



*Increasing Carbon Transport & Storage Product Awareness
and Understanding Through Stakeholder Engagement*



Disclaimer & Acknowledgements

This work was funded by the United States Department of Energy, National Energy Technology Laboratory, in part, through a site support contract. Neither the United States Government nor any agency thereof, nor any of their employees, nor the support contractor, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Acknowledgements: This work was performed in support of the U.S. Department of Energy's Fossil Energy and Carbon Management's Carbon Storage Program and executed through the National Energy Technology Laboratory (NETL) Research & Innovation Center's EDX4CCS (DOE FE 1025007) Bipartisan Infrastructure Act (BIL) funded FWP.

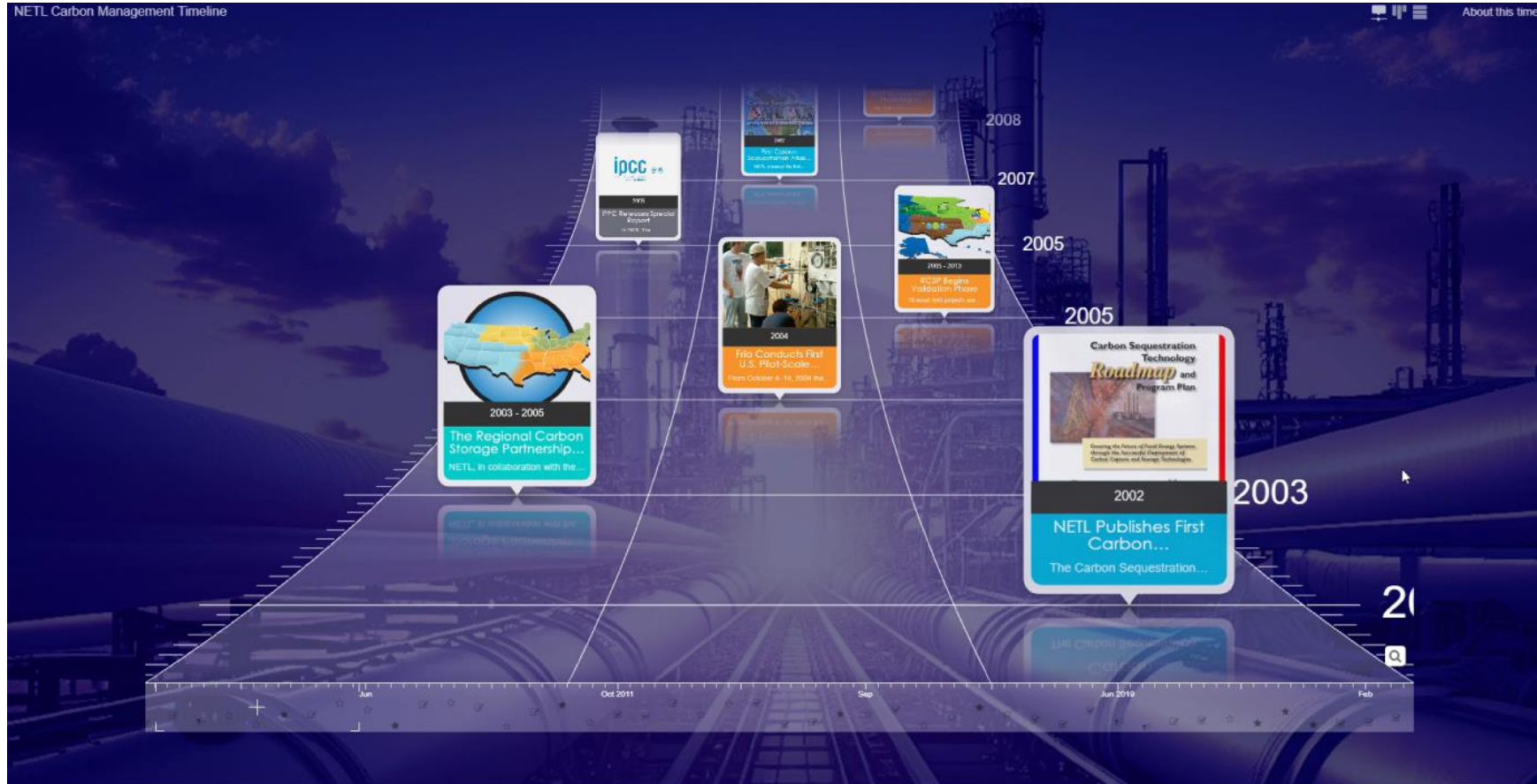
Almost 30 years of DOE Carbon Storage & Transport R&D



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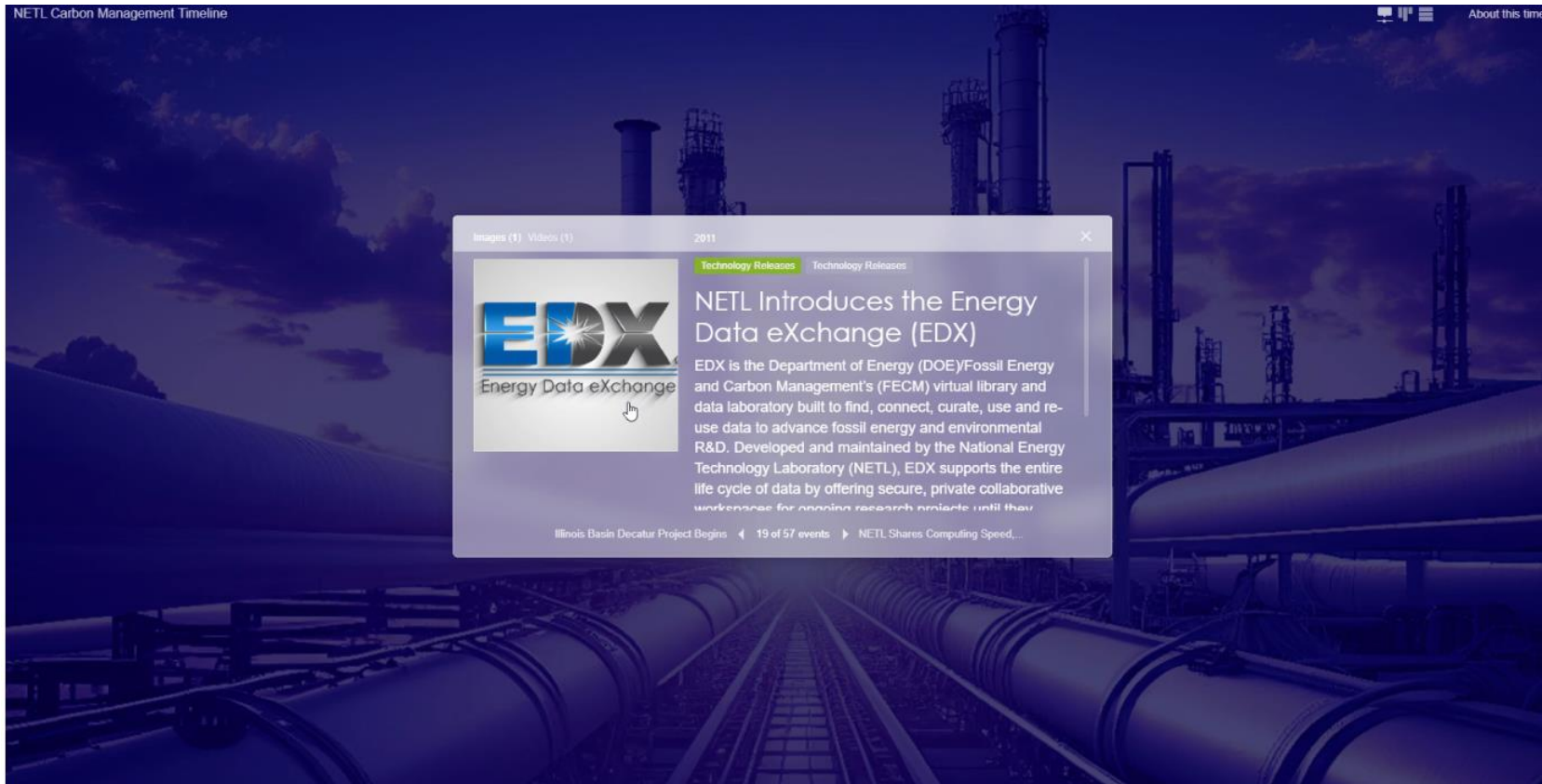


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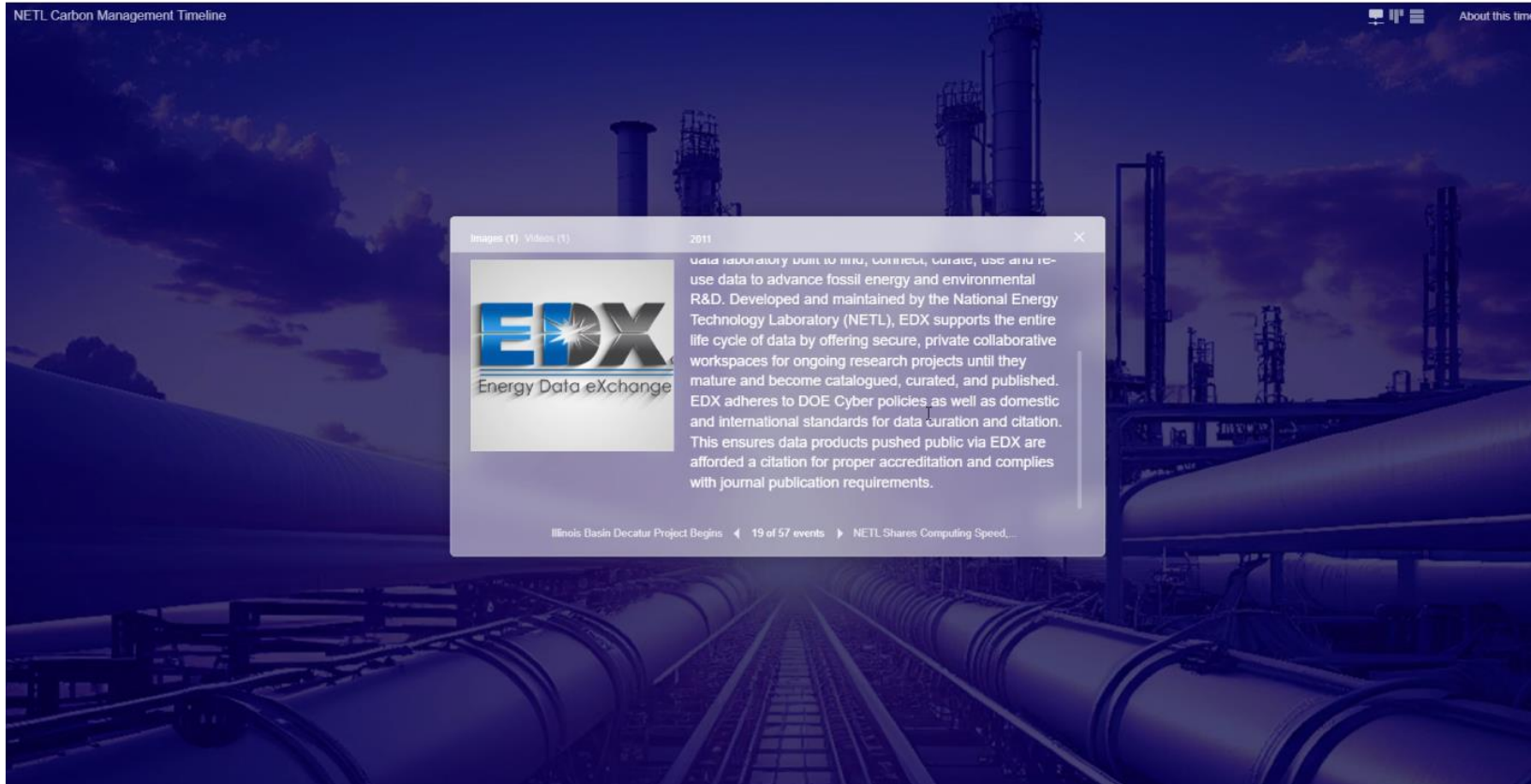
Almost 30 years of DOE Carbon Storage & Transport R&D

1997... 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024+



Almost 30 years of DOE Carbon Storage & Transport R&D

1997... 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024+



Almost 30 years of DOE Carbon Storage & Transport R&D

1997... 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024+



Almost 30 years of DOE Carbon Storage & Transport R&D



NETL Carbon Management Timeline

2012

Images (1)



One of the world's fastest supercomputers was installed at the Office of Fossil Energy's (FE) National Energy Technology Laboratory's (NETL) Simulation-Based Engineering User Center to help develop solutions to carbon capture, utilization, and storage technology barriers. Researchers from partnering organizations, such as the members of the NETL-Regional University Alliance (NETL-RUA) are able to access the supercomputer via NETL's user centers in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania.

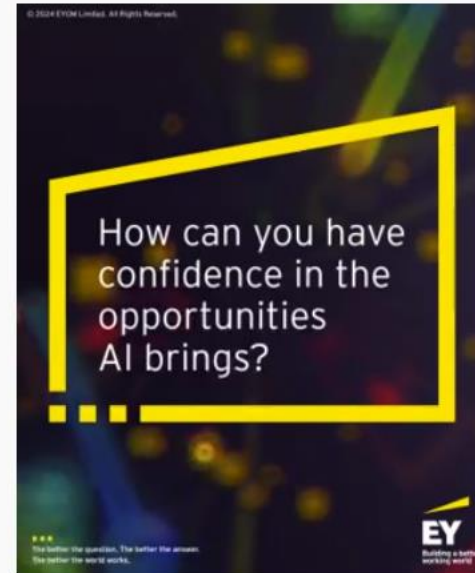
NETL Introduces the Energy Data... 20 of 57 events Version 4 of the Carbon Storage Atlas...

Digital Discovery is Accelerating... and yet...

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 millions of AI chips

By Britney Nguyen Published Friday 4:17PM



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By Britney Nguyen Published Friday 4:17PM



BARRON'S

Topics ▾ Stock Picks Lists & Rankings Magazine Data Advisor Penta

< Live Coverage Feed

13 days ago ★

Nvidia CEO Says AI Has Closed 'The Technology Divide'

By Eric J. Savitz

Nvidia CEO Jensen Huang said that the first great achievement of artificial intelligence software is to "close the technology divide," making it far easier for the average person to tap the power of advanced computing without deep technical skills.

"You don't have to be a C++ programmer to be successful," Huang said during a press conference at the company's GTC event in San Jose on Tuesday. "You can just be a prompt engineer. When my wife talks to me she's prompt engineering me. It works perfectly ... We all need to know how to prompt AIs ... everybody knows how to do that. It's closed the technology divide."

NVIDIA Corp. NVDA (U.S.: Nasdaq)

\$903.63 USD 0.07 0.01% ↑

Digital Discovery is Accelerating... and yet...

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.

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\$903.63 USD 0.07 0.01% ↑

Digital Discovery is Accelerating... and yet...



**It's not
magic...
It takes
expertise
to enact**

Microsoft and OpenAI plan supercomputer worth \$100 billion

The U.S.-based data center

By Britney Nguyen

Google
mea

The r
Deep

By Britne

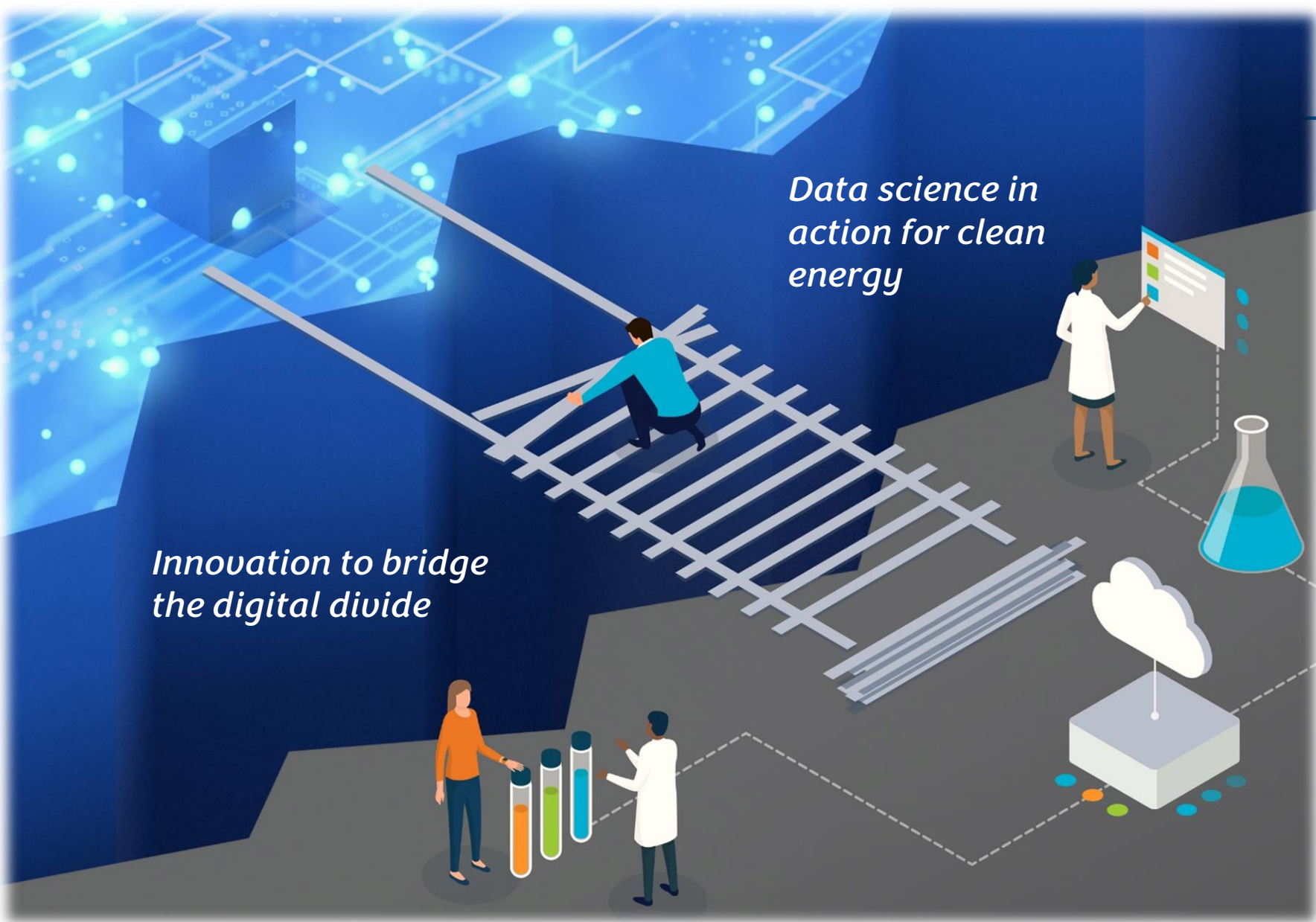
Advisor Penta

Technology

of artificial intelligence
for the average person
skills.

g said during a press
You can just be a
ering me. It works
knows how to do that.

3.63 USD 0.07 0.01%



Data science in action for clean energy

Innovation to bridge the digital divide

... & complex systems require more

<https://www.energy.gov/sites/default/files/2021-12/FECM%20Infrastructure%20Factsheet.pdf>

THE INFRASTRUCTURE INVESTMENT AND JOBS ACT:

Opportunities to Accelerate Deployment in Fossil Energy and Carbon Management Activities

The Infrastructure Investment and Jobs Act, also known as the Bipartisan Infrastructure Law, is a long-overdue investment in the United States' infrastructure, workers, families and competitiveness.

The infrastructure deal [includes more than \\$62 billion for the U.S. Department of Energy \(DOE\)](#) to deliver a more equitable clean energy future for the American people by investing in American manufacturing and workers; expanding access to energy efficiency and clean energy for families, communities and businesses; delivering reliable, clean and affordable power to more Americans; and building the technologies of tomorrow through clean energy demonstrations. It also specifically includes historic investments in carbon management, both to mitigate and remove carbon dioxide (CO₂) emissions.

CARBON DIOXIDE UTILIZATION AND STORAGE

*Carbon Storage Validation and Testing:
\$2.5 billion*

For FYs 2022-2026, DOE is allocated \$2.5 billion to develop new or expanded large-scale commercial carbon sequestration projects and supporting transport infrastructure. These projects will prioritize commercial capacity development and the ability to support storage from multiple carbon capture facilities—enhancing FECM's efforts to ensure long-term reliable storage for captured CO₂. Commercial CO₂ storage is critical both for CO₂ mitigation and CO₂ removal.

Basic Science R&D

Increases the knowledge base of a field of research while applied science uses that knowledge to solve specific problems.

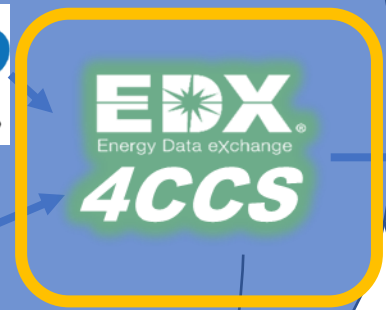
Applied Science R&D

The discipline dealing with the art or science of applying scientific knowledge to practical problems

Actionable Science R&D

Defined as science delivered to a decision-maker that is timely...and meaningful—in terms of safety, economics, health, welfare, security, or any other values that matter to society.
-National Academies of Sciences

Commercial & Regulatory Applications



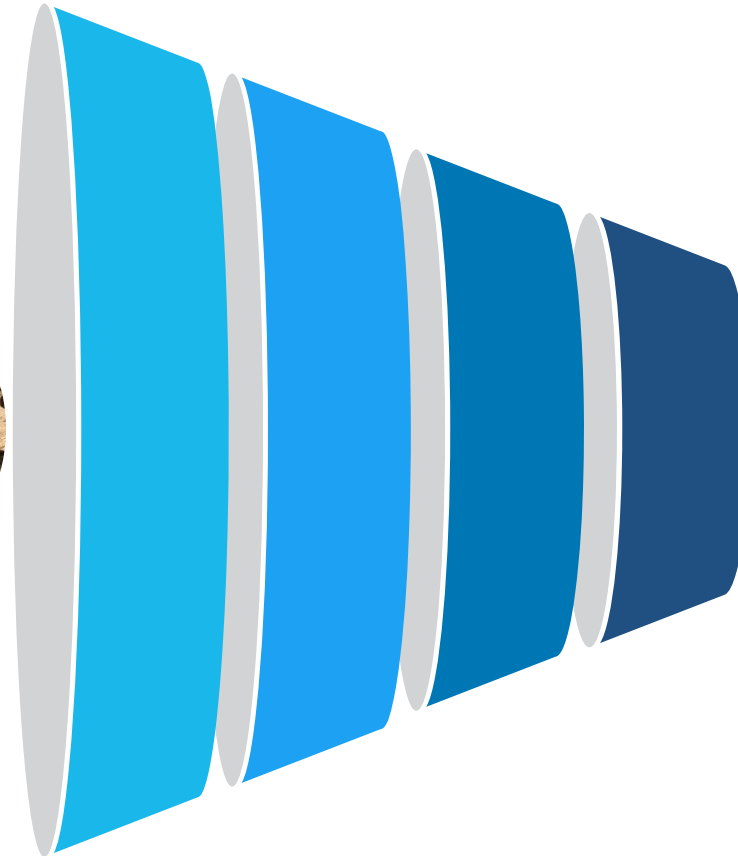
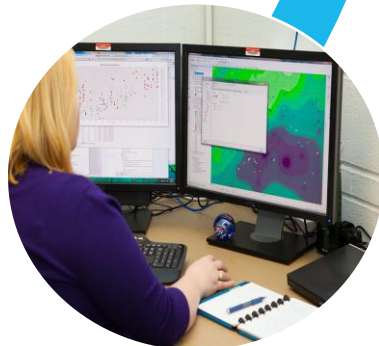
Lab Work



Field Work



Modeling & Simulation



**Accelerating
Our Digital
Future**

A History of DOE Program Product Curation & Digitalization

DOE Carbon Storage



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

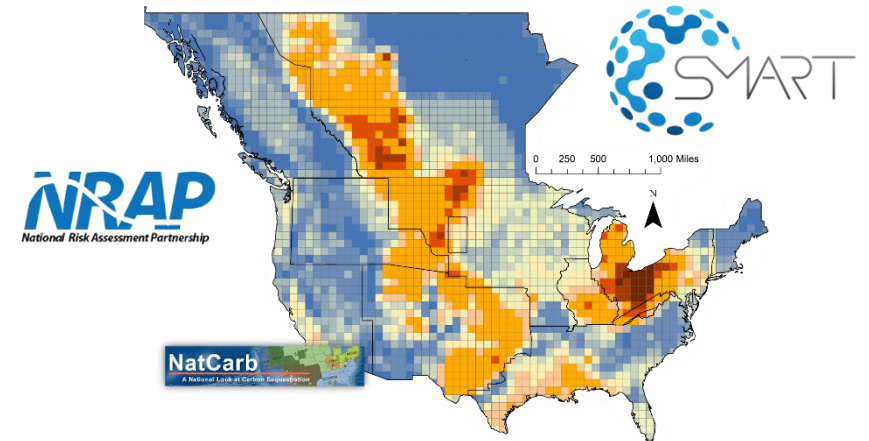
2024 EDX is optimizing access to >3500 CTS community digital assets

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**)



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

A screenshot of the EDX website interface. The browser address bar shows 'edx.netl.doe.gov/dataset/?q=&sort=metadata_modified+desc&ext_bbox=&ext_prev_extent=-151.5234375%2C7.36246686553575%2C-38.671874999999999%2C61.10078883158897'. The page header includes 'National Energy Technology Laboratory' and 'NETL's Energy Data eXchange'. A search bar contains 'Find data products on EDX...'. Below the header, there are navigation tabs for 'Submissions', 'Data.gov', and 'Other'. A search bar shows 'Search datasets...' and 'Last Modified'. A 'Toggle Filters' button is visible. The main content area displays '17,202 submissions found' and lists several datasets, including 'Rittenhouse et al. 1960s Historical Archived Produced Water Dataset', 'Energy Assets Transformation (EAT) Database', and 'Triple_Conducting_Perovskite_Defect_Model'. Each dataset entry includes a title, ID, description, and download options.

v.1 2012

12+ years


EDX++ v.4 2024



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

EDX Features and Key Elements Recap

- An enterprise scale, R&D data curation & collaboration **multi-cloud system, v4 deployed March 2024**
- **Initiated and in use since in 2011**
- Built to provide **compliance** with DOE and Federal requirements/orders while enabling **multi-entity research team** needs to ensure more efficient and secure research execution
- **Handles CUI through public** resources and governance
- **Private side** uses role-based security to allow for **secure, private, research.**
 - Ongoing integration of cloud-based computing and scalable AI RD capabilities
- **Public side** hosts and serves as an **internationally registered and recognized** data repository.
- **Amplifies** visibility for DOE data products, including ties to Data.gov, Geoplatform, OSTI, Re3Data, Google search etc
- **Federates** and aligns with key DOE, Federal and International platforms
- **Multi-cloud** architecture, integrating compute, curation & virtual collaboration
- Continuously evolving with input from the technical/R&D community
 - **Built by researchers for research** and technical users
- **Vetted** for use by all DOE national labs + HQ and other facilities
- **Endorsed** by DOE OCIO, DOE Chief Counsel, FECM, S1
- Over **3 million resources downloaded**; **>2.5 million resources hosted**

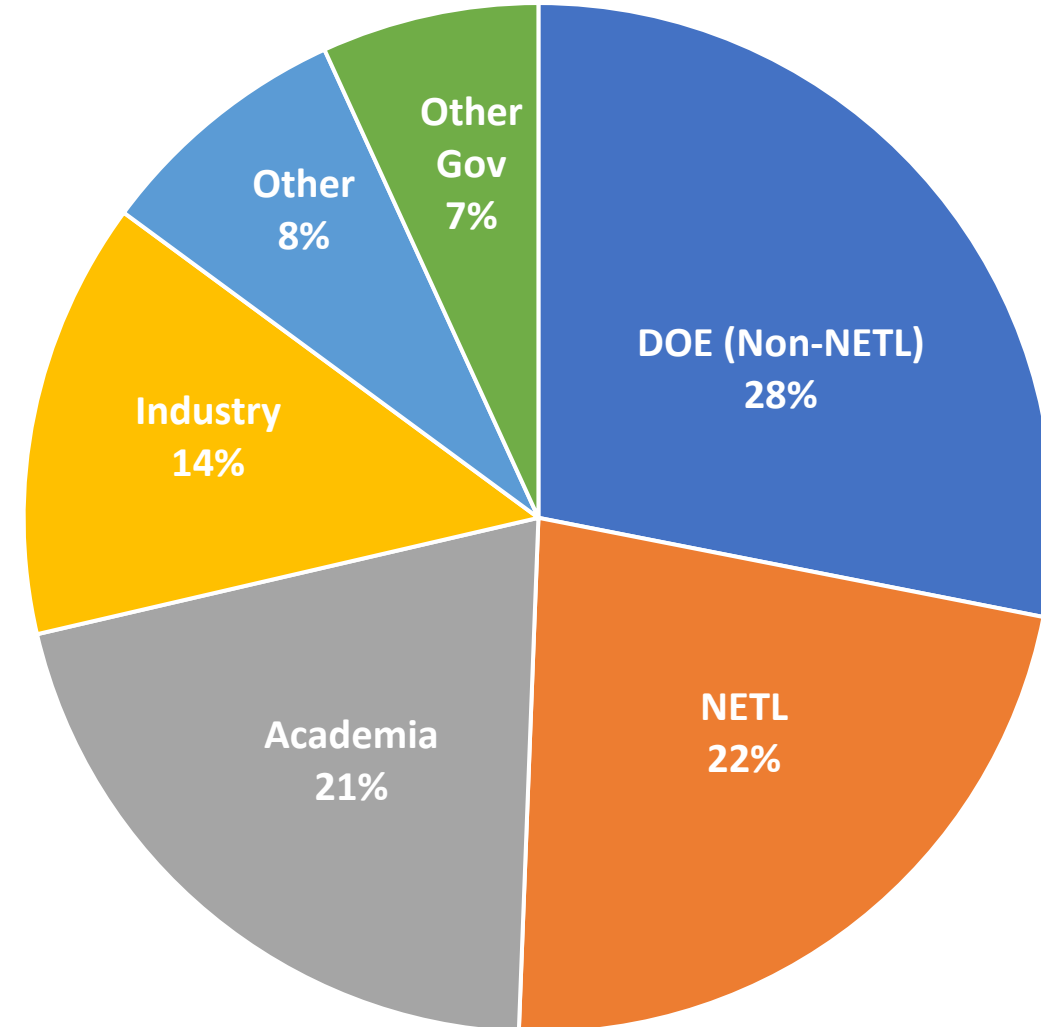


Registered Users: 4,196
Resource Count: 2,524,444
Resource Downloads: 3,111,492



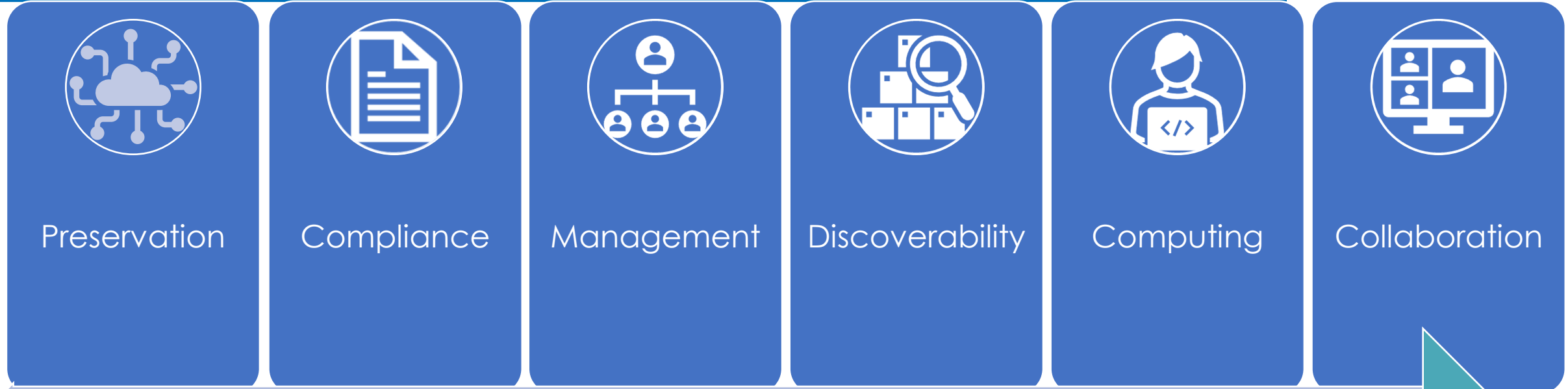
Reaching Stakeholders via EDX

- ✓ NETL/FECM employees
- ✓ External collaborators
- ✓ General public

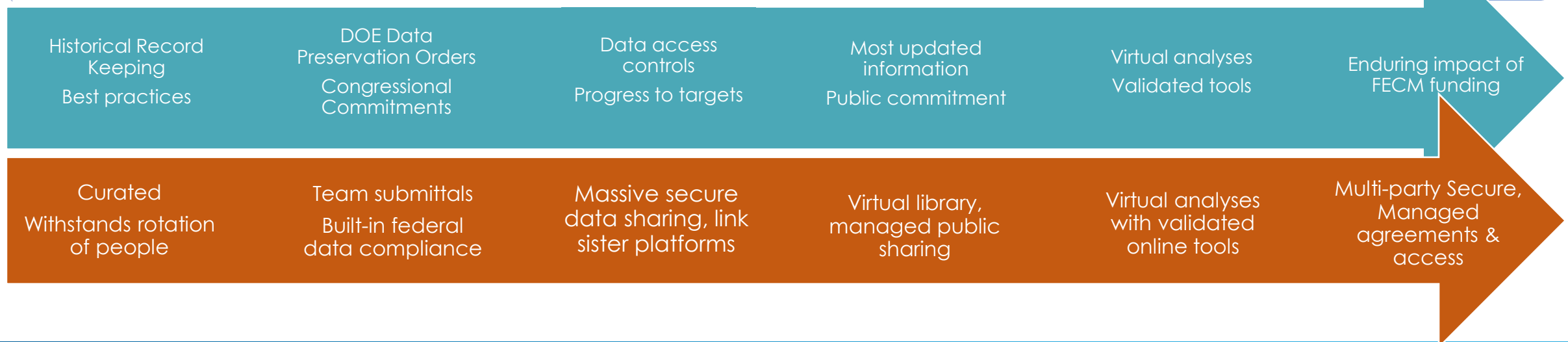


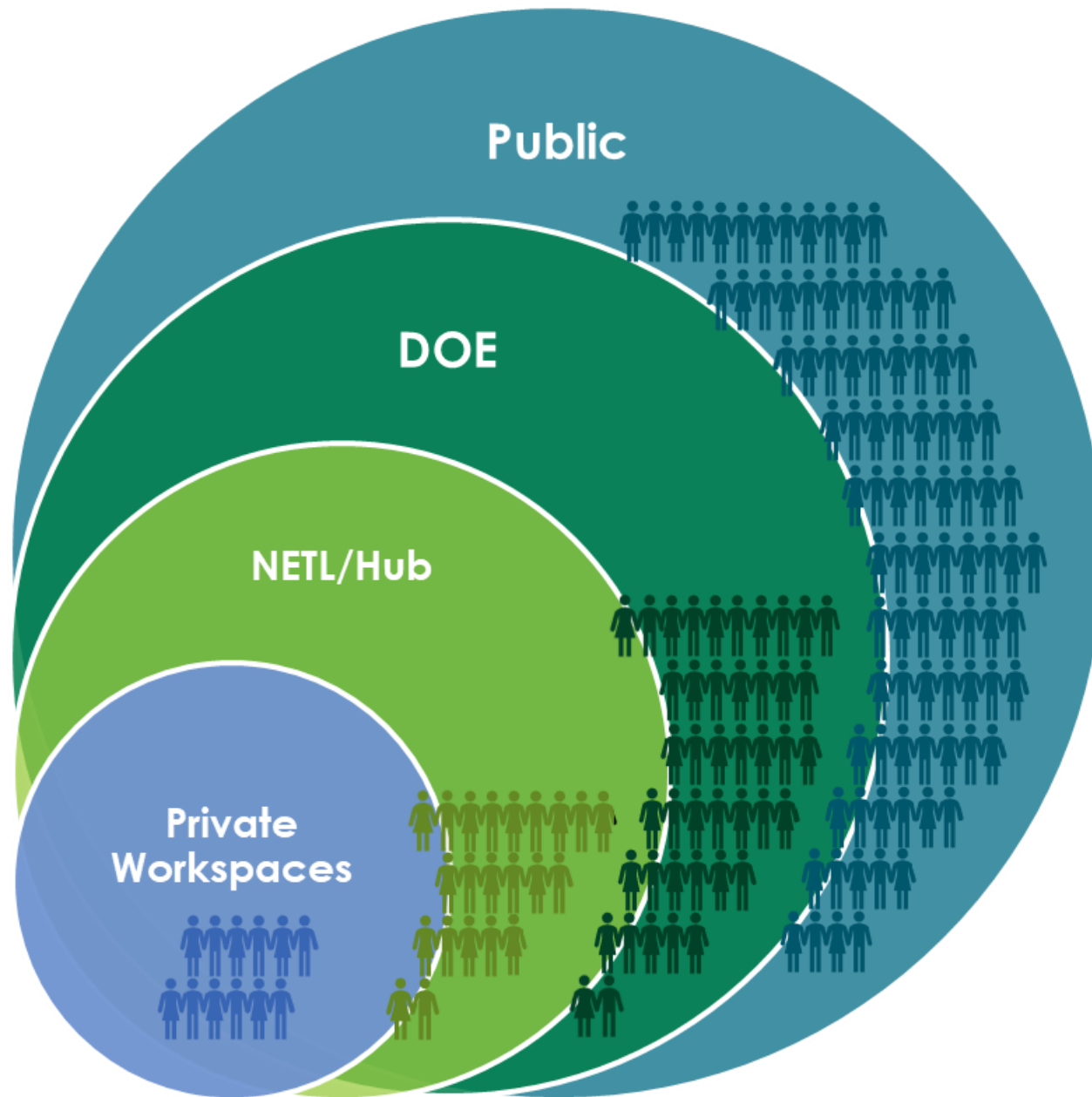
**4196+ EDX Registrants
(private side only)**

Information management tailored to meet stakeholder needs



Programs
Projects



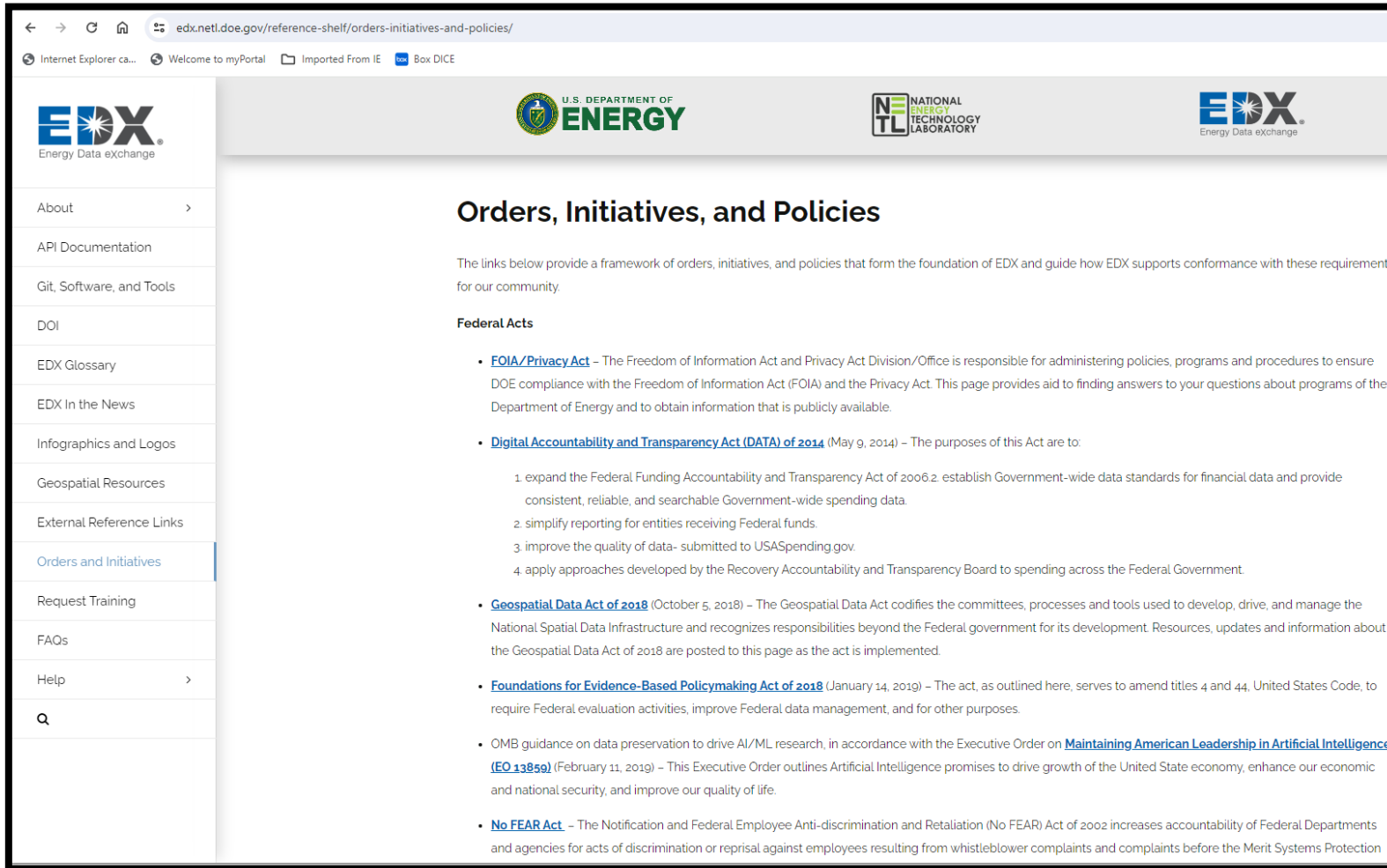


Managed Access to
Provide R&D Digital
Product Management

CUI thru Public

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 address bar shows the URL: edx.netl.doe.gov/reference-shelf/orders-initiatives-and-policies/. The page features a navigation menu on the left with items like 'About', 'API Documentation', 'Git, Software, and Tools', 'DOI', 'EDX Glossary', 'EDX In the News', 'Infographics and Logos', 'Geospatial Resources', 'External Reference Links', 'Orders and Initiatives' (highlighted), 'Request Training', 'FAQs', 'Help', and a search bar. The main content area is titled 'Orders, Initiatives, and Policies' and contains an introductory paragraph and a list of federal acts.

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.
 2. 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

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 Stall ¹✉, Geoffrey Bilder², Matthew Cannon ³, Neil Chue Hong ⁴,
Scott Edmunds ⁵, Christopher C. Erdmann ⁶, Michael Evans⁷, Rosemary Farmer⁸,
Patricia Feeney², Michael Friedman ⁹, Matthew Giampoala¹, R. Brooks Hanson¹,
Melissa Harrison¹⁰, Dimitris Karaiskos¹¹, Daniel S. Katz ¹², Viviana Letizia¹³, Vincent Lizzi³,
Catriona MacCallum¹⁴, August Muench¹⁵, Kate Perry⁸, Howard Ratner ¹⁶, Uwe Schindler ¹⁷,
Brian Sedora ¹, Martina Stockhause ¹⁸, Randy Townsend¹⁹, Jake Yeston²⁰ & Timothy Clark ²¹

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

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



can help!

EDX is a publisher of R&D data products



NETL's Energy Data eXchange

Find data products on EDX...

Search Contribute Groups Portfolios Workspaces Tools EDX Spatial

Submissions / National Critical Minerals Data...

Dataset Groups Activity Provide Feedback View Metadata Nominate to Group

National Critical Minerals Data Dashboard

doi 10.18141/1962402

License(s):
Creative Commons Attribution

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.

Followers: 2
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Authors
Rachel Yesenchak Devin Justman Sophia Bauer Michael Sabbatino C. Gabriel Creason Andrew Gordon Scott N. Montross Kelly Rose

Citation (Click to Copy)
Rachel Yesenchak, Devin Justman, Sophia Bauer, Michael Sabbatino, C. Gabriel Creason, Andrew Gordon, Scott N. Montross, Kelly Rose, National Critical Minerals Data Dashboard, 3/21/2023, <https://edx.netl.doe.gov/dataset/national-critical-minerals-data-dashboard>

Data and Resources
Filter resources by name...
Date: Newest → Oldest
Read Info Open Link

National Critical Minerals Data Dashboard
Creative Commons Attribution
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.

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

can help!

OSTI DOI Number →

Data License →

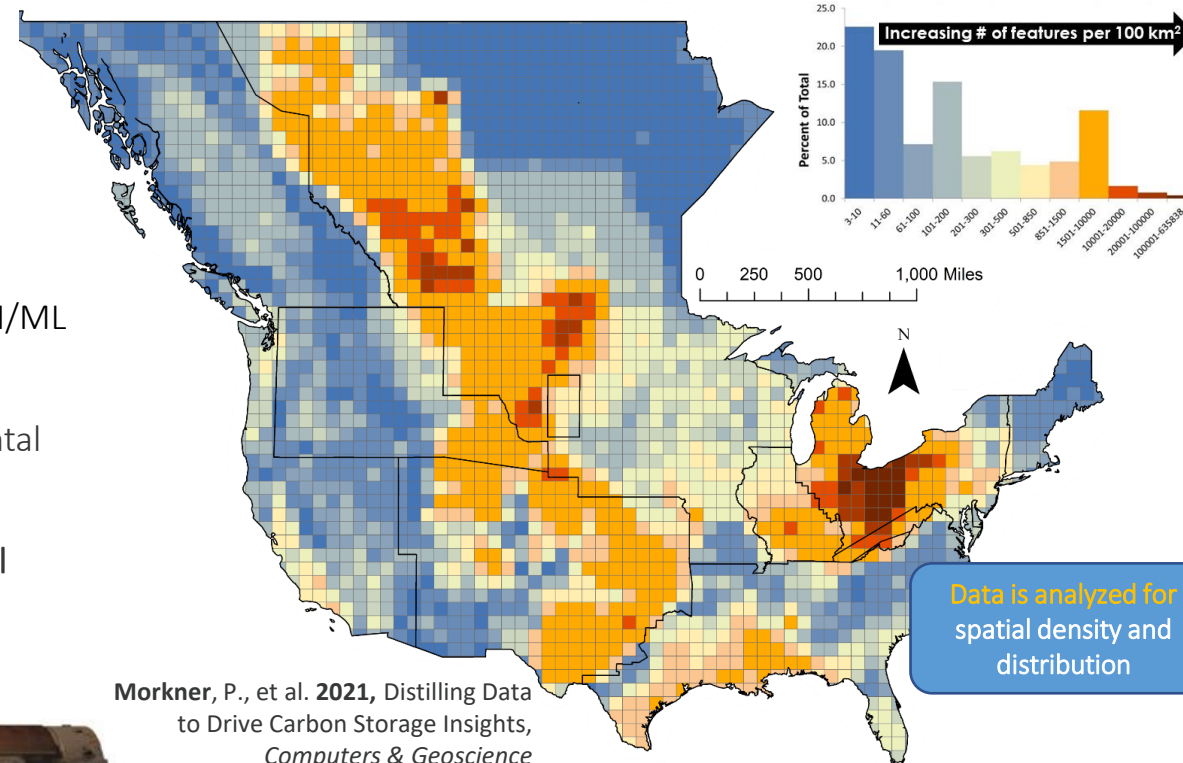
Data Citation →

Data Access →

DOE Has Invested in Creating a CTS R&D Digital Resource-base

Need to advance for democratized use & useability

- **PB of data preserved** using the **public and private** sides of EDX
- Curating access to **downloadable instances** of system-specific, science-based AI/ML models & tools
- **Developed custom, AI/ML/NLP enhanced tools** to drive energy and environmental digital discovery
- **Enabling** geospatial data and web mapping for energy infrastructure and natural systems & resources



Morkner, P., et al. 2021, Distilling Data to Drive Carbon Storage Insights, Computers & Geoscience

Now using AI to transform and accelerate digital resources & capabilities...

... accelerating findings for CTS adoption and safe commercial implementation

5 Years, Focus on Delivering...

Inform

Analyze & Optimize

Integrate & Label

Explore & Transform

Move & Store

Discover & Collect

...democratizing stakeholders and community access to CTS digital infrastructure & putting data assets to work



- CTS Integrated *Data* Resources
- CTS *Tools*
- Core CTS EDX disCO₂ver platform
- *Outreach* & Capacity Building

THE INFRASTRUCTURE INVESTMENT AND JOBS ACT:

Opportunities to Accelerate Deployment in Fossil Energy and Carbon Management Activities

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CARBON DIOXIDE UTILIZATION AND STORAGE

Carbon Storage Validation and Testing: \$2.5 billion

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Combining Digital CTS “Pieces” – *Creating New Deployment-Ready Products & Identifying Key Gaps*

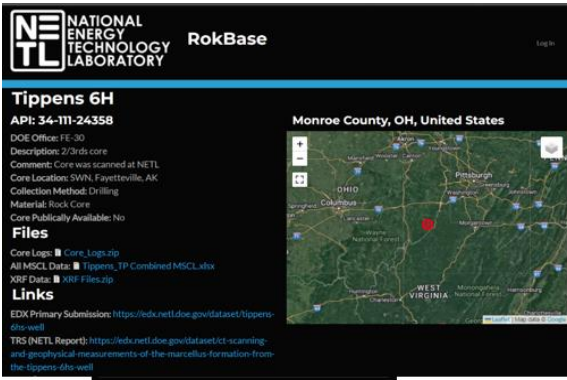


Source: Gemini



Source: Gemini

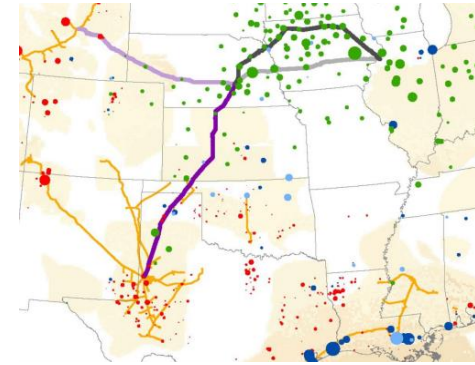
Actionable Data Science for CTS – *Highlighted* products



RokBase

Virtual data portal and tool

Explore & query available core and rock property data

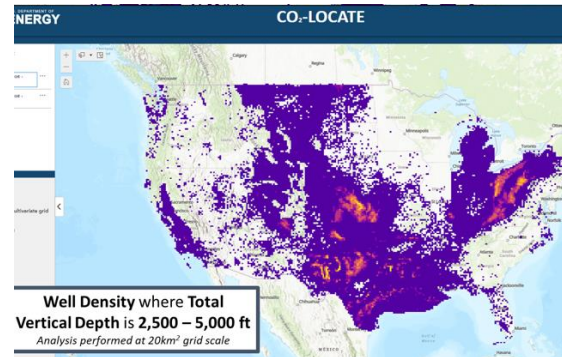


CTS Pipeline Planning

Database & Tool for the spatial routing of pipelines and transport of CO₂

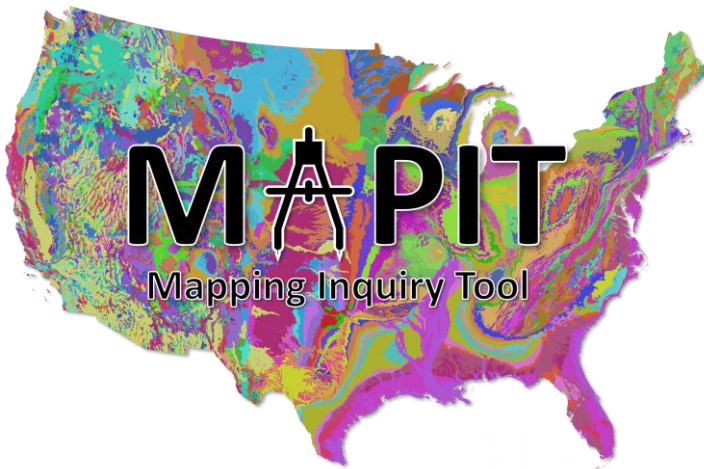
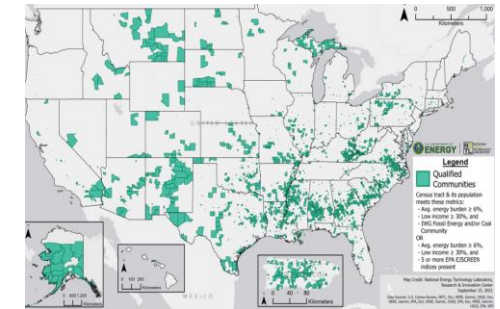
CO2-Locate

Tool & Database of National Well Information, for Reuse and Planning support



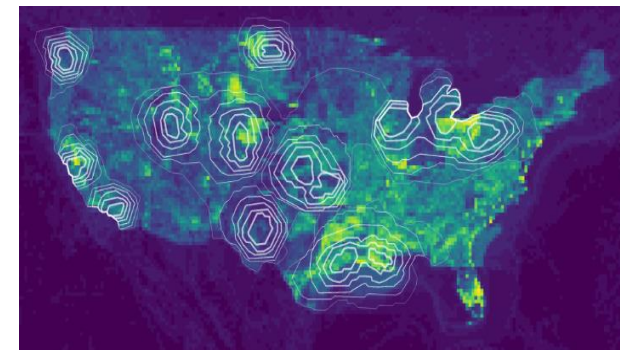
CTS EJ-SJ

Database & Web Tool for social & environmental justice CTS decision making



CTS MapIT

Geodatabase and planning support tool for Underground Injection Control (UIC) Class VI permits



CS Technical Viability Assess.

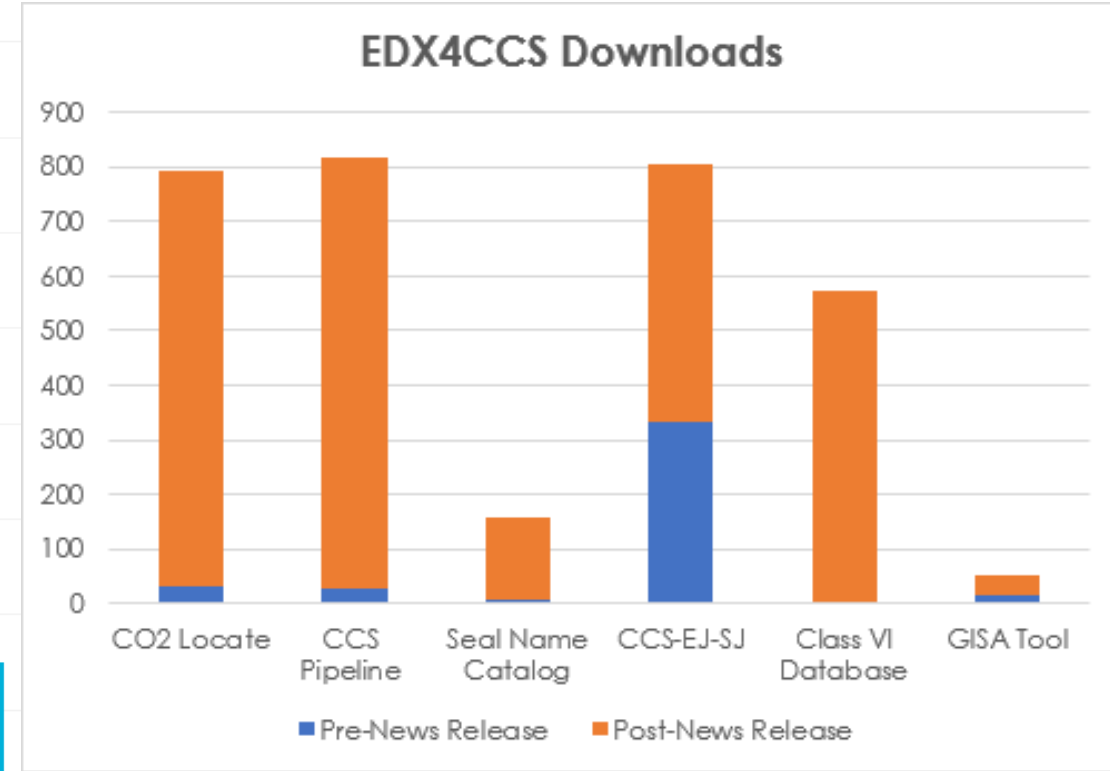
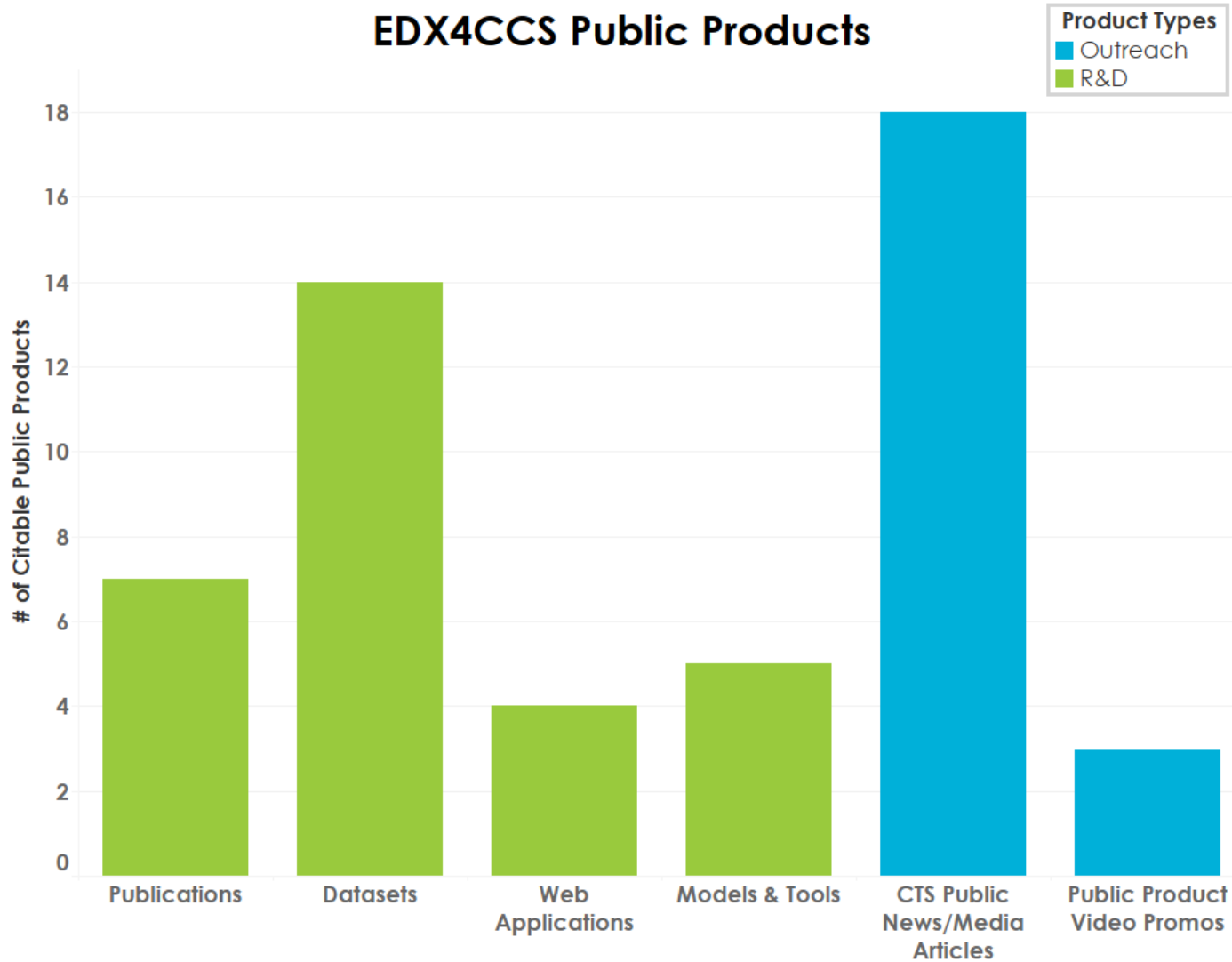
National geodatabase & interactive tool of open source geologic, geophysical, structural, hydrologic, energy extraction, transportation infrastructure, & environmental data

Actionable Data Science for CTS –



2 years
30 CTS digital
products via EDX

EDX4CCS Public Products



Carbon Management Projects (CONNECT) Toolkit Value Proposition

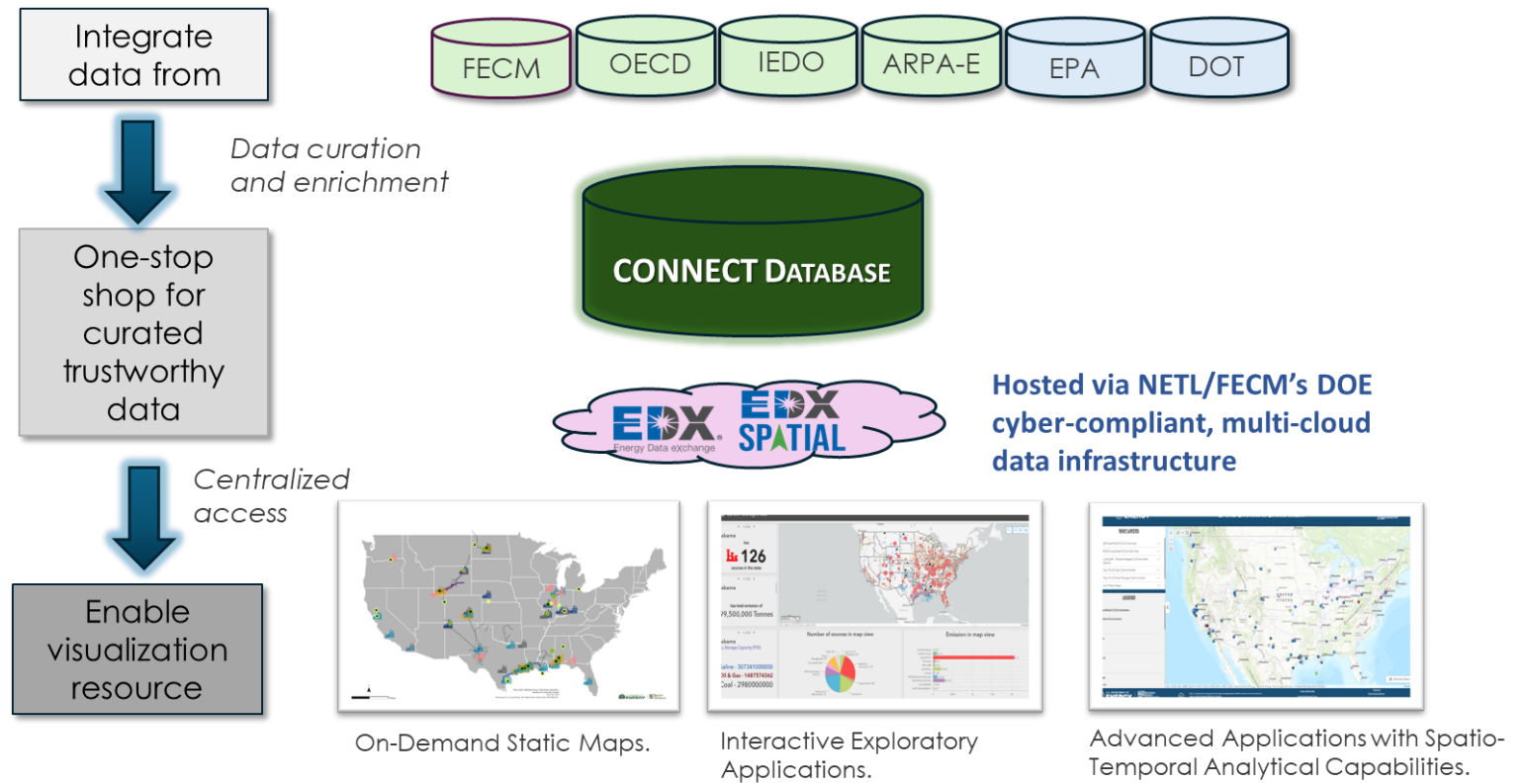
Challenge: Lack of a centralized repository of authoritative information detailing government investments in technologies spanning the carbon management value chain

Objective:

- Build an automated database and interactive dashboard to share and interact with comprehensive carbon management project data

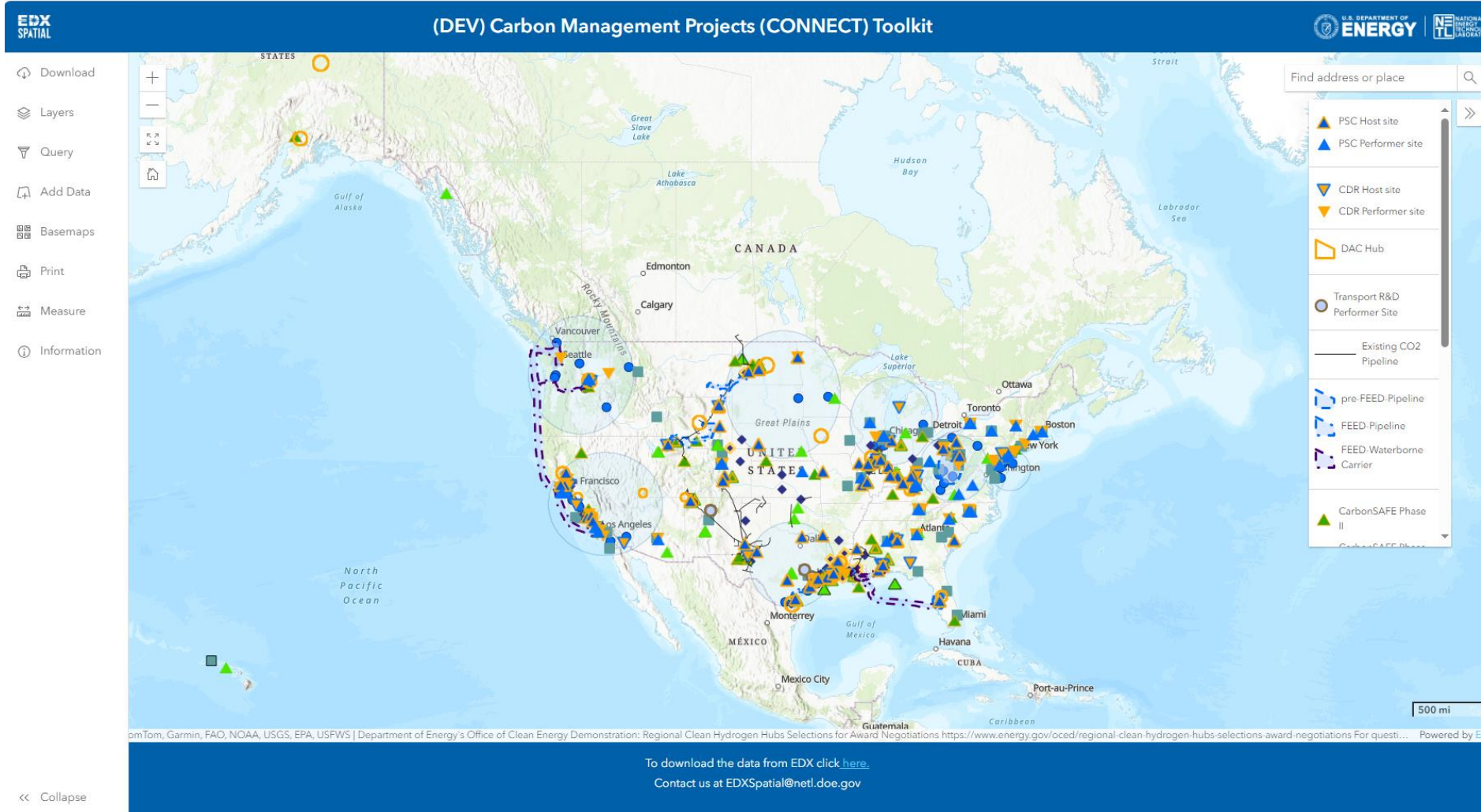
Value:

- Provide the public with a single-point access to integrated and regularly curated information on federally funded carbon management research, development, and demonstration (RD&D) projects in the United States
- Enable users to drill down into project details, generate national/regional/county-level maps, and perform other analytics
- Serve as a hub of public information on these projects and related federal initiatives



CONNECT Toolkit- Database and Explorer

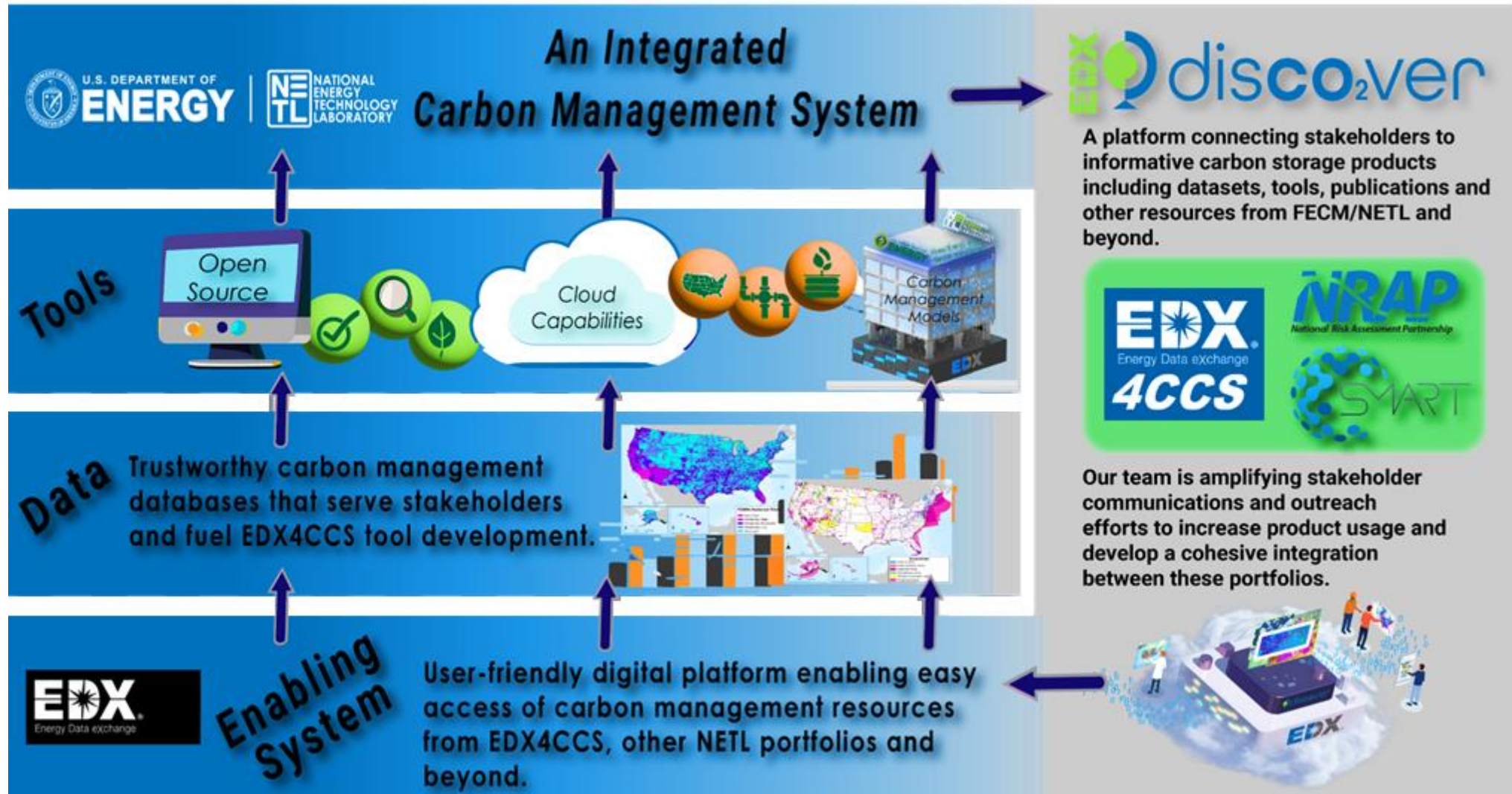
<https://edx.netl.doe.gov/dataset/carbon-management-connect-database-and-explorer>



BENEFITS:

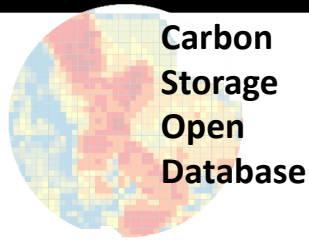
- Saves time and money for collecting desired information from multiple sources
- Access to authoritative data and links to more details
- Quick customized maps for presentations and reports
- Interactive applications for advanced analysis
- Evaluate in relation to other federal initiatives, environmental justice-social justice (EJ-SJ), etc.

EDX disCO₂ver – Unlocking CTS' Digital Future



Connecting Stakeholders to Authoritative Data & Digital Resources

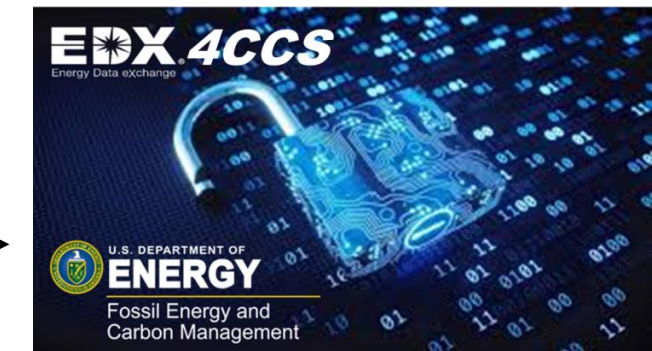
EDX disCO₂ver Takes the CTS Community to Succeed



Carbon Storage Open Database

EDX disCO₂ver

- Development and deployment of the “disCO₂ver Platform” user interface within the EDX ecosystem
- Offering an **integrated**, dedicated user interface
- **Connecting** CTS-community stakeholders to CTS-priority data, tools, and models for use
- Leveraging the core data management, curation, collaboration, and virtualization capabilities offered through the secure, online EDX system.



CarbonSAFE Projects



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

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



<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

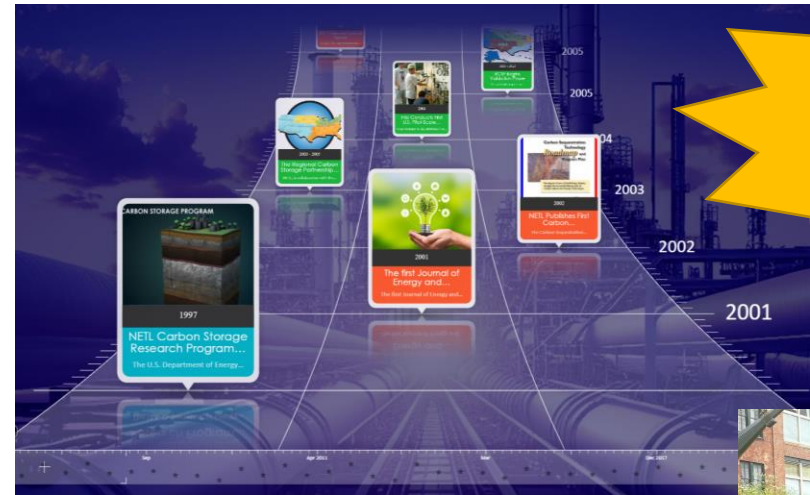
Presentations on EY23 CTS work:

- Advanced Storage FWP/MYRP
- Carbon Storage Data FWP
- Carbon Storage Analysis FWP
- Multi-Modal Transportation FWP/MYRP
- EDX4CCS (EDX disCO2ver)
- NRAP
- SMART

Open to the public

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

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

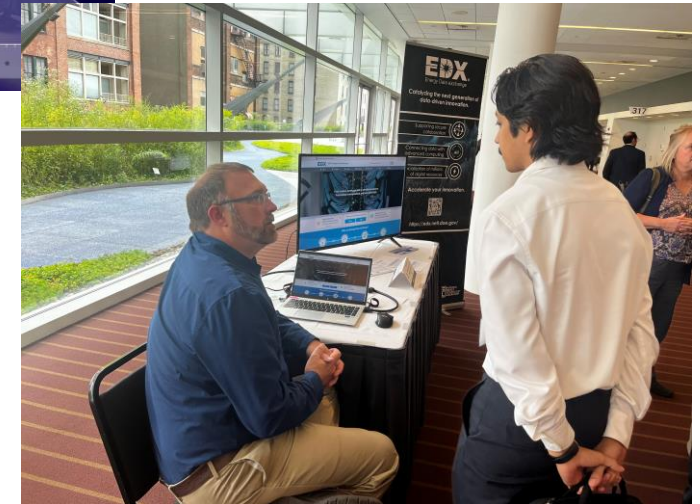


Carbon Storage Timeline summarizing field, lab and computational contributions to CTS' digital future
Live, interactive demo at the booth!

Source: NETL

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

Aug. 5-9, 2024
Pittsburgh
Convention Center



Multiple tool demos will be hosted
Source: NETL

Explore the CTS digital “library”



Kelly.rose@netl.doe.gov



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

Paraphrasing M. Angelou