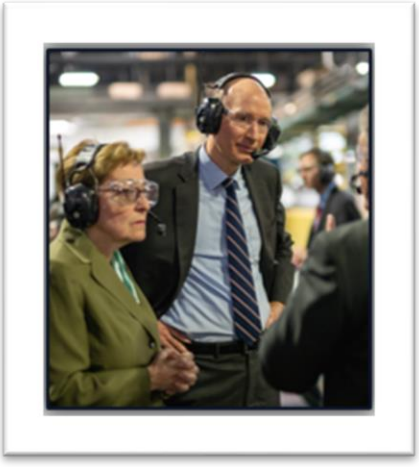
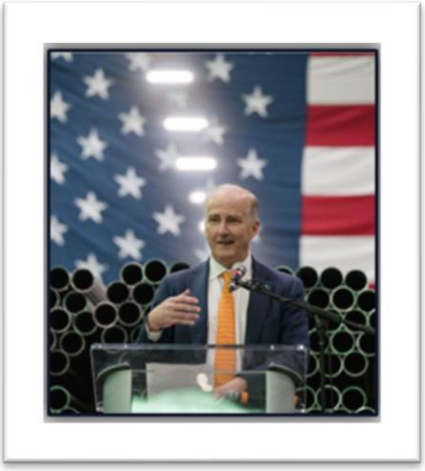
U.S. DEPARTMENT OF ENERGY | OFFICE OF THE UNDER SECRETARY FOR INFRASTRUCTURE

Increasing the National Laboratories' Capacity to Support Industrial Innovation, Supply Chain Resilience, and Clean Energy Deployment





Workshop Report
June 2024

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Executive Summary

The United States is currently experiencing a new industrial revolution: a revolution to decarbonize the industrial sector while massively expanding domestic clean energy manufacturing and supply chains. In the last three years, private companies have announced over $400 billion in clean energy manufacturing investments, buoyed by supportive federal incentives via the Bipartisan Infrastructure Law and the Inflation Reduction Act. As a result, over 500 communities are seeing new or expanded manufacturing facilities come to town, bringing high-quality jobs and unprecedented community benefits with them.[1] These investments will provide American industries and manufacturers a competitive advantage in the race to lead the world in low and net-zero emissions and solidify a "first-mover" advantage, bolstering U.S. domestic energy security and global competitiveness for decades into the future.

To support this historic level of commercial-scale investment and deployment, the U.S. Department of Energy (DOE) created the Office of Infrastructure and tasked this new arm of "America's Solutions Department" with tackling infrastructure-sized problems. With this expanded mission, there is an important opportunity to leverage and expand the National Laboratories' capabilities for greatest impact.

For decades, the National Laboratories have led the world in accelerating transformational research and development (R&D) breakthroughs. In April, DOE's Office of Infrastructure brought leaders from DOE's Office of the Under Secretary for Science and Innovation, the National Laboratories, and industry together to ask: what if the National Laboratories could do more to accelerate clean energy deployment and industrial decarbonization?

A group of 75 leaders from across the National Laboratory system, DOE, and private industry met for three days at Oak Ridge National Laboratory. Participants discussed the key National Laboratory capabilities needed to meet new and increased demands for demonstration and deployment (D&D) support, with a focus on (1) timely, detailed D&D analytics; (2) new Laboratory-led tools and services to engage industry to accelerate decarbonization and close supply chain gaps; and (3) technical assistance to federally supported industrial D&D projects.

Workshop participants generally affirmed the National Laboratories' abilities to expand their support for a range of first-of-a-kind demonstrations and deployment-scale efforts and expressed enthusiasm to continue these discussions across the National Laboratory network. **Participants developed a long-term vision of a nimble, collaborative National Laboratory network whose expanded D&D capabilities would build upon the Laboratories' significant existing strengths:**

Laboratory Subject Matter Experts (SMEs) and Facilities Would Be More Visible and Accessible for Both DOE and Industry.

Laboratories with specialized expertise, tools, and existing user facilities[2] (e.g., for advanced nuclear, hydrogen, sustainable fuels/chemicals, carbon capture, energy storage, etc.) can augment industry's

[1] https://www.energy.gov/articles/remarks-delivered-secretary-jennifer-granholm-new-industrial-revolution-clean-energy

[2] Including the Office of Science's 28 National Laboratory user facilities and other user facilities like ORNL's Manufacturing Demonstration Facility (MDF) or the Carbon Fiber Technology Facility.

expertise on tech-specific D&D challenges, like technology scale-up and later-stage design challenges, safety, and environmental protection.

Laboratories Would Provide Expanded and Expedited Validation Testing.
Expanded validation testing directly at the Laboratories or through deploying National Laboratory experts onsite would stress-test near-commercial technologies to give companies the confidence to (1) start manufacturing at scale and (2) use existing or emerging technology solutions in new environments at commercially relevant scales.

Laboratories Would Run a Live Market and Supply Chain Insights Platform, Building Upon Existing Investments in High-Performance Computing.
National Laboratories' world-class analytical capabilities and high-performance computing power, built with foundational investments from the Office of Science and applied energy programs under the Under Secretary for Science and Innovation, could be harnessed to expand analysis of industrial decarbonization solutions (e.g., expanded techno-economic analyses [TEA]) and build new models to anticipate and minimize global supply chain disruptions.

Laboratories Would Help Companies Understand and Mitigate Adoption Readiness Level (ARL) Risks.
Laboratory teams could build on existing tools to help project developers and investors understand commercialization risks, business cases, regulatory and/or policy impacts, permitting authorities, safety and hazards considerations, and workforce training needs.

Laboratories and DOE Would Share Data Fluidly While Protecting Intellectual Property (IP) And National Security.
A cross-Laboratory, cross-DOE data warehouse and sharing protocols would allow Laboratories to better share their existing world-class datasets, and to further aggregate and analyze data from federally supported projects to help industry better learn from itself.

Participants recognized achieving this vision will take time, with challenges along the way. It will require deep collaboration, investment, and sustained focus from a wide range of stakeholders to shift National Laboratory scope, incentive structures, and culture. However, similar precedents offered participants collective confidence that this vision is both achievable and worth the effort. If successful, this effort would expand the impact of both DOE and the Laboratories while modernizing the Laboratory system to further serve the United States' rapidly evolving clean energy, industrial competitiveness, and energy security goals.

The following pages further detail the vision for long-term Laboratory D&D capabilities (pp.1-2) and provide some ideas for next steps for the consideration of leadership from DOE and the Laboratories (pp.3-5).

Five-Year Vision for the National Laboratories' Role in D&D

Participants envisioned a National Laboratory network that could support D&D-scale efforts with high-priority capabilities, many of which build on existing Laboratory strengths:

Expanded Access to Laboratory SMEs and Increased Laboratory Engagement with Deployment and Commercialization Stakeholders.

Participants from both DOE and industry emphasized the need to make new and existing Laboratory capabilities and expertise more visible to external stakeholders. Participants envisioned expanding technology collaborations (e.g., the Manufacturing Demonstration Facility [MDF] at Oak Ridge National Laboratory [ORNL]) beyond earlier-stage technology readiness levels (TRLs) into D&D stages and clarifying and streamlining pathways to Laboratory connections and collaborations. Alongside increasing visibility into the expertise of existing SMEs supporting applied R&D, Laboratories should expand their SME talent base by (1) hiring more commercialization and economics SMEs and (2) increasing the capacity of existing and future staff to serve as industry liaisons.

Expedited Validation Testing of Lower- and Higher-TRL Technologies for Novel Use-Cases or Environments.

While Laboratories are unlikely to become certifiers, participants highlighted the increased use of the Laboratories' unique existing capabilities (e.g., high-performance computing, digital twins, platforms like Advanced Research on Integrated Energy Systems [ARIES], facilities like the MDF, future testbeds) to validate proof-of-concepts or new applications of known technologies and supported expanded capabilities in validation testing to include demonstration- and deployment-stage TRLs.

Live, Quickly Accessible Market and Supply Chain Insights Platform.

This platform would cover industrial investment flows, global and country-level supply/demand, and other market conditions, with frequent updates. Platform insights would be informed by deeper Laboratory research and analysis projects, like a comprehensive mapping of the U.S. energy sector industrial base. MESC's Modeling, Mapping, and Analysis Consortium (MMAC) provides the foundational investment for this platform. Further expansions to MMAC's scope and capabilities would strengthen this offering (e.g., additional Laboratory participation, expanded technoeconomic analytic capabilities). The primary audience would be DOE and other policymakers. Private industry and investors would be a strong secondary audience, especially where this platform would provide insights not offered in privately available tools.

Support to Help Companies Understand and Mitigate ARL Risks, with a Focus on Federal Awardees and Small to Medium Manufacturers.

Laboratories could focus on four ARL challenges not well addressed by private sector service providers:

Permitting and Siting

The Laboratories could provide high-spatial resolution insights on permitting authorities and project requirements by geography and technology area. This would support grid interconnection, quality standards for clean energy inputs, critical materials projects, and more. One specific tool proposed was a permitting map that would be publicly available and useful for project developers (including smaller and community-based developers), investors, and technology developers.

Environment and Safety

The Laboratories' computing and modeling resources could improve understanding of complex issues like pollutant life cycles, pollutant dispersion, and permanence and safety of carbon storage. At the same time, the Laboratories' physical test facilities and tools could help characterize worker and

community safety risks from materials handling, stationary storage in challenging environments, CO_2 pipelines, battery recycling, and other electrification trends—and develop new safety protocols to disseminate throughout industry. Workshop participants noted these services would be especially valuable for startups and other small businesses who have fewer resources to understand safety and environmental risks of new technologies.

Market Openness

The Laboratories could help developers of near-commercial technologies anticipate market adoption risks that go beyond the individual technology, such as grid integration challenges for new energy forms like hydrogen. Laboratories could provide commercial readiness analysis, with Laboratories providing detailed sensitivity and scenario analyses for commercial readiness level, revenue scenarios, and other issues.

Workforce

Participants flagged diverse workforce analysis and assistance needs, including:

- Skills mapping for emerging clean energy roles (especially for technician and skilled trades roles) to inform new industry-wide credentials and certifications,
- Workforce advising and pilot training programs to help companies and educational institutions meet demand,
- National-level insights on industrial workforce trends and skill gaps, and
- Data aggregation and analysis of the workforce needs and jobs created via federal and private-sector industrial investments.

Cross-Laboratory Data Sharing Platform and Protocols That Protect Sensitive Data While Enabling Greater Sharing with DOE and the Field, Enabling the Analytic Capabilities Noted Above.

Participants outlined a cross-Laboratory data warehouse and associated sharing protocols, which would allow Laboratories to share anonymized or aggregated datasets, analyze data from federal projects, and increase visibility into existing data across Laboratories. Ultimately, the Laboratories should have access to the right data to provide "visibility into the black box" (e.g., on specific supply chain risks, detailed production economics) for DOE industrial policy analyses, whereas current sector-specific analyses often rely on unknown assumptions. Participants also noted the need for flexible contracting and relationships with data vendors to enable this data-sharing platform and drive down data costs for the federal government.

As the Laboratories Expand Their Commercialization and Deployment Capabilities, Laboratory Roles Have a Greater Risk of Overlap with Roles More Appropriate for DOE and/or Private Sector Providers.

Workshop participants noted some capabilities best reserved for private sector actors (inclusive of industry, investors, nonprofits, and others), such as issuing certifications; providing individualized, contracted D&D support for private companies (e.g., permitting consultation); and running full-scale testing or training programs. Similarly, participants noted a few critical capabilities better suited to DOE's role, including working with the private sector to generate demand-side signals and convening federal awardees and potential follow-on investors.

Recommended Actions and Next Steps

Workshop participants developed recommendations for DOE and National Laboratory leadership to consider pursuing this expanded D&D vision, as well as some near-term action items. **Note that these ideas do not represent the perspective of any particular National Laboratory nor are any formal proposals, but rather reflect a summary of the ideas generated at the workshop.**

Recommendation 1

Consider whether to expand Laboratory missions and provide medium-term stable funding to enable Laboratories to expand economic, market, and other adoption readiness analysis and technical assistance (TA) expertise

Action Steps for 2024-2025	
Action	**Description**
Evaluate how D&D activities fit into the Laboratories' existing mission statements, and consider expansions as needed and at DOE's discretion	Akin to how the Laboratories' mission expanded to cover energy security in the early 2000s, formal backing for D&D work will empower the Laboratories to expand expertise focused on high-TRL challenges and commercial-scale deployment needs.
Provide Office of Infrastructure programmatic support that allows Laboratories to expand D&D-focused workforce and expands incentives for Laboratory staff to engage with private industry and investors.	Interested Labs could recruit experts with private sector experience in technology D&D (including financial experts, economists, and community and commercial engagement liaisons). Laboratories also could explore incentives (e.g., alternative performance evaluation structures) that encourage interested Laboratory staff to spend part of their time advising companies and communities directly as SMEs, including companies receiving federal financial assistance.
Expand incentives and flexible funding to allow Laboratories to provide rapid-response commercialization analyses for DOE decisionmakers.	Laboratories may benefit from building rapid analysis delivery into job scopes for certain roles. At the same time, DOE and the Laboratories can explore options for how to have greater quick-start staff capacity available for urgent analytic projects (e.g., technology costs and risks, policy and market impacts, supply chain gaps, etc.). The Office of Clean Energy Demonstrations (OCED) Laboratory Call provides an opportunity to pilot Laboratory and DOE actions here.
Create more opportunities for interested Laboratory staff to develop business and industrial engagement skills	For example, by expanding Energy iCorps program opportunities or having Laboratory leaders with more industry engagement personnel teach workshops for other Laboratories.

Recommendation 2

Consider how to best allocate capacity at DOE and the National Laboratories with authority to own this effort and advance priority capabilities

Action Steps for 2024-2025	
Action	**Description**
Evaluate staffing structures	Consider what staffing structures would best allow DOE to make progress toward a prioritized set of these action items in the next 6 months, in coordination with the industrial joint strategy team.
Build on existing investments and expertise	Engage the Office of the Under Secretary for Science and Innovation alongside the Office of Infrastructure and relevant applied offices and/or Laboratory personnel to build on existing investments and expertise as a platform for accelerating completion of these action items.
Identify a dedicated point-of-contact at each relevant Laboratory	This individual could communicate these efforts to their Laboratory leadership and colleagues. This should be done in coordination with each National Laboratory site office.

Recommendation 3

Develop a standardized line of industry and investor engagement offerings and accompanying access pathways, with a focus on services where the Laboratories provide what the private sector cannot

Action Steps for 2024-2025	
Action	**Description**
Continue building the standardized line of offerings identified below in partnership with Laboratory liaisons	Participants highlighted an initial list of priority standardized offerings: • **Streamlined direct engagement with Laboratory SMEs**, including for federally funded projects, other industrial stakeholders, investors, and Justice40 communities. • **Living Lab demonstrations for industry** that expand on existing validation-scale piloting to build momentum to adopt high-TRL decarbonization and advanced manufacturing solutions.

	• **Support ARL insights and solutions, especially for smaller businesses.** The focus should be on four ARL challenges not well-addressed by private sector: (1) permitting and siting, (2) environmental and safety, (3) workforce, and (4) market openness.
Participants highlighted the many existing Laboratory D&D-stage engagement with industry and investors	This includes programs such as, but not limited to, the Office of Energy Efficiency and Renewable Energy's Better Plants and Better Climate Challenge Programs, the 50001 Ready Program, and Onsite Energy TAPs; MESC's Industrial Assessment Centers; and various voucher programs available through DOE's Partnership Intermediary Agreement (PIA) mechanism associated with the Office of Technology Transitions and the Office of Clean Energy Demonstrations projects (and others).

Recommendation 4

Inventory and increase the visibility of current Laboratory SME network to facilitate greater DOE, industry, and investor engagement with Laboratory SMEs

Action Steps for 2024-2025	
Action	**Description**
Augment Labpartnering.org (a recently developed, OTT-supported database of Laboratory SMEs and patents)	Priority areas for improvement are to (1) expand the database of individual Laboratory-based SMEs to cover more economic analysis and community engagement SMEs, (2) expand beyond SMEs to include catalogs of available Laboratory-made tools and services, (3) improve data reliability and updating frequency, and (4) update the site user experience with a focus on private sector users' needs.
Consider how to socialize the improved Labpartnering.org to grow awareness and use of the tool within DOE and in industry	DOE could bring Labpartnering.org into Office of Infrastructure's suboffice outreach plans and/or consider opportunities to publicize via Secretary's channels and engagements.

Recommendation 5

Expand best practices in Cooperative Research and Development Agreements (CRADAs), including the use of standard "umbrella" CRADAs to reduce the time to new industry partnerships to less than two months across Laboratories

Action Step for 2024-2025	
Action	**Description**
Standardize and socialize the best practices (e.g., fast track CRADAs and streamlined boilerplate) from Laboratories that have developed strong solutions (e.g., ORNL, Lawrence Berkeley National Laboratory)	Program offices under the Under Secretary for Infrastructure can work with lab stewardship offices, their site offices, and other federal partners to discuss potential policy changes to streamline CRADA approaches as appropriate. This might include asking current leading Laboratories to solicit feedback from peer Laboratories and report to DOE what each Laboratory needs to implement existing CRADA best practices, unlocking new benefits and efficiencies across the full RDD&D continuum.

Recommendation 6

Create data protocols and data-sharing agreements that allow greater sharing between industry, DOE, and Laboratories while protecting national security and IP concerns

Action Step for 2024-2025	
Action	**Description**
Each program office under the Under Secretary for Infrastructure and Laboratory could develop data-sharing action plans aligned with the DOE Data Management Strategy from the Chief Data Office	This would emphasize interoperability and standardized frameworks, including access to project data from awards to aggregate/anonymize data and create derivative products. This could be the first step in an implementation plan for an integrated data system across the Office of Infrastructure.
Build an enterprise catalog of datasets and access across DOE and Laboratories *(this effort is currently led by the DOE Chief Data Officer).*	This could lead to the creation of an internal (i.e., only for DOE and Laboratories), data-focused counterpart or subsite to Labpartnering.org

Review current data-related Terms & Conditions for awards	Consider how the current data-related Terms & Conditions for Office of Infrastructure awards do or do not allow DOE to share project data with Laboratories for internal analysis as well as aggregate/anonymize data to share progress with industry, investors, and others in real time.
Pilot sharing approaches	Build data-sharing protocols across Laboratories into the MESC's supply chain MMAC effort.
Inventory opportunities to leverage existing applied RD&D expertise and investments to accelerate development and rollout of new D&D capabilities across the Laboratories.	DOE's sustained, early TRL and market transformation investments across the 17 National Laboratories are one of the single greatest enablers for adding new expertise and improving existing efforts. This springboard decreases time-to-execution and leverages decades of momentum to meet ambitious, near-term D&D goals. • Leverage existing TEA, life cycle assessments (LCA), and state of technology/market methodologies and modeling capabilities and continue to expand these capabilities to D&D. • Leverage existing integrated-energy system models and strategic or policy analysis (e.g., Net Zero World) capabilities at Laboratories for extensibility to D&D.

Appendix A. Workshop Readout

For one day of the workshop, participants broke into three sessions to describe and prioritize the long-term Laboratory capabilities that would enable the Laboratories to better advance and support DOE's D&D mission, across three topics:

- **Data and analytics:** How can the Laboratories better collect and use data, including from federal demonstration and deployment projects? How can the Laboratories provide timely, detailed analytics that inform DOE and others' decision-making on priority investments, industrial decarbonization strategy, and supply chain vulnerabilities?
- **New tools and services for industry:** What new tools and services do industrial stakeholders need to accelerate adoption of later-stage industrial decarbonization solutions and close supply chain gaps?
- **Direct technical assistance to federally supported projects:** How can the Laboratories support the success of DOE-backed industrial demonstration and deployment projects? How can the Laboratories work directly with these companies and communities to mitigate scale-up risks, solve engineering and design challenges, and secure follow-on investment?

The full participant readouts are provided below.

A.1 – DATA AND ANALYTICS TRACK			
CAPABILITIES	**EXISTING LABORATORY STRENGTHS**	**OPPORTUNITIES—HOW TO GET THERE?**	**STRUCTURAL CHANGES NEEDED**
Live, quickly accessible data and analytics platform (covering investment, global and country supply/ demand, trade dynamics, market conditions including risks and potential mitigants) Viewed through multiple lenses: DOE, external, Laboratories, etc. Provide rich, trusted, and timely datasets that Offices, specific projects, reports, and quick turn request could pull from.	Ability to: • Track capacity announcements, commodity flows, and supply/demand balance • Anonymize data and build visualizations • Connect with industry partners, trade groups and consortia • Verify baseline technology data (e.g., energy intensities, thermal efficiencies)	• Evaluate available datasets, connect with collection sources (e.g., interagency, industrial groups, etc.) • Leverage existing data warehouses or curation that may exist in the Office of Science and Innovation and pool capabilities, datasets, analysis tools, etc., for relevant technologies and sectors • Ability to do prospective analysis and impact analysis on the national level • Use high-performance computing, machine learning/artificial intelligence, natural language processing, etc., for mining data and pulling out insights	• Define what needs to be tracked on an ongoing basis • Address data sharing needs and constraints • Leverage existing project data and insights • Fill data gaps and deserts • Invest in visualization • Define and track enabling factors for new technology opportunities and future adoption • Identify and negotiate alternative license sharing arrangements that allow data access across Laboratories and the DOE complex

A.1 – DATA AND ANALYTICS TRACK			
CAPABILITIES	**EXISTING LABORATORY STRENGTHS**	**OPPORTUNITIES—HOW TO GET THERE?**	**STRUCTURAL CHANGES NEEDED**
Comprehensive energy sector industrial base (ESIB) mapping and situational awareness (e.g., supply/value chain mapping, firmographics, vulnerability assessments, visualization, security considerations)	• Legacy of rigor in engineering and physical science fiel ds. • Deep expertise in-house: recognized and trusted for impartiality and objectivity. • Existing multidisciplinary approaches: greenhouse gases (GHG) and TEA, supply chain modeling, and depth of respective skill sets. • Leveraging existing legacy of national security relationship to manage sensitive data, analyses, and insights.	• Need to supplement skill set with business and economic acumen (e.g., financial or market analysis). • Hiring economists and financial/market analysts in addition to engineers and physical scientists • Extending legacy security mission and big data experience to energy infrastructure priorities • Consider company decision-making as analysis unit (vs. process/technology perspective)	• Extend DOE/Lab working relationship to DOE decision-making for projects (i.e., don't stop when analysis is done). • RDD&D feedback loops: Cycle DOE data back into Laboratory models to inform actions—how have supply chains changed (or not changed)? What remaining R&D is needed in technologies? • Trade flow analysis requires new perspective/methods/ data; past is not necessary prologue.
Detailed scenario, sensitivity, and commercial readiness analyses and financial modeling of different deployment models (e.g., bottom-up cost analysis, revenue scenarios, business case analysis, quantify uncertainty)	• State of Technology Assessments • LCAs • Complex, integrated energy system models • Capacity expansion and deployment modeling for energy and manufacturing technologies • Multidisciplinary approaches to problem-solving and analysis • Identifying connections across DOE programs and industry	• Build business and economic acumen to align with decision-makers • Informing industrial policy/strategy on actions needed to be taken by whom. • Feedback loops between the Office of Infrastructure and Office of Science to Innovation and externally • Verification, validation, and consistency of data/models	• Staff at the Laboratories with private sector and/or project financing experience • Understanding market dynamics • Updating tools or models to be more relevant to inform decisions on D&D side. • Being integrated—across DOE and Laboratories—to synthesize project data with interdisciplinary Laboratory teams to rapidly respond to real time questions

A.1 – DATA AND ANALYTICS TRACK			
CAPABILITIES	**EXISTING LABORATORY STRENGTHS**	**OPPORTUNITIES—HOW TO GET THERE?**	**STRUCTURAL CHANGES NEEDED**
Analysis of workforce implications of different deployment models (e.g., labor and skills requirements) Identify workforce needs and capabilities for new technologies Developing and supporting necessary training/certification programs to onboard needed workforce	• Cross-lab: Investment tracking at energy.gov/invest • Successful hands-on and virtual training programs and module development • DOE internship programs (e.g., Workforce Development for Teachers and Scientists, Science Undergraduate Laboratory Internships, Community College Internships, Oak Ridge Institute for Science and Education) • Partner with Industrial Assessment Centers for training and skills road mapping	• Linkage to Energy Equity and Environmental Justice and community/place-based analysis. • Evaluate what is working well with existing internship programs • How can we make transitions more seamless? How can we identify where transitions are? • Work with community colleges and industry on technicians' needs, as a way to understand what new skills are increasingly in demand	• Consider mechanisms to allow workers (outside the project performer) to participate in demonstration projects as a way to deliver hands-on training, with Laboratory support for classroom-based training • Determine data sources for future technologies • Consider bringing unions into training discussions • Establish clean energy training passport of certifications
Market and community-oriented messaging and technical assistance (i.e., products accessible to investors, business, labor, community groups, and other key stakeholders; shared fact-base and tools, LCA/TEA, Environmental Justice impacts) Translate results and message to various audiences by being a trusted data provider Standardize approaches for disseminating information from each method (TEA/LCA/ Diversity, Equity, Inclusion and Accessibility /Community Benefits Plans to each stakeholder group	• Many tools are available for use to build shared fact-base • Matchmaking services between vendors/ awardees and investors/local developers/state and local governments • Model and toolkit development to link producers to off-takers • Community-engaged research questions/projects • Engagement with industry groups to identify gaps/issues	• More bidirectional communication with stakeholders on what information they are looking for • Baseline studies and market reports that resonate with audience • Build shared fact-base • Clearinghouse for tools and resources • Identify key roadblocks and develop messaging, tools, and engagement strategies to address • Invite to pilot facilities • Gain insights from deployment-phase successes and failures of DOE-funded technologies	• Increase bandwidth for these types of engagements • Ability to establish communication channel, including for information exchange

A.1 – DATA AND ANALYTICS TRACK			
CAPABILITIES	**EXISTING LABORATORY STRENGTHS**	**OPPORTUNITIES—HOW TO GET THERE?**	**STRUCTURAL CHANGES NEEDED**
Data-sharing platform and established stewardship, maintenance, evaluation practices that allow for secure collection and analysis of federal project data, sharing of anonymized insights (including mapping data/analysis tools)	• Experience developing and maintaining data-sharing platforms and best practices • Contractual frameworks already developed for the integration, protection, and embargoing of data (project and proprietary) • Ongoing projects involving data platforms that merge datasets in user-friendly graphical user interfaces.	• Explicit support for Laboratory staff in existing data management/collection activities and best practices conducted in industry • Clear expectations: data wrangling vs. stewardship vs. website • Data scientists could consider the best way to architect this data	• Consistent format and requirements for data input and a clearly defined and consistent data management plan • Data sensitivity framework—with DOE evolving and expanding their mission to deployment but also maintaining a competitive advantage • Ongoing funding plan
Flexible contracting and relationships with data vendors, industry, users, other agencies to supplement in-house capabilities and rapidly incorporate third-party insights and data	• Laboratories as critical connector from data to analysis to insight • Access across DOE and Laboratory ecosystem to industry data subscriptions • Supply Chain Data Storage Platform project: existing effort to index/tag data to search in aggregate across DOE/Lab system	• Laboratories as clearinghouse for third-party data and competition for lowest-price contracts • Pilot program to share data insights across the Office of Infrastructure via existing data access before pivoting to a new data consortium • Ensure that D&D work is reflected in Laboratory mission and official Laboratory Capabilities Matrix to avoid work acceptance delays and issues.	• Restructure data procurement entirely: limited number of specialized Laboratory data SMEs with low-cost seats to create (uncopyrighted) derived data products to share across DOE/ Laboratories • Stewardship: revisit data relationships annually to maintain coverage efficiently (time and cost) • Need awareness and amplification with DOE Laboratory system to ensure connection and access

A.1 – DATA AND ANALYTICS TRACK			
CAPABILITIES	**EXISTING LABORATORY STRENGTHS**	**OPPORTUNITIES—HOW TO GET THERE?**	**STRUCTURAL CHANGES NEEDED**
Capabilities and structures to provide "visibility into the black box" while protecting data	• Development and validation of models that use public and proprietary data • Curating, quality controlling, and anonymizing datasets • Being seen as a trusted source of data/citation • Leveraging High-Performance Computing, Artificial Intelligence, and Machine Learning tools to scrape data and draw insights	• Common modeling framework, methodologies, assumptions, testing and validation • Build trust by giving visibility to modeling techniques and data sources • Showing private-sector value proposition in using emerging aggregated analytics and trends • Crowd-source enhancements to models • Accessibility of tools, how-to guides, intuitive user interface, forums/webinars to connect with modeling SMEs.	• Agreement on information boundaries (i.e., shareable) • Prior agreement with data providers • National security considerations • Frameworks, tooling, and/or best practices to evaluate anonymization through aggregation • Annual and ongoing review process to ensure that documentation is synchronized with technology
Data warehouse/ infrastructure network protocols	• Warehouse data generated from DOE awards and other projects, embargoed (as necessary) with proprietary data protected. • Anonymize and aggregate project-level data to inform modeling/analysis. • Trusted datasets, delineated for purpose. • Clear governance structures within DOE/Laboratories • Standardizing the exchange of data in support of enhanced decision-making • Secure systems to safeguard against bad actors	• Common Application Programming Interface framework—to run models and scenarios on demand on the network in a secure and robust fashion • Common model documentation framework—to expose the calculations, assumptions, methodologies, testing and validation • Run-time data lineage—track model inputs and outputs through the data life cycle and automatically flag models that may need to be recalculated when fresh data arrive • Ability to connect experimental capabilities to build new datasets for new technologies or bridge data deserts and data validation on the new frontiers	• Create inventory of datasets, producers and consumers of datasets, real-time vs. periodic publishing frequency • Map stakeholders and identify data needs, sources, and level of protection required to inform data governance issues • Create single source of truth across DOE/ industry • Develop and standardize data mesh, sharing, and protection protocols for (a) DOE awards, (b) interagency (c) international entities and (d) industrial entities and trade groups. Protocols for harmonization, prioritization, or trust levels.

A-2. – Tools and Services for Industry Track			
CAPABILITIES AND IMPACTS	**GAPS IN THE FIELD**	**OPPORTUNITIES FOR LABORATORIES**	**APPLICATION AREAS**
Expedited Validation Testing: (1) Further expedite TRL 4–6 validation testing (an existing cross-Laboratory strength) and (2) expand validation testing capacity to more high-TRL (TRL 7–9) challenges Impacts • Enable small and midsize businesses to compete and enter new fields • De-risk investment in small and midsize businesses • Develop domestic manufacturing for components by lowering barriers to prototype and test for small and midsize businesses	• Skill sets • Resources • Limited availability of accessible, agnostic environments for testbeds, with protection of IP • Access to digital environment and large datasets for modeling and predicting for use by small and midsized businesses	• Growth of private industry • Industry diversification • International markets • Laboratories already deliver extensive validation testing at earlier-TRL levels • Although Laboratories cannot certify products (i.e., Underwriters Laboratories) can help close the gap	• Test bed for systems (e.g., HVAC/R) • Third party testing — Laboratories represent an agnostic environment • Scale testbed for residential, commercial, and industrial applications • Development of digital twins and other similar tools • Unlocking data access for third party collection • Validation/testing best practices and Standard Operating Procedures for emerging tech including high voltage devices, battery materials
Supply Chain Assessment Impacts • Accelerating timelines and decision-making, de-risk, reduce cost • Permitting process clarity: geographical and technology-specific mapping • Define gaps in regulations—identify opportunities for action • R&D considers standards and informs permitting and standards creation	• Overall: knowledge • Queue for charging energization • Standardization of standards, such as technical support for standardization process • Agency authority • Research doesn't consider this aspect of commercialization • Understanding quality standards, materials needed to meet manufacturer requirements	• Developer project siting decision-making • Interconnection (broadly) managers speeding up decision includes placement of heavy industry • "Smart-from-the-start"	• Map of relevant Federal, State, and local regulations for given industrial activities through the country (geographic information system based) • List of actors with applicable authorities • Air and water permitting and siting requirement mapping • Allocation of perceived delays (mining) • Grid interconnection management process for simplification • Permitting requirements for long-term carbon storage
Safety and Hazard Analysis Tools and Assessment Impacts • Emerging areas such as new fuels (Hydrogen) and energy storage (batteries) • Speed of deployment • Societal acceptance • Sufficient (appropriate) standards where applicable	• Current vs. emerging applications • Different levels of expertise • Knowledge of practice • Existing workforce knowledge, including first responders • Larger challenge for small and medium manufacturers vs. large manufacturers	• Ease of insurability • Elevated environmental, social, and governance (ESG), corporate sustainability, workforce standards	• Safety impacts across industries that are decarbonizing • Materials handling, including transportation (especially for powders) • Handling tricky materials (radioactive/ deleterious) • Responsible/ sustainable sourcing and processing • Stationary storage in challenging environments • Battery recycling and end-of-life

A-2. – Tools and Services for Industry Track			
CAPABILITIES AND IMPACTS	**GAPS IN THE FIELD**	**OPPORTUNITIES FOR LABORATORIES**	**APPLICATION AREAS**
			• Electrical hazards and training for electrification • Pipelines for CO_2, high pressures
Workforce Development Impacts: • Investment in diverse stakeholders and different communities • Getting workforce comfortable with new technologies • Upskilling operators and technicians for energy transition • Communities identified or associated with a discrete energy technology • Consideration for nontechnical workforce (i.e., soft skills)	• Pride factor related to purpose befitting their job • Social component—jobs for a diverse population and diverse personalities • Energy literacy—need diverse platforms to publicize info • Cultural identity needs to be part of planning • Expanding education to include all generations • Segmentation and targeting of educational workforce development • Certifications for upskilling	• Industry for upskilling operators and technicians • Generational, socioeconomic, cultural, gender diversity • Train the trainer • Specialized certifications • Satellite National Laboratory offices and public buildings, greater outreach, and public access	• For longer term technologies, opportunity to establish transition plans and working groups • For existing technology transitions, pull together existing training/tools for broad distribution • Featured “day in the life” videos, highlight industry experts • Define standards for certification (i.e., energy storage sizes/levels) • Use existing Laboratory utility control rooms as teaching environment
Environmental Health Impact Assessments Impacts: • Permitting • Siting • Screening/scoping • Accelerated permit to shovel timelines • Community Acceptance	• Rapid tools/ assessments • Independent analysis—leading to the identification of bottlenecks/hurdles • Capability integration • Perceived health and environmental impacts of emerging technologies • Community education and perception	• Non-governmental organizations and involvement • Improvements to environmental justice and metric definition • Project developer outlook and experience (improved investments) • Corporate ESG realization	• Technology-specific approaches for industrial decarbonization incorporating dispersion modeling, pollutant life cycle modeling, mortality, and morbidity studies for pollutants • Improved impacts analysis for emerging energy materials processing in terms of water management emissions • Impact of carbon management on sub-surface stability, CO_2 dispersion and concentration
Standards, Permitting, and Regulation Mapping Impacts: • Help develop domestic supply chain • Identify financial/ geopolitical/resource risk and incentives • Identify Tier 1–4 supply chains	• Country of origin reporting/database • Commodity price index by region • Centralized best practices • Supply chain data availability • Policy gap to support Tier 1, 2 components	• Enhanced commercialization opportunities • More globally competitive domestic processes • More globally competitive R&D pathways	• Improved circularity in supply chains for critical materials, energy storage materials, and grid components • Scope domestic supply chain options for carbon management • Assessment of transformers, circuit breakers, long lead-time components for grid

A-2. – Tools and Services for Industry Track			
CAPABILITIES AND IMPACTS	**GAPS IN THE FIELD**	**OPPORTUNITIES FOR LABORATORIES**	**APPLICATION AREAS**
• Cost models based on capacity/shared capacity	• Sourcing best practices • Capacity leveled demand model • Secure/reliable data • Connecting National Laboratory models together • Shipping capacity		• Study Tier 1–4 suppliers and/or regions for critical components to ensure regionality and security

A.3 – Technical Assistance for Federal Projects Track			
CAPABILITIES	**EXISTING LABORATORY STRENGTHS**	**OPPORTUNITIES**	**STRUCTURAL CHANGES OR ACTIONS NEEDED TO GET THERE?**
Technoeconomic and LCA services Holistic (and harmonious across the Laboratories), process-level, well-vetted technoeconomic and LCA analyses for industrial projects, including cross-sector coverage. Should have undergone industry review and earned widespread confidence.	• Argonne GREET model is considered a gold LCA standard. • Plenty of Laboratory experience and expertise in this area. • Laboratories have traditionally provided tech-specific analysis on areas like hydrogen, carbon capture, plastics/biobased recycling.	• Increased coordination and collaboration across the Laboratories. • Standardizing approaches across the Laboratories. • Accelerating processes to address industry needs.	• Develop process integration models to estimate capital and operating costs. • Faster and umbrella CRADAs. • Identify go-to, expert modelers and analysts.
Holistic scenario analyses and system simulations Map supply chains for new and emerging energy technologies and anticipate and proactively address vulnerabilities. Includes insight into how a facility/project fits into a broader regional ecosystem.	• Some advanced tools and databases are already in place (i.e., FORCE, IDEAS, REEDS, REGEN). • Supply chain logistics, flows, dynamics and uncertainty modeling (for feedstock and product markets) • Clear role for Lab involvement.	• Improved models and systems simulations and computational resources. • Establish a common supply chain for the most basic technology needs.	• Create a database with common assumptions across technologies. • Form industry advisory board, industrial alliances to inform direction. • Employ and expand tools that have already been developed.
Technical performance & scale-up (including risk assessments) Analyze and advise industrial clients on scaling up and de-risking emerging technology products.	• Varied and integrated expertise (including compliance, industry experience, finance, HR, engineering, etc.). • Manufacturing scale-up facilities for production of novel materials to novel production methods (e.g., MDF, Materials Engineering Research Facility). • Existing network of user facilities, proving grounds (e.g., Advanced Research on Integrated Energy Systems, Energy Technology Proving Ground), real-time grid simulators, and tools (e.g., JOBS tool for economic impact evaluation).	• Faster/more agile contracting mechanisms. • Listen to industry more closely on what factors need to be de-risked to enable scale-up. • Better match of Laboratory capabilities to industry needs.	• Scaled up capabilities/ demonstration at existing user facilities and at new user facilities specific to major energy intensive industries and/or identified needs. • Detailed breakdown of Laboratory resources (potential digital twin).
Technical SME support and solution development Multidisciplinary team and tools to troubleshoot industry challenges	• Models in preexisting programs like EERE pilot programs that connect industry to Laboratory SMEs and the small business voucher, and existing programs like the	• Need “DOE ambassadors” to build bridges with industry and develop and cultivate trust. • Ability to quickly match expertise to	• Expand Labpartnering.org to include a portal or database—ideally down to the individual level—of SMEs, areas of Laboratory expertise, and relevant historical projects.

A.3 – Technical Assistance for Federal Projects Track			
CAPABILITIES	**EXISTING LABORATORY STRENGTHS**	**OPPORTUNITIES**	**STRUCTURAL CHANGES OR ACTIONS NEEDED TO GET THERE?**
	Network for National Laboratories for Environmental Management and Stewardship. • Significant and varied subject matter expertise across the Laboratories network.	industry need/request.	• Contracting policy that outlines the rules of engagement for Laboratories and industry to work together.
Support for adoption readiness of projects Models and frameworks for tech-to-market strategies that focus on market readiness for adoption	• Some Laboratories have models in place for tech-to-market acceleration. Need to assess and leverage what exists.	• Partnering with local universities to scale technologies in co-located communities and develop workforce. • Market landscape studies.	• Industry and community participation. • DOE/Lab involvement on projects to issue public-facing reports.
Data management for processes Data sharing agreement that addresses IP, economic, and national security challenges regarding aggregation, sharing, and use	• Energy Data Exchange handles public- and private-facing data from a wide range of data sources. • Alexandria platform for controlled use information data.	• Consider how to coordinate/leverage what already exists across the Laboratories, especially in trying to connect different technology lines to industrial sectors. • Use project data to provide process data engaging with the increase and future direction of smart manufacturing.	• Data sharing standards and frameworks. This could leverage those being developed by Manufacturing USA Institutes CESMII (smart manufacturing) and CYMANII (cybersecurity) • Interfaces for data exchange across existing Laboratory modeling tools. • Clear and standardized IP protection.
Convening and collaborating with stakeholders Utilize the convening power of the federal government to hear and understand what technical assistance industry needs and to be a brokerage to create relationships between program participants and other stakeholders needed for their success.	• Industry technical assistance programs including Better Plants, 50001 Ready, On-Site Energy Technical Assistance Partnerships, and the Industrial Assessment Centers . • DOE previous Xlab events. • DOE matchmaking events.	• Federally funded “demo days” for important follow-on needs such as financing and other partnerships *(may be a DOE role, not a Laboratory role)* • Develop regular engagement plan with companies to ensure technical assistance needs are met and facilitate peer-to-peer learning.	• Identify project participant needs for visibility and connections. • Develop deep, personal relationships based on trust with industry participants.