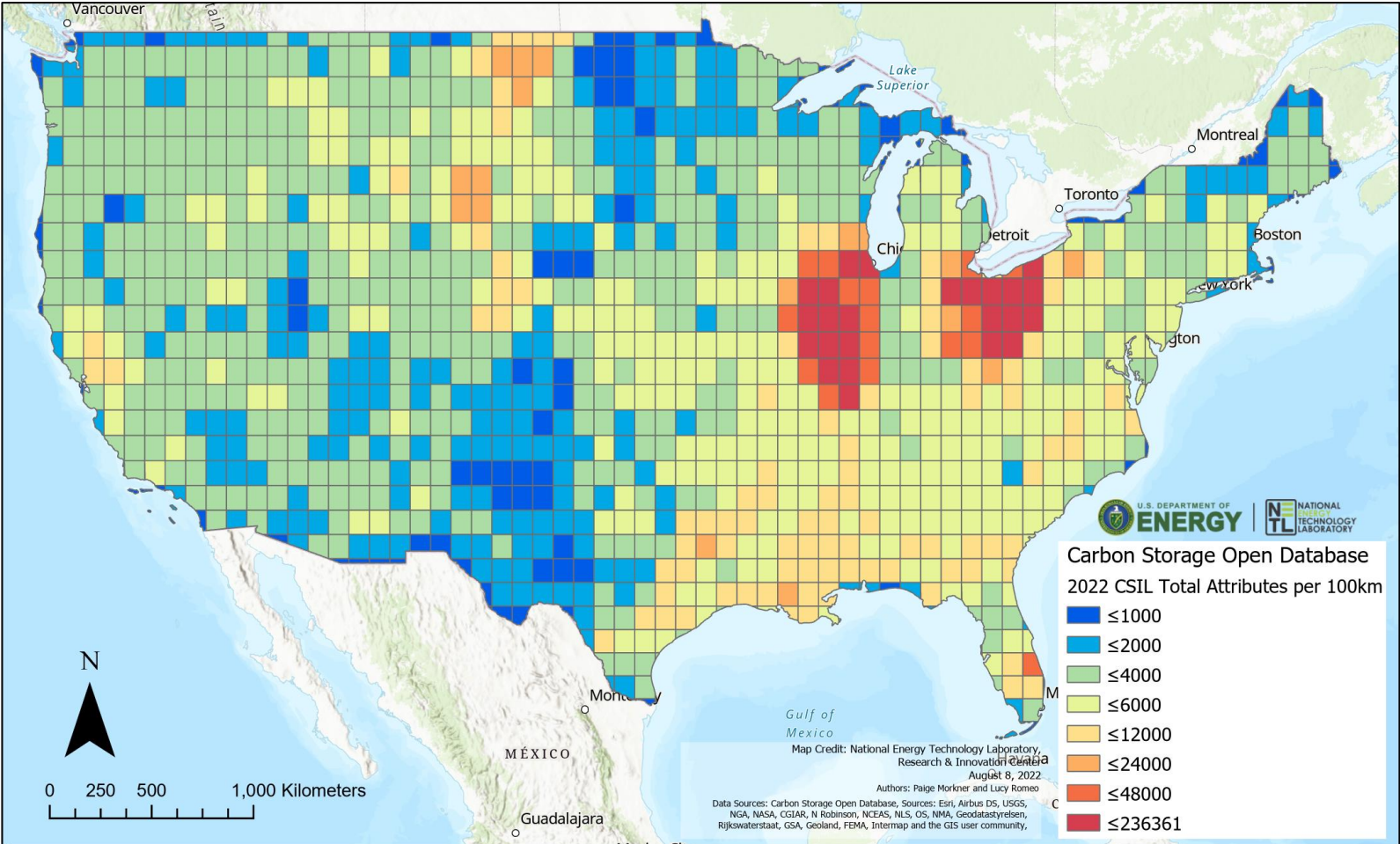# An Updated Carbon Storage Open Database - geospatial data aggregation to support scaling up CCS

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Research Innovation Center

Disclaimer

Authors and Contact Information

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

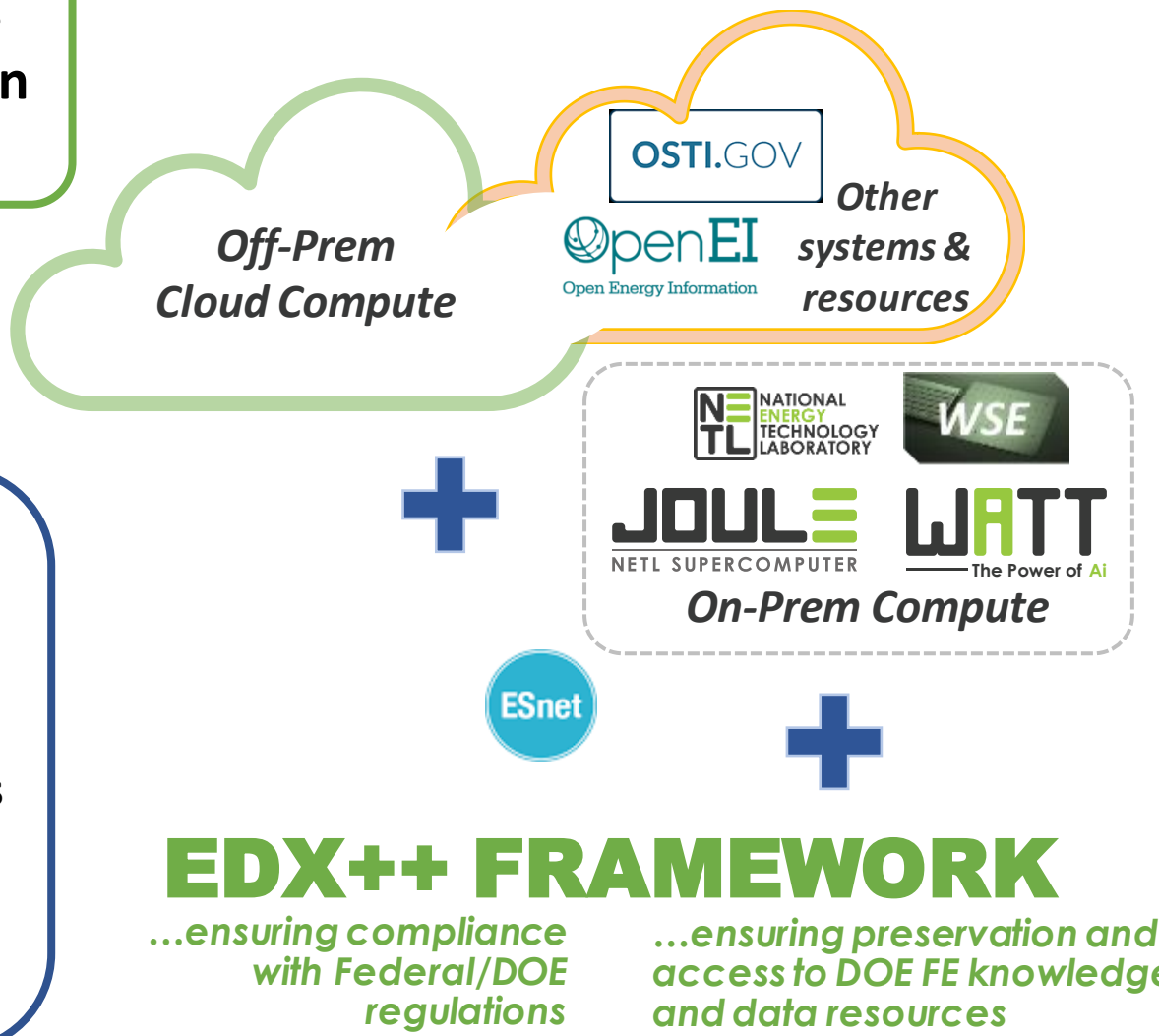[2] NETL Support Contractor, 1450 Queen Avenue SW, Albany, OR 97321, USA

[3] NETL Support Contractor, 3610 Collins Ferry Road, Morgantown, WV 26507, USA

Carbon storage data on EDX

Using AI/ML, millions of data features and attributes have been integrated and preserved across the USA in support of advanced carbon storage projects

This effort has already aided SMART-CS, NRAP and outside entities (e.g. major industry operator) to drive subsurface modeling, machine learning, and insights for a range of end user needs

EDX supports:
- RCSP, CarbonSafe, NRAP data ingestion
- Data mining to aggregate authoritative, open source resources relevant to CS researchers
- Integration of other FE resources
- Access, visualization, and interaction with CS data collections via NETL EDX mapping platforms Natcarb Viewer and Geocube
- Reuse of data by new FE projects via EDX Collaborative Workspaces and more...

Off-Prem Cloud Compute

OSTI.GOV

OpenEI
Open Energy Information

Other systems & resources

NETL NATIONAL ENERGY TECHNOLOGY LABORATORY

WSE

JOULE
NETL SUPERCOMPUTER

WATT
The Power of Ai

On-Prem Compute

ESnet

EDX++ FRAMEWORK
...ensuring compliance with Federal/DOE regulations   *...ensuring preservation and access to DOE FE knowledge and data resources*

Workflow for open data collection

Analyze and catalog data from EDX

Collection of geospatial data from disparate websites

Aggregation of resources into central database

Cataloging and collection of metadata

Integration of metadata and data into EDX++ framework and online mapping platform

EDX Groups

Carbon Storage Open Database

This is a group to bring together data resources related to all open carbon storage data on EDX read more
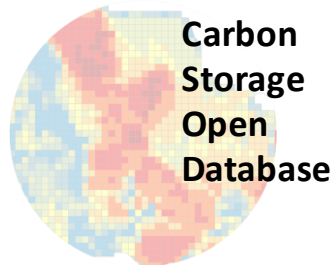
Followers
8

Submissions
311

+ Follow

Data Usage: 1.569 TB

Resources: 1222

Carbon Storage Open Database

https://edx.netl.doe.gov/dataset/carbon-storage-open-database
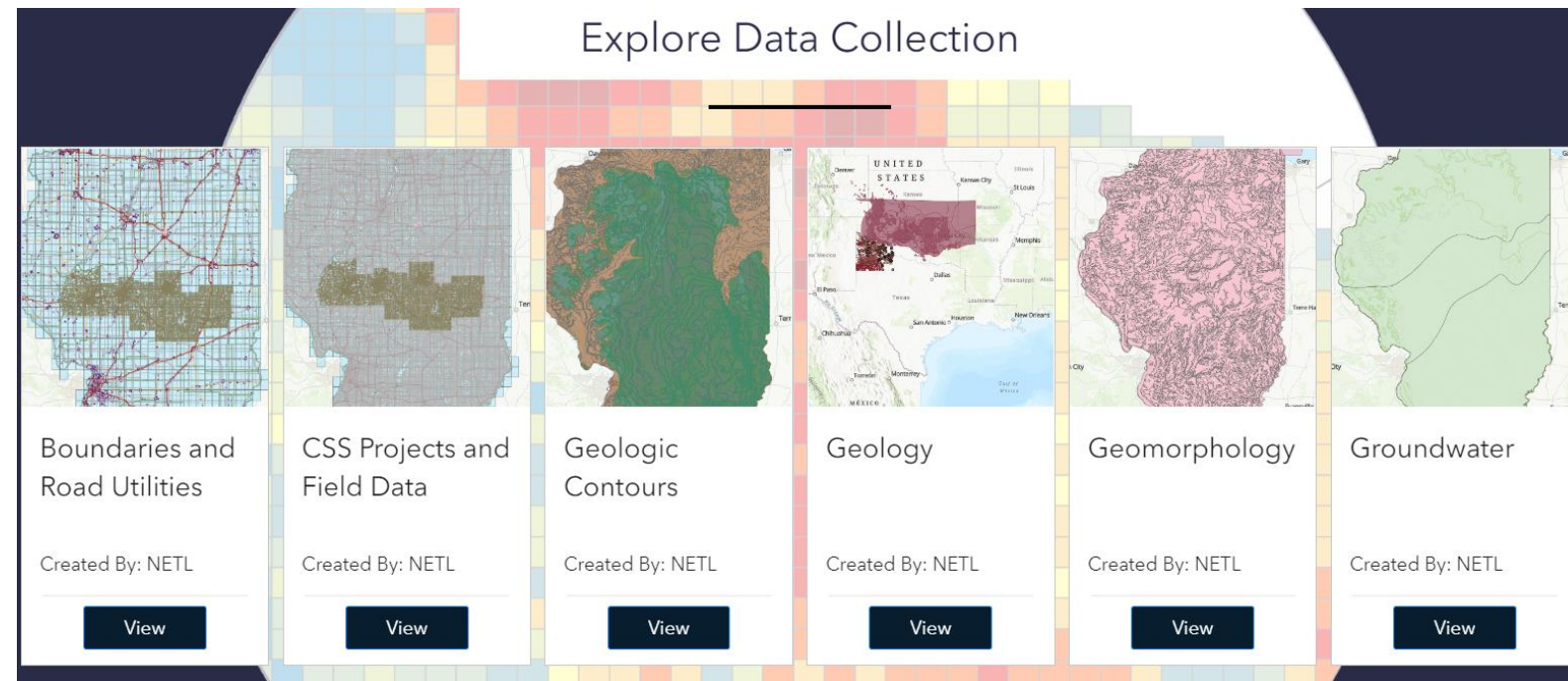https://edx.netl.doe.gov/dataset/geocube

Data aggregation and metadata cataloging

- Metadata are cataloged to provide and develop information for data display on online mapping platform, GeoCube
- Information recorded for each data layer:
  - File Name
  - Layer name (displayed)
  - Sensitive or confidential markings
  - Spatial extent
  - Category
  - Keywords
  - Source
  - Citation

Carbon Storage Open Database
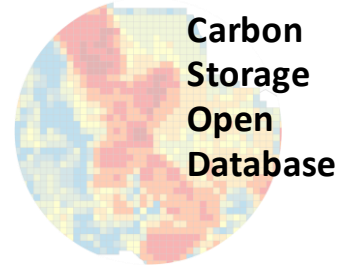
Category	
Boundaries and Roads Utilities	Landcover Classification
CSS Projects and Field Data	Mine
Geologic Contours	Remote Sensing Data
Geology	Structure
Geomorphology	Surface Hydrology
Groundwater	Well Data

Explore Data Collection

Boundaries and Road Utilities — Created By: NETL — View

CSS Projects and Field Data — Created By: NETL — View

Geologic Contours — Created By: NETL — View

Geology — Created By: NETL — View

Geomorphology — Created By: NETL — View

Groundwater — Created By: NETL — View

Open-source data collection and sources

Carbon Storage Open Database
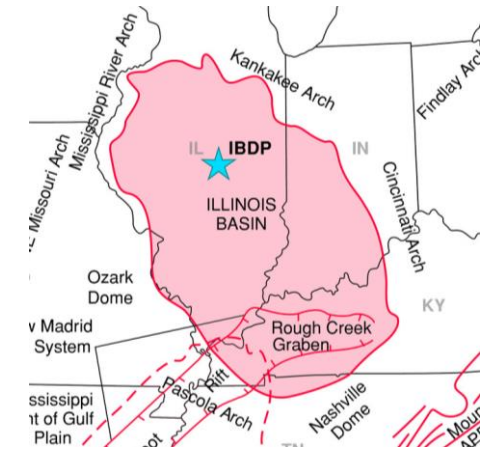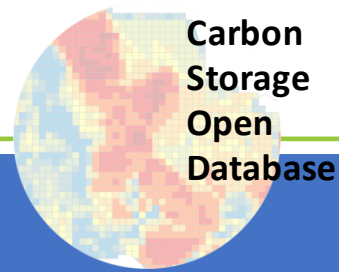
Total Shapefiles and Raster files	Source
312	2019 Carbon Storage Open Database, curated from the Regional Carbon Sequestration Partnerships websites, REST servers, and EDX
3	USGS Carbon Dioxide Storage Resources Assessment, 2013
8	Basal Cambrian Raster layers from EERC on EDX
160	Shapefiles from the FutureGen 2.0 Technical Data on EDX
360	Havorka et al. CO2 Brine Database (Texas BEG)
49	the Illinois State Geologic Survey Illinois Basin Decatur Project data on EDX
892	Total Number of Layers in Geodatabase

https://edx.netl.doe.gov/dataset/carbon-storage-open-database
https://edx.netl.doe.gov/dataset/geocube

Data mapping and availability – GeoCube integration

- GeoCube has been migrated to leverage EDX++ capabilities to host geospatial data
- New website, maps, and capabilities for visualization the Carbon Storage Open Database, NATCARB, and other geospatial data collections

Search, Visualize, Download, Create

This is the platform for exploring and downloading GIS data, visualizing geospatial data, and building apps. You can analyze and combine datasets using maps, as well as develop new web and mobile applications.

Explore Data Collections

Click the icons to browse through specific data collections in NETL Portal.

Carbon Storage Open Database

Global Oil and Gas Infrastructure

NATCARB Viewer 2.0

Offshore Gulf of Mexico

Rare Earth Elements & Coal Open Database

Carbon Storage Open Database

CSIL: Cumulative Spatial Impact Layers™

Cumulative Spatial Impact Layer (CSIL) Tool was used to analyze data density of the updated 2022 Carbon Storage Open Database to compare to 2019 database

GIS-based tool that rapidly quantifies *big* and *disparate spatio-temporal* data into a *useful, informative, and understandable resource*

Desktop Tool for ArcGIS
(Romeo et al., 2019)

Transactions in GIS
(Romeo et al., 2019)

CSILs can evaluate:
1. **Spatial density,**
2. **Spatial Presence**
3. **Attributes**

Producing the final database – analyzing data density
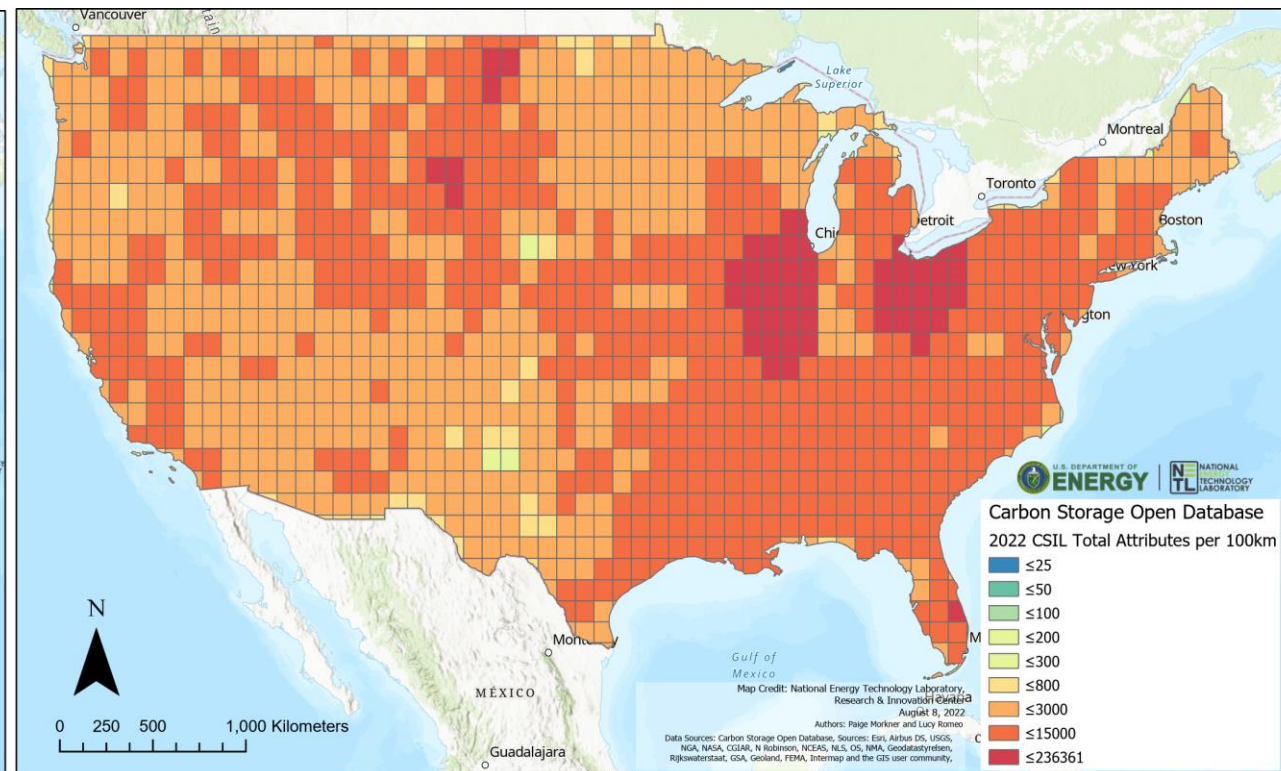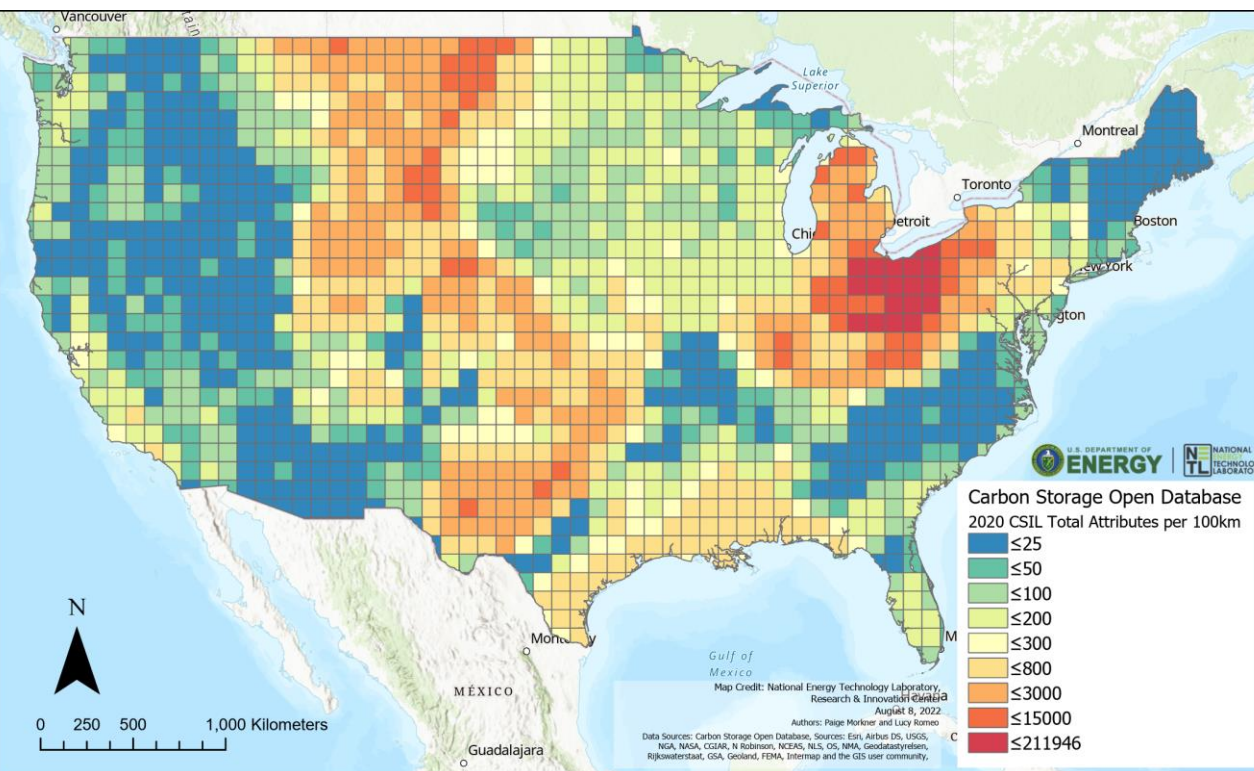
2019 Carbon Storage Open Database on GeoCube

2022 Carbon Storage Open Database on GeoCube with 580 additional shapefiles and rasters

More data, more opportunities!

- Additional data layers are available within the Carbon Storage Open Database on GeoCube

- Data continues to be added to EDX, and will be targeted for integration into the collection in EY22+

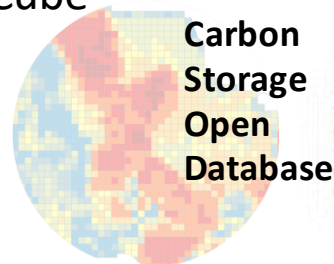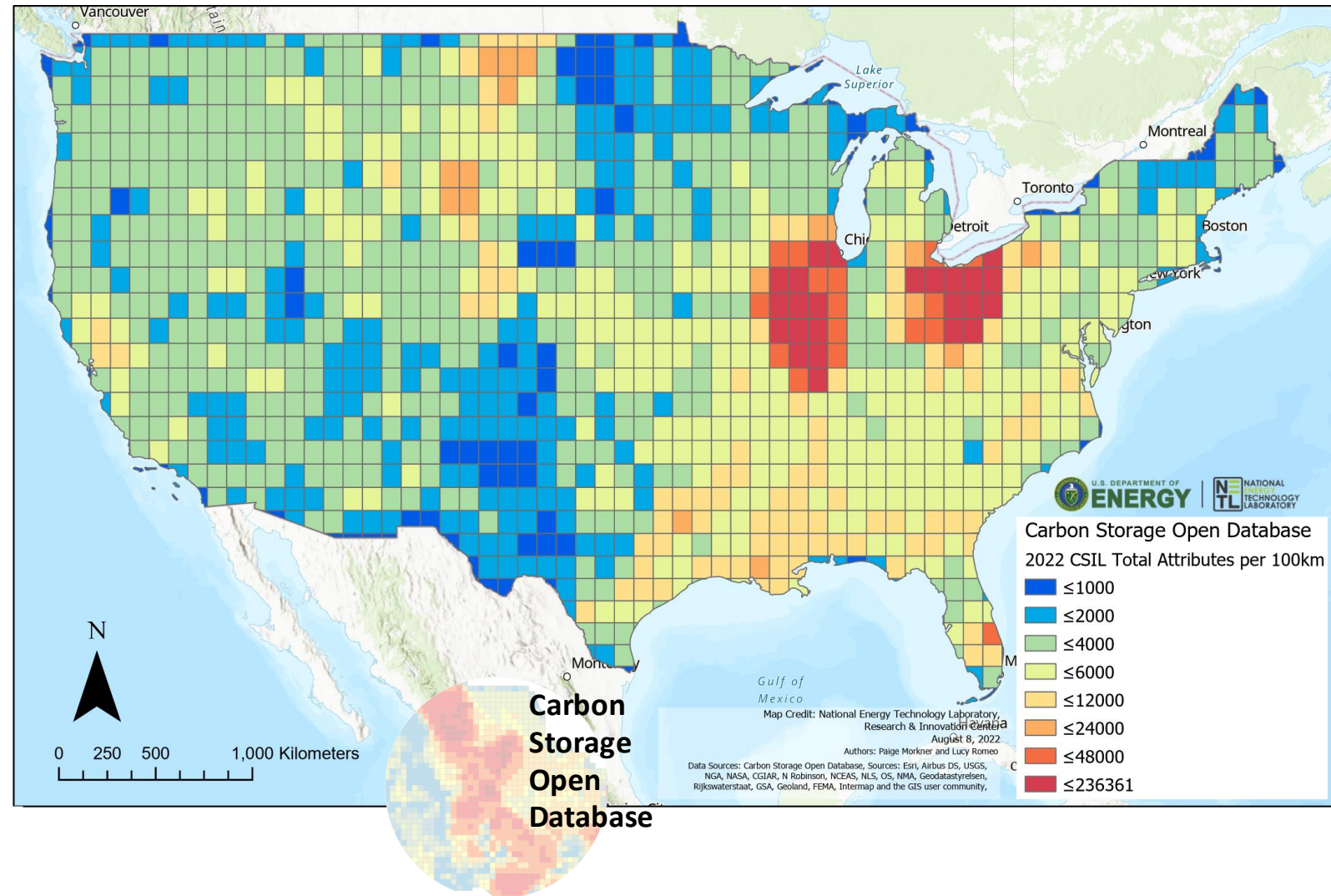- Groups on EDX also continue to grow as data is added by DOE-FECM CCS collaborators

- Data in GeoCube will be linked with the DisCO2ver platform planned through EDX4CCS FWP

Carbon Storage Open Database

Carbon Storage Open Database
2022 CSIL Total Attributes per 100km

- ≤1000
- ≤2000
- ≤4000
- ≤6000
- ≤12000
- ≤24000
- ≤48000
- ≤236361

Map Credit: National Energy Technology Laboratory, Research & Innovation Center
August 8, 2022
Authors: Paige Morkner and Lucy Romeo
Data Sources: Carbon Storage Open Database, Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community,

What's next: EDX4CCS

NETL SmartSearch
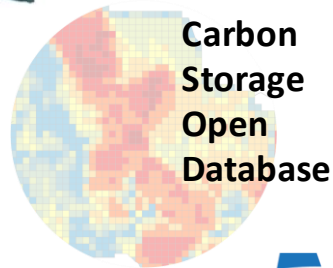
NETL SmartParse

GEO CUBE

EDX®

EDX4CCS

Data, Integration, generation, and deployment to feed SMART, NRAP, and regulatory models

Tools, Develop and/or integrate deployment of tools for data interaction and visualization, decision-support such as for pipelines, regulatory permitting, resource characterization, data visualization, and more

Core CCS EDX DisCO2ver platform, Broader community virtualized data computing platform and central EDX CCS data and tool hub

NatCarb — A National Look at Carbon Sequestration

CarbonSAFE Projects
- Pre-Feasibility
- Feasibility
- Site Characterization and CO2 Capture Assessment

Carbon Storage Open Database

SMART

NRAP National Risk Assessment Partnership

EDX.4CCS — Energy Data eXchange

U.S. DEPARTMENT OF ENERGY — Fossil Energy and Carbon Management

Resources

Contact:

Paige Morkner, Paige.Morkner@netl.doe.gov

Data resources and important URLs:

https://edx.netl.doe.gov/dataset/carbon-storage-open-database

https://edx.netl.doe.gov/dataset/geocube

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

Citations:
Baker, D.V., Rose, K., Bauer, J., and Rager, D., 2016, Computational Advances and Data Analytics to Reduce Subsurface Uncertainty https://www.onepetro.org/conference-paper/ARMA-2016-493, ARMA 16-493, June 26-29, 2016, 16 pgs.
Morkner, P., Bauer, J., Creason, C., Sabbatino, M., Wingo, P., Greenburg, R., Walker, S., Yeates, D., Rose, K. 2022. Distilling Data to Drive Carbon Storage Insights. Computers & Geosciences. https://doi.org/10.1016/j.cageo.2021.104945

NETL
Resources

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📷 **@NETL_DOE**

f **@NationalEnergyTechnologyLaboratory**

Organization Chart

Project Partners
DOE
NETL
RCSPs – Big Sky Carbon Sequestration Partnership, Southwest Partnership, Southeast Regional Carbon Sequestration Partnership, Midwest Regional Carbon Sequestration Partnership, Midwest Geological Sequestration Consortium, Plains CO2 Reduction Partnership
CarbonSAFE projects
SMART
National Risk Assessment Partnership

Lead Organization
NETL

Principal Investigators
Kelly Rose, Jennifer Bauer

Task 28
Curation of Carbon Storage R&D Products Through Advanced Data Computing Solutions

Lead: Jennifer Bauer
Team: Kelly Rose, Chad Rowan, Michael Sabbatino, Paige Morkner, Lucy Romeo, TJ Jones, Aaron Barkhurst, Vic Baker, and other Matric Software Engineers and Developers

Task 27.0
Next Generation Development, Deployment, and Modernization of Database, Tools, Online Viewer, and Atlas

Lead: Jennifer Bauer
Team: Kelly Rose, Paige Morkner, Michael Sabbatino, Patrick Wingo, Andrew Bean, Aaron Barkhurst, and other Matric Software Engineers and Developers

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Task 27.0: Project Timeline Overview

Natcarb - Next Generation Development, Deployment, and Modernization of Database, Tools, Online Viewer, and Atlas (PIs: Paige Morkner, Jennifer Bauer)
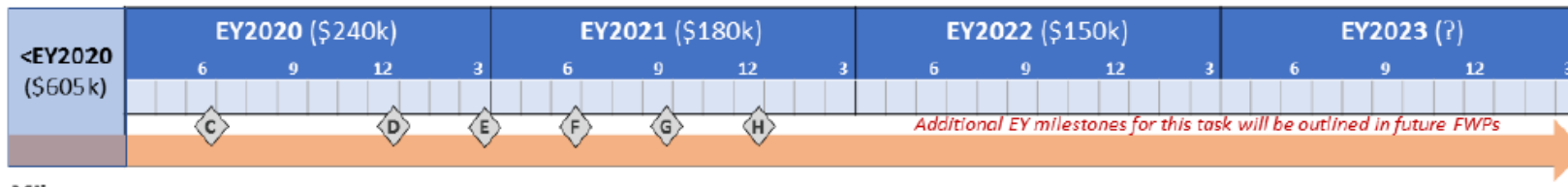
Milestones

Number	Expected Completion Date	Milestone Description
EY20.27.C	06/30/2020	Identify tools and models that will be targeted for integration and inclusion within the Natcarb Viewer.
EY20.27.D	12/31/2020	Outline report/manuscript on updated technical capabilities of Natcarb Viewer.
EY20.27.E	03/31/2021	Release update of Natcarb Viewer and Natcarb Database to EDX.
EY21.27.F	06/30/2021	Catalog additional datasets, models, and text-based resources on EDX for future integration into the Natcarb Viewer and GeoCube.
EY21.27.G	09/30/2021	Catalog datasets returned from SmartSearch results targeting known data gaps in existing Natcarb and Open Carbon Storage Databases.
EY21.27.H	12/31/2021	Document capabilities to be incorporated in advanced spatial search capability for discovering spatial data from EDX and GeoCube.

Chart Key
- ◇ Milestone
- ▮ Project Completion
- ▮ Go/No-Go Timeframe

Impact

Key Accomplishments/Deliverables	Value Delivered
• 2018, Enhanced interface and updates to Natcarb Viewer and release through EDX (Barkhurst et al., 2018; Bauer et al., 2018) • 2019, Integration of advanced data use tools in Natcarb Viewer & GeoCube to improve data access and use • 2020, Integration of open-source data to develop Open Carbon Storage Database (Morkner et al., 2020) • 2021, Manuscript detailing innovative data integration strategies used to aggregate Natcarb, RCSP, and open CS data sources (Morkner et al., in review) • 2022, Support updates to Natcarb database and CS estimates	• Produce a robust subsurface data framework that provides **improved data access, data discoverability, and ease of use within the CS community.** • Integrate **online, advanced analytics and models to help facilitate research** across the CS community. • Support development of content and materials for Carbon Storage Atlas updates.

* Task 27.0 is updating content into an existing tool with no development of a technology. Therefore, no TRL is assigned.