



ClaimMM

Data Infrastructure to Accelerate
Critical Minerals & Materials

Data Science & Innovation to Bridge the Digital Divide

Speaker: Kelly Rose,
Senior Fellow,
Computational Sciences & Engineering,
Research Innovation Center, NETL

4/2024



Digital Discovery is Accelerating...

Microsoft and OpenAI plan supercomputer project worth \$100 billion called 'Stargate,' report says

The U.S.-based data center would reportedly house a supercomputer made up of

By Britney Nguyen



Google's AI chief says the billions going into AI means a 'bunch of hype and maybe some grifting'

The money going into AI is distracting from the science and research its making possible, Google DeepMind CEO Demis Hassabis said

By Britney Nguyen Published 7 hours ago | Updated 7 hours ago



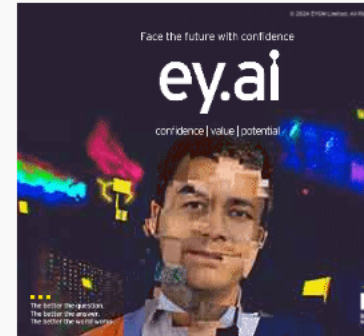
BARRON'S

Topics ▼ Stock Picks Lists & Rankings Magazine Data Advisor Penta

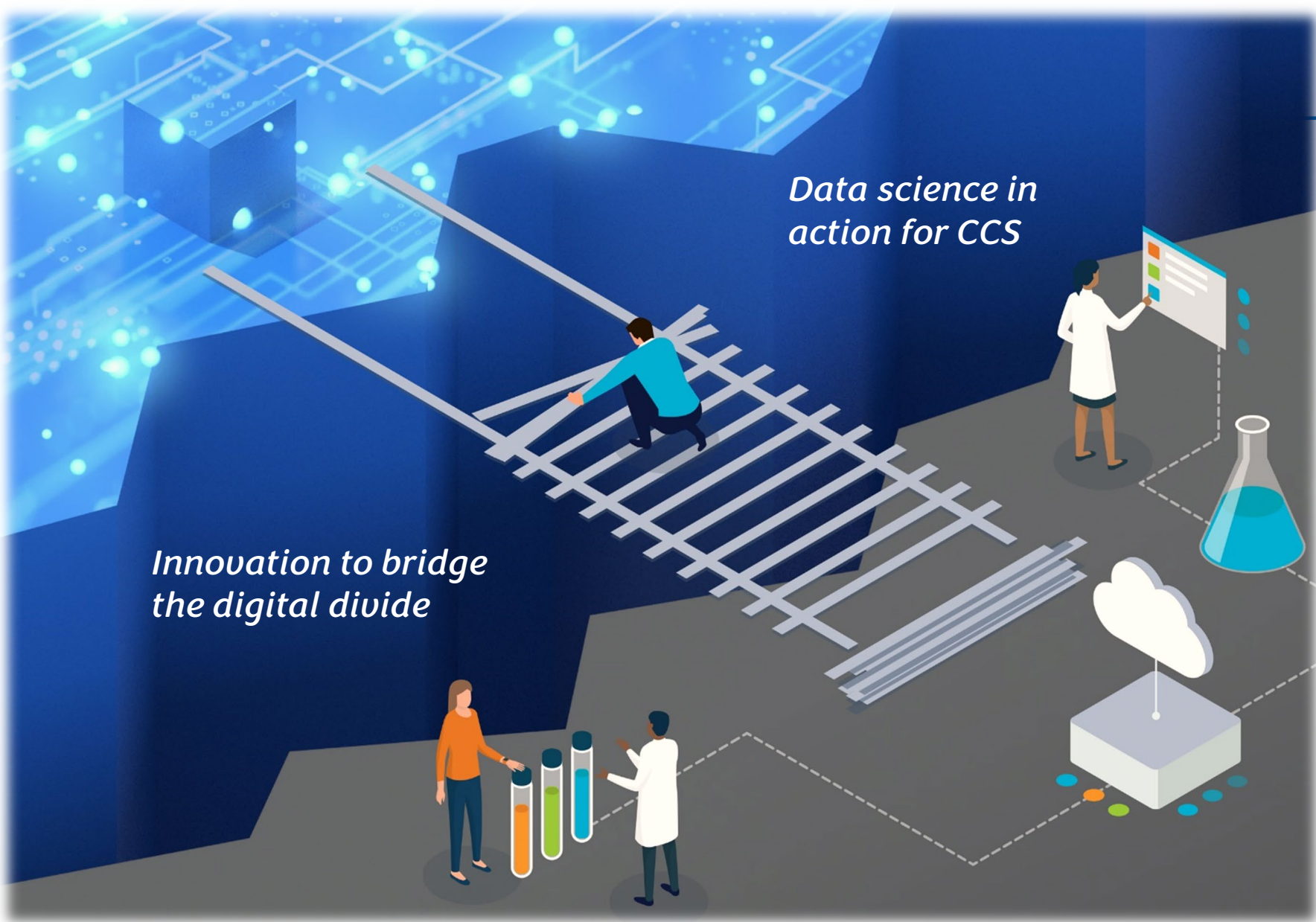
... Closed 'The Technology

... first great achievement of artificial intelligence, "making it far easier for the average person without deep technical skills.

... to be successful," Huang said during a press in San Jose on Tuesday. "You can just be a me she's prompt engineering me. It works prompt AIs ... everybody knows how to do that.



\$903.63 USD 0.07 0.01% ↑



Data science in action for CCS

Innovation to bridge the digital divide

...but complex systems require more

Critical Minerals & Materials Program

By 2035, enable unconventional and secondary sourcing for half of domestic REE/CM needs

- Demonstrate **sufficient resources** usable from domestic unconventional feedstocks
- Generate a **National Prospectus**
- Demonstrate economically competitive and environmentally **sustainable extraction and processing technologies**
- Support development of **sustainable international standards** for supply chains

Develop technologies for **value-added carbon** products

- Energy materials
- High value carbon products
- High volume carbon products

Unconventional & Secondary Sources

Coal Refuse Piles



Acid Mine Drainage & Sludge



Coal Combustion Residuals

Boiler Slag



Bottom Ash



Fly Ash



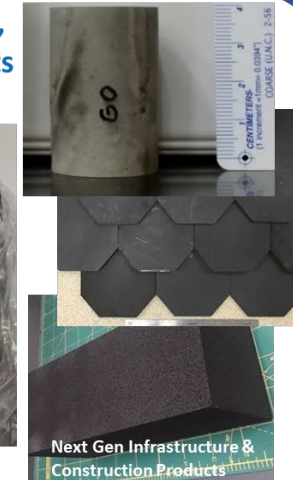
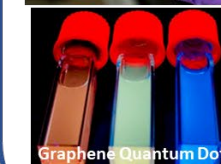
Produced Waters & Extracted Brines



Extraction, Separation, and Processing of REEs and Critical Minerals



Manufacturing of High Value, High Growth Carbon Products



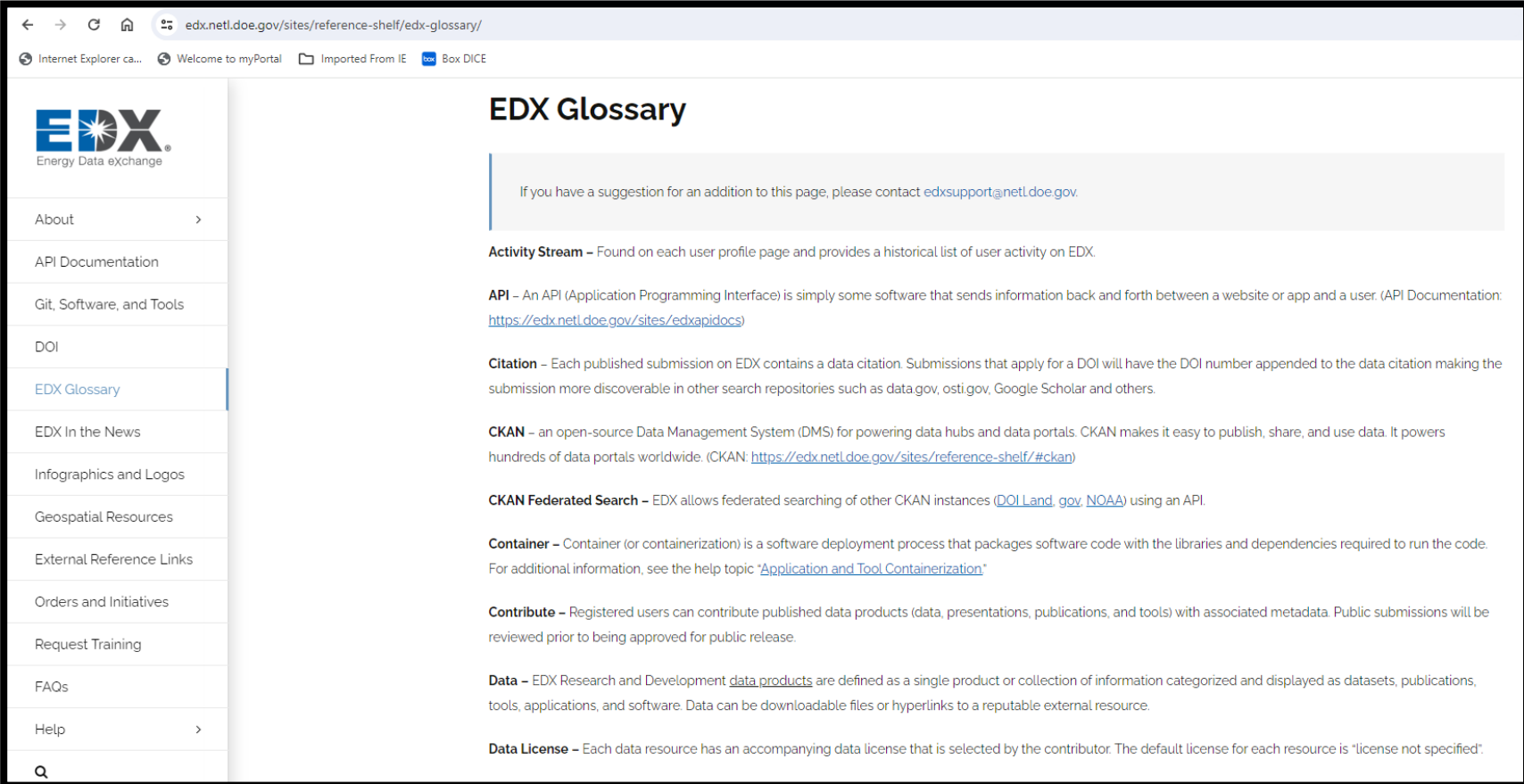
Data are the foundation for innovation

- Data-driven research projects are starved for information
 - Crowd Flower study estimates 80% of researcher project time is spent searching for relevant, existing data
<https://visit.figure-eight.com/2015-data-scientist-report>
- Opportunity to reduce researcher time parsing the digital "forest"
- Improve access to available data resources relevant for each project's need



What are “data”?

- “Essentially, any information that can be encoded into a format that a computer can read and manipulate can be considered data.”
 - [Gemini](#) 2024
- Data – data products are defined as a **single product or collection of information** categorized and displayed as **datasets, publications, tools, applications, and software**. Data can be downloadable files or hyperlinks to a reputable external resource.
 - [EDX](#)



The screenshot shows the EDX Glossary page on the website edx.netl.doe.gov/sites/reference-shelf/edx-glossary/. The page features a navigation menu on the left with the EDX logo and links to About, API Documentation, Git, Software, and Tools, DOI, EDX Glossary (highlighted), EDX In the News, Infographics and Logos, Geospatial Resources, External Reference Links, Orders and Initiatives, Request Training, FAQs, and Help. The main content area is titled "EDX Glossary" and includes a contact link for suggestions (edxsupport@netl.doe.gov). The glossary entries are:

- Activity Stream** – Found on each user profile page and provides a historical list of user activity on EDX.
- API** – An API (Application Programming Interface) is simply some software that sends information back and forth between a website or app and a user. (API Documentation: <https://edx.netl.doe.gov/sites/edxapidocs>)
- Citation** – Each published submission on EDX contains a data citation. Submissions that apply for a DOI will have the DOI number appended to the data citation making the submission more discoverable in other search repositories such as data.gov, osti.gov, Google Scholar and others.
- CKAN** – an open-source Data Management System (DMS) for powering data hubs and data portals. CKAN makes it easy to publish, share, and use data. It powers hundreds of data portals worldwide. (CKAN: <https://edx.netl.doe.gov/sites/reference-shelf/#ckan>)
- CKAN Federated Search** – EDX allows federated searching of other CKAN instances ([DOI Land.gov](#), [NOAA](#)) using an API.
- Container** – Container (or containerization) is a software deployment process that packages software code with the libraries and dependencies required to run the code. For additional information, see the help topic: ["Application and Tool Containerization"](#).
- Contribute** – Registered users can contribute published data products (data, presentations, publications, and tools) with associated metadata. Public submissions will be reviewed prior to being approved for public release.
- Data** – EDX Research and Development [data products](#) are defined as a single product or collection of information categorized and displayed as datasets, publications, tools, applications, and software. Data can be downloadable files or hyperlinks to a reputable external resource.
- Data License** – Each data resource has an accompanying data license that is selected by the contributor. The default license for each resource is "license not specified".

The Carbon Storage & Transport Community's Impact....

A decade of DOE FECM CTS Program Product Curation & Digitalization

2015

2016

2017

2018

2019

2020

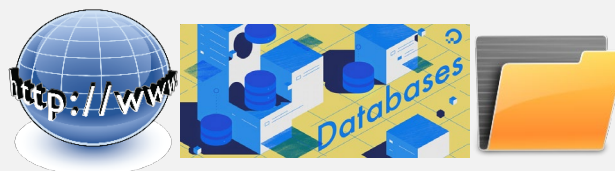
2021

2022+

2015 DOE Program managers initiated requirements to contribute & curate CS data products from CS program in EDX

 **NETL SmartSearch** automates data discovery using AI/ML by ...

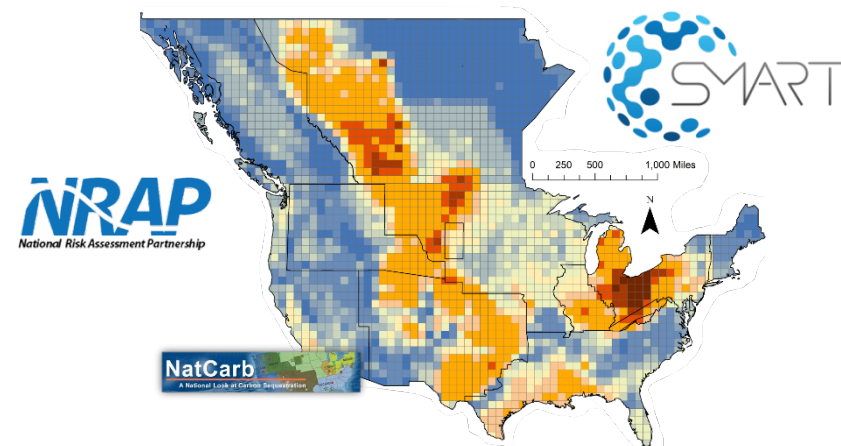
- 1) Analyzing content you like
- 2) Finding new, targeted content



2023 DOE Public Access Plan requires agency-wide 2022 EO compliance
2022 ASFECM requires R&D product preservation



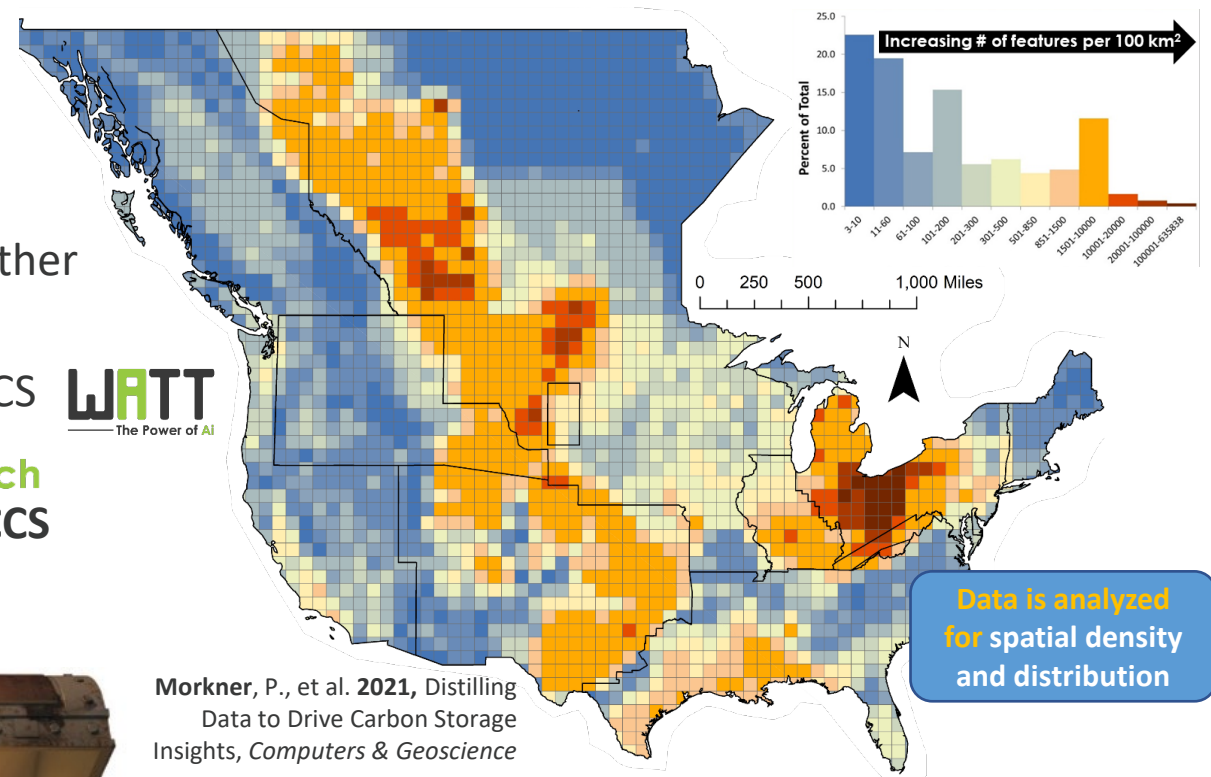
- **Expanded** to more FECM/NETL R&D projects and programs
- EDX used by each CS Program extramural team (>**50 individual Private Workspaces**)
- NETL geo-data science and EDX teams launched development of **AI and data-science enhanced efforts to acquire, tag, organize, refine, and improve virtualization** of CS-program products as they were accumulating



DOE's FECM has Invested in Creating a Carbon Storage Digital Resource-base

Need to advance for democratized use & useability

- **PB** of carbon storage data preserved using the public and private sides of EDX
- Curating access to **downloadable instances** of NRAP and other CS Program **models & tools**
- **Developed custom, AI/ML/NLP enhanced tools** to drive CCS data discovery and knowledge extraction
- **Enabling** geospatial data and CS web mapping for select CCS resources to date



*limitation of these data resources & capabilities...
... still largely require the end-user to have access to the right expertise and computational resources to put them to use...*

Taking the data pieces, putting the puzzle together

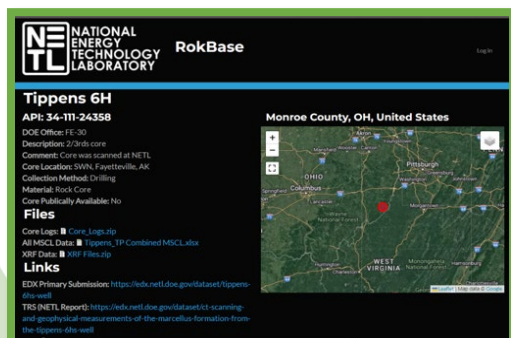


Source: Gemini



Source: Gemini

DOE FECM's Carbon Management Digital Products to Date



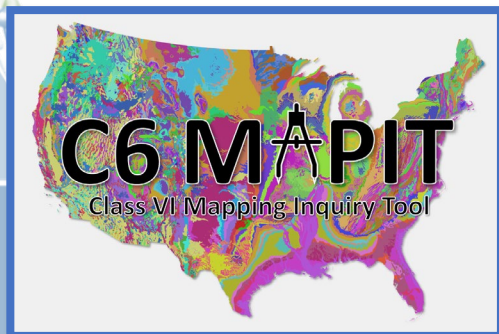
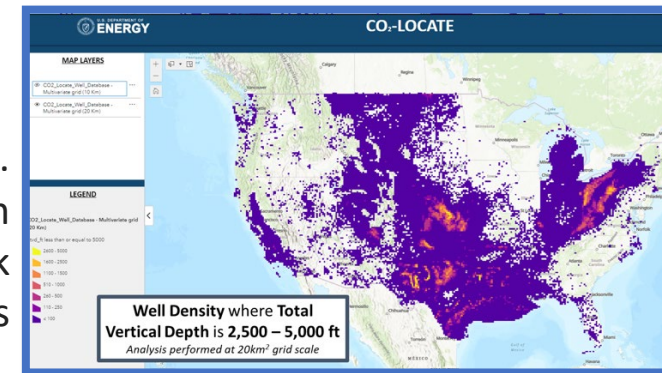
RokBase

A virtual portal and tool for users to explore and query **CS core and rock property data tool**

CO₂-Locate Database

National Well Database

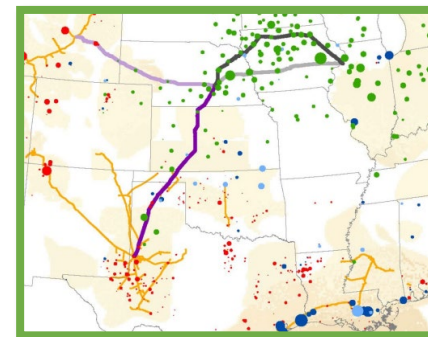
Leveraging **Class II Well data** to inform potential reuse, site selection, risk analysis and other stakeholder needs



Class VI Map It Tool

Geodatabase of spatial data

layers to support the initial development of Underground Injection Control (UIC) Class VI permits



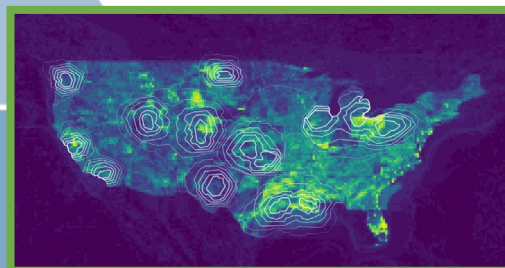
CCS Pipeline Route Planning Database

>90 gigabytes of data aligned to **critical features needed to evaluate routing of CCS pipelines** and transport of CO₂

CS Technical Viability Database V1

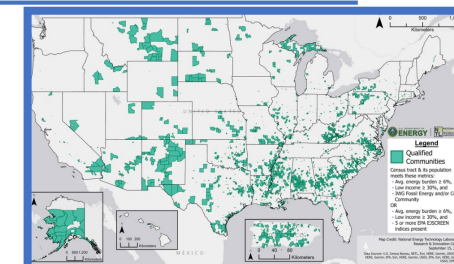
Geodatabase of key public data needed to completed TV evaluations

Includes geologic, geophysical, structural, hydrologic, energy extraction, transportation infrastructure, political boundaries, community and environmental data

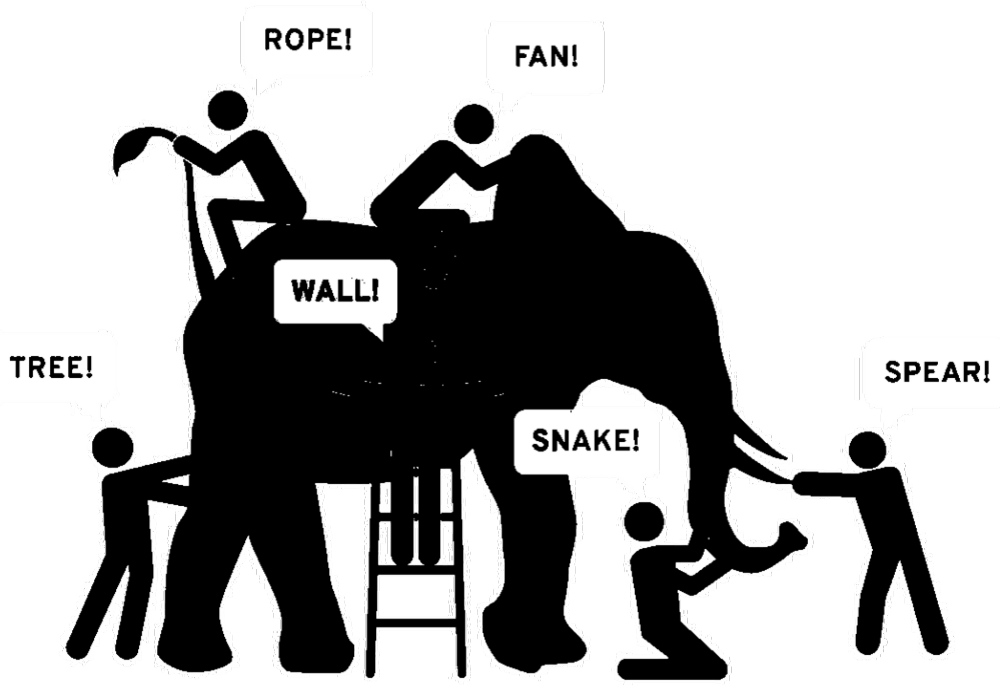
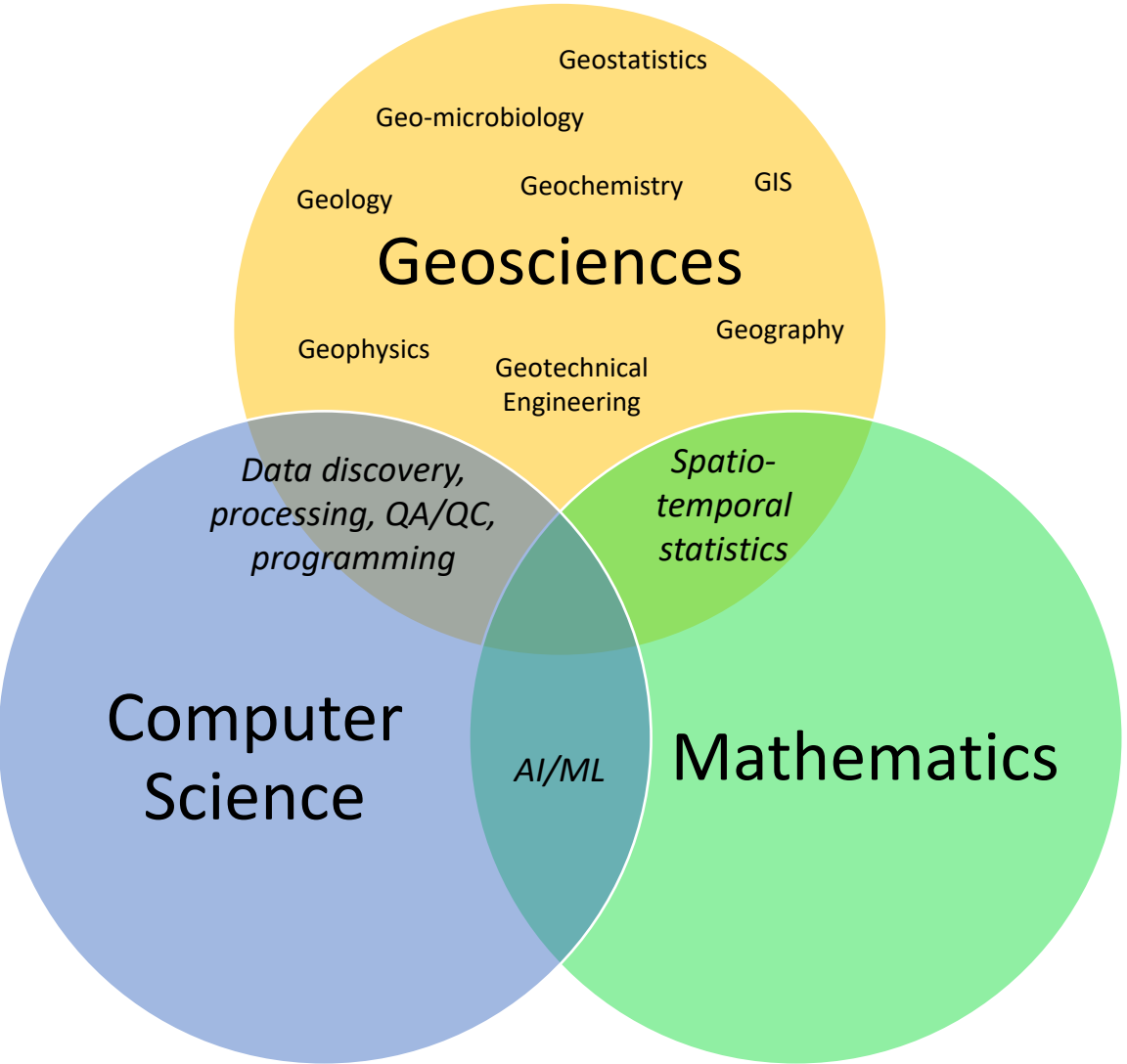


CCS EJ-SJ Database

Social and environmental justice database aligned to carbon storage systems



Leveraging geo-data science to do more

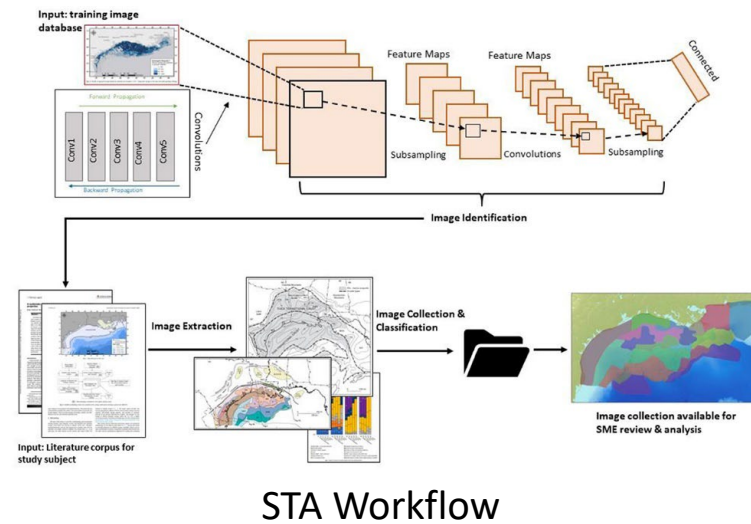


Using data to enable science-based predictions to improve our understanding of the whole

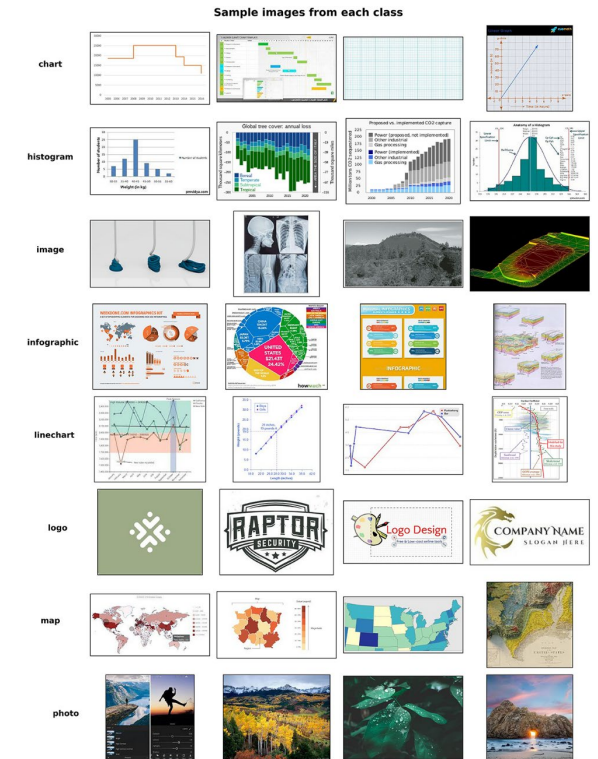
AI to Improve Subsurface Property Predictions

Deep learning approach to support subsurface modeling predictions.

- NETL advanced the subsurface trend analysis (STA) workflow with an AI-informed image segmentation/embedding model.
- The STA method was created to be a **foundational** technology, capable of assisting any subsurface predictive need.
- The [image embedding tool](#) uses **convolutional neural networks (CNNs)** to:
 - Extract images from unstructured data
 - Categorically label the images
 - Create a repository for geologic domain postulation
- A case study on data available for the Gulf of Mexico shows the STA image embedding tool extracts and accurately labels images with **90% to 95% precision**.
- The [STA 2D Tool](#) is available on NETL's Energy Data eXchange® ([EDX](#)).



Hoover B, Zaengle D, Mark-Moser M, Wingo P, Suhag A and Rose K (2023) Enhancing knowledge discovery from unstructured data using a deep learning approach to support subsurface modeling predictions. *Front. Big Data* 6:1227189. doi:10.3389/fdata.2023.1227189



Visualization of multi-category training data for STA image embedding tool.

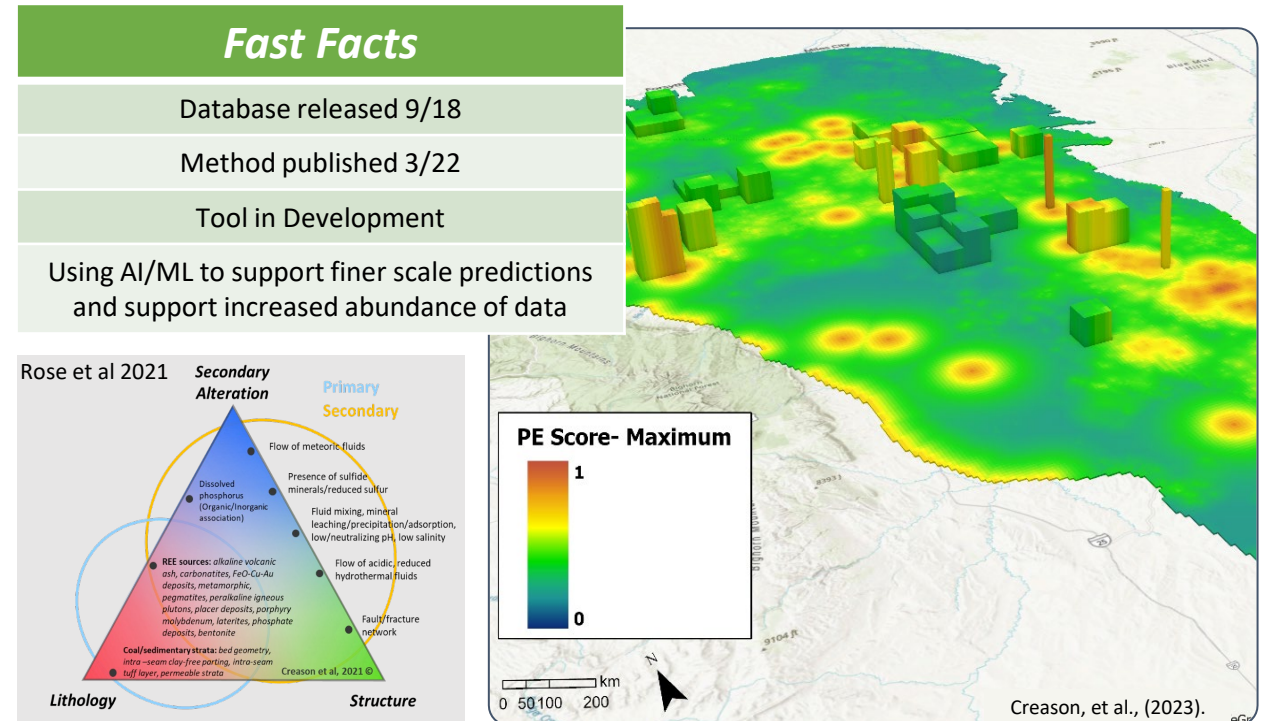
AI for Natural resources forecasting & modeling

Federated-AI modeling for improving discovery of domestic critical mineral deposits

- NETL's geologic resource assessment [AI Model](#) helped uncover **the largest unconventional deposit of magnetic rare earth elements (REE) in the U.S.**
- The AI model** was tested at a coal mine in Wyoming's Powder River Basin and revealed the **largest unconventional deposit of magnetic REEs discovered in the US.**
 - [Featured in the Wall Street Journal - WSJ](#)
 - Also featured in energy trade journal, [JPT](#)
- In the last year, NETL has released [five, peer-reviewed, data-driven products](#) that help characterize unconventional critical minerals

Try the Database: [REE and Coal Open Geodatabase - Submissions - EDX \(doe.gov\)](#)

Read more about the URC Method: [A Geo-Data Science Method for Assessing Unconventional Rare-Earth Element Resources in Sedimentary Systems - Submissions - EDX \(doe.gov\)](#)



Also used for Groundwater, Carbon Storage, H₂, hydrocarbons, geothermal and more



Creason, C.G., Justman, D., Rose, K., Montross, S., Bean, A., Mark-Moser, M., Wingo, P., Sabbatino, M., Thomas, R.B., 2023. A Geo-Data Science Method for Assessing Unconventional Rare-Earth Element Resources in Sedimentary Systems. Nat Resour Res. <https://doi.org/10.1007/s11053-023-10163-x>

Supply chain spatio-temporal forecasting & modeling

Big data & AI to support supply chain optimization & decisions

This **valuable online tool** enables the recovery of high-value carbon and critical minerals from U.S. mining and industrial waste streams needed to **support innovative manufacturing while lowering environmental footprint** of using domestic resources.

Justman, et al. (2022). A database and framework for carbon ore resources and associated supply chain data. *Data in Brief*. <https://doi.org/10.1016/j.dib.2021.107761>

Try the Platform Here: [Carbon Ore Resources Database \(CORD\) - Submissions - EDX \(doe.gov\)](#)

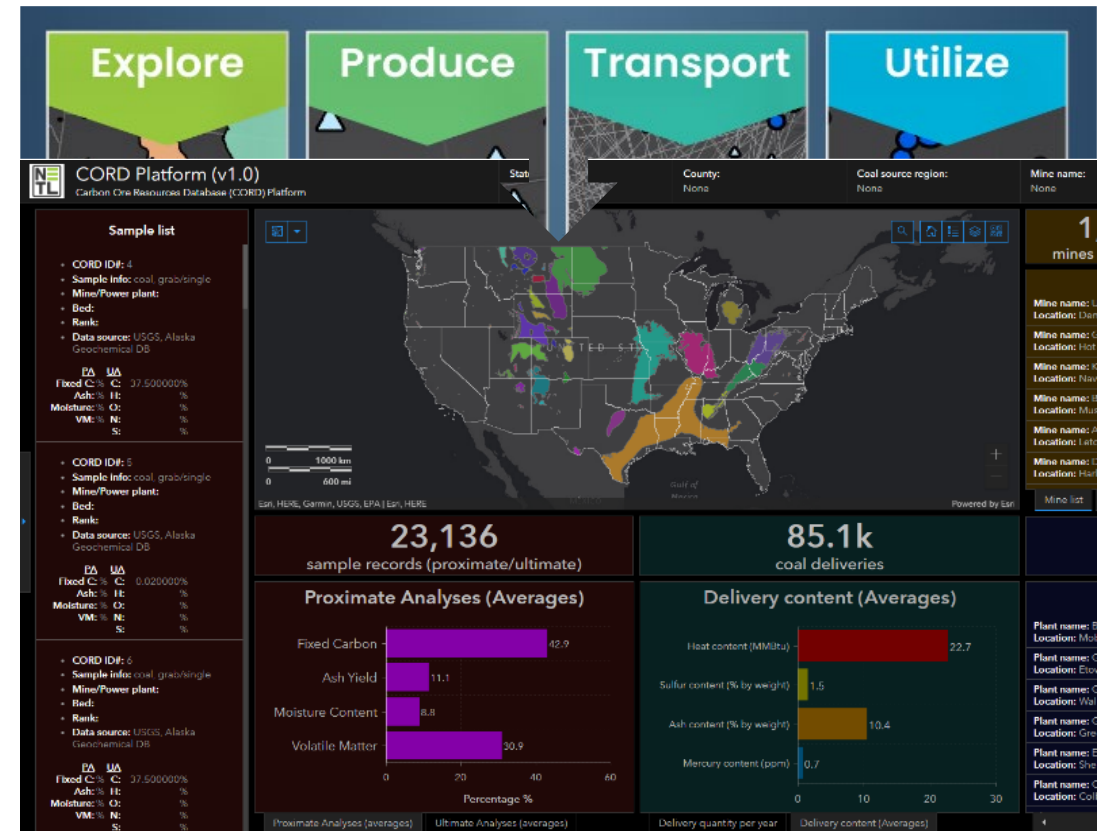
Fast Facts

Database and Platform released 8/21

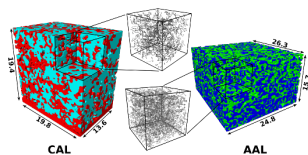
Enables users to interact and query select CORD datasets.

Collection of spatial and non-spatial data

399+ data files associated with carbon ore resources in the US

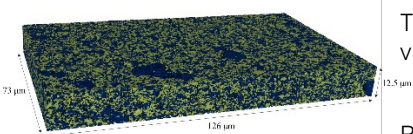


AI-Enhanced Microstructural Analysis, Simulation, and Optimization for Electrochemical Device Electrodes



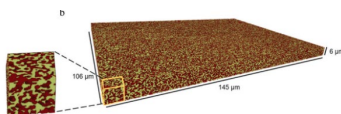
W.K. Epting et al., JACerS v100 pg 2232 (2017)

- Computer vision provides a rapid pathway from physical electrode to microstructural parameters



T. Hsu et al., JPS v386 pg 1 (2018)

- Deep neural networks provide analysis from microstructural parameters to predict long-term performance metrics



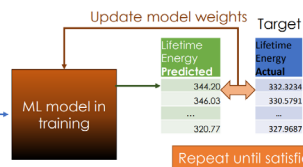
R. Mahbub et al., JECS v167 pg 54506 (2020)

R. Mahbub et al., JPS v498 pg 229846 (2021)

- Connecting the two will produce a rapid electrode assessment tool

Training dataset

Feature	0	1	2	3
pf1	0.230061	0.23864	0.239156	0.239156
pf2ratio	0.709111	0.814911	0.868857	0.868857
diag1	0.363655	0.372662	0.37007	0.416845
diag2	0.385066	0.40092	0.416845	0.416845
diag3	0.413405	0.459561	0.525972	0.525972
rad1	0.138111	0.141968	0.139824	0.139824
rad2	0.130301	0.144869	0.143958	0.143958
rad3	0.148107	0.168732	0.204666	0.204666
hf1	0.000676	0.000379	0.000674	0.000674
hf2	0.000648	0.000861	0.000811	0.000811
hf3	0.000678	0.000708	0.000945	0.000945

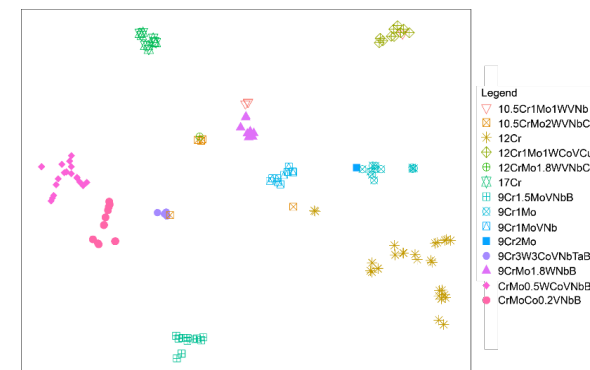


NETL researchers have used EDX® to publicly release **the largest known bank of 3D electrode microstructures** of solid oxide fuel and electrolysis cells (SOCs) for training ML tools.

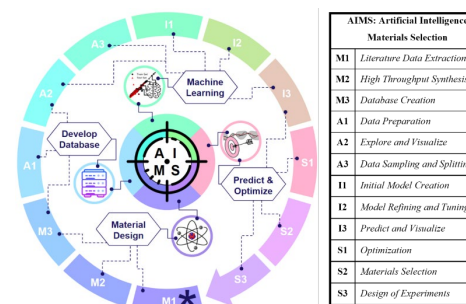
To access the SOC Synthetic Microstructure Bank: [SOC Synthetic Microstructure Bank - Submissions - EDX \(doe.gov\)](https://www.doe.gov/soc-smb)

Machine learning prediction and outlier detection for alloy development and AI for alloy discovery

- Clustering: assessing trends in materials data
- Integrating domain knowledge into analysis
- Assessing outliers to the dataset



Wenzlick, M., et al. *J of Mat Eng and Perf*, 2021. <https://doi.org/10.1007/s11665-020-05340-5>



AIMS: Artificial Intelligence Materials Selection	
M1	Literature Data Extraction
M2	High Throughput Synthesis
M3	Database Creation
A1	Data Preparation
A2	Explore and Visualize
A3	Data Sampling and Splitting
I1	Initial Model Creation
I2	Model Refining and Tuning
I3	Predict and Visualize
S1	Optimization
S2	Materials Selection
S3	Design of Experiments

The [Artificial Intelligence Materials Selection Framework](https://doi.org/10.1016/j.actamat.2022.117751) is used to develop a high-quality database for compositions, processing, and test parameters for various responses of alloys, as well as predict optimized materials for multi-objective problems. <https://doi.org/10.1016/j.actamat.2022.117751>

Building the CMM digital “library”

Ask for support edxsupport@netl.doe.gov



Your data-driven journey begins with that first step...

Paraphrasing M. Angelou

How has NETL addressed R&D data needs?

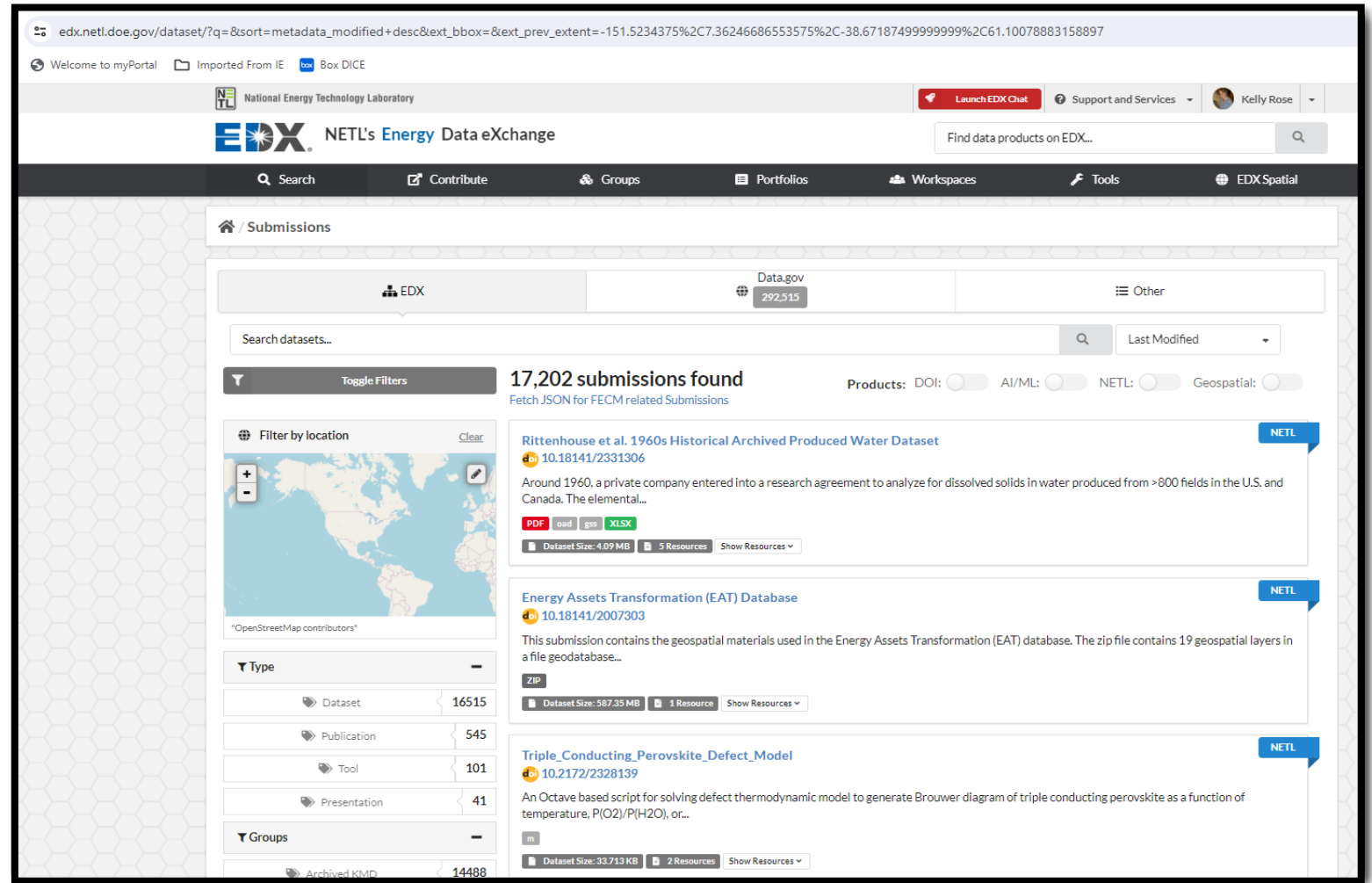
FECM's foundational R&D digital infrastructure & AI test bed

2021 U.S. DOE, Secretary of Energy's Achievement Award winner



Energy Data eXchange

a web-hosted, virtual library and laboratory that supports the NETL/FECM community



v.1 2012

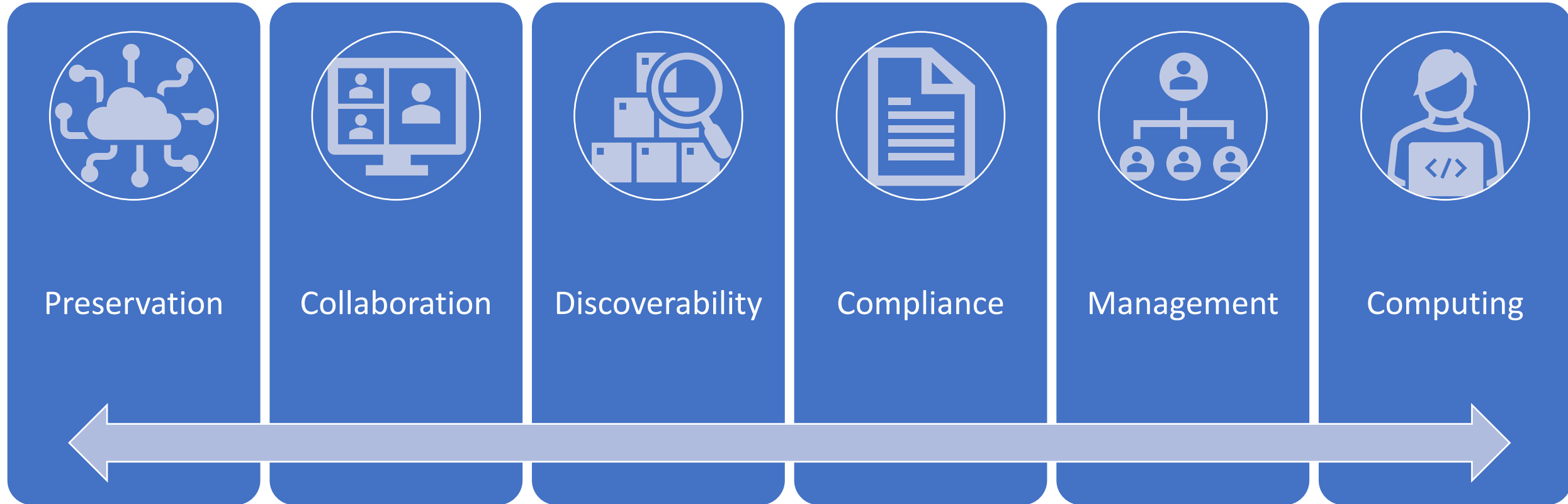
12+ years

EDX++ v.4 2024



<https://edx.netl.doe.gov/reference-shelf>

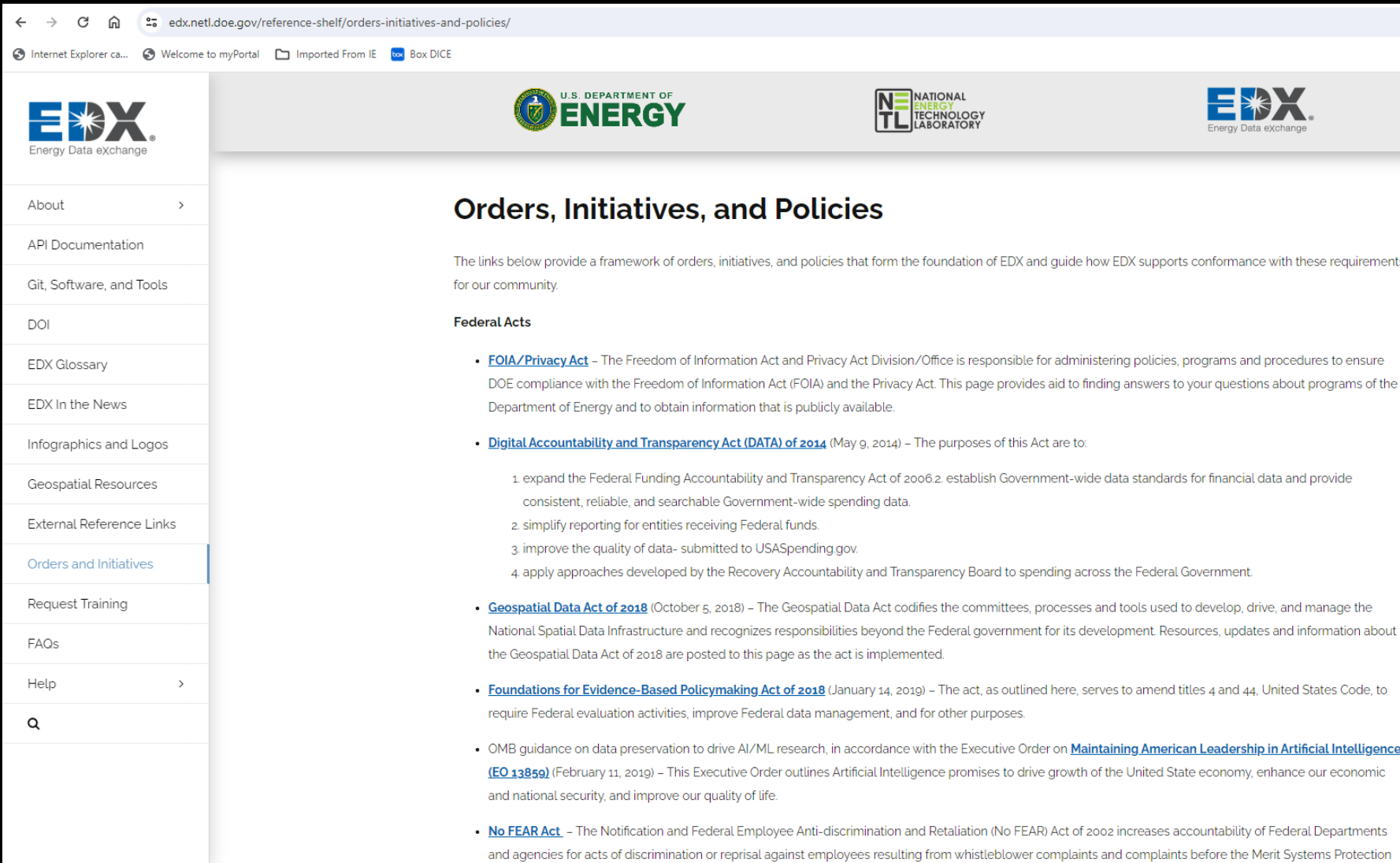
How is EDX currently supporting its community?



NETL/FECM has invested in EDX to serve the FECM community as a virtual data library and laboratory

Complying with Federal Requirements....

<https://edx.netl.doe.gov/reference-shelf/orders-initiatives-and-policies/>



The screenshot shows a web browser window displaying the EDX website. The browser's address bar shows the URL edx.netl.doe.gov/reference-shelf/orders-initiatives-and-policies/. The page header includes the U.S. Department of Energy logo, the NETL logo, and the EDX logo. A left-hand navigation menu lists various categories, with 'Orders and Initiatives' highlighted. The main content area is titled 'Orders, Initiatives, and Policies' and contains an introductory paragraph followed by a section on 'Federal Acts' with a bulleted list of relevant legislation.

Orders, Initiatives, and Policies

The links below provide a framework of orders, initiatives, and policies that form the foundation of EDX and guide how EDX supports conformance with these requirements for our community.

Federal Acts

- [FOIA/Privacy Act](#) – The Freedom of Information Act and Privacy Act Division/Office is responsible for administering policies, programs and procedures to ensure DOE compliance with the Freedom of Information Act (FOIA) and the Privacy Act. This page provides aid to finding answers to your questions about programs of the Department of Energy and to obtain information that is publicly available.
- [Digital Accountability and Transparency Act \(DATA\) of 2014](#) (May 9, 2014) – The purposes of this Act are to:
 1. expand the Federal Funding Accountability and Transparency Act of 2006.
 2. establish Government-wide data standards for financial data and provide consistent, reliable, and searchable Government-wide spending data.
 3. simplify reporting for entities receiving Federal funds.
 3. improve the quality of data- submitted to USASpending.gov.
 4. apply approaches developed by the Recovery Accountability and Transparency Board to spending across the Federal Government.
- [Geospatial Data Act of 2018](#) (October 5, 2018) – The Geospatial Data Act codifies the committees, processes and tools used to develop, drive, and manage the National Spatial Data Infrastructure and recognizes responsibilities beyond the Federal government for its development. Resources, updates and information about the Geospatial Data Act of 2018 are posted to this page as the act is implemented.
- [Foundations for Evidence-Based Policymaking Act of 2018](#) (January 14, 2019) – The act, as outlined here, serves to amend titles 4 and 44, United States Code, to require Federal evaluation activities, improve Federal data management, and for other purposes.
- OMB guidance on data preservation to drive AI/ML research, in accordance with the Executive Order on [Maintaining American Leadership in Artificial Intelligence \(EO 13859\)](#) (February 11, 2019) – This Executive Order outlines Artificial Intelligence promises to drive growth of the United State economy, enhance our economic and national security, and improve our quality of life.
- [No FEAR Act](#) – The Notification and Federal Employee Anti-discrimination and Retaliation (No FEAR) Act of 2002 increases accountability of Federal Departments and agencies for acts of discrimination or reprisal against employees resulting from whistleblower complaints and complaints before the Merit Systems Protection

EO on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence



Date signed: October 30, 2023

- To govern the development and use of AI safely and responsibly, through a coordinated, Federal Government-wide approach to doing so.
- The rapid speed at which AI capabilities are advancing compels the United States to lead for the sake of security, economy, and society.
- Ensure AI is safe and secure through robust, reliable, repeatable and standardized evaluations
- Promote responsible innovation, competition, and collaboration
- AI policies consistent with equity and civil rights
- Protect privacy

Full text of the [Executive Order](#)



EDX++ v4, a multi-cloud solution, connecting data with compute

Freedom for users to use current cloud service providers

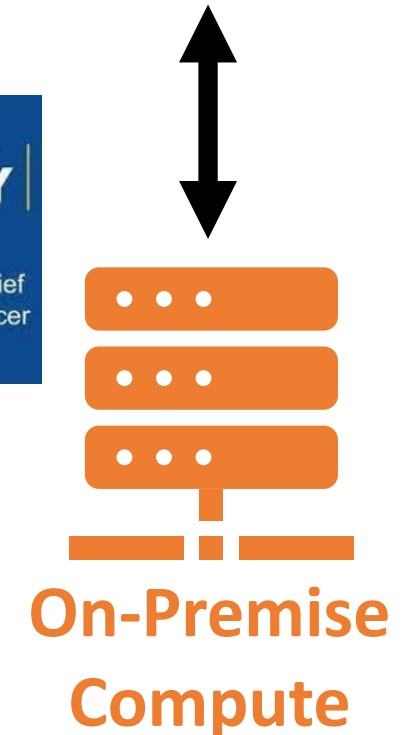
- Utilize APIs to compute, transfer data
- Enabling advanced computing resources for AI and data science
- Connecting EDX with on-premises HPC and advanced compute

Improves flexibility and performance

- Does not limit users to one storage & compute platform
- Compute occurs at the data source
- Right compute solution for the need

Resilience

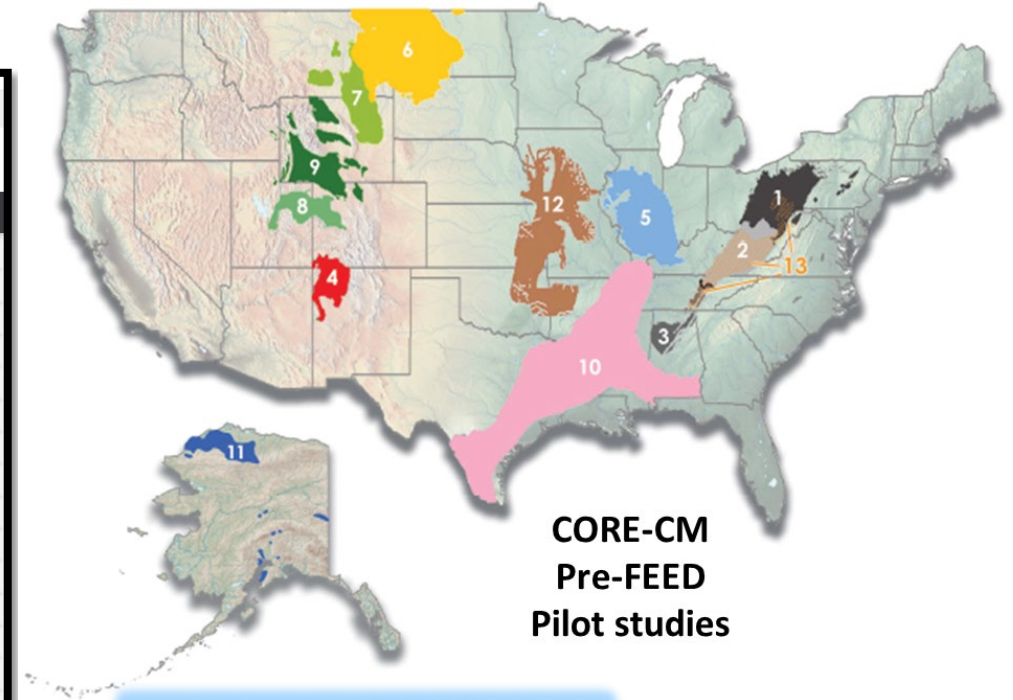
- Redundancy across multiple regions
- Strategic alignment for data transfer and compute across multiple cloud service providers
- GOGO, NETL partnership with DOE OCIO for enterprise Cloud deployment



Building up the CMM data foundation

Your digital publications matter

The screenshot shows the EDX (National Energy Technology Laboratory's Energy Data eXchange) website interface. At the top, there's a search bar with the text "Find data products on EDX...". Below the search bar, there are navigation tabs: Search, Contribute, Groups, Portfolios, Workspaces, Tools, and EDX Spatial. The main content area is titled "Datasets" and features a "Websites to Search" section. This section includes a list of checked search engines: BOEM, BSEE, EIA, NOAA, NETL, NASA, USGS, and PHMSA. A search box contains the query "critical minerals" and shows "About 48,900 results (0.25 seconds)". Below the search box, there are several search results from the U.S. Geological Survey (USGS) regarding critical minerals, including a 2022 list, offshore resources, and a 2018 list of 35 critical minerals.



www.nature.com/scientificdata

<https://www.nature.com/articles/s41597-023-02491-7>













scientific **data**

 Check for updates

OPEN

COMMENT

Journal Production Guidance for Software and Data Citations

Shelley Stall¹  , Geoffrey Bilder², Matthew Cannon³ , Neil Chue Hong⁴ ,
Scott Edmunds⁵ , Christopher C. Erdmann⁶ , Michael Evans⁷, Rosemary Farmer⁸,
Patricia Feeney², Michael Friedman⁹ , Matthew Giampoala¹, R. Brooks Hanson¹,
Melissa Harrison¹⁰, Dimitris Karaiskos¹¹, Daniel S. Katz¹² , Viviana Letizia¹³, Vincent Lizzi³,
Catriona MacCallum¹⁴, August Muench¹⁵, Kate Perry⁸, Howard Ratner¹⁶ , Uwe Schindler¹⁷ ,
Brian Sedora¹ , Martina Stockhause¹⁸ , Randy Townsend¹⁹, Jake Yeston²⁰ & Timothy Clark²¹ 

Software and data citation are emerging best practices in scholarly communication. This article provides structured guidance to the academic publishing community on how to implement software and data citation in publishing workflows. These best practices support the verifiability and reproducibility of academic and scientific results, sharing and reuse of valuable data and software tools, and attribution to the creators of the software and data. While data citation is increasingly well-established, software citation is rapidly maturing. Software is now recognized as a key research result and resource, requiring the same level of

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National Critical Minerals Data Dashboard

DOI: 10.18141/1962402

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The Critical Minerals (CM) Data Dashboard provides data-driven insights to help unlock the potential of conventional and unconventional CM resources in the United States. The dashboard focuses on 12 CM essential for producing zero-emission transportation and clean power technology. More information about these CM and potential resources is available in our CM Story Map. Dashboard data sets can be filtered geographically using the options provided along the top of the dashboard. Data sets can also be filtered by various attributes using the options in the expandable side panel on the left side of the screen. The data sets in this dashboard were compiled from multiple sources including the USGS, USEPA, OSMRE, DHS, and EarthJustice. Users are encouraged to provide feedback/suggestions on the function and content of the dashboard, as well as any issues that may arise.

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Data and Resources

Filter resources by name...

Date: Newest → Oldest

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National Critical Minerals Data Dashboard

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Many journals require models, tools and data be publicly available prior to journal publication.



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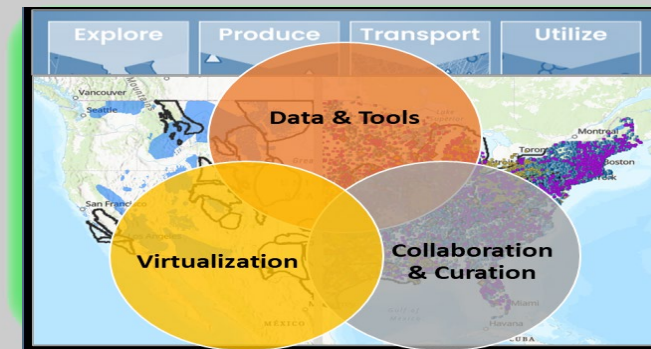
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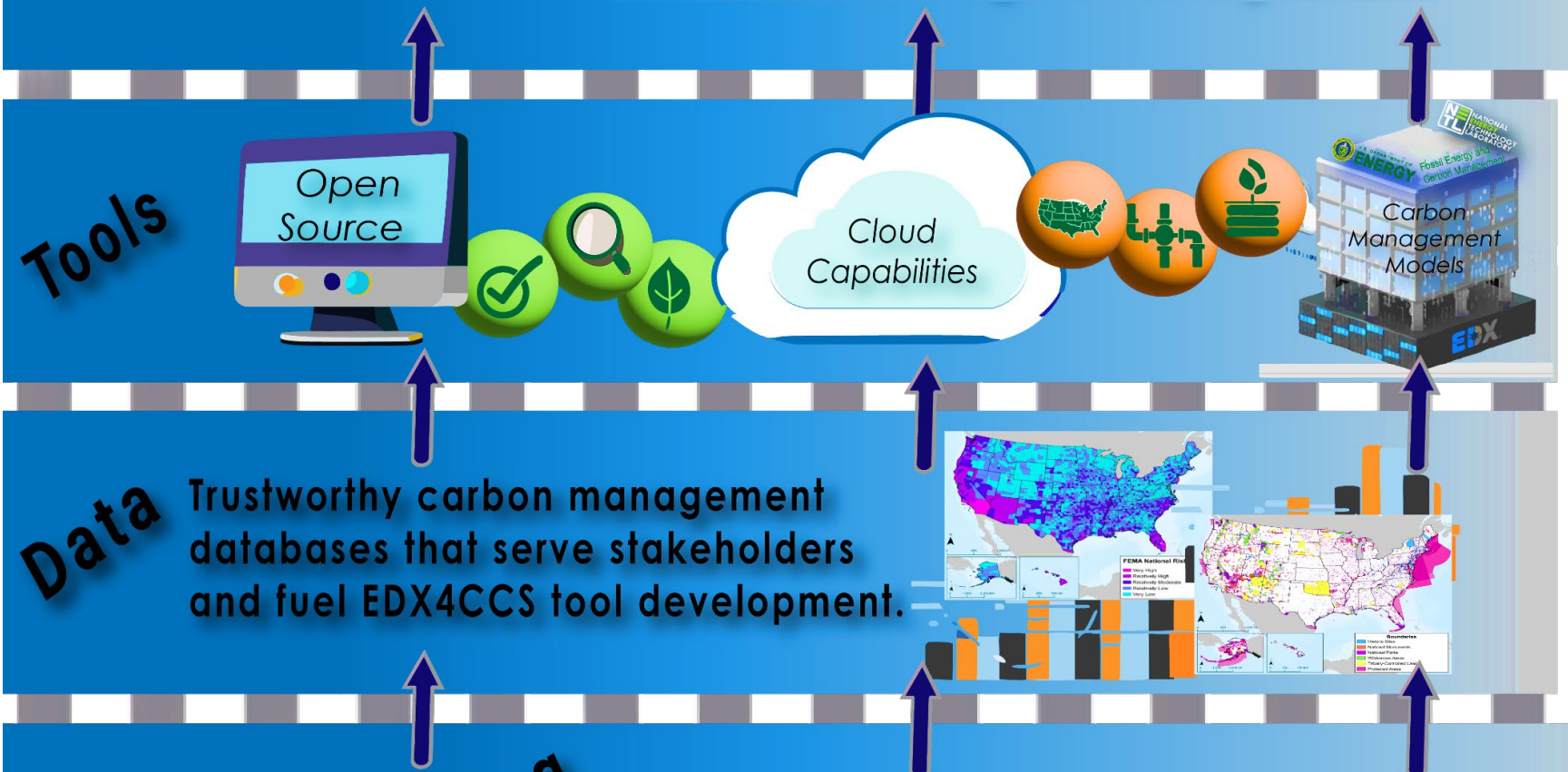
Building an Integrated Critical Minerals & Materials Management System



A platform connecting stakeholders to informative critical M & M products including datasets, tools, publications and other resources from FECM/NETL and beyond.



Our team is amplifying stakeholder communications and outreach efforts to increase product usage and develop a cohesive integration between these portfolios.



Data Trustworthy carbon management databases that serve stakeholders and fuel EDX4CCS tool development.

Tools

Enabling System

User-friendly digital platform enabling easy access of carbon management resources from EDX4CCS, other NETL portfolios and beyond.



EDX ClaiMM Platform

Digital Infrastructure for the **Critical Minerals & Materials Community (CMM)**

- Developing the **Alpha** version of the platform
- Front end user interface hosted by EDX, connecting users to digital CMM resources
- Enables users to search and download for data, tools, models hosted on EDX ClaiMM
- Interact with NETL developed web applications
 - Dashboards, story maps, web maps, data services, etc.

EDX ClaiMM

Welcome to EDX ClaiMM:
The Energy Data eXchange Critical Minerals & Materials platform
Digital resources for the Critical Minerals & Materials community

Search for data resources

Jump to: Data | Tools | Reports & Papers | Submit Feedback

Explore data by category

Geochemistry CM Mines & Deposits Carbon Ore Geology & Geography

Tools & Applications

Unlocking the Potential of Unconventional Critical Mineral Resources
Provides context and understanding of unconventional critical mineral resource potential.
Explore

National Critical Minerals Data Dashboard
Data-driven insights to help unlock the potential of CM resources in the U.S.
Explore

CORD Platform
The CORD (Carbon Ore Resources Database) Platform is a dashboard web application that enables users to interact and query select CORD datasets.
Explore

NEWTS Database Dashboard (beta version)
The National Energy Water Treatment and Speciation database dashboard.
Explore

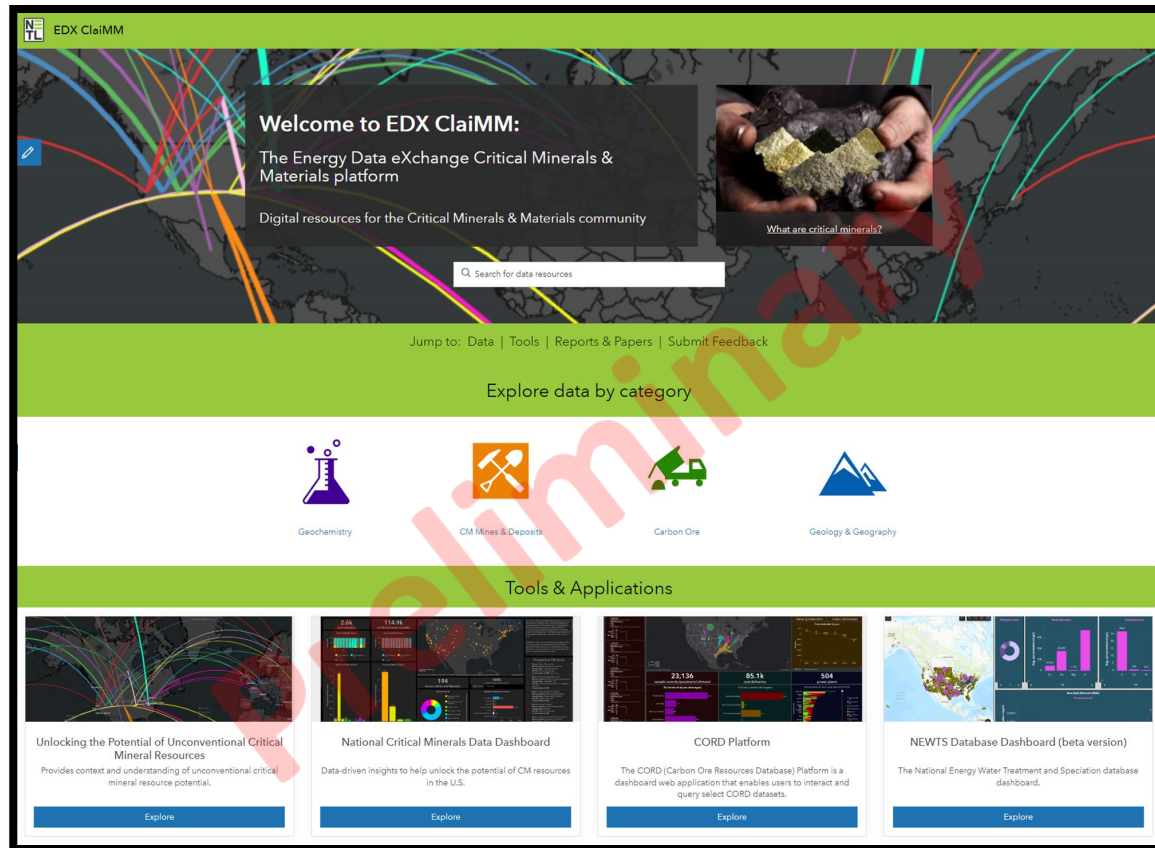
EDX ClaiMM Alpha version is progress

EDX ClaiMM Platform

Digital Resources for the Critical Minerals & Materials Community (CMM)



Next steps



EDX ClaiMM Alpha version is progress

Coming soon (2024):

EDX ClaiMM Alpha Website

- Continue incorporating key datasets and resources
- Website hosting **CMM specific data, tools, and resources** for internal testing

Longer term:

EDX ClaiMM Beta Platform (July 2024)

- Continue incorporating key datasets and resources and improving site layout
- Release beta version for outside stakeholder testing

EDX ClaiMM (Version 1) Platform (March 2025)

- Implement updates based on feedback from stakeholders
- Public release of version 1

EDX ClaiMM Related Tool Demos

1. EDX ClaiMM: The Energy Data eXchange Critical Minerals & Materials Platform (FWP-1022420)
 1. Presenter: Devin Justman, National Energy Technology Laboratory
2. Energy Data Exchange (EDX) new cloud system
 1. Presenter: Kevin Kuhn, National Energy Technology Laboratory
3. RokBase (FWP-1025007)
 1. Presenter: Dustin Crandall and Tom Paronish, National Energy Technology Laboratory
4. NEWTS Database and Dashboard Demo (FWP-1022428)
 1. Presenters: Nicholas Siefert and Rachel Yesenchak, National Energy Technology Laboratory
5. Advanced Infrastructure Integrity Model (AIIM)
 1. Presenter: Lucy Romeo, National Energy Technology Laboratory
6. Unconventional Rare-Earth and Critical Mineral (URC) Assessment Method
 1. Presenter: C. Gabriel Creason, National Energy Technology Laboratory
7. Critical Minerals & Materials Matchmaker (CM3)
 1. Presenters: Jennifer Bauer and Neyda Maymi, National Energy Technology Laboratory

Poster Session /
Interactive Demos /
Reception –

BALLROOM FOYER
Wednesday
4/3/2024

5:00 p.m. – 6:30 p.m.

Stop by the **EDX/SAMI booth**
for more information, tools,
and resources



Citations

Select Pubs, Data, Tools



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Building the CMM digital “library”

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Your data-driven journey begins with that first step...

Paraphrasing M. Angelou

Acknowledgments



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