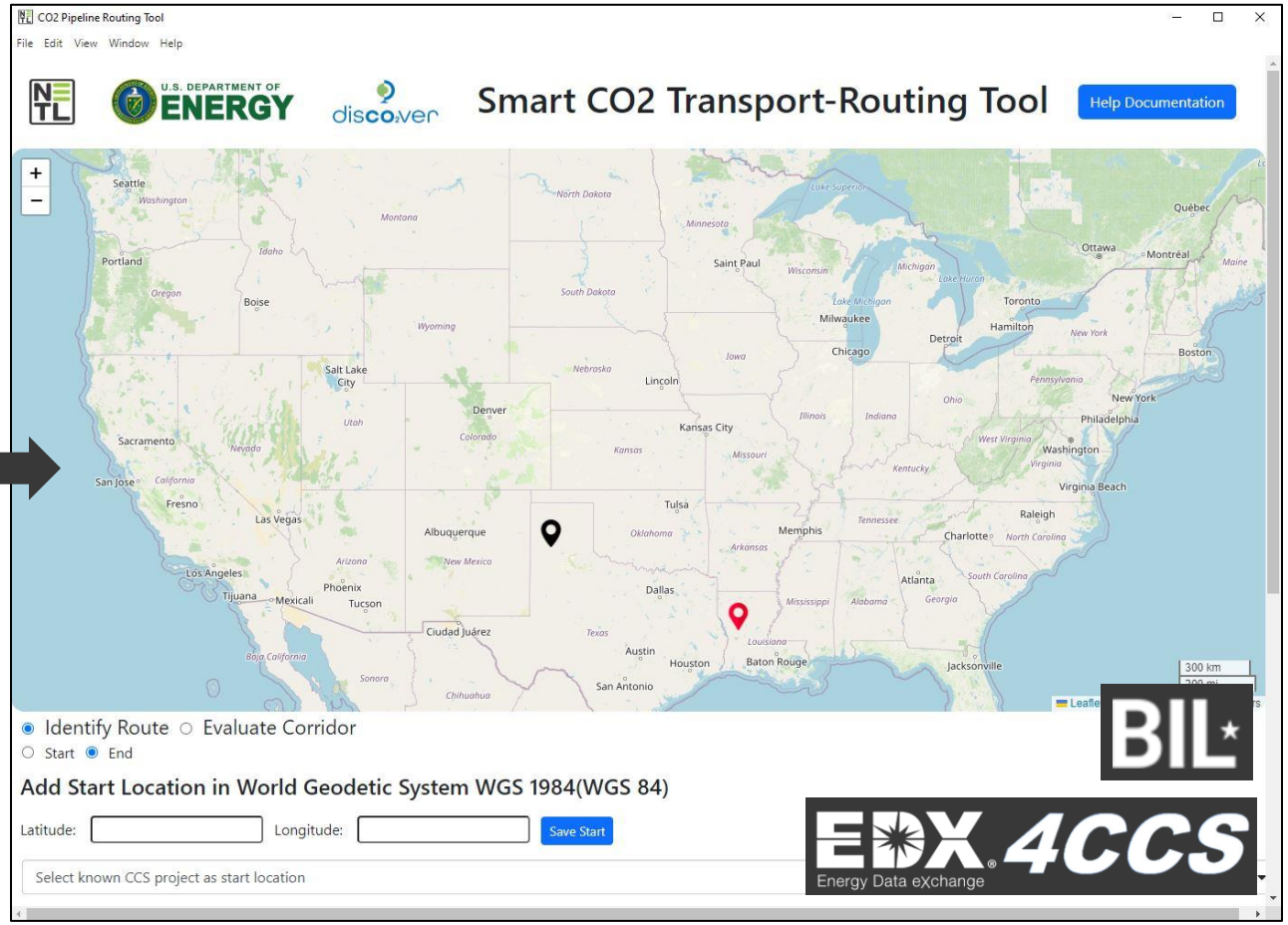

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Authors and Contact Information

Lucy Romeo[1], Stephen Leveckis[1,2], Michael Gao[1,2], Benjamin Houghton[1,2], Dakota Zaengle[1,2], Catherine Schooley[1,2], Devin Justman[1,2], Jennifer Bauer[1], and Kelly Rose[1]

[1]National Energy Technology Laboratory, 1450 Queen Avenue SW, Albany, OR 97321, USA

[2]NETL Support Contractor, 1450 Queen Avenue SW, Albany, OR 97321, USA

Meeting CTS Challenges with Smart and Spatial Solutions

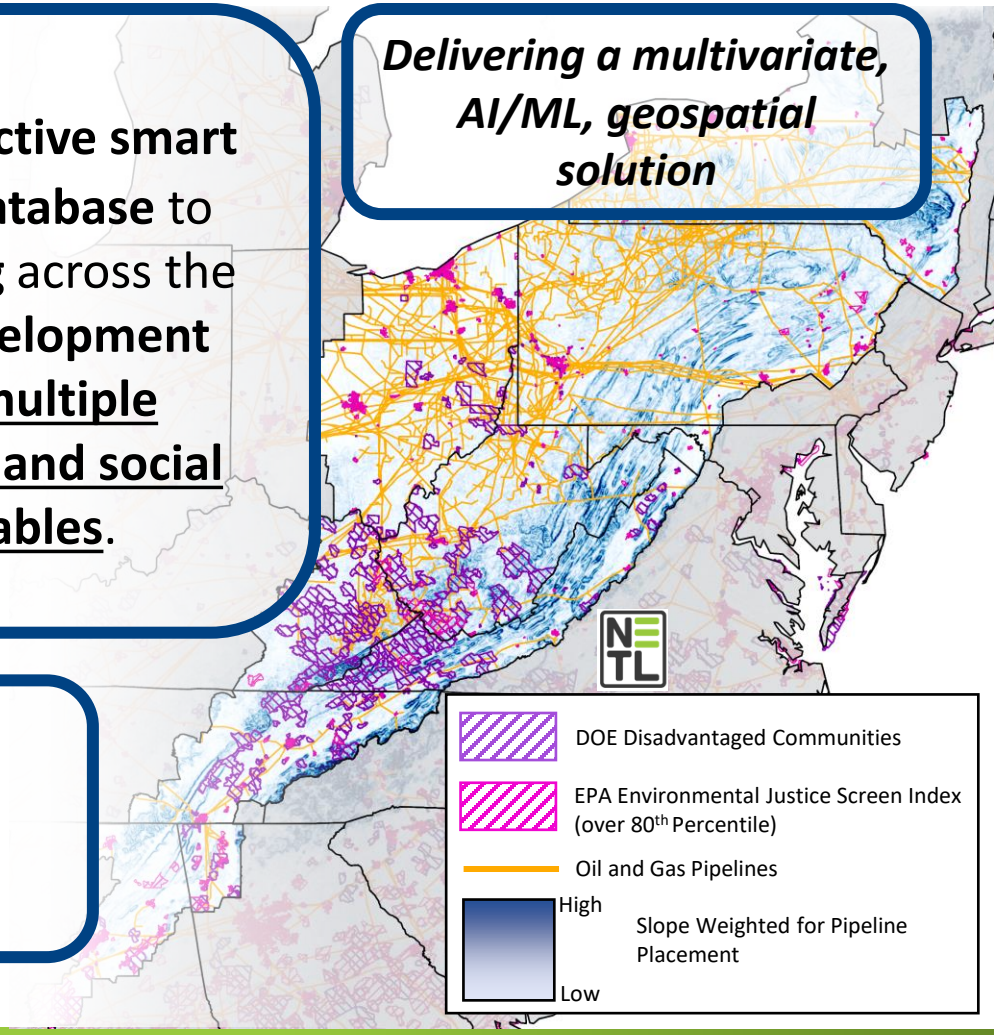
Need & Overview

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

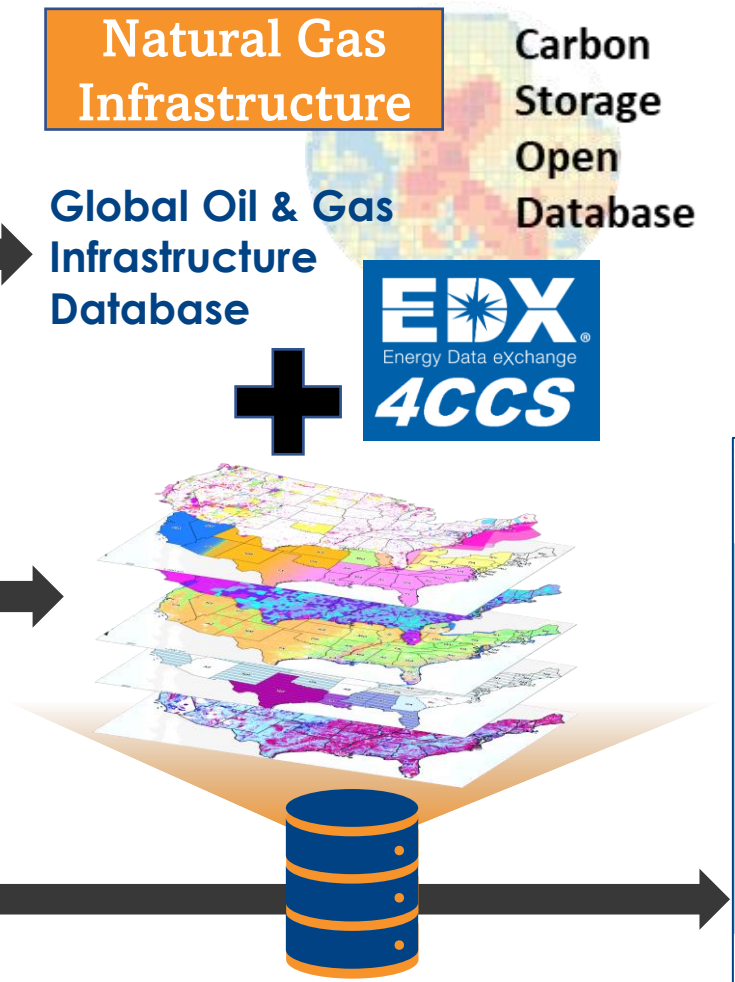
Industry
Regulators
Researchers

Delivering Transformative Resources

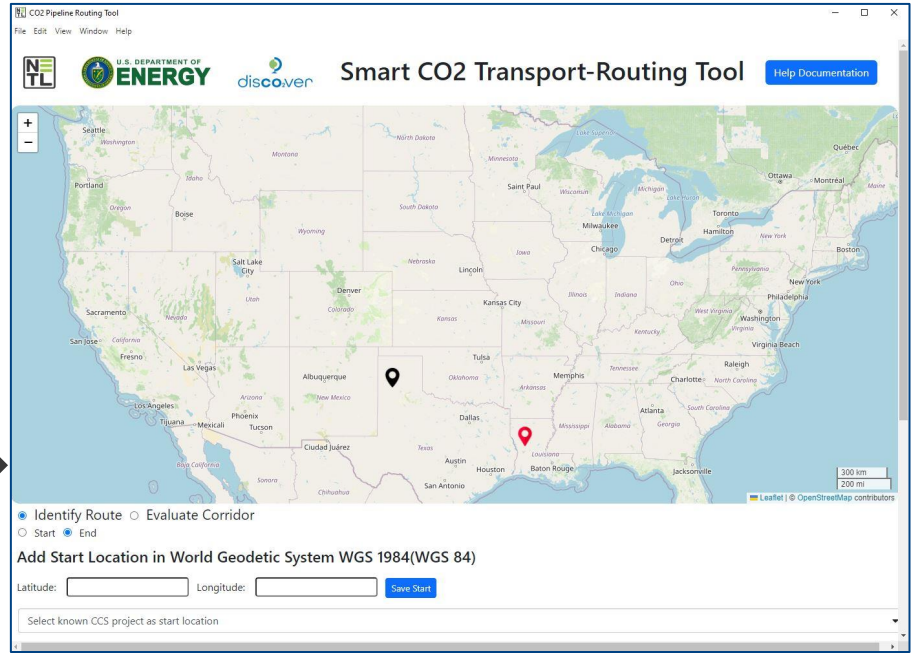
Objectives & Outcomes

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**



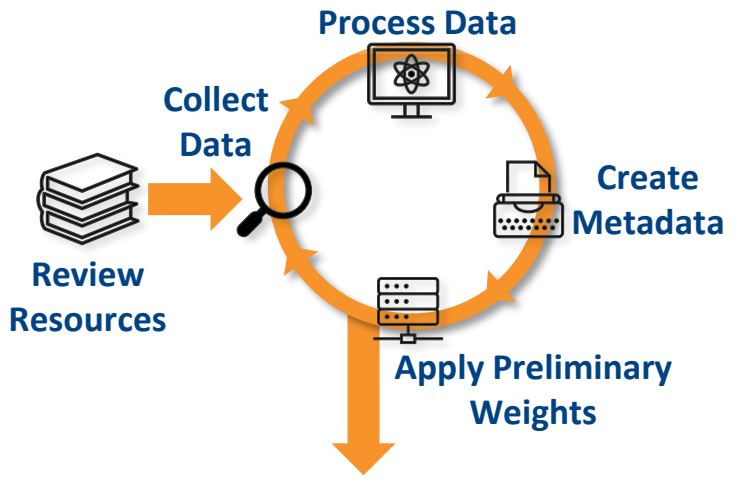
Advancing DOE Program Goals
by developing of ***scientific***, ***smart***, and ***geospatial technologies*** to **accelerate** the **economically**, **socially**, and **environmentally prudent planning** and **development** of ***carbon transport***



Multivariate, AI/ML, & Geospatial Method

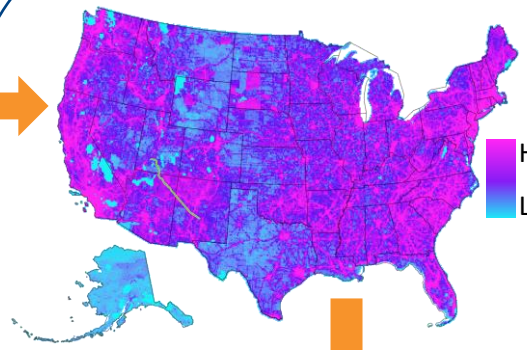
Technical Approach to Inform CTS Planning & Development

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

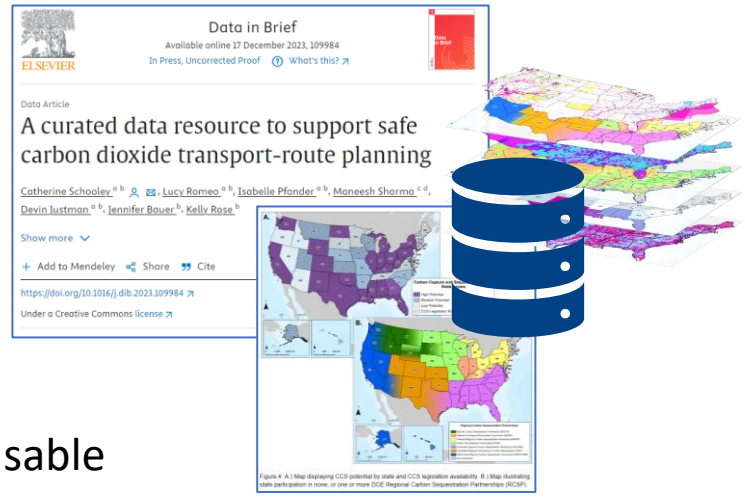
Output

- 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



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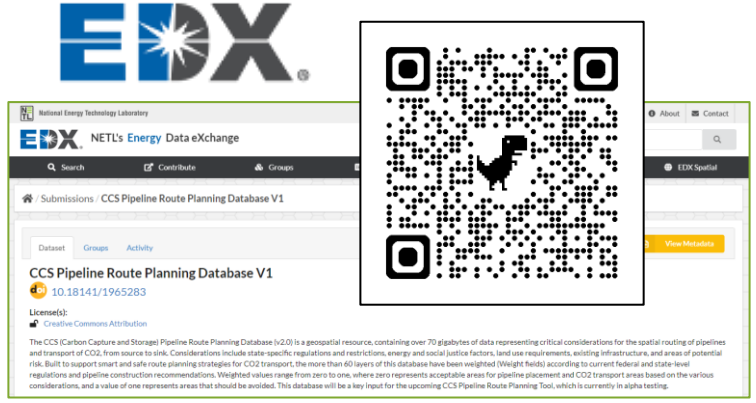


Category	Layer Examples
CCS by State	Restrictions & regulations
Boundaries	Protected areas, urban areas, land cover, buildings
Infrastructure	Pipelines, wells, roads
EJSJ	Social Vulnerability Index, Environmental Justice Screen
Natural Hazards	Floodplains, earthquake, wildfire, slope, landslides
Hydrology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

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

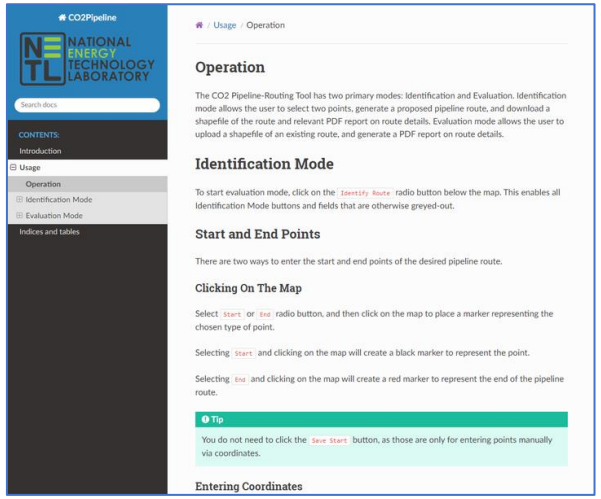
Smart CO_2 Transport-Route Planning Tool

Tool Accomplishments *(March 2022 to present)*

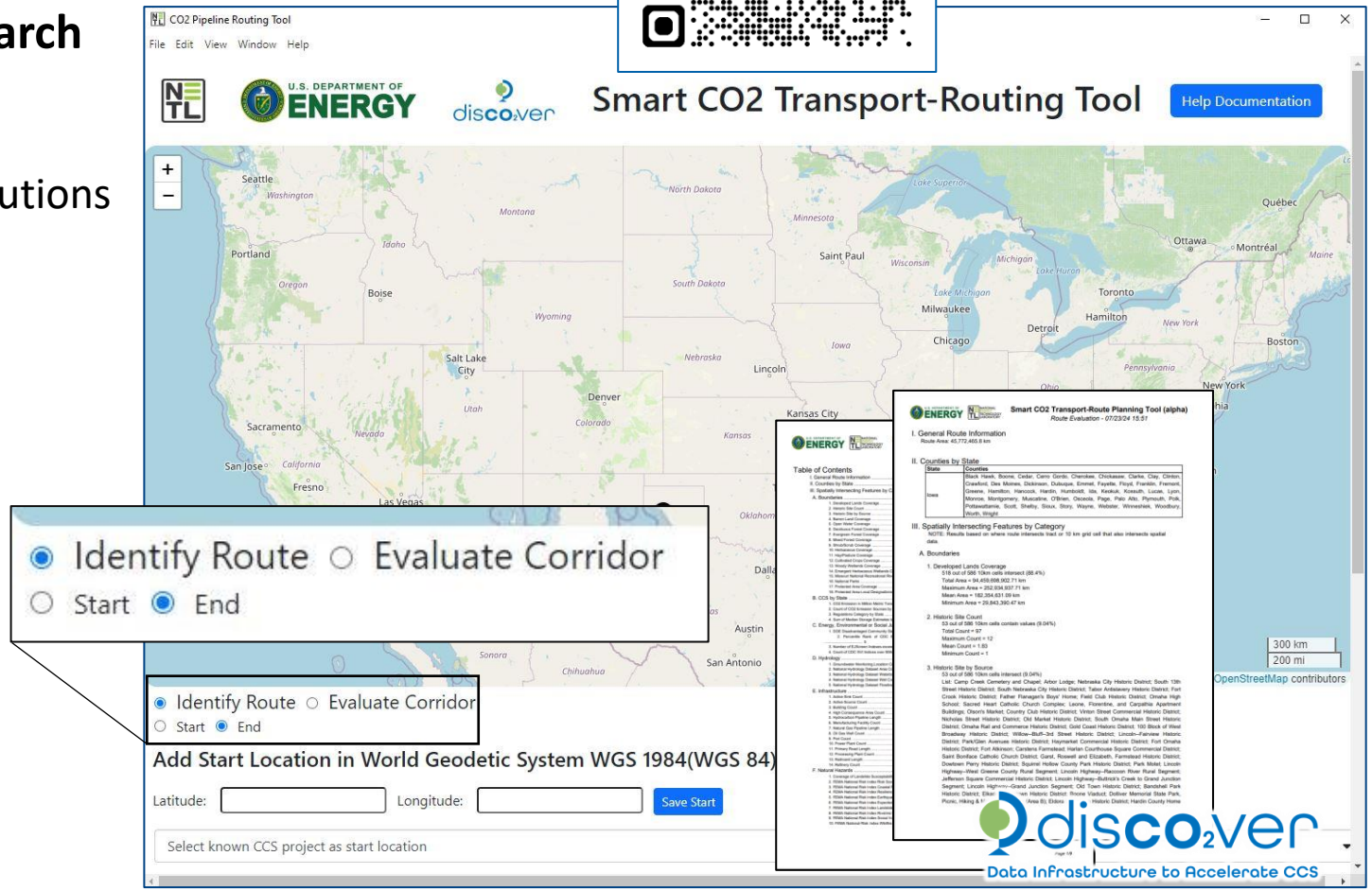
Available on

EDX

- 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

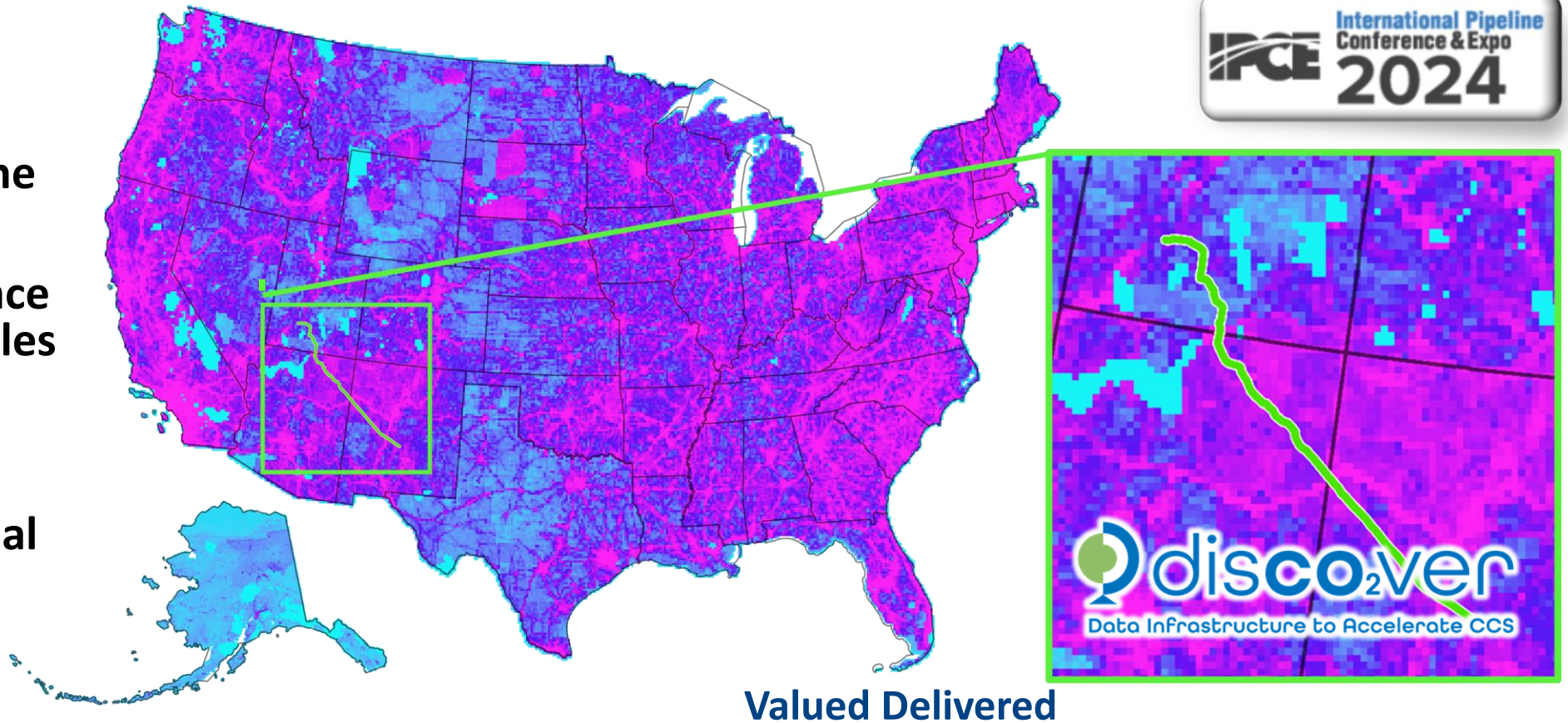


Increasing **Useability & Usefulness**

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



Valued 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 Multi-Modal Transport Model (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

Acknowledgments

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CONTACT:

Jennifer Bauer
Jennifer.Bauer@netl.doe.gov

Lucy Romeo
Lucy.Romeo@netl.doe.gov

Stephen Leveckis
stephen.leveckis@netl.doe.gov