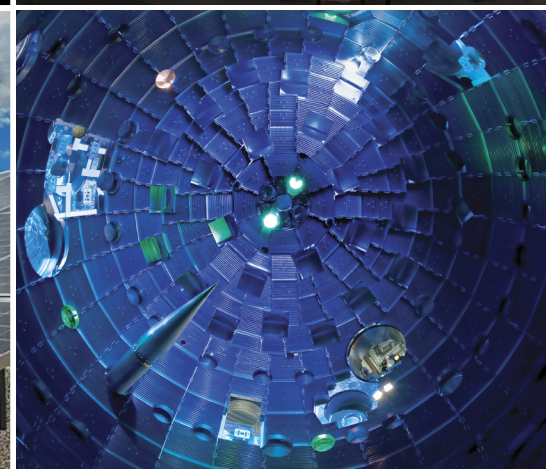
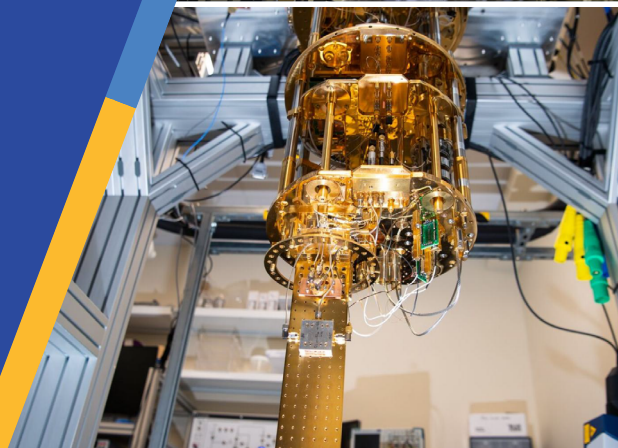
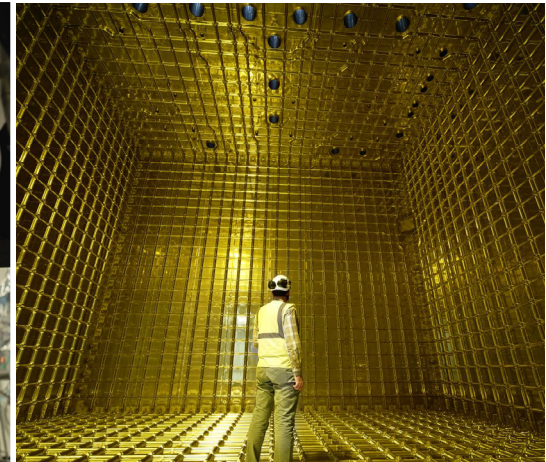




Transition 2024

Issue Papers

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CRITICAL MINERAL SUPPLY CHAINS

Critical minerals and materials are essential to the clean energy transition and national security, but the U.S. market is import-reliant on the People's Republic of China for some processed minerals. In addition to significant investments in domestic supply chains, trade and international alliances are essential to meet forecasted critical energy minerals demand.

Summary

Critical minerals and materials (CMM), defined in the Energy Act of 2020, are any non-fuel mineral, element, substance, or material that the Secretary of Energy determines (1) has a high risk of a supply chain disruption; and (2) serves an essential function in one or more energy technologies. They are crucial to U.S. energy security as geographically concentrated segments of mineral and material supply chains are vulnerable to disruptions that could have significant impact on domestic battery supply chains, enhanced grid reliability, and manufacturing clean energy technologies. In addition to significant investments in domestic supply chains, trade and international alliances are essential to meet forecasted critical energy minerals demand.

Issue

CMMs play vital roles in a wide range of applications from smart phones to energy systems and national defense technologies. Global transitions to clean electricity and economy-wide electrification (e.g., transportation, buildings, industry) are driving unprecedented demand for critical minerals. In 2023, for twelve of the fifty mineral commodities in the [U.S.](#)

[Geological Survey \(USGS\) critical minerals list](#), the U.S. was one hundred percent net import reliant and more than fifty percent net import reliant for twenty-nine other critical mineral quantities. Some challenges to supplying the domestic market include uncertain future government funding; capital expenditure (CapEx) and operational expense (OpEx) market challenges; workforce and talent acquisition; non-market practices; and unstable commodity prices.

Status and Milestones

DOE has high-level workstreams, initiatives, [funding opportunities](#) and international efforts to address CMM supply chain shortfalls for use in clean energy products such as electric vehicle (EV) batteries, traction motors, wind, solar and grid storage. Offices involved in these efforts include Energy Efficiency and Renewable Energy ([EERE](#)), Fossil Energy and Carbon Management ([FECM](#)), Manufacturing and Energy Supply Chain ([MESC](#)), Loan Programs Office (LPO), National Nuclear Security Administration ([NNSA](#)), and [International Affairs \(IA\)](#), guided by [DOE's Strategy to Support Domestic Critical Mineral and Material Supply Chains](#). For example, EERE uses its Critical Materials Accelerator and [Critical Materials Innovation \(CMI\) Hub](#) to advance critical materials processing across technology readiness levels (TRLs). FECM addresses early and middle TRL through its research on extraction of CMM from coal and coal waste streams and a new program on responsible mining research that prioritize innovation. MESC provides cost share grants and tax incentives under the Infrastructure Investment and Jobs Act (IIJA), including [Battery Materials Processing Grants](#) and the [48C tax credit](#). LPO backs commercial scale domestic [critical materials projects](#). NNSA addresses gaps and risks in the nuclear security supply chain. The Office of Intelligence and Counterintelligence (IN) briefs senior leadership on global intelligence in critical materials global markets. IA facilitates coordinated response to supply disruptions with allies and strengthens supply chains and private sector engagement between the U.S. and its allies and strengthens supply chains and private sector engagement between the U.S. and

its allies. These offices also support [Circularity/Recycling](#) and Workforce Development for the clean energy transition. These efforts are coordinated internally under DOE's Critical Minerals & Materials Budget Crosscut, and USG-wide via the [National Science and Technology Council \(NSTC\) Critical Materials Subcommittee](#), the [Federal Consortium for Advanced Batteries](#), and various Interagency Policy Committees.

Background

[EERE](#) prioritizes materials, manufacturing, and product innovations to: (1) increase the domestic supply and basic availability of CMMs and (2) reduce the demand for CMMs for energy applications. To enhance supply, EERE is building domestic capabilities for midstream processing (i.e., creation of high purity critical minerals) and downstream processing (i.e., conversion to end-use applications). This includes a focus on new technologies to produce these materials from unconventional sources such as brines and clays, as well as innovations to enhance the efficiency and productivity of existing manufacturing routes. To further enhance supply, EERE is advancing circularity technologies that enable reuse of critical materials recovered from end-of-life products (e.g., batteries, electrolyzers, electronics, motors). To reduce demand, EERE supports R&D to advance adoption of new clean energy products that reduce or eliminate the use of CMMs in their designs. This includes innovations in battery designs utilizing new chemistries (e.g., sodium-ion) and electric motors that significantly reduce use of rare earths. Underpinning these activities is a focus on minimizing impact of processing on communities through furthering environmentally sustainable practices with minimal ecological impact. Finally, EERE is furthering innovative education and workforce development to map and develop skills needed to support a workforce ready to drive adoption of these technologies in roles ranging from metallurgists that process these materials to battery factory

workers producing new battery designs.

[FECM](#) is prioritizing future innovation to ensure the responsible mining of CMMs by advancing R&D for more efficient and sustainable mineral extraction processes. These innovations aim to minimize the environmental impacts of mining, such as reducing carbon emissions, water usage, and land disruption, while promoting precision extraction methods. Areas of particular interest include advanced drilling technologies, novel geophysics, digital subsurface applications, in-situ mineral extraction, tailings management, impacts of marine mineral production, and mineral traceability – all to mitigate the risks of supply disruptions and ensure that the U.S. can meet its clean energy goals without compromising on sustainability or resource availability. The office also collaborates with industry, academic institutions, and government agencies to address the challenges of responsible mining. Overall, FECM aims to create a mining ecosystem that balances the demand for critical minerals with environmental sustainability and ethical critical materials supply chain practices.

[MESC](#) is utilizing provisions under the IIJA, the Inflation Reduction Act, and the Defense Production Act to invest in domestic manufacturing, identify dependencies and direct energy supply investments where they are needed most, and secure domestic energy infrastructure to support the clean energy transition. To boost processing and manufacturing capacity, the office is deploying [Advanced Energy Manufacturing and Recycling Grants](#), [Battery and Critical Minerals Recycling Grants for Retailers](#), [Battery Manufacturing and Recycling Grants](#), [Battery Materials Processing Grants](#), [DPA Grants for Electric Heat Pumps](#), and [Domestic Automotive Manufacturing Conversion Grants](#). MESC is also deploying several tax credits and rebates under the [48C Tax Credits](#), [Energy Efficient Transformer Rebates](#), and [Extended Product Systems Rebates](#). MESC is supporting state and local government efforts to bolster

circularity and workforce development through the [Battery and Critical Mineral Recycling Grants](#) and the [State Manufacturing Leadership Program](#). Finally, the office has done significant CMM supply chain analysis. MESG announced \$3 billion in project selections under Round 2 of its Battery Materials Processing Grants on September 20, 2024.

[LPO](#) is utilizing various authorities, such as the [Advanced Technology Vehicles Manufacturing Program](#), Title 17 Clean Energy Financing, and the Tribal Energy Finance Program, to issue loans to projects that process CMMs using innovative technology for end use in a variety of eligible clean energy technologies and for projects that manufacture eligible advanced technologies, their components, or the recycling of these components. Through these authorities, LPO has issued loans of approximately \$6 billion towards domestic critical materials projects.

[NNSA](#) is working to enhance the strength, security, and resiliency of its CMM supply chain. NNSA's activities towards achieving this goal include assessing national security needs with defense and intelligence agencies, developing strategic plans for nuclear priorities, investing in R&D with research institutions, conducting supply chain vulnerability assessments, and translating priorities into budget requests in partnership with its various labs, plants, and sites (LPSs). NNSA leverages its network of partners across DOE, interagency groups, and the LPSs to share information and gain visibility over CMM-related risks, advocate for NNSA equities in existing initiatives and investment projects, and coordinate responses to shared supply chain challenges.

[IN](#)'s Energy Security Division produces all-source analysis and intelligence briefings for principals on CMM issues. Their focus is on identifying threats to global critical mineral supply chains and highlighting opportunities for international collaboration and coordination. The office collaborates closely with Intelligence

Community partners on these issues and participates in a variety of interagency working groups and responses to taskings.

[IA](#) is working to support security of supply from international sources through two primary workstreams. First, IA leads DOE's engagement in international settings -- G7, G20, the International Energy Agency (IEA), Organization for Economic Cooperation and Development (OECD), International Standards Organization (ISO), and North Atlantic Treaty Organization (NATO), among others -- to open channels of trade in the critical minerals supply chains. This work facilitates coordination on R&D, develops ESG standards, and friend-shores CMM supply chains to decrease reliance on our foreign adversaries. Most notably, IA launched the Critical Minerals Security Program at the IEA in 2022 to coordinate actions across our allies to effectively prepare for and respond to supply disruptions. Second, IA leads targeted international market development with industry, trade associations, embassies, and other government agencies to fortify strategic Foreign Direct Investment (FDI) in the U.S. critical materials supply chain and advocate for U.S. companies operating abroad in CMM extractive industries. IA is also leading efforts to protect domestic supply and create international standards for recycling and circularity of spent EV batteries.

DOE ENTERPRISE CYBERSECURITY

The Department of Energy (DOE) networks are valued targets of nation state and other malicious actors. DOE's Office of the Chief Information Officer (OCIO) is responsible for the overall cybersecurity of DOE networks and systems and coordinates and synchronizes cybersecurity functions across the DOE labs, plants, and sites.

Summary

Protecting the IT assets of DOE is critical to U.S. national security. Due to its advanced research, responsibility for the transmission of wholesale electricity to thirty-four states, and its national security missions, DOE is constantly targeted by sophisticated nation-state adversaries and other malicious actors.

DOE has a complex cybersecurity environment encompassing seventeen National Laboratories and approximately one hundred field installations. Its mission ranges from open, collaborative research to maintaining the Nation's nuclear stockpile. Cybersecurity postures and approaches are tailored to the appropriate risk profile for each installation. Cybersecurity funding and authority is divided between the OCIO and the program offices. The OCIO is responsible for developing policy, performing oversight, and providing an enterprise-wide incident response and coordination capability as well as providing services to OCIO's IT services customers and shared services, such as supply chain risk management.

The cybersecurity program at DOE faces significant challenges including several mandates with competing financial priorities, requiring DOE

to focus cybersecurity resources to areas of highest risk. DOE must be positioned to ensure the early detection of cybersecurity vulnerabilities and incidents, and timely response, remediation, and recovery. In addition, Artificial Intelligence (AI), Quantum Computing and Post Quantum Cryptography (PQC) introduce a spectrum of cybersecurity threats and opportunities. Like many federal agencies, DOE is also addressing a shortage of cybersecurity workforce staff.

Issue 1: Enterprise Cybersecurity Visibility

The White House, Office of Management and Budget (OMB), and Congress are requiring greater visibility into the implementation of cybersecurity policy and control metrics throughout the government. While each DOE site has insight into their environments, enterprise visibility of networks and systems across DOE is limited. The limitation is due to operational, compliance, risk management, and governance data being decentralized, which leads to gaps in policy implementation and a fragmented view of cybersecurity at the enterprise level. OCIO is deploying solutions that, when fully operational, will roll this site-specific visibility up to the enterprise level.

Status

In fiscal year (FY) 2024 DOE's Continuous Diagnostics and Mitigation (CDM) program significantly increased visibility into network joined assets by expanding coverage of the real time inventory capability across the enterprise. The program will continue to expand coverage of CDM Asset Management capabilities in FY 2025, including integration of additional sensors, and leveraging CDM data for automated reporting.

OCIO has established the Enterprise Cyber Collaboration Office (ECCO) to coordinate across DOE, providing better visibility of cybersecurity status for departmental elements, labs, plants, and sites. The ECCO pilot modeled how the program will streamline engagement with the enterprise and aggregate cyber data to ensure a resilient DOE enterprise and improve compliance

with federal mandates. Requirements gathering for the cyber metrics dashboard is underway.

Milestones

- All components reporting data to CDM Dashboard in FY 2025 Quarter 1.
- All components engaging with ECCO in FY 2025 Quarter 3.

Issue 2: Keeping Current with Rapidly Evolving Cybersecurity Mandates

The cybersecurity threat is constantly evolving. Starting with Executive Order (EO) 14028, the federal government has issued several cybersecurity mandates that furthered requirements for zero trust architecture, encryption, logging, multifactor authentication (MFA), endpoint detection and response (EDR), and the transition to post quantum cryptography. While these mandates are appropriate and constitute best practices for IT cyber hygiene, they often contain deadlines that are sooner than the annual appropriations process can accommodate.

Adding to the complication of implementing these mandates is the very large presence of operational technologies (OT) used to monitor and control physical processes and machinery within DOE. The requirements are either unachievable or immensely costly to apply to OT and OCIO is in regular discussions with OMB on this topic.

This mismatch between the urgency of the need to address cybersecurity threats and the annual appropriations process requires careful management and prioritization.

Status

DOE takes a risk-based approach to prioritize funding for the highest-impact uses. Some department elements, such as the Power Marketing Administration (PMAs) and Environmental Management (EM) do not have sufficient funding and there is an expectation that OCIO will supplement. Cybersecurity and

Infrastructure Agency (CISA) funding for DOE CDM licensing ended in FY 2024, requiring OCIO funds to be diverted to CDM maturation and leaving entities across the enterprise without critical funding for cybersecurity programs.

Per metrics established by the Federal Information Security Modernization Act (FISMA), DOE is below target on four of five high impact cyber metrics driven by the EO. Our most significant challenge is that we have zero percent compliance with logging requirements for high value assets (HVAs). In other areas, we have sixty-five percent of a ninety percent compliance requirement for MFA, sixty-six percent of a ninety percent compliance requirement for EDR, and seventy-seven percent of ninety percent compliance requirement for encryption of data. These compliance numbers include OT and will improve when the OT is identified and documented.

Issue 3: Artificial Intelligence (AI), Quantum Computing, and PQC

There are three aspects of AI that are impactful to cybersecurity: 1) Ensuring AI tools used in DOE are cyber secure including the data sets used in the AI tool; 2) Defending DOE networks from AI based attacks; and 3) Utilizing AI based cyber tools to help defend against AI attacks. The use of AI has created new opportunities for cyber threat actors and adversaries are increasingly exploiting AI to launch faster, broader and more effective cyberattacks. As AI capabilities expand, so does the potential for malicious actors to leverage those capabilities and enhance their attacks on critical energy systems. Concurrently, the implementation of AI-powered security tools and strategies is a crucial aspect of countering cyberattacks. These risks are exacerbated by requirements that the government must follow to roll out AI responsibly, with accountability for records, privacy, and assessment of rights and safety impacts for the general public. Our adversaries are not bound by these constraints.

Quantum computing represents a threat to the federal government's most used cryptographic capabilities, including the "hack now, crack later" strategy whereby adversaries steal sensitive data today with the intent to decrypt when quantum computing matures. The quantum group QURECA estimated in 2023 that \$36 billion had been invested by governments worldwide in quantum computing, \$15 billion of that from China. Currently, there is no dedicated funding for DOE to address the PQC risk. Given the rapid advancements in quantum computing and the investments of our adversaries in this space, there is an imminent threat to our critical infrastructure, underscoring the urgent need to prioritize funding. The cost of updating DOE devices to quantum safe cryptography is currently estimated at \$2.5-\$3 billion, to include both interim mitigations and hardware refresh once solutions are available on the market.

Status

DOE is exploring the impact of artificial intelligence and quantum computing on cybersecurity risk.

OCIO maps AI activities through a risk management program and collaborates with officials to establish new processes that evaluate the performance and safety of AI systems. The DOE Cybersecurity Strategy aligns with the National Cybersecurity Strategy pillars (understanding and mitigating risk, ensuring mission resilience, developing our cyber workforce, and protecting our critical infrastructure) and includes activities to address the impact of AI on these areas. OCIO is also developing an AI Strategy and AI Policy that will address cybersecurity risks.

NIST recently published standards for PQC, aligning with guidance outlined in memorandum memorandum M-23-02. These standards define key algorithms for secure digital communication, designed to withstand future attacks from quantum computers. In response, DOE is actively evaluating these algorithms,

along with the vendor solutions that implement them, to ensure strong key establishment and digital signatures that are quantum resistant.

Additionally, DOE is conducting in-depth technical reviews of Public Key Infrastructure (PKI), Personal Identity Verification (PIV) cards, and mobility solutions. These reviews aim to map out the complete cryptographic lifecycle, identifying potential vulnerabilities that could be exposed by quantum computing advancements. To stay ahead of emerging threats, DOE performs an annual cryptographic inventory across the department, identifying and addressing and legacy algorithms that may be at risk of quantum-based attacks.

Milestones:

- DOE AI Strategy by FY 2025 Quarter 2.
- DOE Cryptographic Inventory (per M-23-02) by FY 2025 Quarter 3.
- PQC Budget Estimates (per M-23-02) by FY 2025 Quarter 2.

Issue 4: Cyber Workforce

The Federal cyber workforce plays a vital role in protecting government technology systems, networks, and data from the most sophisticated adversaries; supporting and protecting critical infrastructure; and investigating and prosecuting malicious cybersecurity activity. The government is experiencing challenges in recruiting and retaining these professionals. The federal hiring process is complex and pay gaps between the public and private sector for these skillsets are significant.

Status

With regard to current challenges, the complexity of the hiring process means we cannot issue job offers as quickly as the private sector. In addition, DOE can no longer use current salary as a justification for bringing in specialists from the private sector at higher than standard government salary.

To address the private sector pay gap, DOE instituted a cybersecurity retention bonus program for cyber professionals performing specific, critical work roles. This program, reauthorized annually, will continue into FY 2025.

To build our pipeline of applicants, our annual Cybersecurity and Technology Innovation conference has sessions tailored to students to drive interest in DOE careers. We also participate in the National Cyber Workforce Education Strategy effort.



DOE UKRAINE ENERGY ASSISTANCE

Since February 2022, DOE has provided critical assistance to bolster Ukraine's capacity to defend and maintain the safe operation of critical energy infrastructure and nuclear facilities, and counter escalating Russian attacks through the provision of equipment, training, technical assistance, and focused bilateral engagements.

Summary

DOE has worked closely with Ukraine on energy and nuclear security for more than twenty years. Since February 2022, Russian forces have directly targeted energy infrastructure in Ukraine. As a result of Russian strikes, Ukraine has lost fifty-one percent of its total pre-war power generation capacity. Russia's actions, and threat of nuclear weapons use, have significantly increased non-proliferation concerns and continue to threaten the safety and security of the three Nuclear Power Plants (NPPs) that remain in Ukraine's control, as well as the Zaporizhzhia Nuclear Power Plant (NPP), which Russian forces have shelled, occupied and militarized. Since Russia's full-scale invasion in 2022, DOE has received \$738.8 million in appropriations from Congress to help support Ukraine's critical energy infrastructure resilience, nuclear risk reduction, and emergency preparedness and response.

Issue

Ukraine potentially faces a collapse of its electricity and heating sectors this winter and is in the beginning phases of planning for the repair

repair and rebuild of its energy sector following the end of the conflict. Ukraine's operating NPPs face continued risk as they are operating outside of pre-war regulatory standards and face pressure to continue to operate. If Ukraine's electrical grid collapses, although the danger to Ukraine's NPPs would vary from site to site, each would face loss of offsite power supply, which is essential to the safe operation of Ukraine's NPPs. The risk of a nuclear accident, potentially including a release of radiation, continues to increase the longer the war continues. Accordingly, DOE assistance is aimed at supporting Ukraine's ability to manage these challenges. DOE expects to sustain ongoing lines of effort associated with nuclear risk reduction, emergency preparedness and response, and critical energy infrastructure resilience while planning for unanticipated military escalation dynamics and related consequences, and ongoing and future repair/reconstruction efforts.

Status

U.S. policymakers and decision authorities rely upon DOE for timely and accurate analysis and innovative solutions on energy and nuclear matters stemming from Russia's invasion of Ukraine. In coordination with the U.S. government interagency, Ukrainian counterparts, and international partners, DOE provides analytical, advisory, and material support to Ukraine including specialized training, exercises, technical reach-back, and equipment.

Milestones

- Identify, procure, and deliver emergency electrical equipment to Ukraine to support its power and gas sectors including gensets, transmission equipment, circuit breakers, switches, and spare parts. Status: *Ongoing*
- Support the safe, secure, and reliable operation of Ukraine's NPPs through provision of equipment, continuous monitoring and analysis, direct advisory support, and implementation of protective measures. Status: *Ongoing*
- Deploy and monitor a suite of sensors in Ukraine and the surrounding region that

provide near real time situational analysis on the radiological and nuclear conditions in Ukraine. Status: *Ongoing*

- Leverage expertise at the National Laboratories to provide continuous monitoring and analysis of Ukraine's electrical infrastructure with an eye toward understanding and mitigating the risk of a catastrophic accident and/or total grid fracture. Status: *Ongoing*

Background

As Russia's war against Ukraine continues, the energy and nuclear security dimensions of the conflict require DOE to prepare for, prevent, and minimize the consequences of nuclear incidents, and to restore elements of Ukraine's energy and nuclear security impacted by the war. DOE established a formalized, integrated structure through the Ukraine Task Force to continue support to the government and people of Ukraine during this time of crisis, work to reduce the nuclear and energy security risks associated with the war, respond to emerging needs, and support the recovery of Ukraine following the war.

Office of International Affairs (IA)

IA coordinates DOE's participation in frequent National Security Council (NSC) led meetings in which energy-wide issues are discussed (note: NNSA coordinates non-proliferation specific meetings). IA manages \$44.7 million of funding for work the National Laboratories undertake with Ukraine, inter alia: modeling of Ukraine's electricity and natural gas grids; providing advice on cybersecurity measures; assessing electricity interconnections between Ukraine and neighboring countries; and the Net Zero World initiative. Of IA's \$44.7 million, approximately \$10 million is unobligated, but IA expects that number to decrease as Ukraine contends with issues during winter 2024/2025.

Office of Nuclear Energy (NE)

NE coordinates analysis of nuclear safety measures for Ukraine's NPPs to reduce risks to nuclear safety and generation. NE is a key conduit for information on NPP operation and changing risk factors and informs DOE's participation in reducing risks to nuclear safety and generation. Currently, NE is managing \$14 million of USAID funds, sent through the State Department, for work the National Laboratories undertake with Ukraine to provide materials, equipment and services to reduce nuclear safety and generation risks. Of NE's \$14 million, approximately \$7.4 million is unobligated, but NE expects that number to decrease as Ukraine contends with issues during winter 2024/2025.

National Nuclear Security Administration (NNSA)

NNSA coordinates analysis and assistance to reduce radiological and nuclear risks in Ukraine. NNSA has a long history of bilateral engagement with Ukraine on nuclear and radiological security and emergency preparedness and response. NNSA received \$161.3 million in FY 2023 supplemental funding and \$150 million in FY 2024 supplemental funding to carry out these activities. Additionally, NNSA implements select energy assistance efforts on behalf of DOE (e.g. distributed power generation and passive protection).

EXTERNAL INTERACTIONS

DOE's interactions with Congress, Intergovernmental Partners, and the Office of Management and Budget (OMB) are key to fulfilling the Department's mission.

Summary/ Background

Interactions with key external partners are outlined in three main sections:

- Interactions with Congress – Information on committees of interest for DOE, members with special interests, required reports and updates to Congress, relevant pending legislation, leadership changes in a new Congress, and working with other legislative offices to clear materials for Congress.
- Interactions with Intergovernmental Partners
- Interactions with OMB

INTERACTIONS WITH CONGRESS

Summary

The Secretary and members of DOE's leadership team have regular interactions with Authorizing, Oversight, and Appropriations Committee Chairs and Ranking Members, and with individual Members of Congress, especially throughout the hearing, markup, and conference process. The Office of Congressional and Intergovernmental Affairs (CI) and the Office of the Chief Financial Officer (CF) work with Congressional staff to address Member interests and constituent issues.

Within the Department, the Assistant Secretary

for CI manages overall relations with Members of Congress and supports the Secretary as the chief strategic advisor on all congressional interactions not directly related to the House and Senate Appropriations Subcommittees. CI prepares Departmental officials for congressional hearings, including confirmation, and programmatic and oversight hearings before authorizing committees. In this capacity, CI manages testimony development, prepares DOE officials for engaging in hearings, and manages responses to questions for the record (QFRs).

The Chief Financial Officer (CF) leads the Department's day-to-day interaction with the Senate and House Appropriations Committees, informs DOE leadership and staff of the interests and concerns of Appropriators, prepares the Secretary and other departmental leadership for interactions with Appropriators, and works with Subcommittee staff to achieve the Administration and Secretary's budget priorities.

Tight coordination between CI and CF is key to obtaining good outcomes for Departmental elements from Congress. NNSA has its own Congressional Affairs office, and similarly should coordinate closely with CI and CF.

COMMITTEES OF INTEREST FOR DOE

Appropriations Committees (Interaction Lead - CF)

The United States House of Representatives and United States Senate Appropriations Committees have jurisdiction over annual and supplemental discretionary spending legislation for the Federal government. Each Appropriations Committee is divided into 12 subcommittees with jurisdiction over funding for designated Executive Branch departments and agencies. The Subcommittees on Energy and Water Development, and Related Agencies (referred to as "HEWD" for the House subcommittee and "SEWD" for the Senate subcommittee) have jurisdiction over DOE. References in this section to the Appropriations Committee refer to the full Appropriations Committees, HEWD, and SEWD. Member and staff information for the 118th Congress, as of September 2024, is provided below.

CF serves as the central point of contact between Congressional Appropriations Committees and the Department. CF staff interact with the House and Senate Appropriations Committees regularly, primarily through the HEWD and SEWD subcommittees. CF's congressional relations functions include presenting the President's annual budget request ("rollout") and any

supplemental requests; preparing principals for hearings before the Appropriations Committees; responding to formal inquiries; and providing information to the Committees through reports, briefings, and technical assistance. CF arranges, prepares attendees, and participates in program office interactions with the subcommittees.

Committee		Chairman	Majority Staff Contact	Ranking Member	Minority Staff Contact
H O U S E	Appropriations Committee	Rep. Tom Cole (R-OK)	Susan Ross, Staff Director	Rep. Rosa DeLauro (D-CT)	Chris Bigelow, Staff Director
	Subcommittee on Energy and Water Development, and Related Agencies	Rep. Chuck Fleischmann (R-TN)	Laura Cylke, Clerk	Rep. Marcy Kaptur (D-OH)	Scott McKee, Clerk
S E N A T E	Appropriations Committee	Sen. Patty Murray (D-WA)	Evan Schatz, Staff Director	Sen. Susan Collins (R-ME)	Betsy McDonnell, Staff Director
	Subcommittee on Energy and Water Development, and Related Agencies	Sen. Patty Murray (D-WA)	Doug Clapp, Clerk	Sen. John Kennedy (R-LA)	Lindsay Garcia, Clerk

Authorizing Committees (Interaction Lead - CI)
DOE activities fall within the jurisdiction of several congressional authorization committees. The Department's primary authorizing committees

are: Senate Energy and Natural Resources, Senate Armed Services, House Science and Technology, House Armed Services, and the House Energy and Commerce Committee.

Committee	Chairman	Majority Staff Contact	Ranking Member	Minority Staff Contact
House Energy and Commerce Committee	Rep. Cathy McMorris Rodgers (R-WA)	Nate Hodson, Staff Director	Rep. Frank Pallone (D-NJ)	Tiffany Guarascio, Staff Director
House Committee on Science, Space, and Technology	Rep. Frank Lucas (R-OK)	Josh Mathis, Staff Director	Rep. Zoe Lofgren (D-CA)	John Piazza, Chief of Staff
House Armed Services Committee	Rep. Mike Rogers (R-AL)	Chris Vieson, Staff Director	Rep. Adam Smith (D-WA)	Brian Garrett, Staff Director
Senate Energy and Natural Resources Committee	Sen. Joe Manchin (I-WV)		Sen. John Barrasso (R-WY)	
Senate Armed Services Committee	Sen. Jack Reed (D-R.I.)	Elizabeth King, Staff Director	Sen. Roger Wicker (R-MS)	John Keast, Staff Director

Oversight Committees (Interaction Lead - CI)

CI coordinates with the Office of General Counsel (GC) in managing Congressional oversight and investigation requests, including the document

production process for oversight committee requests on DOE matters. The primary legislative bodies that deal with oversight of DOE issues include:

Committee	Chairman	Majority Staff Contact	Ranking Member	Minority Staff Contact
House Oversight and Accountability Committee	Rep. James Comer (R-KY)	Mark Marin, Staff Director	Rep. Jamie Raskin (D-MD)	Lauren Doney, Staff Director
Senate Committee on Homeland Security and Government Affairs	Sen. Gary Peters (D-MI)	David Weinberg, Staff Director	Rand Paul (R-KY)	Kendal Tigner, Professional Staff Member

Other Members With Special Interest

There are a number of Congressional Caucus Groups that focus on specific issues related to

DOE. CI has primary responsibility for interacting with these caucus groups. Some congressional caucuses of interest to DOE include:

Senate	
• Artificial Intelligence Caucus • Climate Solutions Caucus • Cybersecurity Caucus	• National Labs Caucus • Renewable Energy and Energy Efficiency Caucus
House	
• Advanced Energy Storage Caucus • Artificial Intelligence Task Force • Congressional Asian Pacific American Caucus • Congressional Black Caucus - Energy, Environment, and Agriculture Task Force • Congressional Grid Innovation Caucus • Congressional Hispanic Caucus	• Electrification Caucus • Spent Nuclear Fuel Solutions Caucus • Sustainable Energy and Environment Coalition • Congressional Labor Caucus • Fusion Energy Caucus • House Nuclear Cleanup Caucus • Offshore Wind Caucus • Manufacturing Caucus

REQUIRED REPORTS AND UPDATES TO CONGRESS*Funding Notifications and Appropriations*

There is a statutory requirement (often referred to as the "Section 301 notifications") that the Secretary notify HEWD and SEWD at least three (3) full business days in advance of making any grant awards or contracts of more than \$1 million, issuing a letter of intent to make an allocation award, or announcing publicly the intention to

make an award. CF works with program offices to notify appropriators of these awards.

Appropriations legislation instructs DOE to provide HEWD and SEWD reports on information on various topics. Reporting requirements appear in both legislative bill text and the report language that accompanies appropriations bill text. CF aims to implement requests in report language for an enacted appropriations bill and the original House and Senate reports, even if the legislation accompanying the report was never passed. Appropriators are interested in the Department adhering to this practice.

CF manages reports required in appropriations bill and report language by assigning reports to program offices and tracking progress to completion. Once CF receives a finished report, the report is cleared through the Office of the Secretary and provided to OMB for clearance. The final report and cover letters are transmitted under CF's signature. In general, reports required by appropriations language are shared only with the relevant Subcommittee and are not public.

WORKING WITH OTHER LEGISLATIVE OFFICES TO CLEAR MATERIALS FOR CONGRESS

Testimony and Questions for the Record

A committee initiates a request to hold a hearing by contacting CI or CF to identify a witness for a hearing under development. This witness may be the Secretary, Deputy Secretary, or other leaders in the Department from relevant Program or Staff Offices. This usually occurs through a formal letter of invitation from the Chairman, and at times CI or CF may receive advance notice from committee staff. CI manages appearances before authorizing committees on authorization-related topics; CF manages appearances before appropriations committees. CI and GC are responsible for Oversight testimony.

Once testimony is drafted by the appropriate program office, CI or CF (depending if the hearing is for an authorization or appropriations committee) coordinates the draft testimony with relevant program and staff offices for review and clearance, and then with OMB for approval. OMB may disseminate the testimony to other agencies for review through an interagency process managed by OMB. The Secretary and office witnesses often rely on CI or CF for Member biographies, briefing materials, and other hearing preparation.

Department witnesses are frequently asked to answer questions posed by Members of Congress after a hearing (Questions for the Record or "QFRs"). Responses to QFRs are

coordinated by CI/CF, prepared by the relevant programs, and cleared through a similar OMB process as testimony before being sent back to the Committee and incorporated in the official hearing record.

The Secretary traditionally testifies at hearings on the President's Budget before the Department's major committees of jurisdiction: House Energy and Commerce, House Science, Space, and Technology, Senate Energy and Natural Resources, Senate Appropriations Energy and Water Development Subcommittee, and House Appropriations Energy and Water Development Subcommittee. Under Secretaries and Assistant Secretaries may also be asked to testify on the budget.

Congressional Budget Office (CBO)

CBO is a legislative branch agency that produces independent analyses of budgetary and economic issues to support the Congressional budget process. CF staff provide technical assistance to CBO staff on an as-needed basis to explain President's Budget proposals or the impacts of pending legislation in Congress.

Government Accountability Office (GAO)

CF leads DOE interactions with the Government Accountability Office, a legislative branch audit agency with statutory authorities to review DOE programs and operations. CF designates lead offices for new audits, assists Program, Functional and Field offices in responding to data requests as needed, provides weekly reports on GAO activity, and tracks and reviews responses to GAO audit reports. As of September 17, 2024, GAO was performing 110 separate audits or assessments affecting DOE. The number of active audit engagements has increased over the past year. CF is also the designated Audit Follow-up official at DOE (per OMB Circular A-50); as such, CF is charged with leading DOE follow-up efforts for agreed-upon corrective actions and resolving disagreements.

Milestones

The 119th Congress is scheduled to begin January 3, 2025.

RELEVANT PENDING LEGISLATION

- **FY 2025 Appropriations bills**
Congress passed a Continuing Resolution (CR) to fund the government at FY 2024 levels through December 20, 2024. The HEWD subcommittee markup took place on June 28, 2024, and the full committee markup took place on July 9, 2024. Senate Appropriations full committee markup took place on August 1, 2024. The bill has not yet passed either the full House or Senate.

- **FY 2025 National Defense Authorization Act**
The National Defense Authorization Act (NDAA) authorizes appropriations for defense programs of the Department of Energy, including the National Nuclear Security Administration (NNSA), the Office of Intelligence and Counterintelligence (IN), and portions of the Office of Science (SC) and the Office of Environmental Management (EM). The NDAA also establishes new defense policies and changes to previous policies.

The NDAA process begins with the transmission of the President's budget request to Congress in February. The Administration/DOE often transmits legislative policy proposals to the committees of jurisdiction in conjunction with the budget request. The House Armed Services Committee (HASC) and the Senate Armed Services Committee (SASC) begin work on the NDAA following annual budget hearings, which typically lead to the drafting and markup of separate bills in the House and the Senate in May/June.

LEADERSHIP CHANGES IN THE 119TH CONGRESS

Appropriations Committees: CF is not tracking any expected retirements in House or Senate

appropriations committees or HEWD/SEWD leadership. Senator Murray has been acting Chair and then Chair of SEWD in addition to the Chair of the full appropriations committee since Senator Feinstein passed away in 2023. CF will remain in contact with the professional appropriations staff to understand and report on any Committee changes.

CI is currently tracking potential changes to DOE's authorizing committees for the 119th Congress:

Senate Energy and Natural Resources

Committee: Senator Joe Manchin (I-WV) is the current Chair of the committee but will be retiring at the end of the 118th Congress.

Senator Heinrich (D-NM) is expected to serve as Chair or Ranking Member for SENR in the 119th Congress (depending on Senate Majority). The current Ranking Member, John Barrasso (R-WY) will remain in committee leadership unless he fills the Senate Republican Whip position, in which case he will have to step down from his position as Ranking Member. If Senator Barrasso steps down, Senator Lee (R-UT) is expected to serve as Chair or Ranking Member for SENR in the 119th Congress.

House Energy and Commerce Committee:

Rep. Cathy McMorris Rodgers (R-WA) is the current Chair of the committee but she is retiring at the end of her term. Rep. Frank Pallone (D-NJ) will continue as Ranking Member or will become the Chairman of the committee depending on House Majority in the next Congress. Rep. Bob Latta (R-OH) and Rep. Brett Guthrie (R-KY) are potential replacements for Chair Cathy McMorris Rodgers.

House Science, Space, and Technology

Committee: Rep. Frank Lucas (R-OK) is the current Chair but is term-limited under party rules governing committee chairmanship and will be unable to serve as Chair or Ranking Member. At this time a replacement is yet to be determined. Rep. Zoe Lofgren will continue as Ranking

Member or become Chair of the committee depending on House Majority in the next Congress.

House Armed Services Committee: Rep. Mike Rogers is the current Chairman of the Committee but he is running for Senate. At this time a replacement is yet to be determined. Rep. Adam Smith (D-WA) will continue as Ranking Member or become Chair of the committee depending on the House Majority in the next Congress.

INTERACTIONS WITH INTERGOVERNMENTAL PARTNERS

Summary

CI maintains ongoing communications with governors, state legislators, tribal, and local officials across the country. CI proactively engages stakeholders to ensure that their views are considered as part of the Department's decision-making process. CI also communicates routinely with all relevant stakeholders on DOE announcements, initiatives, proposals, and grants, and assures appropriate follow-up.

The Department has a physical presence in thirty states. Of those, much of CI's focus is on twelve states where multiple, ongoing DOE missions are executed at DOE sites and National Laboratories (California, Colorado, Idaho, Illinois, Ohio, Kentucky, Nevada, New York, New Mexico, South Carolina, Tennessee, and Washington).

CI interacts on a regular basis with intergovernmental and tribal associations including but not limited to the National Governors Association, U.S. Conference of Mayors, National Conference of State Legislatures, Council of State Governments, National League of Cities, National Association of Counties and the National Association of State Energy Officials. The focus of CI's work with these organizations is to communicate the

activities of DOE programs, policies, and initiatives and solicit these groups' views, comments, and concerns. These efforts extend to a broad group of constituencies, to include business/industry, civic groups, colleges, universities, foundations, trade associations, and energy-oriented organizations.

Tribal Affairs: CI engages with the five hundred seventy-four federally-recognized tribes and the tribes' more than two hundred fifty reservations. This work includes: advising and informing DOE senior officials on potential impacts of Departmental programs on tribal interests and culture; developing and enhancing working relationships with Tribal leaders and organizations and entities working with tribal governments; representing DOE with sovereign Tribal governments and at tribal meetings and conferences; and recommending policies and procedures for ongoing collaboration between DOE and tribes. CI also works closely with the DOE Office of Indian Energy (IE) to assist in the management of the Indian Country Energy Working Group, the National Tribal Energy Summit, and IE's work with congressional partners to advance the mission of implementing activities that assist American Indian Tribes and Alaska Native villages with energy development, capacity building, energy cost reduction, and electrification of Indian lands and homes.

INTERACTIONS WITH THE OFFICE OF MANAGEMENT AND BUDGET (OMB)

Summary

OMB is a critical partner in fulfilling the Department's mission and achieving Administration and Departmental priorities. CI serves as the Department's liaison to most OMB offices to assess the effectiveness of agency programs, address competing funding demands among programs, and set funding priorities. DOE's Office of General Counsel (GC) serves as the Department's liaison to OMB's Office of Information and Regulatory Affairs (OIRA), which

reviews Department rules, funding announcements, and information requests, among other matters.

OMB organization

The largest component of OMB is the five Resource Management Offices, the Budget or “B” side, organized along functional lines mirroring the U.S. federal government, each led by an OMB associate director. These are divided into divisions and branches. DOE works with three branches:

- Defense Investments Branch (NNSA)
- Energy Branch (all programs excluding NNSA and the Power Marketing Administrations)
- Water and Power Branch (PMAs)

The Management or “M” side of OMB includes several offices that focus on policy and guidance for Departments to adhere to. For example:

- Performance Team: Manages implementation of the Government Performance and Results Act Modernization Act (GPRA-MA) that sets requirements for strategic planning and performance evaluation
- Office of Federal Financial Management and Office of Federal Procurement Policy: provide guidance and policy on financial management

OIRA is the central authority for the review of Executive Branch regulations, approval of government information collections, and coordination of Federal privacy policy. OIRA facilitates communication and coordination among various Federal agencies regarding regulatory matters. Specifically, OIRA reviews all significant DOE rulemakings and solicits DOE feedback regarding significant rulemakings from

other agencies. In addition, OIRA evaluates the economic impacts of regulations to help assess their costs and benefits and aids in the formulation of regulatory policy to ensure alignment with the Administration’s priorities.

DOE staff also work with OMB-wide support offices which include the Office of General Counsel, the Office of Legislative Affairs, the Office of E-Government and Information Technology, OIRA, the Budget Review Division, and the Legislative Reference Division.

- The Budget Review Division performs government-wide budget coordination and is largely responsible for the technical aspects relating to the release of the President’s Budget each February.
- The Legislative Reference Division is the central clearing house across the federal government for proposed legislation or testimony. This Division coordinates the articulation of the Administration’s position on legislation by overseeing the review and clearance of legislative proposals, testimony, and statements on bills progressing through Congress. This Division is also responsible for preparing Statements of Administrative Policy (SAPs) for the President. These statements are used for OMB to communicate the President’s and agencies policies to the government as a whole and set forth policymaker’s agendas.

DOE staff also work with several Offices within the Executive Office of the President (EOP) including the Office of Science and Technology Policy (OSTP), the National Security Council (NSC), the Council on Environmental Quality (CEQ), the Homeland Security Council, among others.

Transition year formulation

In a typical (non-transition) budget year, the contents of the President’s Budget are negotiated between federal agencies and OMB from

September to January, with a complete budget due to the first Monday in February. In recent transition years, the incoming President has issued a top-level budget in either mid-February (Clinton), late February (Obama, G.W. Bush), March (Trump), or April (Biden). The full array of detailed budget publications has commonly been released in early April, although the Trump and Biden Administrations delayed a full budget release until May of their respective first years. The Obama Administration delayed the budget requests in 2009 and 2013 due to the work needed to enact the Recovery Act and a full-year annual appropriation.

OMB typically has all budget-related policy appointees in place quickly. OMB will generally develop a top-level budget in a manner that reflects the most important campaign promises, with fewer opportunities for cabinet agencies (which may not have confirmed appointees) to negotiate top-line numbers. OMB will usually initiate the process within a week or two of the Inauguration. OMB will usually provide:

- A single number for each agency's appropriations; and,
- A few policy issues to be highlighted in the budget document to be released in February.

Clearance process

OMB ensures that all agency reports, rules, testimony, and proposed legislation are consistent with the President's Budget and with Administration policies.

Within the Executive Branch, there are several types of clearance processes required for DOE documents. Requirements for OMB clearance are outlined in OMB Circulars A-11 and A-19. CF will assist the new leadership in navigating these processes and developing timelines for DOE products and proposals.

FY 2025 BUDGET STATE OF PLAY

Each year when developing the President's Budget Request, DOE program offices and leadership work together to make sure the Request reflects the President's and Secretary's priorities and fulfills the Department's mission.

FY 2025 Budget Request Overview

DOE proposed \$51 billion in budget authority for FY 2025, a \$3.6 billion, or 7.5 percent, increase from the FY 2023 Enacted Level. The Budget priorities included creating jobs and investing in

innovation for the energy economy; expanding cutting-edge research at National Laboratories; investing in critical and emerging technologies, advancing critical climate goals including industrial decarbonization; building the clean innovation pipeline; reducing health and environmental hazards for at-risk communities, bolstering the cybersecurity and resilience of the energy sector; and making historic investments to strengthen the Nation's nuclear security.

Current Status of Appropriations

The FY 2025 President's Budget submission was sent to Congress for consideration in March 2024. The key appropriations subcommittees that determine funding levels for DOE, the House and Senate Energy and Water Development Subcommittees (respectively known as "HEWD" and "SEWD") then worked to develop their own bills.

Overview of Recent Funding Marks for DOE

	FY 2023 Enacted	FY 2024 Enacted	FY 2025*		
			Request	HEWD Bill	SEWD Bill
050 (defense)	\$30.96B	\$32.945B	\$33.731B	\$33.948B	\$34.599B
Non-050 (non-defense)	\$14.97B	\$17.007B	\$17.683B	\$16.015B	\$17.704B
<i>Recissions</i>	<i>\$2.052B (SPR)</i>	-	-		<i>\$67M (DNN)</i>
Total DOE	\$45.932B	\$49.952B	\$51.42B	\$49.963B	\$52.304B

*A breakdown of funding by DOE organization is at the end of the issue paper.

Starting October 1st, the Department began operating under a Continuing Resolution with an end date of December 20th while Congress decides on the future of the FY 2025 budget request. This means the Department will be operating under FY 2024 enacted funding levels.

In FY 2025, there are several funding challenges

that need to be negotiated before a final appropriations bill can be enacted. These include:

- How to handle the budget caps imposed by the Fiscal Responsibility Act in FY 2025. (Congress originally negotiated a funding level for this but they borrowed from the FY 2025 levels when negotiating the final

FY 2024 appropriations bills so government-wide topline may need to be adjusted.)

- A funding shortfall for the Department of Veterans Affairs of \$12 billion.
- Potential negotiations on how to handle the debt ceiling by January 2025 (the likely deadline).

Decisions on the FY 2025 path forward are expected after the election.

FY 2026

Early in the new Administration, the Office of

Management and Budget (OMB) will ask all agencies for priorities to help inform the FY 2026 budget request. The Office of the Chief Financial Officer (CF) will lead this process and work with Department leadership and program offices.

It is likely that the Administration will develop a “budget blueprint” in February or March which will include high level policies based on major priorities, topline discretionary targets by major agency, and key mandatory and tax proposals. This will be followed by a more complete budget justification later in the Spring.

FY 2025 Proposed Appropriations Summary

DEPARTMENT OF ENERGY FY 2025 Appropriations Summary (Dollars in Thousands)

	FY 2023 Enacted Final	FY 2024 Enacted Final	FY 2025 President's Budget Request	FY 2025 HEWD bill	FY 2025 SEWD bill	FY 2025 SEWD bill v. FY 2025 Request	
						\$	%
Department of Energy Budget by Appropriation							
Energy Efficiency and Renewable Energy*	3,460,000	3,460,000	3,118,000	1,960,000	3,440,000	322,000	10.33
Electricity	350,000	280,000	293,000	250,000	280,000	-13,000	-4.44
Cybersecurity, Energy Security and Emergency Response (270)	200,000	200,000	200,000	200,000	200,000	-	-
Strategic Petroleum Reserve	207,175	213,390	241,169	295,148	213,390	-27,779	-11.52
Naval Petroleum and Oil Shale Reserves	13,004	13,010	13,010	13,010	13,010	-	-
Strategic Petroleum Reserve Petroleum Account	100	100	100	100	100	-	-
Northeast Home Heating Oil Reserve	7,000	7,150	7,150	7,150	7,150	-	-
Office of Petroleum Reserves	227,279	233,650	261,429	315,308	233,650	-27,779	-10.63
Nuclear Energy (270)	1,623,000	1,525,000	1,440,660	1,623,000	1,525,000	84,340	5.85
Fossil Energy and Carbon Management	890,000	865,000	900,000	875,000	865,000	-35,000	-3.89
Uranium Enrichment Decontamination and Decommissioning (UED&D)	879,052	855,000	854,182	864,182	865,000	10,818	1.27
Energy Information Administration	135,000	135,000	141,653	141,653	135,000	-6,653	-4.7
Non-Defense Environmental Cleanup	358,583	342,000	314,636	324,000	342,000	27,364	8.7
Science	8,100,000	8,240,000	8,583,000	8,390,000	8,600,000	17,000	0.2
Technology Coordination and Commercialization					34,500	34,500	
Office of Technology Transitions	22,098	20,000	27,098	20,000	0	-27,098	-100
Office of Clean Energy Demonstrations	89,000	50,000	180,000	27,500	125,000	-55,000	-30.56
Federal Energy Management Program	0	0	64,000	0	0	-64,000	-100
Grid Deployment Office	0	60,000	101,870	60,000	60,000	-41,870	-41.1
Office of Manufacturing & Energy Supply Chains	0	0	113,350	0	20,000	-93,350	-82.36
Office of State and Community Programs	0	0	574,000	0	0	-574,000	-100
Advanced Research Projects Agency - Energy	470,000	460,000	450,000	450,000	459,150	9,150	2.03
Nuclear Waste Disposal Fund	10,205	12,040	12,040	12,040	12,040	-	-
Departmental Administration	283,000	286,500	334,671	286,500	290,422	-44,249	-13.22
Indian Energy Policy and Programs	75,000	70,000	95,000	95,000	70,000	-25,000	-26.32
Inspector General	86,000	86,000	149,000	100,000	86,000	-63,000	-42.28
Title 17 Innovative Technology Loan Guarantee Program	136,018	0	-184,558	-115,000	-115,000	69,558	-37.69
Advanced Technology Vehicles Manufacturing Loan Program	9,800	13,000	27,508	18,000	20,000	-7,508	-27.29
Tribal Energy Loan Guarantee Program	4,000	6,300	6,300	6,300	6,300	-	-
Total, Credit Programs	-122,218	19,300	-150,750	-90,700	-88,700	62,050	-41.16

	FY 2023	FY 2024	FY 2025	FY 2025	FY 2025	FY 2025 SEWD bill v.	
	Enacted	Enacted	President's Budget	HEWD bill	SEWD bill	FY 2025 Request	
	Final	Final	Request			\$	%
Department of Energy Budget by Appropriation							
Energy Projects	221,969	83,724	0	0	36,037	36,037	
Critical and Emerging Technologies	0	0	5,000	0	0	-5,000	-100
Total, Energy Programs	17,357,968	17,283,214	18,061,839	15,903,483	17,590,099	-471,740	-2.61
Weapons Activities	17,116,119	19,108,000	19,848,644	20,338,752	19,930,000	81,356	0.41
Defense Nuclear Nonproliferation	2,490,000	2,581,000	2,465,108	2,445,000	2,563,000	97,892	3.97
Naval Reactors	2,081,445	1,946,000	2,118,773	2,118,773	2,077,000	-41,773	-1.97
Federal Salaries and Expenses	475,000	500,000	564,475	564,475	564,000	-475	-0.08
Total, National Nuclear Security Administration	22,162,564	24,135,000	24,997,000	25,467,000	25,134,000	137,000	0.55
Defense Environmental Cleanup	7,025,000	7,285,000	7,059,695	7,132,000	7,550,000	490,305	6.95
Other Defense Activities	1,035,000	1,080,000	1,140,023	1,179,000	1,188,000	47,977	4.21
Defense Uranium Enrichment D&D	586,035	285,000	384,957	0	577,000	192,043	49.89
Total, Environmental and Other Defense Activities	8,646,035	8,650,000	8,584,675	8,311,000	9,315,000	730,325	8.51
Nuclear Energy (050)	150,000	160,000	150,000	170,000	150,000	-	-
Total, Atomic Energy Defense Activities	30,958,599	32,945,000	33,731,675	33,948,000	34,599,000	867,325	2.57
Southeastern Power Administration	0	0	0	0	0	-	-
Southwestern Power Administration	10,608	11,440	11,440	11,440	11,440	-	-
Western Area Power Administration	98,732	99,872	100,855	99,855	100,872	17	0.02
Falcon and Amistad Operating and Maintenance Fund	228	228	228	228	228	-	-
Colorado River Basins Power Marketing Fund	0	2,000	0	0	2,000	2,000	
Total, Power Marketing Administrations	109,568	113,540	112,523	111,523	114,540	2,017	1.79
Federal Energy Regulatory Commission	0	0	0	0	0	-	-
Total, Energy and Water Development and Related Agencies	48,426,135	50,341,754	51,906,037	49,963,006	52,303,639	397,602	0.77
Sale of Northeast Gasoline Supply Reserve	0	-95,000	-95,000			95,000	-100
Excess Fees and Recoveries, FERC	-9,000	-9,000	-9,000			9,000	-100
Title XVII Loan Guar. Prog Section 1703 Negative Credit Subsidy Receipt	-14,000	0	-2,051			2,051	-100
UED&D Fund Offset	-586,035	-285,000	-384,957			384,957	-100
Discretionary Funding by Appropriation	47,817,100	49,952,754	51,415,029	49,963,006	52,303,639	888,610	1.73
DOE Budget Function	47,817,100	49,952,754	51,415,029	49,963,006	52,303,639	888,610	1.73
NNSA Defense (050) Total	22,162,564	24,135,000	24,997,000	25,467,000	25,134,000	137,000	0.55
Non-NNSA Defense (050) Total	8,796,035	8,810,000	8,734,675	8,481,000	9,465,000	730,325	8.36
Defense (050)	30,958,599	32,945,000	33,731,675	33,948,000	34,599,000	867,325	2.57
Science (250)	8,100,000	8,240,000	8,583,000	8,390,000	8,600,000	17,000	0.2
Energy (270)	8,758,501	8,767,754	9,100,354	7,625,006	9,104,639	4,285	0.05
Non-Defense (Non-050)	16,858,501	17,007,754	17,683,354	16,015,006	17,704,639	21,285	0.12
* Important note for EERE comparisons: the President’s Budget request proposes FEMP, SCEP and MESC as separate accounts. The HEWD bill includes funding for SCEP, MESC and FEMP within EERE. The SEWD bill includes funding for SCEP and FEMP within EERE, with MESC broken out as a separate account.							

* Important note for EERE comparisons: the President's Budget request proposes FEMP, SCEP and MESC as separate accounts. The HEWD bill includes funding for SCEP, MESC and FEMP within EERE. The SEWD bill includes funding for SCEP and FEMP within EERE, with MESC broken out as a separate account.

INFLATION REDUCTION ACT CLEAN ENERGY TAX INCENTIVES

The Inflation Reduction Act of 2022 created or expanded 26 energy tax credits supporting domestic deployment and manufacturing of energy technologies, energy efficient equipment, and critical materials. DOE provides technical expertise to IRS and Treasury on the development and implementation of the energy tax incentives.

Summary

There are twenty-six energy tax incentives that were created or expanded under the Inflation Reduction Act (IRA). The Department of Energy (DOE) provides technical expertise and assistance to the Department of the Treasury (Treasury) and Internal Revenue Service (IRS) which have regulatory authority over the incentives. The tax incentives cover a wide range of energy technologies, including electricity, home and buildings efficiency measures, vehicles, fuels, as well as domestic energy manufacturing. DOE's technical expertise supports Treasury and IRS to ensure the best available science informs the development of Treasury guidance to make sure the credits are usable and easy for stakeholders to understand. DOE plays an additional role in implementing several credits, as detailed below.

Issue

DOE provides technical assistance to Treasury and IRS across all energy tax incentives. DOE also maintains eligibility maps for various credits as well as the Greenhouse gases, Regulated

Emissions, and Energy use in Technologies (GREET) ® model and tax credit specific variations which are adopted by Treasury to determine emissions rates for the credits. DOE has additional roles in some credits:

- 48C Qualifying Advanced Manufacturing Tax Credit – DOE's Office of Manufacturing and Energy Supply Chain (MESC) manages the implementation of this credit, which is competitively awarded to projects that develop clean manufacturing, produce or recycle critical minerals, or reduce industrial greenhouse gas emissions. DOE also maintains a map of 48C Energy Communities, which the statute specifies must receive at least 40% of the overall 48C funds.
- 48(e) Low-Income Communities Bonus Tax Credit Program - DOE's Office of Energy Justice and Equity (EJE) manages the implementation of this program. DOE also maintains a map showing low-income communities, where a subset of projects must be located to be eligible for funds.
- 45Q Credit for Carbon Dioxide Sequestration – DOE's Office of Fossil Energy and Carbon Management (FECM) supports the implementation of this credit by reviewing lifecycle analysis (LCA) net emission rates for carbon utilization pathways, which are required to determine eligibility for the credit.

Status

DOE provides ongoing technical assistance to Treasury and IRS across the energy tax incentives as they develop and finalize regulations. Status of the two provisions DOE manages:

- 48C Qualifying Advanced Manufacturing Tax Credit – Treasury announced selections for the first \$4 billion of the \$10 billion in available credits in 2023. The second round for the remaining \$6 billion in 48C allocations is underway. MESC is currently accepting applications.

- 48(e) Low-Income Communities Bonus Tax Credit Program – The program is in its second year and applications are being accepted on a rolling basis.

Milestones

Milestones for each credit are different but largely revolve around guidance from Treasury and IRS who release rules, regulations, revenue procedures, and supporting documentation and resources like frequently asked questions, fact sheets, and templates. Different tax credits also take effect and expire at different dates.

Background

Inflation Reduction Act related Tax Guidance:
[IRA-Related Tax Guidance | U.S. Department of the Treasury](#)

PATHWAYS TO COMMERCIAL LIFTOFF

DOE's Pathways to Commercial Liffort reports provide a shared language and fact base that connect DOE strategy and investments with the business community.

Summary

The Pathways to Commercial Liffort is a cross-DOE effort to develop and maintain common analytical fact bases that identify and track the path to widespread market adoption of multiple emerging technologies from the perspective of the private sector. The Liffort Reports are informed by commercial and market-based analysis and through hundreds of interviews with external stakeholders. The reports are used internally and externally to inform strategy and activities to accelerate market adoption and scale-up.

The Liffort initiative has published comprehensive reports on eleven topics while building out the capacity to maintain each fact base after initial publication. Frequently, private sector counterparts pursuing investments in nascent energy technologies have expressed appreciation for the analysis and insights Liffort provides.

Issue

Development and maintenance of Liffort content requires significant coordination, staff time, and resource support to gather technology and business intelligence externally and across multiple DOE offices. Because Liffort reports are framed in terms of market adoption, Liffort topics do not always fit neatly within the existing DOE

organizational structure. This means that the Liffort initiative provides high value in developing shared understanding of rapidly evolving technology and market dynamics across DOE offices while requiring significant coordination to ensure broad DOE and external engagement, input, dissemination, and timely updates.

The success from this initiative to date has been underpinned by: (1) robust, analytically rigorous fact-base calculations, (2) ground-truthing of commercial state of play via extensive industry dialogs, and (3) continuous feedback across DOE to capture and maintain key insights about commercialization status and needs based on the Liffort topic engagement process.

Status

Liffort reports bring tech and market perspectives into decision-making by informing:

- DOE investments (Notice of Funding Opportunity development and selections, budget planning, portfolio risks, commercial adoption readiness)
- DOE strategy (serving as a source for the development of DOE strategy documents for energy storage, carbon management, clean hydrogen, industrial decarbonization, and others)
- DOE external engagement strategy

Liffort reports inform public understanding of market opportunity for new technologies by:

- leveraging DOE's role as an objective, analysis-based information resource for technology commercialization opportunities
- disseminating a shared fact base to relevant audiences via industry events, media, etc.
- engaging targeted external stakeholders (e.g., Electric Power Research Institute (EPRI), industry associations, investment groups)

Milestones

- **Spring 2023:** Wave 1 Liffort reports on Clean Hydrogen, Advanced Nuclear, Carbon

Management, and Long Duration Energy Storage (LDES) were released at CERAWeek

- **Fall 2023:** Wave 2 Liftoff reports on Industrial Decarbonization (crosscut), Chemicals & Refining, Cement, and Virtual Power Plants were released at Deploy23
- **Spring 2024:** Wave 3 Liftoff reports on Next-Gen Geothermal (Power sector application), Offshore Wind, and Innovative Grid Deployment were released
- **Over the course of 2023 and 2024,** eighteen Deploy Dialogues convened across seven events including CERAWeek 2023 and 2024, Deploy23, the 2024 BNEF Summit, and RE+
- **Fall 2024:** Updates to Clean Hydrogen, Advanced Nuclear, and Carbon Management Liftoff Reports are targeted for release
- **December 2024:** Sixteen more Deploy Dialogues are slated to be held at the Department's Deploy24 event

Background

The Department of Energy plays a critical role in accelerating the commercialization of emerging technologies and maximizing the return on investment to American taxpayers.

DOE's [Pathways to Commercial Liftoff](#) provide public and private sector actors with a data-driven fact base as to how and when various technologies could reach full-scale commercial adoption—critical signposts to inform investment decisions. Given the constantly and rapidly evolving market, technology, and policy environment, the Liftoff Reports are designed to be “living documents” – and updated as the commercialization outlook on each technology evolves.

Liftoff reports are descriptive distillations of complex market and technology development dynamics. While they may be used to inform

various policy or investment decisions, they are deliberately developed and maintained arms-length from such activities. They do not reflect DOE official policy or strategic plans; they are a resource intended to inform decision making across the Department, as well as industry, investors, and the broader stakeholder community. Additionally, any market data used in a Liftoff report is not proprietary to the government and could be obtained directly by a private citizen (albeit potentially behind a paywall, absent permissions obtained by DOE to publish in the Liftoff Report).

Liftoff topics are chosen by qualitative assessment of their relative technical maturity, market potential, and the need for shared understanding of the technology status by stakeholders internal and external to the federal government.

The Liftoff team maintains this knowledge base via market data and metric tracking; continuous engagement across relevant DOE offices, labs, and private sector counterparts; updates to the original reports; and development of complementary work products. Periodically, DOE hosts or cohosts Deploy Dialogues, a series of professionally facilitated workshops that provide space for industry leaders and investors to discuss challenges and identify solutions in areas related to the reports.

Each Liftoff report is the result of intensive collaboration across relevant DOE offices, integrating the demonstration and deployment focus of the offices within the Office of the Under Secretary for Infrastructure with the research and development emphasis of the offices within the Office of the Under Secretary for Science and Innovation. The Pathways to Commercial Liftoff are coordinated by the Office of Technology Transitions (OTT), the Office of Clean Energy Demonstrations (OCED), the Loan Programs Office (LPO), with significant contributions from partner offices including the Office of Policy (OP), Office of Energy Efficiency and Renewable Energy (EERE), and others.



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CHALLENGES TO DOMESTIC MANUFACTURING AND SUPPLY CHAINS

As the nation works to build domestic clean energy manufacturing and supply chains, the U.S. is confronting many challenges to establishing a sustainable domestic industry, including market and supply chain manipulation from foreign adversaries, and availability of labor, power, and raw materials.

Summary

U.S. manufacturing of energy products and processing of critical minerals and materials (CMM) face challenges to establishing a sustainable domestic industry. Market and supply chain manipulation from foreign adversaries, including export controls for raw materials and the sale of CMM at below the cost of production, increases U.S. commercial risk and threatens the onshoring of critical supply chains. These interventions challenge our domestic producers attempting to compete in a fair market environment. Demand-side tools, such as contracts for differences and fixed price floors, could potentially combat adversarial manipulation of markets and protect domestic supply chains. In addition, scarcity of labor, power, and raw materials for manufacturing and CMM processing facilities pose significant challenges to both the construction and operation of the new facilities needed to grow a domestic manufacturing base.

Issue

Foreign entities of concern (FEOCs), particularly China, dominate CMM markets today, in addition to certain other clean energy manufacturing

sectors. The market pricing for lower volume critical materials (e.g., graphite and rare earth metals like praseodymium) is opaque because so much of the trade is bilateral and not reported on indices. This makes pricing difficult for domestic producers negotiating offtake agreements. There are indications that FEOCs are flooding markets with materials at prices below production costs and taking other measures to deter nascent U.S. domestic investments. This market-distorting behavior hinders capital formation for domestic CMM projects and imperils DOE investments in projects. While U.S. investments through the Infrastructure Investment and Jobs Act (IIJA) and Inflation Reduction Act (IRA) have catalyzed a significant increase in investment across the supply chain, continued downward pressures on prices are challenging the viability of these investments.

In addition to market conditions, the need for raw construction materials, available power, and a skilled manufacturing workforce are also potential barriers to bringing online significant additional domestic clean energy manufacturing and critical materials processing capacity. The Bureau of Labor Statistics estimates that, as of summer 2024, there are over half a million unfilled domestic manufacturing jobs, potentially growing to nearly two million by the early 2030's if workforce challenges are not addressed. Further, obtaining grid connections and securing a sufficient supply of clean power for new industrial facilities – which often have significant power requirements – could potentially lead to significant delays in the commissioning of both new manufacturing and CMM processing plants.

Status

DOE is working to support domestic manufacturing, making the U.S. competitive against China for the first time in decades. Financial assistance programs in the Office of Manufacturing and Energy Supply Chains (MESCC) and the Loan Programs Office (LPO) support new domestic energy manufacturing and

materials processing capacity across the U.S. MESC also released, in April 2024, a Request for Information (RFI) on Critical Materials Market Dynamics. Findings and suggestions from this RFI include policy options that could ease hurdles for demand-side uncertainty due to market manipulation, such as contracts for differences, fixed price floors, and loan guarantees. In addition to findings in the RFI, coordination of other government tools such as tariffs and tax credits that bolster demand could also play a role.

Several programs across DOE work to address labor availability. MESC's Industrial Training and Assessment Centers (ITAC) Program provides hands-on job training for clean energy and manufacturing careers while helping small and medium sized manufacturers (SMMs) save energy, improve performance, and reduce emissions. Over fifty ITAC centers based in forty states and Puerto Rico – including those based at universities, community and technical colleges, trade schools, union training programs, and apprenticeship readiness providers – are training thousands of workers to build the next generation of clean energy manufacturing workers.

To bolster power availability broadly, DOE's Grid Deployment Office, LPO's Title 17 Clean Energy Financing Program, tax credits made available through the IRA, and other programs catalyze investments in clean power generation and electric grid infrastructure. DOE also announced its Electricity Demand Growth Resource Hub, which includes information and tools to support public and private stakeholders in issues related to load growth.

Milestones

- July 2023: DOE released update to [Critical Materials List](#).
- March 2024: [DOE and Department of Labor announced Battery Workforce Initiative](#) to support the growing battery workforce.

- August 2024: DOE MESC released [preliminary findings on its Request for Information on Critical Materials Market Dynamics](#).
- August 2024: DOE released [U.S. Energy and Employment Report \(USEER\)](#).
- August 2024: DOE announced [Electricity Demand Growth Hub](#).

Background

The U.S. Geological Survey (USGS) has identified fifty critical minerals across economic sectors. For thirty-one of these critical minerals, the U.S. relies on other countries for more than fifty percent of our requirements. DOE has also designated a list of critical materials for energy, which includes all of the critical minerals on the USGS list, but also a small number of additional materials that were identified based on projected future needs for energy applications. These additional materials include copper, electrical steel, silicon and silicon carbide. Domestic processing of CMMs is essential to strengthening U.S. energy and transportation sector supply chains. Domestic manufacturing for energy technologies – including solar, nuclear, electric vehicles, grid components, and others – can ensure a resilient and secure supply chain. However, CMMs are key inputs to clean energy supply chains. CMMs like lithium, graphite, and nickel are important for batteries, and polysilicon for solar and semiconductors, while rare earths are used for permanent magnets found in electric vehicles and wind turbines. Securing CMMs, in addition to domestic manufacturing, is therefore important for national and economic security, as well as ensuring the clean energy transition is built on a supply chain that uses environmentally responsible sourcing and ethical treatment of workers.

CLEAN HYDROGEN IMPLEMENTATION

Achieving the goals outlined in the *U.S. National Clean Hydrogen Strategy and Roadmap* will require significant private sector led investments, like those being made through the Hydrogen Hubs and Demand-Side program, as well as significant coordination across U.S. agencies, implementation of the 45V tax credit, and continued RDD&D, including Hydrogen Shot, to achieve necessary cost reductions for hydrogen technologies.

Summary

Clean hydrogen is hydrogen produced with lower emissions than the incumbent methods. The Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA) created a surge in private sector-led, government-enabled investments in clean hydrogen. DOE collaborated across United States Government (USG) agencies to develop the June 2023 [U.S. National Clean Hydrogen Strategy and Roadmap](#), a comprehensive national framework for facilitating large-scale production, processing, delivery, storage, and use of clean hydrogen to help meet bold decarbonization goals across virtually all sectors of the economy. Goals include production of ten million metric tons (MMT)/year clean hydrogen by 2030, twenty MMT/year by 2040, and fifty MMT per year by 2050.

Major events that support the U.S. National Clean Hydrogen Strategy and Roadmap include:

- In 2023, [the Hydrogen Interagency Task Force](#) (HIT) was launched to further advance a whole-of-government approach to clean hydrogen. The HIT is co-chaired at the Deputy Secretary and White House level, across twelve agencies and facilitated by the DOE Hydrogen and Fuel Cell Technologies Office (HFTO).
- In March 2023, DOE released the [Pathways to Commercial Liftoff report](#) for clean hydrogen to capture the private-sector's perspective and create a common "fact base" on technology and market adoption challenges and opportunities to scale domestic clean hydrogen production.
- In October 2023, DOE's Office of Clean Energy Demonstrations (OCED) announced the selection of seven [Regional Clean Hydrogen Hubs](#) (H2Hubs) for award negotiations to kickstart a national network of clean hydrogen producers, consumers, and connective infrastructure. Since then, three hubs have been awarded and announced for Phase 1 (ARCHES, PNWH2 and ARCH2). In Phase 1, the H2Hubs begin preliminary designs, prepare for National Environmental Policy Act (NEPA) reviews, and assess offtake and the economics of the projects.
- In December 2023, the US Department of Treasury (Treasury) released a [Notice of Proposed Rulemaking \(NPRM\)](#) to articulate the implementing details for the §45V tax credit to produce clean hydrogen. 45V is a production tax credit (PTC) tiered in value based on the GHG emissions from a hydrogen production facility and labor requirements. The draft and final rulemaking will have significant implications on clean hydrogen project financing (such as the H2Hubs), as the PTC can make clean production technologies more cost-competitive with traditional hydrogen production leading to greater investor certainty.

- In January 2024, OCED announced the selection of a consortium to help accelerate commercial liftoff of the clean hydrogen economy and support the launch of H2Hubs. The consortium, which includes the Energy Futures Initiative Foundation (EFIF), S&P Global (S&P), and the financial exchange operator Intercontinental Exchange (ICE), will design and implement demand-side support mechanisms for unlocking the market potential of clean hydrogen.

Issues

- **H2Hubs & Demand-Side Program:** The NEPA process for developing the OCED-supported H2Hubs could take two to three years, which might affect the construction timeline of many of the H2Hubs' projects, that otherwise could construct in one to two years. In addition, OCED is focused on ensuring demand for clean hydrogen that, at a minimum, meets the amount of clean hydrogen production the H2Hubs plan to produce. Clean hydrogen can be an important alternative fuel source for transportation, industrial, power, and heating, but early production pathways may be higher cost than incumbent technologies. The demand-side auction design, timing, and amount will depend on the full suite of H2Hubs under award, as well as a final rule for 45V.
- **45V:** Nearly 30,000 form comment letters were submitted in response to the NPRM, varying from approval of the proposed guidance to highlighting key concerns for administrability. Roughly 400 unique comment letters were submitted, including feedback from all seven H2Hubs. The H2Hubs selections were made by OCED before draft rules on 45V were made public. The H2Hubs designs and scopes to be further developed in Phase 1 and the demand-side program are interdependent with the final 45V rulemaking.

Status

- OCED will continue negotiations with the H2Hubs not yet under award.
- OCED will continue negotiations to establish a special purpose entity, Hydrogen Demand Initiative (H2DI), to execute on the H2 demand-side program.
- Treasury is working with interagency partners to address stakeholder comments on 45V and will incorporate that feedback into a final rule.
- The HIT will continue to coordinate across government to achieve national strategy goals.

Milestones

- Winter 2024: Publish update to the [DOE Hydrogen Program Plan](#)
- June 2026: Publish update to the U.S. National Clean Hydrogen Strategy and Roadmap

Background

The U.S. National Clean Hydrogen Strategy and Roadmap responds to language in section 40314 of the Infrastructure Investment and Jobs Act (Public Law 117-58, also known as BIL). This document was posted in draft form for public comment in September 2022, and the final version of the report was informed by stakeholder feedback, further analysis on market liftoff, as well as engagement across several federal agencies and the White House. There will also be future opportunities for stakeholder feedback, as the report will be updated at least every three years as required by the law.

Section 40314 also provided \$8 billion for DOE to provide grants for regional clean hydrogen hubs. The selected H2Hubs were announced in October 2023. The H2Hubs program is managed through a four-phased award structure. Phase 1 encompasses initial planning, preliminary design

and analysis activities. Phase 2 finalizes engineering designs, permitting, NEPA, offtake agreements, and community benefits activities. Phase 3 is when the majority of costs will be incurred as part of construction activities. Phase 4 ramps-up the project to full operations. OCED will evaluate projects at the end of each phase to determine if the project met the applicable go/no-go criteria and negotiate the subsequent phase. Composition of individual Hubs is expected to evolve over time, based on project economics, 45V final guidance, and overall market dynamics.

CONSUMER PROTECTION AND ANTI-FRAUD MEASURES FOR STATE-MANAGED PROGRAMS

Federally-funded, State-managed programs, such as Weatherization Assistance Program or the Home Energy Rebates, create seams where addressing fraud can be more difficult. SCEP has developed a suite of measures to address these risks. These are best practices that should be sustained and replicated.

Summary

The Office of State and Community Energy Programs (SCEP) oversees a number of federally-funded, state-managed programs. Such structures are generally prescribed by Congress in SCEP's authorizing statutes. They can be an effective way to provide federal support for state governments as they pursue their clean energy priorities and craft tailored programs and plans. However, this local control also increases the difficulty of conducting fraud prevention efforts at the federal level. Further complicating these efforts is limited state capacity to design, negotiate, manage, and oversee these programs.

Fraud prevention is a top concern at SCEP and DOE. SCEP actively manages programs to minimize fraud and identify issues should they occur and has developed a suite of proactive measures to address these risks that we seek to

continually refine. A key feature of fraud prevention in these sorts of state-managed programs is the careful crafting of guidance that directs states to the best practices for fraud prevention. Since DOE is not directly administering these programs, many of the direct activities related to preventing fraud start with the states, territories and Tribes. SCEP's role therefore is to ensure sufficient fraud protection is required in the program guidance and then to actively oversee the states to ensure they are implementing that guidance, and their fraud protection activities are sufficient to provide the necessary protection, including at the subgrantee level.

Another critical feature of fraud prevention is to practice continuous improvement. This includes sharing best practices and learnings across states so that all programs can improve their protections. Our monitoring and oversight role keeps us engaged with the states throughout the life of the program so that we can always be identifying ways to learn and communicate.

Issue

Like other offices across DOE, SCEP works closely with the Office of Inspector General (OIG) in identifying potential gaps in programming that may allow for fraud as well as mechanisms to prevent fraud. SCEP manages \$16 billion across twenty-eight programs, and some of these have been highlighted as programs that could benefit from a proactive review by the OIG or audit to identify potential program risk of fraud.

The OIG has recently published a report on the Home Electrification and Appliance Rebates (HEAR) Program with recommendations to reduce the risk of fraud. SCEP appreciates the auditor's work to share best practices, and their collaboration with SCEP has already contributed to further strengthening our programs.

Special Report DOE-OIG-24-31, entitled *"Using 'Lessons Learned' From the Pandemic Relief Programs, Which Suffered Substantial Fraud*

Losses, to Protect the \$4.257 Billion Made Available Under the Inflation Reduction Act's Home Electrification and Appliance Rebates Program," was published on September 30, 2024, and provided two recommendations to reduce fraud. SCEP concurred with both recommendations and is continuing to advance a comprehensive fraud prevention plan that addresses those recommendations.

Status

SCEP has been and will continue implementing a suite of fraud-reduction measures for the HEAR Program. These include requirements for state programs to collect and validate 31 data elements for each rebate, which establish household identity, income eligibility, physical address, scope of project, and amount of rebate; requirements for the collection of geotagged photos of existing and newly installed appliances; automated screening and flagging of suspicious data, such as questionable physical addresses; quarterly compliance monitoring by DOE staff; maintenance of qualified contractor and participating vendor lists; and limiting self-attestation to emergency replacements and requiring verification after the fact. Once completed, the fraud prevention plan and any associated guidance modifications will be incorporated by reference into standard grant terms and conditions, as necessary and applicable. SCEP will also name a fraud protections lead on our compliance team who will systematically look at the data submitted by the states to identify patterns and other ways to detect and defer fraud.

DOE has increased oversight and communication with WAP grantees to closely monitor production and average costs, ensure on-time reporting, and provide additional technical assistance based on production and quality trends. SCEP is doubling the number of technical monitoring visits conducted annually. Along with the enhanced monitoring guidance and routine quarterly desktop monitoring, program leadership will review data at least twice quarterly to further

identify trends of concern. Identifying expenditure trends early and often is critical. As part of its process, SCEP will monitor average cost per unit (ACPU) thresholds regularly. SCEP is generally seeing improvement in overall unit production and reduction in ACPU across the network because of actions taken during routine desktop monitoring and engagement calls that provide guidance and technical assistance to grantees. However, upon review of the upcoming quarterly reports due December 31, 2024, SCEP will notify grantees immediately if SCEP will require a corrective action plan be provided within thirty days to address unit production issues for states with no reported IJJA completions.

Milestones

The recommendations of the current OIG report will be fully implemented through the actions listed above by March 31, 2025. However, many of the individual actions and report recommendations will be or have already been implemented on a faster timeline.

Background

SCEP practices continuous improvement and strives to minimize fraud in all programs. The OIG is a partner in this process. Previous OIG reports outlining program recommendations, improvements, and findings for SCEP programs can be found here: [Calendar Year Reports | Department of Energy](#)

ELECTRIC TRANSMISSION INFRASTRUCTURE

The Department of Energy (DOE) has a number of programs and statutory authorities to accelerate the planning, financing, and construction of needed electric transmission infrastructure.

Summary

High voltage transmission lines can take over ten years to build. With data centers, appliance electrification, and higher summer temperatures increasing electricity demand, and extreme weather events threatening grid resilience, transmission investments must be accelerated to enable electricity reliability and affordability. The Grid Deployment Office (GDO) is executing several high-profile programs to expand the electric transmission system to improve reliability and resilience, reduce consumer costs, meet rapidly rising demands, and provide system flexibility.

Issues

Section 216(a) of the Federal Power Act (FPA) directs DOE to conduct a triennial study of transmission constraints and congestion and to issue a report that may designate areas experiencing or expected to experience transmission constraints and congestion that negatively impact consumers as **National Interest Electric Transmission Corridors (NIETCs)**. NIETC designation focuses policymaker and public attention on areas of significant need and allows project developers to access federal funding and permitting tools. GDO is managing the potential designation of several NIETCs. DOE's two prior 2007 NIETCs were vacated by the Ninth Circuit Court of

Appeals, and GDO has made major changes to the execution of this authority as a result. Determining eligibility for the \$2 billion **Transmission Facility Financing (TFF)** loan authority enacted in the Inflation Reduction Act (IRA) is contingent upon a NIETC designation. These efforts combined with the continued financial support of key new lines through the **Transmission Facilitation Program (TFP)** are critical to the accelerated deployment of transmission capacity.

GDO is also the lead agency to coordinate federal environmental reviews and permitting processes for qualifying transmission lines under the **Coordinated Interagency Authorizations and Permits (CITAP) Program**. In addition, GDO has been delegated authority to issue **Presidential Permits (PP)** for the construction, connection, operation, and maintenance of facilities for transmission of electric energy across U.S. international borders. DOE currently has two PP applications under review, including the Caribbean Transmission Development Corporation's (CTDC) application for transmission facilities between the United States Commonwealth of Puerto Rico and the Dominican Republic. Additionally, Basin Electric applied for a PP for transmission facilities between the North Dakota and Canada.

Status

NIETC Designation: GDO entered Phase 2 of the NIETC designation process in May 2024 when it released a preliminary list of ten potential NIETCs. The comment period on the preliminary list of potential NIETCs closed on June 24, 2024, and GDO is evaluating the submissions received.

TFP: GDO has made selections to nearly fully commit the \$2.5 billion TFP revolving fund capacity contracts to seven key transmission projects and a public-private partnership for a transmission project to connect a remote microgrid in Alaska. GDO has finalized capacity contracts and obligations with three projects selected in October 2023. On September 26,

2024, it announced the selection of four additional projects for capacity contract awards and the selection of a microgrid connection project in Alaska for a public-private partnership award. GDO is monitoring project performance for the three finalized projects and conducting due diligence and contract negotiation on the remaining selected projects. When the outside financing for these projects have matured, funds will return to the TFP and be available to support other new projects.

Milestones

NIETC: Phase 3 will begin in December 2024 for selecting a subset of potential preliminary NIETCs and is expected to last two to three years based on the variable length of time necessary to conduct public engagement, complete required environmental reviews, and finalize designation reports.

TFP and TFF: For TFP, due diligence and contract negotiation for projects selected in October 2024 will be concluded and funds obligated by the end of January 2025. GDO anticipates opening applications for TFF financing in the third quarter of Fiscal Year (FY) 2025.

Background

NIETC: In general, an NIETC is a geographic area where, based on its triennial National Transmission Needs Study or other relevant information, DOE has identified present or expected transmission capacity constraints or congestion that adversely affects consumers, and which DOE has designated as an NIETC. In December 2023, DOE announced a new four-phase process for designating NIETCs that was designed to ensure robust engagement with project developers, states, local communities, and other impacted stakeholders and reflect lessons learned from earlier legal setbacks that stalled the program. Transmission facilities within a NIETC are eligible for certain federal financing and permitting tools, including:

- Public-private partnerships under TFP and direct loans under the TFF; and
- Limited federal backstop siting and permitting authority for the Federal Energy Regulatory Commission (FERC) under FPA section 216(b). This aspect of NIETC designation has made the program controversial in some states and communities.

TFP: TFP (enacted through Section 40106 of the Infrastructure Investment and Jobs Act (IIJA)) authorizes DOE to borrow up to \$2.5 billion from a revolving fund to accelerate transmission deployment through three financing tools:

- **Capacity contracts** with eligible projects where DOE serves as an “anchor customer” to encourage other customers and financiers to commit to the project.
- **Loans and Public-private partnerships** within a NIETC or between planning regions for projects demonstrating an increase in electricity demand across more than one state.

TFF: Enacted in Section 50151 of the Inflation Reduction Act (IRA), TFF authorizes DOE to provide loan support for transmission facilities designated by the Secretary to be necessary in the national interest under FPA section 216(a). Transmission facilities that will be located within a NIETC are eligible to receive a loan under the TFF program.

Federal Permitting: GDO executes DOE’s authority under section 216(h) of the FPA through the **CITAP Program** to accelerate the federal environmental review processes for qualifying electric transmission facilities. As coordinator among nine federal agencies, GDO will lead the development of project-specific schedules that sets binding deadlines to complete all necessary federal authorizations and environmental reviews on a two-year timeline with no impact to the standard of quality.

Additionally, GDO has been delegated responsibility for implementing Executive Order (EO) 10485, as amended by EO 12038, which requires the issuance of a **Presidential Permit** for the construction, operation, maintenance, or connection of electric transmission facilities at the U.S. international border.

MEETING LOAD GROWTH

As the U.S. returns to a period of significant load growth, DOE is actively engaging with key stakeholders to ensure electricity demand is met with solutions that can improve flexibility and modernize the grid while maintaining reliability and affordability.

Summary

U.S. electricity demand is projected to grow significantly in the next five to ten+ years, driven by data center expansion and the rise of artificial intelligence (AI) applications, domestic manufacturing growth, and electrification of transport, industry, and buildings. For AI in particular, America has strong national security and economic imperatives to keep large-scale data center operations in the U.S. to ensure the grid can fully support continued economic growth. DOE has coordinated a cross-office response led by the Office of Policy to address industry and public concerns about powering this load growth by leveraging the full set of relevant DOE tools and resources.

DOE is pursuing the following strategies among others to meet the growing demand for power, including from data centers: leveraging energy community opportunities to re-use infrastructure at retired coal facilities; enabling data center flexibility through onsite power generation capacity and storage solutions; collaborating with stakeholders on innovative tariff structures to support innovative technology development while protecting other customers; enhancing the existing and expanding the transmission and distribution grid, such as with grid-enhancing technologies; and expanding and commercializing key technologies for firm power

such as next-generation geothermal, advanced nuclear, and long-duration energy storage.

DOE has a range of tools from financing to technical assistance available to support stakeholders aggregated at energy.gov/electricitydemand, and a dedicated email inbox for fielding questions about DOE resources on this topic: businesshub@hq.doe.gov.

Issue

Priority issues to address include: keeping large-scale AI operations domestically to maintain national security and economic objectives; ensuring American household ratepayers are not unfairly impacted by the investments made to support data center load growth; leveraging the full suite of energy, storage, grid, and enabling solutions available to build a more resilient, reliable, secure, and affordable grid; maximizing energy efficiency and optimizing the utilization of the existing grid and full suite of solutions available to mitigate inefficient investment; and directing investments towards energy communities to leverage existing resources and support repowering efforts.

Status

DOE is actively engaging stakeholders to educate them on load growth characteristics and available energy solutions and linking them to relevant DOE technical assistance and funding programs. DOE has established a “front door” for data center developers and other industry stakeholders facing challenges related to load growth.

Milestones

- June 2024: DOE announced a Notice of Intent to fund up to \$900 million to accelerate deployment of Generation III+ Small Modular Reactors (Gen III+ SMR) critical to meeting the growing demand for clean firm power.
- August 2024: DOE hosted Gen III+ SMR Industry Day to facilitate networking and team formation among utilities, end-users /

offtakers (including data center developers), and nuclear technology vendors for a forthcoming funding opportunity.

- August 2024: DOE launched the Electricity Demand Growth Resource Hub to centralize relevant DOE resources; the Secretary of Energy Advisory Board (SEAB) provided 16 recommendations to the Secretary to meet load growth.
- September 2024: The White House hosted a meeting with the DOE Secretary and CEOs from leading developers (e.g., Meta, Amazon, Google) to align on data center deployment objectives.
- December 4-5, 2024: DOE's Deploy24 conference will convene stakeholders to advance a public private partnership to address issues such as meeting load growth.
- Forthcoming in 2024: DOE's Lawrence Berkeley National Laboratory publication of a congressionally mandated 2024 Data Center Energy Efficiency report on current and near-future data center energy consumption and water use.

needs, particularly new technologies and tools that were not available during prior periods of demand growth. A suite of enabling solutions (e.g., interconnection process improvements, innovative tariff structures, commercialization of key clean firm technologies) have and continue to be developed by DOE and industry players to support deployments. Data center growth represents an opportunity to deploy innovative technologies that can increase grid capacity in the short term and bring new power technologies online in the long term. These solutions include readily available technologies like solar, onshore wind, grid-enhancing technologies, and virtual power plants, as well as emerging solutions like next-generation geothermal, advanced nuclear, or long-duration storage.

Background

DOE has anticipated and planned for increasing electricity demand as part of its overall long-term strategy. While load growth is increasing relative to the recent past, it is not unprecedented – prior to 2005 the U.S. commonly experienced and met ten-year load growth of over thirty percent, double the rate projected by North American Electric Reliability Corporation (NERC) for the coming decade. However, with the rapid recent rise in data center demand (particularly for AI applications), there are public concerns over the capability of the U.S. grid to meet electricity demand needs.

There are a broad suite of energy and grid solutions available today to meet projected demand growth and ensure resource adequacy

REGIONAL ELECTRICITY LOAD GROWTH AND RESOURCE ADEQUACY

With forecasted increases in Pacific Northwest electricity consumption, Bonneville is planning for the needs of its customers. Bonneville is working on an initiative of Western utilities to address resource adequacy in the region.

Summary

Pacific Northwest regional forecasts estimate that electricity consumption in the region could increase by over thirty percent in the next ten years. Increase in electricity demand is attributed to growth in industrial loads and data center development as well as continuing trends for electrification. Clean energy policy objectives prioritize the expansion of variable renewable resources to meet this demand. Regional utilities are collaborating to design a voluntary reliability, planning, and compliance program to address the need for adequate resource availability at times of peak electricity demands and extreme weather conditions.

Issues

Key issues for Bonneville and its customers include:

- Meeting preference power customer load obligations through allocation of existing Federal base system resources and any new resource acquisitions consistent with Bonneville's statutory obligations.

- Determining with other regional utilities the timeline to begin binding operations in the Western Resource Adequacy Program. Bonneville believes achieving critical mass for participation in 2027 is important for the success of the program.
- Ensuring that Bonneville meets its statutory obligations for an adequate, economical, and reliable power supply, and for its environmental obligations.
- Litigation with the states of Oregon and Washington, several Columbia Basin Tribes, and environmental organizations over the impacts of the Lower Snake River Dams, which generate hydropower marketed by BPA, on salmon, steelhead, and other native fish populations.

Status

In September 2024, Bonneville released its annual Pacific Northwest Loads and Resources Study.

Bonneville expects to issue its 2024 Resource Program in fall 2024 which evaluates long-term resource acquisition strategies.

Bonneville expects to commit to binding operations in the Western Resource Adequacy Program (WRAP) beginning in 2027. The costs of joining the WRAP program will be built into BPA's rates that are paid by customers. There is no federal funding needed.

Milestones

Bonneville updates its regional loads and resource study annually and conducts its resource program process every two years.



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Background

The Bonneville Power Administration annually updates its forecasts of Federal system power sales contract obligations and generating resources. Its September 2024 analysis showed annual energy surpluses across the ten-year study period, but under low-water conditions the Federal system will have annual energy deficits. The Federal Resources include electric generation from the four lower Snake River dams which some regional advocates are calling to be breached to aid endangered salmon and steelhead passage.

Other Pacific Northwest electric utilities are planning for their own load growth while achieving state and company goals for clean energy portfolios. These actions are continuing the retirement of baseload coal generation and diminishing the reliance on other fossil fuel-based generating resources. Bonneville and these regional utilities are planning for how to meet load growth with changing resource mixes while preserving electric system reliability and affordability. This initiative is the Western Resource Adequacy Program coordinated through the Western Power Pool under an independent governance structure.



SECURING A COMPETITIVE BATTERY SUPPLY CHAIN

U.S. Government policies and direct investments have helped stimulate private capital and accelerate the buildout of a domestic battery supply chain, but more work is needed to ensure a resilient and competitive industrial base. Potential areas of future engagement and support include firming up demand to backstop investment, patiently providing low-cost capital to unlock more favorable project economics and offsetting structural advantages of competitors through innovation and deepened international partnerships.

Summary

Batteries are a critical technology needed for a resilient, affordable, and secure future energy system. The U.S. has historically led in battery innovation but ceded commercialization and manufacturing to other countries, including Japan, Korea, and now China. Investments and policy support from the Infrastructure Investment and Jobs Act (IIJA) passed in 2021 and Inflation Reduction Act (IRA) have catalyzed the buildout of domestic manufacturing capacity, which is beginning to increase supply chain resiliency and improve domestic energy security. However, further progress is needed in the U.S. to achieve stable and predictable demand, secure capital for strategic sectors under pressure, and continue innovation in next-generation batteries to ensure that U.S. manufacturing remains competitive. An enduring supply chain analytics

capability will help to inform future policies by creating visibility, assessing risk, and targeting investments.

Issue

The U.S. has historically led in battery innovation but ceded commercialization and manufacturing to other countries. Investments from IIJA and IRA have driven the onshoring of battery manufacturing and materials processing facilities in the recent past. However, further buildout of U.S. industry is needed to ensure a strong supply chain via a domestically integrated end-to-end battery manufacturing ecosystem in partnership with allies and trading partners. While downstream cell and pack manufacturers are well-positioned, the upstream and midstream supply chain is challenged by difficult project economics, demand uncertainty, and a depressed-price environment driven by oversupply and market manipulation by foreign competitors, all of which result in limited access to affordable capital. Foreign competitors are also investing heavily in the next generation of battery technologies. The U.S. traditionally has strength in innovation but it needs to ensure next-generation battery technologies developed here are also commercialized here. Further complementary investment is needed to ensure U.S. battery manufacturing continues to lead the world in innovations for the next generation of battery technologies and remains competitive in the global market.

Status

Several DOE programs have been working to support expanded battery manufacturing and related critical materials processing capacity in the U.S.:

- Under the Office of Manufacturing and Energy Supply Chains (MESC) Battery Materials Processing and Manufacturing Grants Program, funded by the IIJA, DOE has committed approximately \$5 billion to approximately forty projects, with ~\$700 million remaining unallocated.

- Since 2022, and as of September 30, 2024, the Loan Programs Office's (LPO) Advanced Technology Vehicle Manufacturing (ATVM) Loan Program has closed approximately \$3 billion of loans, with another \$17 billion in projects reaching conditional commitment, and has an estimated \$46 billion in remaining loan authority.
- Though its sector coverage is broader, LPO's Title 17 Clean Energy Financing Program has an outstanding conditional commitment for approximately \$400 million supporting long-duration energy storage batteries, and \$68.5 billion in remaining loan authority.

Other DOE programs or tax credits, such as MESC's Advanced Energy Manufacturing and Recycling grant program and the 48C tax credit, also support battery manufacturing but are not solely targeted at battery manufacturing. Still other DOE programs, such as in the Vehicle Technologies Office in the Office of Energy Efficiency and Renewable Energy, support research into new battery chemistry and cell technologies.

Finally, MESC is developing a supply chain analytics capability through its Modelling, Mapping, and Analysis Consortium of DOE national laboratories. This capability, which includes inputs such as a [recent clean energy supply chain Request for Information \(RFI\)](#), will provide long-term visibility into supply chains, vulnerabilities, commercial viability of operations, and foreign exposure.

Milestones

- July 2022: DOE LPO closes its first loan for a critical minerals processing project, and to date has conditionally committed or closed five loans totaling more than \$5 billion.
- September 2022: DOE MESC announced its first round of battery materials processing and manufacturing selections, leading to fifteen awards totaling approximately \$2 billion.

- December 2022: DOE LPO closes its first battery manufacturing loan of \$2.5 billion.
- August 2023: DOE MESC releases [supply chain progress report](#).
- March 2024: DOE MESC announces [\\$4 billion of investments from Round 1 of the 48C Qualifying Clean Energy Tax Credit program](#), including projects for battery manufacturing and critical materials processing and refining relevant to batteries.
- April 2024: DOE MESC releases clean energy supply chain [Request for Information](#).
- August 2024: DOE MESC holds first IJJA ribbon-cutting on battery materials facility.
- September 2024: DOE MESC announces over [\\$3 billion in grants for twenty-five projects for battery manufacturing and materials processing](#).

Background

Supply chains are increasingly recognized as critical to economic and national security, as well as ensuring a timely energy transition. China has established dominance of clean energy manufacturing supply chains over the past decade, particularly for battery manufacturing. This advantage ranges from critical material processing to battery precursors, to battery cell and module manufacturing, to electric vehicle and grid storage integration. Investments from the IJJA and IRA have catalyzed and directly supported domestic build-out of supply chains, particularly in downstream manufacturing segments.

U.S. ENERGY SECTOR CYBERSECURITY

The Department of Energy (DOE) has statutory, sector-specific, scientific, and national security missions that contribute to advancing our Nation's cybersecurity. DOE is responsible for supporting energy sector cybersecurity through its role as the designated Energy Sector Risk Management Agency.

Summary

Cyber threats to the energy sector are growing in number and sophistication. The Intelligence Community's 2024 Worldwide Threat Assessment has identified active and persistent cyber threats to U.S. Government, private-sector, military asset, and critical infrastructure networks from China, Russia, Iran and North Korea. A cyber strike on infrastructure could be used to deter U.S. military action by impeding U.S. decision making, inducing societal panic, and interfering with the deployment of U.S. forces. Russia views cyber disruptions as a foreign policy lever to shape other countries' decisions and continuously refines and employs its espionage, influence, and attack capabilities to maintain the ability to target critical infrastructure, including underwater cables and industrial control systems in the United States, as well as in allied and partner countries. Iran's growing expertise and willingness to conduct aggressive cyber operations make it a major threat to the security of U.S. and allied and partner networks and data. Transnational organized criminals involved in ransomware operations are improving their attacks, extorting funds, disrupting critical services, and exposing sensitive data.

DOE is the statutorily designated sector risk management agency for cybersecurity for the energy sector. In carrying out this role, DOE's Office of Cybersecurity, Energy Security and Emergency Response (CESER) leads DOE efforts to ensure secure and resilient energy infrastructure guided by the 2023 National Cybersecurity Strategy and corresponding implementation plan. CESER has the authority to issue orders to protect or restore the reliability of critical electric infrastructure or of defense critical electric infrastructure during an attack on the grid, subject to certain Presidential determinations regarding the nature and extent of the attack and its impacts. CESER fulfills dual purposes: to work with industry to increase cybersecurity protections across multiple energy subsectors and interdependent sectors of critical infrastructure; and to coordinate the cybersecurity mission among multiple stakeholders within the Department.

CESER partners across Departmental Elements to ensure cybersecurity risks and solutions are incorporated into DOE programs and projects. These partnerships advance research and train the next generation of the energy cybersecurity workforce including operators of renewable-energy-generating assets, electric vehicles (EV) charging infrastructure, microgrids, and distributed energy resources (DER). CESER further partners with the sector, industry, academia, and DOE's National Laboratories to conduct research, development, and deployment of tools, technologies, frameworks, and techniques to prevent and mitigate cybersecurity threats to the sector. The goal is to transition these tools and technologies to practice with broad sector adoption.

Issues

Cybersecurity Mission Growth: Increasing threats and a changing energy technology and operational landscape have required CESER to strategically evolve the cybersecurity mission at DOE, including by building new capabilities to perform cyber discovery and pursuit functions;

conducting cyber threat intelligence sharing and ensuring situational awareness; engaging in cyber modeling and simulations; and fostering cyber protections for emerging technologies in energy sector systems. These functions are undertaken in collaboration with DOE program offices, the Office of Intelligence and Counterintelligence (IN), and in partnership with external stakeholders in industry and State, local and Tribal governments. For example, CESER works closely with the Office of Energy Efficiency and Renewable Energy (EERE) to implement cybersecurity protections in the design, manufacture and operation of its technologies, including via the Cybersecurity Manufacturing Innovation Institute to build cyber protections into power electronic-based generation and load, and other devices that interact with the electricity system; develop cybersecure components and supply chains throughout the energy system; and collaborate on the cyber-physical security of EV charging infrastructure which is critical to protect EV users, the EV charging network, and the grid.

Supply Chain Risk: DOE is actively engaged in identifying and addressing evolving cyber threats against the U.S. energy sector from the People's Republic of China (PRC) and has been heavily involved with evaluating the Volt Typhoon / PRC cyber-attacks on U.S. infrastructure and working to help industry respond by joining the Department of Homeland Security and other agencies in issuing an Advisory and Technical Guidance.

Cyber-Threat Information-Sharing: For over a decade the Cybersecurity Risk Information Sharing Program (CRISP), a public-private partnership, co-funded by DOE and industry and now managed under agreements between the Electricity Information Sharing and Analysis Center (E-ISAC), CESER, and Pacific Northwest National Laboratory, has housed the premier critical infrastructure and cyber-threat intelligence platform. CRISP collaborates with energy sector partners to facilitate the timely sharing of unclassified and classified threat information,

develop situational awareness tools that enhance the sector's ability to identify, prioritize, and coordinate the protection of critical infrastructure and key resources and leverage advanced sensors and threat analysis techniques. Current CRISP participants provide power to over seventy-five percent of the total number of continental U.S. electricity customers.

Industry Engagement: Over the past two years, CESER and IN have worked hand-in-hand with interagency, international, and industry owners and operators – including through DOE's Energy Threat Analysis Center (ETAC), which was authorized and funded by the Infrastructure Investment and Jobs Act – to ensure that today's technical guidance is relevant and applicable for all parts of the energy sector beyond CRISP's utility participants. The Energy Resilience facility in the Denver, Colorado metropolitan area will be the permanent physical central hub for the ETAC. CESER is working with Congress toward legislation to provide a long-term authorization for its activities.

Status

- Cybersecurity Mission Growth
 - CESER's plan is reflected in DOE's FY 2025 budget request.
- Cybersecurity Engagement with Industry
 - In late February 2024, CESER and National Association of Regulatory Utility Commissioners (NARUC) released a new set of cybersecurity baselines for electric distribution systems and distributed energy resources.
- Supply Chain Risk Management
 - CESER manages the Cyber Testing for Resilient Industrial Control Systems (CyTRICS) program. CyTRICS partners across stakeholders to identify high priority operational technology components, perform expert testing, share information about vulnerabilities in the digital supply chain, and inform improvements in component design

and manufacturing. The program leverages best-in-class test facilities and analytic capabilities at four DOE National Laboratories and strategic partnerships with key stakeholders including technology developers; manufacturers; asset owners and operators; and interagency partners.

- Cyber-Threat Information Sharing
 - The ETAC completed its pilot phase at the end of FY 2024 and continues as an enduring CESER capability. ETAC is expanding industry participation by bringing eleven new industry partners onboard in FY 2025.
 - The ETAC published eight cyber advisories in FY 2024 that provided insight and mitigation strategies to cyber threats to the energy sector.
 - As part of the ETAC, DOE conducted two special initiatives with industry and IN to address challenges impacting the energy sector.
 - DOE initiated the construction of the Energy Resilience Building on the National Renewable Energy Laboratory (NREL) campus to support ETAC operational and analytical activities. Construction is expected to be completed by the end of FY 2027.
 - CESER deployed the initial ETAC Data Platform in FY 2024 to enable efficient information and data sharing across the ETAC enterprise.



WILDFIRES

Along with risk to human life, the increased frequency and scale of wildfires have created new operational and fiscal challenges for the energy sector.

Summary

Wildfires are a national and international issue that continues to endanger Americans, with fires occurring in regions that were not previously at significant risk (e.g., Southeastern U.S., Hawaii) and resulting in increasingly dangerous and costly impacts to communities and governments across the nation. Wildfire risk continues to be a top priority for the energy sector, as it causes not only operational challenges in managing the grid but also increases financial risk. This financial risk involves both the financial impacts of “strict liability” being applied to utilities of all sizes as well as challenges in maintaining service as utilities struggle to renew Rights-of-Way (ROW) licenses with the Bureau of Land Management (BLM) and U.S. Forest Service (USFS). Downgrades to utility credit ratings due to increased wildfire and operating risk now affect electric utility access to capital. With a rapid increase in demand for electricity projected in order to meet increasing transportation and industrial electrification, and data-center growth, wildfires imperil not only existing infrastructure, but potentially undermine the nation’s competitiveness across a variety of economic sectors.

Issue

In response to growing wildfire risks, the Electricity Subsector Coordinating Council (ESCC) Wildfire Working Group (WWG) was established in 2020 to coordinate wildfire risk mitigation and response efforts at a national level. The Electricity Subsector Coordinating Council

(ESCC) is a chartered organization under the Critical Infrastructure Partnership Advisory Council (CIPAC) and serves as the principal liaison between leadership in the federal government and in the electric power sector to coordinate efforts to prepare for national-level incidents or threats to critical infrastructure. The ESCC facilitates and supports policy- and public affairs-related activities and initiatives designed to enhance the reliability and resilience of the electric grid. These activities include all hazards, steady-state preparation, and emergency preparedness, response, and recovery for the nation’s electricity sector.

Utilities identified onerous land management policies, specifically regarding permitting processes on federal lands as the primary challenge to preventing accidental wildfires through vegetation management. As the Sector Risk Management Agency for the Energy Sector, DOE’s Office of Cybersecurity, Energy Security and Emergency Response (CESER) supported the development of the ESCC WWG to carry out actions at the Secretarial level, elevate and advance executive level communication with BLM, and facilitate a quarterly touchpoint between utility leaders, BLM, USFS, and the Federal Emergency Management Agency (FEMA). Since 2020, DOE has hosted multiple in-person and virtual meetings with the ESCC WWG, National Security Council (NSC), BLM and USFS on wildfire risk.

Status

CESER hosts bi-monthly ESCC Interagency WWG meetings and maintains an action tracker to capture commitments and accountability of wildfire-related activities underway across the group. Efforts to streamline and allocate permits through USFS and BLM are a top priority, along with workstreams to address strict liability and insurance availability. Industry has been active on the Hill, with Congressional letters and the development of new wildfire legislation, including a recommendation to designate CESER as the interagency lead for wildfire mitigation and

interagency planning. If designated as lead, there will be a significant need to build capacity and dedicate resources to address this issue.

CESER continues to seek innovative solutions to advance wildfire mitigation including:

- Providing Artificial Intelligence expertise and tools to advance land management agency permitting efforts.
- Working with state associations such as the National Association of Regulatory Utility Commissioners and the National Association of State Energy Officials to drive wildfire mitigation policies and activities at the state level.
- Collaborating with the Grid Deployment Office (GDO) staff on identifying gaps and industry needs to ensure technical assistance funding can meet the sector's needs.
- Continuing to update the Wildfire Lab Work Tool Kit as new tools and technologies are developed. Between 2023 and 2025, CESER will invest over \$16 million with National Labs and research partners for projects that support the three phases of wildfire incident response: preparedness and mitigation, response, and recovery.
- Building a diverse portfolio of ongoing wildfire Research and Development efforts across all phases of the hazard including:
 - Leveraging Artificial Intelligence and Machine Learning (AI/ML) to prevent wildfire ignition from the electric grid; research on the efficacy of protective measures/equipment, and accelerated grid recovery post-wildfire.
 - New initiatives including testing of advanced conductors in wildfire environments; near-real-time wildfire risk tools; and AI/ML-based wildfire detection.



TANK WASTE AND SPENT NUCLEAR FUEL

The Office of Environmental Management (EM) is responsible for Spent Nuclear Fuel (SNF) generated from nuclear weapons production and energy research and tank waste generated from past SNF reprocessing and plutonium production.

Tank waste represents over half of DOE's \$400 billion+ environmental liability, is projected to take over four decades to address, and requires a third of EM's total annual budget of about \$8.5 billion.

Summary – Tank Waste

EM is responsible for the safe and effective management of radioactive and chemical liquid tank waste from SNF reprocessing and plutonium production activities. This waste is primarily stored in underground tanks at three DOE sites: Hanford, the Savannah River Site (SRS), and Idaho National Laboratory (INL). Tank waste management represents DOE's largest environmental and financial liability. EM began converting liquid tank waste to stable solid forms several decades ago, a process not expected to be completed in full for five more decades. This conversion process typically separates the waste into two portions: a low-level waste stream eligible for permanent disposal and a high-level waste (HLW) stream requiring interim storage until a disposal pathway is available.

Issue – Tank Waste

While EM successfully began converting liquid tank waste to stable solid form several decades

ago, EM's greatest challenge is to treat and solidify fifty-six million gallons of tank waste stored in one hundred seventy-seven tanks: one hundred forty-nine underground single-shell tanks (SSTs) and twenty-eight double-shell tanks (DSTs) at the Hanford site in Washington state. To address this challenge, EM prepared the world's largest radioactive-waste treatment plant, the Waste Treatment and Immobilization Plant (WTP), at the Hanford site. At WTP, EM will begin treating low-level liquid waste in 2025 at Hanford's Low Activity Waste (LAW) facility, where it will be vitrified (immobilized in glass). In April 2024, DOE announced a landmark agreement with the State of Washington and the Environmental Protection Agency (EPA) on the future of tank waste cleanup at the Hanford Site. Under this Tri-Party Agreement, DOE has legal commitments in 2024 and 2025 to meet certain commissioning milestones and produce containers of vitrified waste. EM plans to begin operations in 2033 to vitrify Hanford's HLW. Congress, the U.S. Government Accountability Office, the State of Washington, Tribal Nations, and other stakeholders maintain an active interest in treating Hanford's tank waste.

Construction of Hanford's SSTs, which feature one liner encased in concrete, began in 1944. DOE discovered leaking SSTs, and as a result began constructing DSTs in the 1960's, which contain an inner and outer shell encased in concrete to provide containment redundancy. In 2004, Hanford completed transferring most of the pumpable liquids from the SSTs into the newer DSTs. While some SSTs have been fully retrieved, the majority continue to store sludge, saltcake, and interstitial liquids. To protect human health and the environment, EM operates a robust program that includes tank integrity assessment and monitoring, groundwater treatment, and retrieval efforts to move waste remaining in the SST to the DSTs.

Since 2018, DOE has used an interpretation of the HLW definition to allow for the safe disposition of reprocessing waste from SRS based on its radiological content, not its origin as defined in

the Nuclear Waste Policy Act and the Atomic Energy Act. DOE recently agreed with the State of Washington that DOE intends to forbear from using this interpretation for waste located at or from Hanford. That agreement contemplates that DOE might, in the future, terminate or propose to terminate such forbearance.

Status – Tank Waste

DOE, EPA, and the State of Washington announced an agreement in principle in 2023, and completed negotiations in 2024, to revise the Tri-Party Agreement, a legally enforceable agreement defining overall Hanford cleanup requirements and milestones. An associated Consent Decree, relevant to the tank waste mission, to define an achievable path forward for Hanford's tank waste mission was also completed. The Tri-Party Agreement conditions include cleanup milestones, required infrastructure, technology development, and also specifies waste forms for treated and disposed tank waste.

At SRS, all HLW processing facilities are currently operational. A suite of facilities is solidifying over thirty-three million gallons of liquid tank waste stored in forty-three tanks, with six tanks in or at the groundwater level. Low-level tank waste is immobilized and disposed on-site in a concrete-like form. HLW is vitrified and stored onsite in stainless steel containers awaiting a disposal path. These activities are part of a regulatory framework between the state of South Carolina, EPA and DOE. EM estimates the SRS tank waste mission will be completed in 2037.

In 2023, EM's Idaho site began operating the Integrated Waste Treatment Unit to convert nine hundred thousand gallons of highly radioactive, sodium-bearing liquid tank waste to a more stable granular solid called calcined waste. EM also manages forty-four hundred cubic meters of previously calcined waste from legacy SNF reprocessing, currently stored onsite until a treatment and disposal path is determined. The court-ordered Idaho Settlement Agreement

(between the State, Navy and DOE) and related regulatory agreements define DOE obligations for treatment and disposal of these wastes.

Tank waste from the New York West Valley Demonstration project, the nation's sole former commercial SNF reprocessing facility, was successfully vitrified several years ago. These vitrified waste containers are stored on site, awaiting a disposal path.

Summary – Spent Nuclear Fuel

EM is responsible for managing DOE's approximately twenty-five hundred metric tons of SNF at four sites: Hanford, SRS, INL, and the Fort St. Vrain commercial storage facility in Colorado. SNF has a variety of characteristics that make it challenging to manage including age-related deterioration, damage, and hazardous chemical constituents. Most SNF is stored in a dry condition, although some remains in water pool storage.

SNF is generally managed in place in preparation for future disposal. Most SNF is expected to be disposed of in its current form, although at SRS the Accelerated Basin De-inventory (ABD) program dissolves and dispositions SNF into sludge batches that will be processed and vitrified at the Defense Waste Processing Facility.

Issue – Spent Nuclear Fuel

In Idaho, management of SNF is subject to regulatory or legal agreements that contain DOE obligations and milestones associated fines and penalties. Through the court-ordered Idaho Settlement Agreement all SNF at INL must be shipped out of state by January 1, 2035.

At SRS, the ABD program is expected to run through the mid-2030's but will not fully eliminate the SNF inventory in L-Basin. DOE must determine a disposition path for the remaining inventory and future SNF receipts.

Background

The Nuclear Waste Policy Act of 1982 provides for disposal of SNF and HLW in a deep geologic repository. NWPA currently limits consideration of such a repository to Yucca Mountain, which has been found to not be a feasible option because of lack of public acceptance. DOE manages all liquid radioactive waste as HLW prior to treatment. Managing tank waste in this manner preserves optionality so that the appropriate disposal path and waste type can be determined at the time of treatment.

AUKUS

Announced in September 2021, the Australia-United Kingdom-United States (AUKUS) enhanced trilateral security partnership seeks to enable Australia's acquisition of a conventionally armed, nuclear-powered submarine (SSN) capability (Pillar I) and empower cooperation on advanced defense capabilities (Pillar II). NNSA, particularly the Office of Naval Reactors and the Office of Nonproliferation and Arms Control, play a key role in implementing AUKUS.

Issue

AUKUS presents a generational opportunity to modernize and enhance longstanding partnerships and cooperation to address global security challenges and contribute to stability and prosperity in the Indo-Pacific region and beyond. Prior to AUKUS, the United States (U.S.) had only shared naval nuclear propulsion information and technology with the United Kingdom (UK). Enabling Australia's acquisition of an SSN capability is challenging because of Australia's limited experience with nuclear power, small industrial base, and the forthcoming increased oversight of nuclear activities in Australia by the International Atomic Energy Agency (IAEA) when compared to the U.S. and UK. As a result, delivering such a capability will require a phased approach over more than a decade. NNSA support is key to ensuring the success of this effort. The Office of Naval Reactors is heavily involved in the training of Australian personnel, the uplift of the UK's naval nuclear propulsion technology, and the development of nuclear stewardship in Australia. The Office of Nonproliferation and Arms Control works closely with Australian and UK partners and the IAEA to develop a robust package of verification

measures that will enable the IAEA to continue to verify that all nuclear material in Australia is being used as declared and that there is no indication of misuse of nuclear facilities or undeclared nuclear materials or activities in Australia.

Status

In just over three years since the AUKUS partnership was announced, the U.S., UK, and Australia have made significant progress in laying the groundwork for Australia's acquisition of SSNs while setting the highest nonproliferation standard and protecting classified and controlled information. In March 2023, AUKUS leaders announced a three-phase "Optimal Pathway" for AUKUS Pillar I:

- Phase 1: In 2023, Australian military and civilian personnel began embedments with the UK and U.S. navies and submarine industrial bases. As early as 2027, the UK and the U.S. plan to establish a rotational presence of submarines at a naval base in Western Australia.
- Phase 2: Beginning in the early 2030s, the U.S. intends to sell Australia three Virginia-class submarines, with the potential to sell up to two more, if needed.
- Phase 3: Starting in the early 2040s, Australia will build the UK-designed SSN-AUKUS, which will include advanced U.S. submarine and reactor plant technology.

Over the last year, Royal Navy (RN) and U.S. Navy personnel have worked to train Royal Australian Navy (RAN) and Australian contractor personnel to maintain, sustain, operate, and crew nuclear-powered submarines. More than fifty RAN personnel are currently in various stages of the U.S. SSN training pipeline to equip a cadre of Australian officers and sailors with experience operating and maintaining SSNs, including the Virginia-class SSNs that the RAN will operate from the early 2030's. All three governments have increased investments in expanding their

submarine industrial bases to support initiatives related to supplier development, shipbuilder and supplier infrastructure, workforce development, technology advancements, and strategic sourcing. In August 2024, the first-ever maintenance activity of a U.S. SSN in Australia was completed involving approximately thirty RAN personnel who worked alongside U.S. Navy and contractor personnel to conduct routine maintenance and observe safety and stewardship evolutions. This is an important step in building Australia's capacity to support a rotational presence of UK and U.S. SSNs at Submarine Rotational Force – West (SRF-West) beginning as early as 2027, as well as Australia's future sovereign SSN capability.

Regarding AUKUS Pillar II, AUKUS partners' trilateral science and technology, acquisition and sustainment, and operational communities are working across the full spectrum of capability development—generating requirements, co-developing new systems, deepening industrial base collaboration, and bolstering our innovation. Areas of focus include integrated trilateral experiments on autonomous uncrewed systems in the maritime domain and innovative uses of artificial intelligence technologies to enhance decision making and bolster combined military effects. In April 2024, Australian, UK, and U.S. defense leaders announced principles for engaging additional partner countries on opportunities to collaborate on AUKUS Pillar II projects. In particular, consultations with Japan to improve interoperability with Japan's maritime autonomous systems began this year and consultations are ongoing with Canada, New Zealand, and the Republic of Korea to identify possibilities for collaboration on advanced capabilities under AUKUS Pillar II.

Milestones

- September 15, 2021 – AUKUS announced by the leaders of Australia, the UK, and U.S.
- February 8, 2022 – The Exchange of Naval Nuclear Propulsion Information Agreement (ENNPIA) entered into force to facilitate the sharing of naval nuclear propulsion information trilaterally.
- March 13, 2023 - AUKUS partners announced the Optimal Pathway to enable Australia to acquire a conventionally armed, nuclear-powered submarine capability while ensuring all three partners maintain the highest nonproliferation standards.
- August 5, 2024 – The AUKUS Naval Nuclear Propulsion Agreement (ANNPA) was signed by representatives of the three governments. The ANNPA will supersede the ENNPIA, will enable the continued sharing of naval nuclear propulsion information among the partners, and will facilitate the transfer of nuclear material and equipment to Australia needed to implement AUKUS in accordance with the U.S. Atomic Energy Act.
- ~2027 –SRF-West to be established at HMAS Stirling near Perth, Australia.
- Early 2030s – Australia to purchase three U.S. Virginia-class SSNs, subject to Australia meeting specific conditions-based milestones.
- Early 2040s – Australia and the UK to produce a new class of SSN, called SSN-AUKUS, using a UK design and incorporating U.S. technology (including reactor plant technology).



Background

The AUKUS partnership represents a modernization of the longstanding alliances and partnerships between the United States, Australia, and the United Kingdom. It deepens our longstanding diplomatic, security, and defense cooperation to meet the complex challenges of the future. It will strengthen our combined military capabilities, boost our defense industrial capacity, enhance our ability to deter aggression and promote our shared goal of a free and open Indo-Pacific. Australia's modernization of its submarine fleet will be a multi-decade undertaking that will be done in a manner that sets the highest nonproliferation standard and strengthens the nuclear nonproliferation regime.

COLUMBIA-CLASS BALLISTIC MISSILE SUBMARINES

As the most survivable leg of the nuclear triad, ballistic missile submarines play a critical role in the national strategic deterrence mission. Columbia-Class ballistic missile submarines (SSBN) will replace the current Ohio-Class at the end of their service life.

Background

The ongoing DOE reactor plant efforts include design, development, and analysis of lead ship reactor plant configuration, components, instrumentation and control, and requisite safety and risk management efforts to ensure alignment of key reactor plant milestones with overarching submarine construction and testing of this first of class ship.

Issue

Procurement of long-lead material and manufacturing of the reactor core for the Columbia Class ballistic missile submarines began in fiscal year (FY) 2019 and construction of the lead Columbia-Class submarine began in FY 2021. The FY 2025 budget request supports completion of the lead submarine reactor core and delivery to the shipyard in FY 2026 and oversight and safety analysis work required to support lead ship reactor testing.

Status

DOE funded efforts are on track. Work on Columbia-Class cores is tightly synchronized with Navy funded propulsion plant and overall construction of the ship.

Milestones

DOE funded design, development, and manufacture of reactor plants with a life-of-ship core throughout the FY 2023 cycle and is continuing. This core will serve over 40 years, eliminate the need for refueling, increase operational availability, and serve the strategic deterrence mission with fewer ships.

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INTEGRATED PLUTONIUM PROGRAM

NNSA uses plutonium for multiple missions, supporting both the U.S. nuclear deterrent and global security. NNSA is reestablishing the capability to produce plutonium pits for weapons at the rate needed to support Department of Defense (DoD) requirements while simultaneously establishing a long-term, sustainable mission for surplus plutonium disposition.

Summary

Establishment of the capability and capacity to produce plutonium pits for nuclear warheads under the Integrated Plutonium Program (IPP) remains critical to national security. The ability to study plutonium aging impacts is also of vital importance to stockpile certification, as pit performance degrades over time. In parallel, NNSA is committed to dispositioning plutonium declared excess to national security requirements. Pursuing these efforts in tandem requires coordination across multiple NNSA organizations to properly prioritize and advance each line of work, including deconfliction of resources or equipment within the same facilities.

The establishment of a capability to produce new plutonium pits for nuclear warheads is a key national security mission for NNSA's Office of Defense Programs, and the capability is an essential component of a modern production complex. Success relies not only on the efforts to modernize and establish production facilities but also on key inputs from plutonium research and development (R&D) efforts that can influence influence design decisions. Understanding pit

aging and its effect on weapon performance is vital to determining how long older pits can remain in the stockpile and therefore when new pits must be manufactured. The Research Program Plan for Plutonium and Pit Aging (referenced below as the "plan") is a decadal R&D plan designed to address these questions and inform stockpile assessments.

The United States has made nonproliferation policy commitments to dispose of thirty-four metric tons of plutonium declared excess to national security requirements and has legal commitments to the State of South Carolina to remove certain inventories of plutonium. NNSA's Office of Defense Nuclear Nonproliferation is responsible for the permanent disposition of this material.

Issues

Plutonium Pit Production: Following the shutdown of the Rocky Flats plant in 1989, the United States lost the capability to produce new plutonium pits for nuclear weapons at volume. NNSA is now reestablishing that production capability, which is essential to maintaining a nuclear deterrent. Existing plutonium facilities require more floor space, additional capacity, and modern equipment to meet needs. New facilities are also required to expand pit production capacity to manufacture at the necessary scale. NNSA is establishing mission resilience through a two-site strategy, with pit production capabilities distributed between the Los Alamos National Laboratory (LANL) and the Savannah River Site (SRS). At LANL, Plutonium Facility-4 (PF-4) houses both pit-production and plutonium-disposition activities that must be coordinated to meet both NNSA objectives.

Plutonium Science: The predominant issues with plutonium R&D efforts are providing modernized scientific facilities to conduct experiments, executing the research plan, and maintaining consistent and effective communications with all stakeholders. NNSA is currently executing the Enhanced Capabilities for

Subcritical Experiments (ECSE) project to address gaps in experimental capabilities. Repeated and numerous congressional requests on this topic indicate a concern with prioritization and appropriateness of the overall R&D plan. NNSA's Advisory Committee for Nuclear Security (ACNS) has recommended maintaining facility acquisitions on the intended schedule and noted the importance of both executing the plan communicated to Congress and conducting reviews to inform the range of stockpile-related decisions.

Surplus Plutonium Disposition (SPD): For excess plutonium disposition, the United States and Russian Federation signed the Plutonium Management and Disposition Agreement in 2000, which committed both countries to dispose of no less than thirty-four metric tons of weapons-grade plutonium. NNSA is working to permanently dispose this material declared excess to national security in support of legal commitments, U.S. policy, and global and nuclear security goals.

Status

Plutonium Pit Production: NNSA's Office of Production Modernization and Materials Management oversees the installation of a significant amount of new equipment and removal and decommissioning of legacy equipment, such as gloveboxes, at existing and new facilities to achieve production capacity on the scale required to meet DoD requirements. Production capacity at LANL depends on how quickly manufacturing and certification processes mature, old equipment is removed, and new equipment is manufactured and installed.

At SRS, design efforts are underway for the process equipment, gloveboxes, and numerous facility systems at the Savannah River Plutonium Processing Facility (SRPPF). SRPPF includes a Main Process Building (MPB), a High-Fidelity Training and Operations Center (HFTOC), and other supporting facilities, all which are currently under design and construction. Removal of old

material and equipment from the MPB is complete. Site preparation and construction of some supporting facilities, notably a large sand filter critical for building filtration, must commence before equipment installation in the MPB.

Plutonium Science: NNSA's Office of Research, Development, Test & Evaluation is executing to the decadal Research Program Plan for Plutonium and Pit Aging using experimental capabilities at facilities across the Nuclear Security Enterprise. Over the last year, the Plutonium/Pit Aging program has also supported an audit by the Government Accountability Office and a review by the ACNS subcommittee on the IPP.

Defense Programs continues to balance R&D facility acquisitions with other complex-wide modernization priorities and is doing so in a time-phased manner. ECSE is a portfolio of work aimed at improving the ability to assess nuclear weapons without underground nuclear explosive testing. To achieve this objective, new measurements of plutonium from subcritical experiments will provide data to help reduce uncertainties in the weapon computer models NNSA uses to assess the stockpile. Data from ECSE will support certification of future stockpile modernization programs and will also support future Annual Assessments.

Surplus Plutonium Disposition: To meet U.S. policy and legal commitments, the United States will permanently dispose much of the plutonium declared excess to national security requirements through the dilute and dispose approach, also known as plutonium downblending. This process blends plutonium with an adulterant and produces a proliferation-resistant waste product, which will be permanently emplaced at the Waste Isolation Pilot Plant (WIPP). The Department stood up the downblending process in 2017 and began shipments of downblended plutonium to WIPP in 2022. The Department also has legal commitments to the State of South Carolina to remove certain inventories of plutonium that were

consolidated to SRS as a result of the end of the Cold War. The Settlement Agreement requires that DOE remove approximately 9.5 metric tons from SRS by the end of 2036, or the Department may be subject to additional fines and penalties.

Multiple NNSA organizations coordinate to properly prioritize and advance each of the above mission sets work, including deconfliction of resources or equipment within the same facilities.

Milestones

- First Production Unit at LANL by the end of CY 2024
- SRPPF project design to reach 60% design complete by CY 2024
- LANL reaches rate production as soon as CY 2028
- HFTOC operational by CY 2028
- SPD project complete by FY 2031
- SPD operational by CY 2031
- SRPPF MPB operational by CY 2032
- SRPPF reaches rate production as soon as CY 2036

Background

Plutonium pits are a vital component in every U.S. nuclear weapon. NNSA's approach to meeting a congressionally mandated requirement to deliver no fewer than eighty new pits per year includes completing the modernization of PF-4 at LANL and repurposing the former MOX Fuel Fabrication Facility at SRS as the SRPPF.

The Plutonium/Pit Aging program is resourced and managed across several R&D programs/funding lines, including experimental facilities, computational assets, and engineering capabilities. In response to FY 2021 Appropriations language (SEWD), NNSA

developed a classified ten-year R&D plan (Research Program Plan for Plutonium and Pit Aging) detailing milestones, facilities, and resource requirements.

Under the plutonium disposition mission, the majority of the excess plutonium is in the form of pits dismantled from nuclear weapons, which requires disassembly and conversion of plutonium metal into oxide in preparation for disposition. The only capability NNSA has to perform this function today is in PF-4 at LANL, alongside pit production activities. Currently, the SPD Program is continuing its pace of the program, particularly pit disassembly and oxide processing, at a very small scale and on a non-interference basis with pit production activities ongoing within PF-4. Expanded capability will be necessary to dispose of all the plutonium declared excess to national security. The program is currently executing a line-item project to add dilution capability at SRS, which is necessary to support the removal of plutonium from the State of South Carolina, consistent with the Settlement Agreement. Current plans are to defer expansion of pit disassembly and processing until rate pit production capability is achieved. The deferral of the SPD Program also requires the complex to stage pits declared excess for an extended period of time and consider results from pit aging studies as part of future program planning.

PRODUCTION MODERNIZATION

NNSA is modernizing the entire Nuclear Security Enterprise. This effort includes the replacement or recapitalization of infrastructure as well as the reestablishment of lost or outdated capabilities with modern processes.

Summary

Defense Programs' Office of Production Modernization and Materials Management is responsible for producing strategic materials and certain nuclear weapon components, as well as maintaining, upgrading, or replacing the facilities and capabilities necessary for their production. These efforts enable the long-term viability of nuclear weapons production infrastructure by improving, and in many cases reestablishing the capabilities needed to produce strategic materials and components for nuclear weapons at the capacities needed to support the nuclear deterrent.

Issue

To maintain a safe, secure, and effective nuclear deterrent, NNSA requires infrastructure and processes capable of producing the strategic materials and components for nuclear weapons at the capacity needed to meet current and future demands. The nuclear security enterprise (NSE) is dependent on aging infrastructure and antiquated technologies and processes. This has led to operational inefficiencies, single points of failure, and in some instances hazardous conditions for workers. For some processes, current capacity is insufficient to meet growing demands. In addition, certain critical capabilities and supply chains have been lost and must be reestablished. To ensure our ability to meet current Program of Record requirements and

future needs, NNSA must modernize infrastructure and processes across the NSE. These investments can no longer be deferred without risking impacts to critical deliverables. The effort to revitalize production infrastructure and processes is led by NNSA's Office of Production Modernization and Materials Management, composed of three programs: Pit Production Modernization; Strategic Materials Production Modernization; and Warhead Assembly and Non-Nuclear Modernization.

Status

Production Modernization efforts support multiple strategic priorities. One key priority is establishing the capability to produce nuclear weapon primaries, including War Reserve (WR) plutonium pits – a critical nuclear weapon component. The required pit production rate is driven by stockpile plans to support statutory policy, and Department of Defense (DoD) requirements. Pit production efforts include significant capital line-item construction projects across multiple NNSA sites, primarily the Los Alamos Plutonium Pit Production Project (LAP4) and the Savannah River Plutonium Processing Facility (SRPPF) project. Additionally, NNSA is developing the requisite human capital and processes to support the required rate of production for future stockpile systems. NNSA currently estimates achieving the capability to produce no fewer than eighty plutonium pits per year during the mid-2030's. Production Modernization investments also support the material availability and manufacturing processes required to produce the secondary stage and radiation cases of nuclear weapons. Several of the highest priorities in this space involve improving safety for high hazard processes – such as the production/processing of lithium and conversion/purification of enriched uranium – and the reestablishment of lost capabilities – such as the alloying of niobium and depleted niobium to make binary for radiation cases and domestically enriching uranium to provide unobligated fuel for tritium production. These efforts are at various stages of maturity, but some are needed as soon as the late 2020's.

For capabilities that exist today, in addition to implementing process improvements, Production Modernization leads efforts to modernize the facilities in which these capabilities are housed. Many date back to the Manhattan Project and require replacement or recapitalization to continue to operate.

Nuclear weapons contain a significant number of non-nuclear components, accounting for over half the cost of weapons modernization programs. Increasing non-nuclear component manufacturing capacity is a strategic priority for NNSA, as current throughput at key facilities is too low to meet projected deterrent needs. Beyond non-nuclear components, Production Modernization is responsible for ensuring the enterprise's ability to meet stockpile requirements for high explosives and energetics. In addition to reliability challenges associated with the manufacturing of insensitive high explosive (IHE) to weapons specifications, the sole supplier of a key precursor material for a type of IHE used in the stockpile announced that it would discontinue manufacturing of the precursor in 2025. Production Modernization has been at the forefront of efforts to mitigate impacts from the loss of this material.

Milestones

- Reach rate production at Los Alamos National Laboratory as soon as CY 2028.
- Reach rate production at Savannah River Plutonium Processing Facility as soon as CY 2036.
- Replace aging hydrogen isotope separation equipment at the Savannah River Site's H-Area to sustain tritium capabilities and capacities while continuing to develop more efficient isotopic separation technologies.
- Reestablish supply chain for High-Purity Depleted Uranium by 2028.
- Deploy and qualify Direct Casting at Y-12, a more efficient radiation case production technology.
- Achieve Critical Decision-2/3 for the Lithium Processing Facility to replace an 81-year-old legacy facility.
- Establish Y-12 Special Materials facilities and production capabilities to meet weapon system requirements.
- Complete construction of the Uranium Processing Facility at Y-12, providing new floorspace for enriched uranium casting, salvage and accountability, and other operations.
- Start operations in FY 2034 for the Pantex High Explosives Synthesis, Formulation, and Production facility to provide internal, reliable main charge high explosives.
- Complete design and get authorization to start construction in 2025 for the Sandia National Laboratories Power Sources Capability project that will replace a 75-year old converted warehouse.
- Complete the multi-project Kansas City Short Term Expansion Plan that will increase manufacturing and development space by over 450K sq. ft.
- Complete three phases of Kansas City Non-Nuclear Expansion Transformation by 2030 to provide critically needed manufacturing and office space.

Background

Production Modernization activities support the production of plutonium pits, tritium, high explosives, and energetics for nuclear weapons primaries. The weapon’s secondary stage requires an array of strategic materials, including enriched and depleted uranium and lithium, in addition to the technologies and equipment needed to manufacture components from said materials and the facilities to house these capabilities. Non-nuclear components and weapons assembly modernization efforts focus on increasing the operational throughput of facilities that house the production of non-nuclear components, such as radiation-hardened microelectronics and power sources, and recapitalizing/replacing aging facilities and infrastructure to support the assembly of finished components into a warhead.

SAVANNAH RIVER PLUTONIUM PROCESSING FACILITY

This facility must be completed by 2032 in order to establish a fifty pits per year production capability at SRS to support the Department of Defense (DoD) pit production requirements.

Summary

The Savannah River Plutonium Processing Facility (SRPPF) is located at the Savannah River Site in Aiken, South Carolina, along the Georgia-South Carolina border. The National Nuclear Security Administration (NNSA) is required to establish a fifty War Reserve (WR) plutonium pits per year production capability, out of a total NNSA production goal of eighty pits per year, on a timeline that supports DoD's pit production requirements as outlined in the Requirements and Planning Document (RPD). A war reserve pit is one that has been accepted for use in the nuclear stockpile, as distinct from developmental or production prove-in pits. An aggressive timeline to meet the need requires that the SRPPF Project achieves the Department of Energy Order (DOE O) 413.3B, *Program and Project Management for the Acquisition of Capital Assets*, Critical Decision (CD)-4, Approve Start of Operations or Project Completion, by the first quarter of fiscal year (FY) 2032. Under DOE's construction guidance, CD-4 means the construction project is complete and the resulting facility is ready to be operated for its intended purpose.



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Issue

The SRPPF Project has continued to experience significant delays and cost increases during the design process for a variety of reasons including: (1) design evolution and maturation (e.g. design integration, space constraints, detailed requirements misinterpretation); (2) directed changes (e.g. "High Fidelity" portion of Training and Operations Center, whitespace utilities, single point failure equipment, safety controls, equipment to support change in first pit type); (3) contractor performance (not progressed design as expected, execution/mobilization of approved scope); and (4) economic conditions (e.g. labor shortages, supply chain risks realized, inflation, COVID impacts).

Status

Design Status

The Project's overall design is comprised of various components in various stages of development:

- Process equipment, including gloveboxes is approximately 80-90% design complete;
- balance of plant, including utilities for the building and process equipment, is 45-60% design complete; and
- safeguards and security to support the Project are 60% design complete.

The Project continues to progress towards design completion, with 60% overall design completion forecasted for first quarter fiscal year (FY) 2025.

Long Lead Procurements and Site Preparation

The Project's completion strategy allows for the contractor to conduct long lead procurements and site preparation prior to the Project reaching the CD-2/3 milestone, Approve Performance Baseline and Start of Construction. Under DOE Order 413.3B, CD-2, Approve Performance Baseline, marks the acceptance of the performance baseline and requires the completion of preliminary design. CD-3,

Approve Start of Construction, provides authorization to complete all procurement and construction. Approval of CD-3 authorizes the project to commit all the resources necessary, within the funds provided, to execute the project.

The Project is made up of 12 CD-3X packages spread among six subprojects, that permit the contractor to conduct long lead procurements and perform site preparation before CD-2/3 for preparation, sandfilter/fan house, administrative building, main processing facility, safeguards and security subproject, and the high fidelity training and operations center.

- Seven packages are approved and in progress (~\$1.9 billion of scope)
- Five additional packages are planned

Project Baseline and Construction Start (CD-2/3)

In alignment with DOE O 413.3B and the current Project tailoring strategy, CD-2/3 is forecasted in first quarter of FY 2027; however, an updated tailoring strategy is under consideration by the SRPPF Project Management Executive (PME). The proposed strategy includes a DOE O 413.3B exemption, which would approve the Main Processing Building subproject for CD-2/3 though it is at less than Final (i.e., ninety percent) design. Under the revised proposed tailoring strategy, the six subprojects will be rolled up to three subprojects and the number of CD-3X packages will be minimized to reduce the administrative burden. If approved, CD-2/3 is forecasted to be reached a year earlier, in the first quarter of FY 2026, with Preliminary Design (e.g., forty percent for non-nuclear and sixty percent for nuclear design). This tailoring strategy is necessary to maintain project completion by 2032 but introduces more risk to project execution from potential late design changes causing rework and the potential for design interface issues. The risk is being minimized by issuance of the Preliminary Documented Safety Analysis and issuance of the Safety Evaluation Review Letter at Preliminary Design, which mitigates significant safety basis

comments and the associated late design changes. The project management office will only authorize work to begin on work scope that is at Final Design minimizing design interface issues.

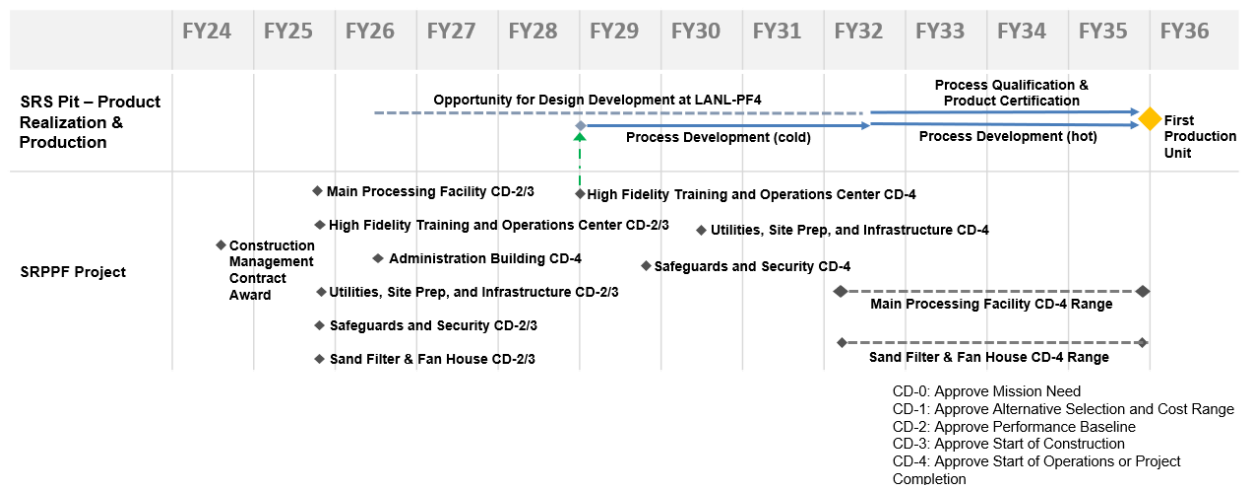
Cost Estimate

The CD-1, Approve Alternative Selection and Cost Range, approval obtained in June 2021 provided a cost range of \$6.9 billion to \$11.1 billion and a CD-4, Project Completion, range of first quarter FY 2032 to fourth quarter FY 2035. In May 2023, NNSA requested Savannah River Nuclear Solutions (SRNS), the management and operating contractor at the Savannah River Site that is ultimately responsible for SRPPF construction, to develop a comprehensive bottom-up estimate (BUE), inclusive of an integrated master schedule for SRPPF. NNSA concurred that the SRNS BUE results indicated the CD-1 cost range had grown by more than fifty percent and a CD-1 Reaffirmation (CD-1R) must occur, in alignment with DOE O 413.3B. NNSA is currently taking steps towards completion of the CD-1R process, necessitating the PME to approve a revised CD-1, identifying the new or reaffirmed selected alternative and an updated CD-1 cost range.

Construction Management

In order to improve project performance, NNSA directed SRNS to obtain a construction management (CM) contractor to manage the engineering, procurement, and construction scope of the project through CD-4. SRNS elected to pursue a sole-source affiliate sub-contract with Fluor, awarded in the fourth quarter of FY 2023. Fluor took over the CM on August 15, 2024. SRNS will retain responsibilities for Project and Contractor Integration, Design Authority and Nuclear Safety/Security Authorities, and Operation Commission and Turnover.

Milestones



Background

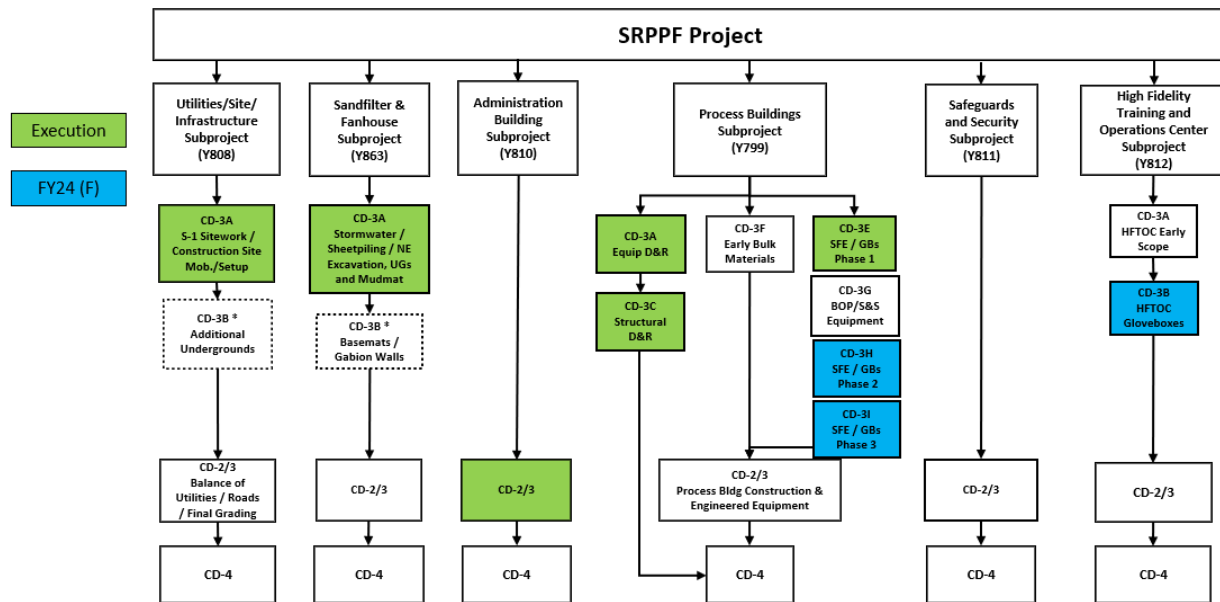
In 2018, the Nuclear Weapons Council endorsed the Department of Energy's National Nuclear Security Administration's two-site approach to supply no fewer than eighty War Reserve (WR) plutonium pits per year in alignment with Department of Defense Requirements: Los Alamos National Laboratory will produce no fewer than thirty WR pits per year and SRS will produce no fewer than fifty WR pits per year no later than 2030.

SRS will establish a pit production capacity through the repurposing of the unfinished Mixed Oxide Fuel Fabrication Facility, that was designed to meet stringent security and safety requirements for plutonium operations. The CD-1 package detailing the conceptual design and estimated cost range was approved in FY 2021. Based on information developed to support CD-1 approval, DOE/NNSA determined achieving the required fifty WR pits per year production rate at SRS in 2030 was not feasible.

The project's CD-1, Approve Alternative Selection and Cost Range, was approved on June 25, 2021, with a cost range of \$6.9 billion to \$11.1 billion. The project is made up of six subprojects.

DOE Order 413.3B allows for tailoring to support good project management practices, as well as the completion of Critical Decision packages simultaneously. The CD-3X tailoring strategy allows discreet package of scope with a mature design to be baselined and executed ahead of CD-2/3. This strategy is allowing NNSA to start long lead procurements and site preparation, supporting acceleration. The following is a graphic depicting the approved SRPPF tailoring strategy.



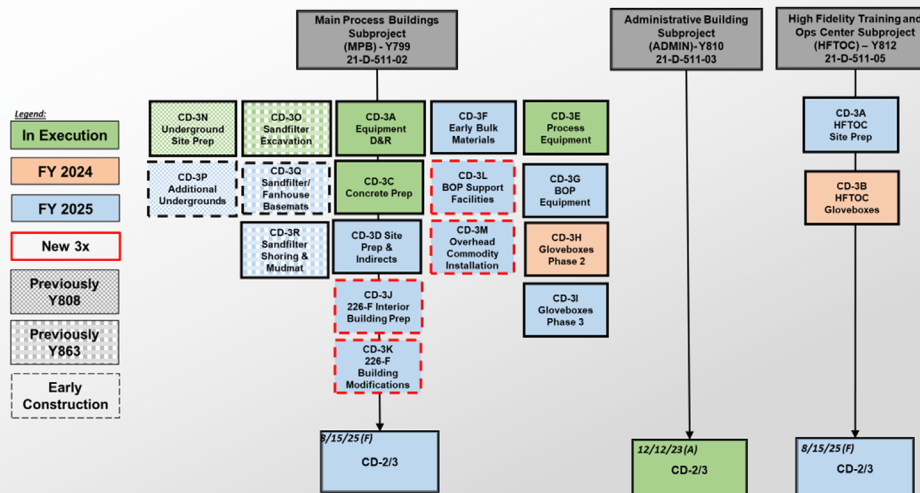


Here is the most current version of the proposed Tailoring

Draft final - Tailoring Structure & Phasing

Project Overview

INNOVATE. COLLABORATE. DELIVER.



Note: Name changes caused by roll up of 6 subprojects to 3. Changes were necessary to eliminate duplicate CD-3X designations which cause errors in data management systems. Further changes to proposed CD-3X packages which, support the critical path, probable based on development of the Integrated Master Schedule and CD-2/3 Performance Baseline.



STOCKPILE MANAGEMENT

The Office of Defense Programs, within the National Nuclear Security Administration, directs and oversees all nuclear weapon design, development, manufacturing, maintenance, annual assessment, and dismantlement activities throughout the Nuclear Security Enterprise (NSE) to ensure the United States' nuclear weapons stockpile remains safe, secure, and reliable.

Issue

NNSA's most resource-intensive mission is to design, produce, certify, and deliver the U.S. nuclear stockpile while advancing the scientific, technological, and engineering capabilities that underpin it. Our nuclear deterrent remains the foundation of U.S. national defense.

Status

For context, at the height of the Cold War, the U.S. nuclear weapons arsenal included over 31,000 warheads. As of the most recently declassified release in September 2023, the U.S. nuclear stockpile consisted of 3,748 warheads. NNSA continues to focus on delivering seven major stockpile modernization programs simultaneously, having most recently received authorization and appropriation for the B61-13 gravity bomb and established a program of record for the Nuclear-Armed Sea-Launched Cruise Missile (SLCM-N) in accordance with congressional direction in FY 2024. These seven modernization programs are at different stages of design, engineering, production, and delivery. NNSA is also executing sustainment activities for warheads currently in service, to include extensive surveillance to support NNSA

Laboratory Director assessments that the nuclear stockpile remains safe, secure, reliable, and militarily effective without the need to resort to underground nuclear explosive testing.

Milestones

- The Pantex Plant in Panhandle, Texas is the nation's primary site for assembly and disassembly of nuclear weapons. Pantex completed the First Production Unit (FPU) for the B61-12 in FY 2022 and has since maintained one hundred percent on-time deliveries to the U.S. Air Force. The Last Production Unit (LPU) is anticipated in FY 2025.
- Pantex completed the W88 Alteration (Alt) 370 FPU in FY 2021 and has since maintained one hundred percent on-time deliveries to the U.S. Navy. The LPU is anticipated in FY 2025.
- Congress authorized the B61-13 program and began Phase 6.3, Development Engineering, activities in FY 2024. The B61-13 program will progress into Phase 6.4, Production Engineering, in FY 2025 with the goal of achieving system FPU in FY 2026.
- The W80-4 warhead for the long-range standoff missile entered Phase 6.4, Production Engineering, in FY 2023 and remains on track for FPU in September 2027.
- In accordance with the FY 2024 National Defense Authorization Act, NNSA and the Department of Defense (DoD) established a program to develop a SLCM-N capability. The program entered Phase 6.2, Feasibility Study and Downselect, in June 2024. NNSA is coordinating with DoD to down-select the warhead family in FY 2025.
- The W87-1 Modification Program entered Phase 6.3, Development Engineering, in FY 2023, and is scheduled to begin production in the early 2030s.

- The W93 entered Phase 2, Feasibility Study and Design Options, in May 2022 and remains on track for production starting in the mid-2030s.
- NNSA is also pursuing two Phase 1 Concept Studies for future systems to meet DoD military needs, as directed by the Nuclear Weapons Council.
- The Report on Stockpile Assessments (ROSA) for the Cycle 28 Annual Assessment was submitted to the President in August 2024, which again concluded that the nuclear stockpile remains safe, reliable, and militarily effective and that there are no technical concerns warranting a return to nuclear explosive testing.
- **Nuclear Enterprise Assurance.** NEA is an enterprise-wide countersubversion program to prevent, detect, and/or mitigate potential consequences of hostile subversion of nuclear weapons and weapon-enabling capabilities, including deliberate unauthorized acts, that may lead to Denial of Authorized Use or degrade weapon reliability or performance.
- **Weapons Dismantlement.** WDD executes the safe and secure dismantlement of excess and retired nuclear weapons and components. WDD is critical to NNSA's integrated effort to transform the enterprise and the stockpile. Specific activities include weapons disassembly, recycling of material and hardware for the stockpile, disposition of retired warhead system components, and ensuring components are available for safety testing.

Background

- **Stockpile Major Modernization.** The Stockpile Major Modernization program manages life extension and refurbishment programs for the existing stockpile systems while also pursuing future warhead acquisition programs to meet emerging DoD requirements.
- **Stockpile Sustainment:** The Stockpile Sustainment subprogram executes maintenance, limited life component exchanges, minor alterations, surveillance, assessment, surety studies and capability development, and management activities for all enduring weapons systems in the stockpile.
- **Production Operations.** Production Operations (PO) provides the base capabilities that enable NNSA's production mission. PO ensures the necessary knowledge and tools are maintained for component manufacturing, weapon assembly and disassembly, maintenance, and production data management for all stockpile activities.
- **Stockpile Research, Technology, and Engineering:** The SRT&E portfolio provides the scientific foundation and infrastructure to design, certify, and assess the current and future stockpile to include the capabilities, tools, and components that provide confidence in its safety and reliability. Since the 1992 moratorium on nuclear explosive testing, the U.S. has maintained and modernized the nuclear stockpile and assessed weapons using state-of-the-art experimental facilities, complex computer models, and expert judgment.
- **Certification:** Warhead designs must be certified as meeting all military requirements before they can be delivered to the stockpile. Certification is based on data from historic nuclear explosive tests, ongoing experiments, computational modeling and simulation, and scientific understanding. The Science-Based Stockpile Stewardship Program (SSP) enables the rigorous certification process.

- **Annual Assessment:** The Annual Assessment of the U.S. Nuclear Stockpile, as required by law, provides assurance to the President and Congress that the U.S. nuclear weapons stockpile is safe, secure, reliable, and militarily effective. The Directors of the National Security Laboratories and the Commander of the U.S. Strategic Command provide comprehensive written assessments on the state of the nuclear stockpile, which inform and compose part of the ROSA that DoD and DOE submit to the President by February 1 of each year.



URANIUM PROCESSING FACILITY REPLAN AND PERFORMANCE

Revised Performance Baselines have been verbally approved for the Uranium Processing Facility. Initial performance against the new plan has been positive.

Issue

The Uranium Processing Facility (UPF) at the Y-12 National Security Complex in Oak Ridge, Tennessee, is intended to consolidate and streamline uranium processing activities for the NNSA in support of the nuclear deterrent. After several years of cost and schedule growth, revised Performance Measurement Baselines (PMB) have been established for the three remaining Uranium Process Facility (UPF) Subprojects. The new total project cost (TPC) for the Main Process Building (MPB) Subproject and Salvage and Accountability Building (SAB) Subproject are \$7.45 billion and \$2.25 billion, respectively. The project completion date (CD-4) for both Subprojects is January 2032. The new TPC for all of UPF is \$10.35 billion. Contractor cost and schedule performance in 2024 has been positive. An interim Performance Measurement Baseline (PMB) was loaded into the project tool set pending final approval of the new UPF Performance Baseline (PB). Incidents of historical cost and schedule growth that prompted the recent replan have not resurfaced and the project has increased confidence of completing the project on cost and schedule against the new baseline.

Status

A new PMB was loaded into project tools at the end of July 2024. Earned value management system metrics for August 2024 (first month to be measured for the new PMB) are not yet available. However, since December 2023, the project has been under cost and ahead of schedule.

Milestones

Subproject	Milestone	Schedule
MPB	PIDAS Construction Complete	12/9/2026
	MPB Casting Construction Turnover to Startup	3/23/2027
	MPB Construction Complete	8/17/2028
	MPB System Testing Complete	1/28/2029
	NNSA Operational Readiness Review (ORR) Complete	1/20/2032
SAB	PSB Construction Complete	2/27/2028
	SAB Construction Complete	4/2/2028
	SAB System Testing Complete	2/4/2029
	NNSA ORR Complete	1/20/2032

Background

The UPF project is forecasting to exceed its originally approved TPC of \$6.5 billion and CD-4 date of December 2025. Verbal approval for the new UPF PB was obtained by the Chief Executive of Project Management in September 2024. Written approval is in process. The new TPC for UPF is \$10.35 billion and the CD-4 date is January 2032. The primary root causes for the TPC exceedance and schedule extension were identified to be:

- Contractor performance below expectations
- Direct and indirect impacts from the COVID pandemic
- Labor availability and procurement costs
- Performance induced funding shortfalls

A Root Cause Analysis (RCA) was completed in support of the approved FY 2024 PP Change for the UPF project.

ACCELERATING NUCLEAR DEPLOYMENTS

Nuclear is one of the few proven options that could deliver additional clean, firm capacity needed to meet clean energy goals – while creating high-paying jobs with economic benefits for local communities. The nuclear industry is building momentum but has barriers to overcome.

Summary

DOE supports the nuclear industry's deployment of advanced technologies through private-public partnerships and loan guarantees to develop advanced reactors, establish capabilities industry needs to demonstrate pre-commercial designs, and explore new applications to decarbonize nontraditional markets. DOE also works with universities and community colleges to ensure a trained and dedicated workforce is available to construct and safely operate the reactors.

Issue

DOE's LiftOff report shows the U.S. will need ~700-900 GW of additional clean, firm capacity to reach net-zero. Globally, the International Atomic Energy Agency (IAEA) recently forecasted up to 950 GW of nuclear power capacity will be needed by 2050. This is further strengthened by the Declaration to Triple Nuclear Energy by 2050 made at COP28 in 2023. Unfortunately, only one new nuclear power plant has been deployed in the United States in the past thirty years. The nuclear industry is building momentum to break the commercial stalemate but must overcome barriers to achieve liftoff. Utilities and potential customers recognize the need for new nuclear;

however, many cite cost or cost overrun risk as the primary barrier to committing to projects.

Status

DOE conducts essential research and development to enable industry to mature and ultimately demonstrate their advanced reactor designs through private financing, private-public partnerships, or potential loan guarantees. Additionally, DOE continues to respond to industry's priorities for specialized testing capabilities and workforce development opportunities.

- DOE recently announced a final loan guarantee commitment of up to \$1.52 billion to Holtec Palisades, L.L.C. to restart the existing 800 MW Palisades Nuclear Plant in Michigan.
- Multiple reactor vendors that DOE supports through private-public partnerships have continued to advance their design towards deployment through activities such as:
 - TerraPower submitting a Construction Permit (CP) application to the Nuclear Regulatory Commission (NRC) for its Natrium reactor in March 2024 through its DOE-funded Advanced Reactor Demonstration Program (ARDP) demonstration project;
 - X-energy continuing preapplication activities with the NRC and working to submit a CP application within the coming months through their ARDP demonstration project;
 - Kairos Power receiving NRC approval for its Hermes reactor CP in 2023 and building on that success by submitting a CP application for their Hermes 2 reactor supported outside its ARDP risk reduction project;
 - Holtec building upon its successful ARDP risk reduction project by announcing plans for two SMR-300 reactors at the reopening Palisades site; and

- o NuScale submitting a Standard Design Approval application, which is currently under review with the NRC and expected to be finalized in summer 2025.
- DOE actively coordinates with several DoD efforts to deploy microreactor pilot programs.
- DOE is constructing two testbeds at Idaho National Laboratory to provide industry the testing capability needed to generate the data required to support future licensing applications, including supporting two microreactor vendors through detailed engineering and experiment planning for potential testing in Demonstration of Microreactor Experiments (DOME).
- The Department's Nuclear Energy University Program (NEUP) has issued more than \$1 billion to universities/colleges since its inception, including \$73.8 million through the University Nuclear Leadership Program (UNLP) program, which has resulted in ninety-two percent of students staying in the industry.
- In January 2024, DOE's Civil Nuclear Credit (CNC) Program finalized terms for up to \$1.1 billion in credit payments for the Diablo Canyon Power Plant. Units 1 and 2 of Pacific Gas and Electric Company's Diablo Canyon Power Plant provide nine percent of the total California power generation. These two units were previously scheduled to cease commercial operations in 2025 and 2026 but credits from the CNC Program support a path forward for Diablo Canyon to continue operating.

Milestones

- DOE plans to release two relevant solicitations in Fall 2024:
 - o The Generation III+ Small Modular Reactor Pathway to Deployment solicitation, totaling up to approximately \$900 million, to support up to two first mover teams committed to deploying a first plant and facilitating a multi-reactor orderbook; and
 - o The Nuclear Reactor Safety Training and Workforce Development Program funding opportunity which will focus on the demonstration and implementation of reactor safety training programs and the establishment or enhancement of industry-recognized nuclear reactor safety training credentials.
- DOME construction and commissioning is scheduled to be completed in 2026 and the Laboratory for Operation and Testing in the U.S. (LOTUS) is scheduled to be completed in 2028.
- To follow up on receiving a CP for its Hermes reactor, Kairos will file a separate application for an operating license with the NRC.

Background

- The DOE Office of Nuclear Energy (NE)'s Advanced Reactor Technologies Program addresses industry's highest priority challenges for innovative fast reactors, molten salt reactors, high temperature gas-cooled reactors, and microreactors.
- NE's ARDP was initiated by Congress in FY 2020 to focus DOE and non-federal resources on supporting the development of advanced reactors that have the potential for near and mid-term demonstration and commercial

deployment and addressing challenges hindering their deployment.

- The NE Gateway for Accelerated Innovation in Nuclear (GAIN) initiative enables industry access to the DOE national laboratory complex to advance the commercialization of innovative nuclear energy technologies for both advanced reactors and the existing nuclear fleet.
- The demonstration of U.S. reactor technologies at facilities licensed by the NRC will facilitate fleet level deployment as U.S. utilities recognize the safety, affordability, and environmental benefits of nuclear reactors, and utilities build them into their integrated resource planning processes as potential replacements for aging fossil fuel generation assets.
- The export and deployment of U.S. reactor technologies overseas, while retaining intellectual property rights, would also contribute to U.S. national security by supporting global climate action, promoting the strongest nuclear safety, security, and nonproliferation norms, and offsetting efforts by China and Russia to dominate the global market.



APPLIANCE AND EQUIPMENT STANDARDS

This paper provides a summary of the Department of Energy's Appliance and Equipment Standards Program, which prescribes efficiency standards and test procedures for consumer products and industrial equipment in accordance with statutory direction.

Summary

The United States Congress has mandated through various statutes that the Department of Energy (DOE) implement energy conservation standards and test procedures for residential products and commercial and industrial equipment. DOE has published regulations in the Code of Federal Regulations for more than seventy categories of appliance and equipment types. The authority to develop, revise, and implement minimum energy conservation standards for appliances and equipment was established by Congress in Part B of Title III of the Energy Policy and Conservation Act (EPCA). These laws are codified in the United States Code at Title 42, Chapter 77, Subchapter III Part A—Energy Conservation Program for Consumer Products (Other Than Automobiles) and Part A-1—Certain Industrial Equipment.

Standards for a given product may be mandated by Congress or established by DOE pursuant to statutory authority. Standards established by DOE are developed through a multi-step rulemaking process that includes public participation. Under these statutory provisions, DOE is directed to review existing standards for covered products at least once every six years and to set standards at levels that achieve the

maximum improvement in energy efficiency that is technologically feasible and economically justified. The standards apply to residential products and commercial and industrial equipment manufactured or imported into the U.S.

The national energy efficiency standards adopted through April 2024 are expected to save Americans over one hundred sixty quads through 2035, which is more energy than the entire U.S. consumes in one year. The cumulative utility bill savings to consumers and businesses came to almost \$1.6 trillion in 2023 and is expected to grow to \$2.8 trillion by 2035. These savings create jobs when they are redeployed into sectors of the economy that are more labor-intensive than the utility sector. The environmental benefits are also substantial, including reductions in air pollution and greenhouse gas emissions that harm human health, the environment, the economy and national security.

These standards also reduce the regulatory burden on manufacturers by preempting a potential patchwork of state standards with a single federal standard. A uniform national standard assures a larger market, lower compliance costs, and better economies of scale for manufacturers, their distributors, and retailers. Test procedures prescribed by DOE help provide a neutral platform upon which manufacturers can compete to differentiate and market the performance of their products. The Program's enforcement efforts protect industry competitiveness by lowering the risk of investing in energy efficient technologies and ensuring importers of foreign-made products play by the same rules.

Issue

DOE is directed by EPCA to review existing energy efficiency standards for covered products and equipment every six years and its test procedures every seven years, and to issue amended standards or test procedures if it

determines it is necessary to do so to comply with the provisions of EPCA. This requires timely review and issuance of rules to avoid missing statutory deadlines, and the program is designed to achieve this objective.

Status

To comply with statutory obligations, we currently estimate that DOE will need to issue eight proposed or final energy conservation standards rules and six proposed or final test procedure rules in CY 2025.

DOE is currently engaged in active litigation on rulemakings for several types of products and equipment. Specifically, plaintiffs have challenged DOE's energy conservation standards rulemakings for consumer furnaces and commercial water heaters, consumer clothes washers, clothes dryers, and dishwashers, and dedicated purpose pool pump motors. DOE has also been challenged on its rulemaking regarding manufactured housing efficiency standards.

Milestones

Over the last four years, DOE has completed 34 energy conservation standards final rules and an additional twelve final determinations not to amend existing standards. DOE has also completed fifty test procedure final rules during this period.

Background

EPCA was enacted in 1975, and established a federal program consisting of test procedures, labeling, and energy targets for consumer products. EPCA was amended in 1979 and directed DOE to establish energy conservation standards for consumer products.

The National Appliance Energy Conservation Act of 1987 established minimum efficiency standards for many common household appliances. Congress set initial federal energy efficiency standards and established schedules for DOE to review and update these standards. The Energy Policy Act of 1992 (EPAct) added

new standards for twelve products. EPAct also allowed for the future development of standards for many other products.

In 2005, the Energy Policy Act (EPAct 2005) set new standards for sixteen products and directed DOE to set standards via rulemaking for another five. In 2007, Congress passed the Energy Independence and Security Act (EISA 2007), enacting new or updated standards for thirteen products.



BATTERY RESEARCH AND DEVELOPMENT, MATERIALS PROCESSING, AND MANUFACTURING

Batteries power our daily lives from consumer electronics to transportation, support the electric grid, and are also a growing area of global competitiveness. Reducing battery cost, growing the domestic supply chain and maintaining technological leadership for this globally strategic area requires a national commitment to both solving breakthrough scientific challenges for new materials and developing the processing, manufacturing, and recycling capacity that meets the demands of the growing battery market.

Summary

Battery technology holds the key to ushering in a worldwide electric vehicle (EV) transformation and creating the grid of the future with integrated resiliency and flexibility. Over the past several years, it has become clear that these changes can fundamentally transform world energy markets and lead to the birth of new industries. These industrial and economic benefits have spurred a worldwide race to capture the advanced battery market. While the U.S. has a world-leading battery research and development (R&D) community, this strength has not yet translated to a complete domestic manufacturing and supply chain.

To this end, the Federal Consortium for Advanced Batteries (FCAB) was created bringing together

over twenty Federal Agencies to accelerate the development of a robust secure domestic industrial base for advanced batteries. FCAB is led by DOE with significant involvement from other agencies, notably the Departments of Defense, Commerce, and State. It is augmented by the Li-Bridge public-private battery industry alliance with six hundred companies and led by DOE's Vehicle Technology Office (VTO) through Argonne National Laboratory. In recent years, \$140 billion in U.S. battery supply chain investment has been announced, leading to growing U.S. independence for critical parts of the supply chain, although gaps still exist. In addition, DOE's VTO has led in the development of new battery chemistries that rely on more earth abundant minerals and also offer lower cost. The DOE Office of Electricity (OE) has led in developing new non-lithium-ion-based grid battery technology.

Issue

The worldwide lithium-battery market is expected to grow by a factor of five to ten in the next decade. The U.S. industrial base must be positioned to respond to this vast increase in market demand that otherwise will likely benefit well-resourced and supported competitors in Asia and Europe. In 2021, FCAB published the National Blueprint for Lithium Batteries. The blueprint is intended to serve as a guide for federal investments aimed at developing a domestic lithium-battery manufacturing supply chain by 2030 that creates manufacturing jobs in America and maintaining US battery R&D and innovation leadership.

Attaining the following five goals will position the United States to secure this vision:

- GOAL 1: Secure access to raw and refined materials and discover alternatives for critical minerals for commercial and defense applications
- GOAL 2: Support the growth of a U.S. materials-processing base able to meet domestic battery manufacturing demand

- GOAL 3: Stimulate the U.S. electrode, cell, and pack manufacturing sectors
- GOAL 4: Enable U.S. end-of-life reuse and critical materials recycling at scale and a full competitive value chain in the United States
- GOAL 5: Maintain and advance U.S. battery technology leadership by strongly supporting scientific R&D, STEM education, and workforce development

Status

Within DOE, the Office of Energy Efficiency and Renewable Energy (EERE) VTO and the Office of Manufacturing and Energy Supply Chains (MESC) are leaders and key contributors to meeting these objectives and goals. The EERE Advanced Materials & Manufacturing Technologies Office (AMMTO), Office of Fossil Energy and Carbon Management (FECM), Advanced Research Projects Agency-Energy (ARPA-E), Loan Programs Office (LPO), Office of Science (SC), and EERE Geothermal Technologies Office (GTO) all offer support as related to their offices' missions. OE leads RD&D on non-lithium-ion grid-scale batteries while SC leads early-stage research that supports fundamental materials discovery for batteries.

Since 2022, DOE's MESC has announced over \$5 billion from the Infrastructure Investment and Jobs Act (IIJA) for forty projects to boost the domestic production of advanced batteries and battery materials nationwide. The selected projects span strategic segments across the supply chain, building and expanding commercial-scale facilities to extract and recycle critical minerals including lithium, graphite, and manganese, as well as manufacture components. These components represent the essential building blocks of the battery supply chain. The selected projects also cover traditional, next-generation lithium-ion chemistries, as well as non-lithium-ion technologies, to ensure a diverse portfolio.

VTO's Battery R&D portfolio of next-generation battery chemistries focuses on cost reduction while ensuring a strong domestic supply chain. These next-generation chemistries offer a direct pathway to lower cost batteries by increasing energy density and lowering the cost of inactive material for similar range vehicles. Supporting chemistries that reduce or eliminate critical materials offer a more flexible and resilient supply chain capable of withstanding supply shocks and market manipulation and can reduce battery cost by using lower cost materials. This includes VTO R&D on battery chemistries that eliminate cobalt and nickel, enable solid-state and Li-metal batteries with energy density of 500 Wh/kg, and lower cost for collecting, sorting, transporting, and processing recycled lithium-ion batteries so as to increase recovery rates of key materials such as cobalt, lithium, nickel, and graphite.

AMMTO's work enables rapid scale up of innovative, cost-effective manufacturing techniques for emerging battery chemistries, including those that improve battery quality, reliability and recyclability. AMMTO's portfolio of battery chemistries -- including lithium metal, sodium ion, and flow batteries -- addresses both mobile applications and long duration storage.

Milestones

Battery costs fell ninety percent between 2008 and 2023 (from \$1202/kwh in 2008 to \$118/kwh in 2023). As a result, announced battery cell production capacity has risen to nearly 1,400 GWh/yr – more than ten times higher than 2021 and enough to supply about ten to fourteen million light-duty EVs annually. By 2030, VTO's goal is to further reduce battery cost to \$75/kWh. The Li-Bridge Alliance released its Strategic Plan for Building a Sustainable Battery Supply Chain earlier this year, recommending actions to accelerate mineral extraction permitting in the U.S. and global mineral resource engagement, including collaboration with the European Battery Association.

Background (Reading Material)

National Blueprint for Lithium Batteries ([National Blueprint for Lithium Batteries 2021-2030 \(energy.gov\)](#))
Building a Robust and Resilient US Lithium Battery Supply Chain ([Li-Bridge Industry Report | Argonne National Laboratory \(anl.gov\)](#))

CRITICAL AND EMERGING TECHNOLOGIES

Critical and emerging technologies (CETs) are a subset of advanced technologies that are significant to U.S. national security, competition, and innovation. DOE's new CET office brings renewed focus on capabilities across DOE and its 17 National Laboratories in artificial intelligence (AI), biotechnology, quantum information science (QIS), and microelectronics.

Summary

The Department of Energy (DOE) and its seventeen National Laboratories have long invested in critical and emerging technologies, from advancing the country's supercomputing capabilities, co-leading the Human Genome Project, pushing the vanguard of quantum information science, and fabricating radiation-hardened microelectronics. In parallel with promoting the benefits of these dual-use technologies, DOE is actively engaged in export controls, Committee of Foreign Investment in the United States (CFIUS) reviews, and other efforts to protect them.

Issue

Artificial Intelligence (AI): DOE leads the development of powerful supercomputers and supports research into AI, advanced computing, and broad applications, including grid-to-chip solutions for power and efficiency.

Biotechnology: DOE invests in life sciences, enabling sustainable production of biofuels, bioproducts, and biomaterials using its advanced biological research capabilities.

Microelectronics: DOE has a long history of driving microelectronics advancements, including manufacturing and product development. It also manages the largest government-owned fabrication facility for radiation-hardened microelectronics.

Quantum Information Science (QIS): DOE is uniquely positioned to lead the development and deployment of QIS technologies, from foundational research to practical applications.

Status

Artificial Intelligence. DOE has met requirements set out by Executive Order (EO) 14110 on Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence. DOE's [Frontiers in AI for Science, Security, and Technology \(FASST\)](#) initiative – pending Congressional authorization – proposes to leverage DOE's workforce, partnerships, and infrastructure to build the world's most powerful integrated AI models to further DOE's science, applied energy, and national security missions.

AI Governance: In July 2024, DOE rechartered the cross-Department AI Advancement Council (AIAC) to oversee AI governance efforts. Activities include a focus on AI rights & safety, AI-use case collection, and facilitation of AI technology for Departmental operations.

Biotechnology: DOE is a member of the National Bioeconomy Board (NBB), which is working with partners to advance interagency coordination on biotechnology and biomanufacturing, with a series of deliverables due March 2025. DOE is also engaging with the [National Security Commission on Emerging Biotechnology](#), whose final report is expected to be influential.

Microelectronics: The CHIPS and Science Act established the National Semiconductor Technology Center (NSTC), a public-private consortium to advance semiconductor R&D and grow the domestic workforce. DOE is a voting

member of the NSTC and is engaged in developing the NSTC's strategic roadmap. DOE is also actively working to improve energy efficiency in microelectronics.

QIS: DOE established five National QIS Research Centers which include partnerships with industry and academia. A 2022 National Security Memorandum on Quantum Computing sets policy to promote U.S. leadership in quantum computing while mitigating associated risks.

Milestones

Establishing the OCET: In late 2023, DOE announced it would establish the Office of Critical and Emerging Technologies to oversee and coordinate CET work across the Department and its laboratories.

AI: In FY 2024, DOE met directives from EO 14110 on Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence ([AI and energy, testbeds, workforce training, tools for AI foundation models](#)), and red-teaming AI models for radiological and nuclear risks. DOE released a FASST initiative roadmap and an [RFI](#). Finally, DOE national labs have initiated many exciting AI partnerships (e.g., new battery materials, new cancer drugs). Lawrence Berkeley National Laboratory (LBNL) is also finalizing a report to Congress on U.S. Data Center Energy Use, due December 2024.

Biotechnology: DOE invested \$55.5 million to advance biological solutions for carbon dioxide removal/sequestration as part of DOE's Energy Earthshots Initiative, funded a pilot plant that will produce cellulosic ethanol for sustainable aviation fuel, and [announced](#) a \$213.6 million conditional loan guarantee to produce organic acids for use in hard-to-decarbonize sectors.

Microelectronics: In FY 2024, DOE invested [\\$160 million to establish new Microelectronics Science Research Centers](#). Sandia National Laboratory is bolstering the U.S. semiconductor industry's capacity for high-reliability and secure microchips.

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QIS: DOE is investing over \$65 million to advance quantum computing for scientific research, including software and algorithm improvements. DOE is also partnering with Defense Advanced Research Projects Agency (DARPA) to coordinate future research and development (R&D) and testing of this groundbreaking technology.

Major Decisions/Events

Legislation: The DOE AI Act (authorizes FASST) and the reauthorization of the National Quantum Initiative (NQI) Act are both pending before Congress.

AI: Implementation of FASST may require the issuance of a DOE directive that provides a governance structure based on lessons learned from the successful Exascale Computing Project.

Microelectronics: The CHIPS and Science Act authorizes nearly \$1 billion for microelectronics, and there is significant opportunity for additional appropriations and R&D cooperation.

Biotechnology: National Security Commission on Emerging Biotechnology (NSCEB) final report expected late 2024/2025; may necessitate Hill engagement.

Background

The White House runs interagency coordination on critical and emerging technologies through the National Security Council and the Office of Science and Technology Policy.

AI: The 2023 AI Executive Order charged DOE with many actions which the Department has implemented. DOE is also implementing Office of Management and Budget (OMB) directives and is developing an AI governance framework for enterprise AI use cases. DOE will implement the AI National Security Memorandum through FY 2025.

Biotechnology: The 2022 Executive Order on Advancing Biotechnology and Biomanufacturing Innovation charged DOE with key implementation actions, which the Department has delivered. DOE continues working through the NBB and other mechanisms, and the NSCEB final report and activities are expected to potentially lead to additional Congressional actions.

Semiconductors: The CHIPS and Science Act's \$56 billion investment in reshoring microelectronics production does not solve significant R&D challenges, especially in advanced packaging and radiation-hardened technology. Close collaboration with defense agencies is essential to achieve industry-scale success.

Quantum: DOE's QIS activities in recent years have been guided by the NQI Act, enacted in 2018, and coordinated through the National Quantum Coordination Office at the White House.



ENERGY EARTHSHOTS

DOE's eight Energy Earthshots could save American energy consumers \$850 billion and avert over 3.9 billion metric tons of CO₂ emissions by 2050.

Summary

The Energy Earthshots Initiative, launched in 2021, set ambitious technical and cost-reduction targets for eight energy-related technologies. These technologies represent priority areas for energy research, development and demonstration (RD&D) investment across DOE's basic science and applied energy programs (including ARPA-E). U.S. investment in emerging energy technologies is critical to ensuring continued U.S. leadership in the global energy future, as well as reducing energy costs, creating good jobs, making the energy system more reliable and secure, and decarbonizing the energy economy to solve the climate crisis.

The eight Energy Earthshots focus on the following topics: hydrogen, carbon dioxide removal, long-duration energy storage, floating offshore wind, enhanced geothermal systems, industrial heat, clean fuels and products, and affordable home energy.

Issue

Given the targets established by the Earthshots, continued focus, action, and investment in RD&D will be needed to deliver on these goals and maintain U.S. leadership in each technology area.

Background

To meet the Energy Earthshot targets, DOE will leverage the diverse expertise of American universities, businesses, and the U.S. National Laboratories to tackle the toughest remaining

barriers to deploying clean energy technologies at scale. The common, core characteristics of each Energy Earthshot require that it:

- Center on measurable, ambitious, time-bound cost and/or performance target(s) that requires multi-year, multi-office integrated RD&D vision and planning;
- Communicate a compelling, bold, public-facing and inspirational challenge for DOE innovation and a defined and necessary clean energy breakthrough;
- Involve significant engagement with stakeholder communities during the process of refining the Earthshot objectives and RD&D roadmap, advancing significant pieces of work, and measuring progress against milestones;
- Inform multiple aspects of program office strategic planning, including budget formulation, development of funding opportunities, and talent acquisition; and
- Enable DOE to take calculated risks, supported by program decisions that are interdependent and focused on making progress towards achieving the Earthshot.

Status & Milestones

DOE has invested federal funds across a wide range of programs and technology areas to support the goals of each Energy Earthshot, and activity is underway to deliver on the Energy Earthshot targets. For example:

- **The Hydrogen Shot:** DOE recently allocated \$750 million in R&D funding to fifty-two projects that will advance manufacturing technologies for electrolyzers and hydrogen fuel cells, a significant step towards realizing the Hydrogen Shot goal of reducing the cost of clean hydrogen to \$1 per kilogram by 2031.

- **The Carbon Negative Shot:** DOE has been running a series of prizes to accelerate innovation in carbon dioxide removal technologies, totaling almost \$100 million, and allocated an additional \$100 million to develop a commercially viable carbon dioxide removal industry in the United States through funding pilot projects and testing facilities. DOE has partnered with the National Oceanographic and Atmospheric Administration and other federal agencies to accelerate marine carbon dioxide removal. These efforts will enable the development of methods and technologies for the removal of carbon dioxide from the atmosphere and storage at gigaton scales for less than \$100/net metric ton of carbon dioxide equivalent to meet 2050 climate goals.
- **The Long Duration Storage Shot:** DOE recently made selections on three long duration energy storage demonstration projects, worth \$15 million, and made selections to establish three R&D consortia to solve technological storage challenges to prepare tech for market. The Long Duration Storage Shot targets a ninety percent cost reduction for long-duration (ten+ hours) energy storage systems within a decade. Note that this does not include awards made by the Office of Clean Energy Demonstrations.
- **The Enhanced Geothermal Shot:** DOE's Frontier Observatory for Research in Geothermal Energy program has tested new technologies and methods that reduce the time required to drill a geothermal well to a depth of 6,000 feet from 440 hours to 60 hours. As drilling accounts for as much as fifty percent of development costs for enhanced geothermal systems, this is an important step forward in achieving the Enhanced Geothermal Shot targets of a ninety percent cost reduction (to \$45 per megawatt hour) for enhanced geothermal systems by 2035.
- **The Floating Offshore Wind Shot:** Targets a seventy percent reduction in floating offshore wind costs (to \$45 per megawatt-hour) by 2035. As of May 2024, the interagency inter-agency partners including the Departments of Energy, Commerce, Transportation, and Interior have spurred close to \$1 billion in federal funding to advance U.S. leadership in floating offshore wind, including investments in turbine R&D, environmental sustainability, community engagement, port development, transmission, and more.
- **The Industrial Heat Shot:** DOE recently founded the Electrified Processes for Industry Without Carbon (EPIXC) Clean Energy Manufacturing Institute with \$70 million of federal funds, as a five-year public-private partnership aimed at developing and coordinating the network of researchers, companies, educators, and workers required to replace fossil fuel-based heating with electric heating. EPIXC just announced \$11.8 million in 'jump start' projects to accelerate the deployment of electrified heating technology. The Industrial Heat Shot targets an eighty-five percent reduction in GHG emissions from industrial heating technologies by 2035.
- **The Clean Fuels & Products Shot:** targets the development of cost-effective technologies that reduce GHG emissions from the fuel and chemical industries by at least eighty-five percent by 2035. In 2024, DOE invested more than \$30 million in RD&D projects to decarbonize chemicals manufacturing and held a 200-person interagency chemicals leadership summit to help set a national agenda for chemicals manufacturing that prioritizes sustainable, low-carbon technology solutions and the health and well-being of American communities.

- **The Affordable Home Energy Shot:** targets a fifty percent reduction in the upfront cost of home energy upgrades in affordable housing, as well as a twenty percent reduction in residents' home energy bills, within a decade. The Buildings Upgrade Prize provides more than \$22 million in cash prizes and technical assistance to forty-five communities across the nation to accelerate energy efficiency and building clean heat upgrades. DOE also launched a new Equitable and Affordable Solutions to Electrification (EAS-E) Prize to support technology innovations that make building retrofits easier and more affordable.

FUSION

To realize fusion in a decadal timeframe, we will need to take bold action to address the critical scientific and technological gaps that remain and establish the supply chains that will enable fusion energy at scale.

Summary

- The promise of fusion energy cannot be understated. Harnessing energy from fusion reactions has the potential to address climate change by providing a sustainable and resilient firm and carbon-free source of energy, and to provide the economic engine for the world's future energy sector supply chain.
- The combination of scientific support for fusion energy as well as basic plasma science and technology research will also create spin-off technologies that will benefit society, such as microelectronics manufacturing, cancer treatment, plasma medicine, surface processing, and more.
- Further, because of the transformative potential of this technology, it is essential that we treat fusion energy as a national security imperative. The U.S. cannot afford to have other nations surpass our technological leadership in this emerging sector.

Issue

While recognizing that no single government program will be able to translate fusion and make it competitive in future energy markets, DOE is taking a multifaceted approach to realizing fusion energy:

- Drive innovation and close key science and technology gaps to accelerate advances at the necessary speed and scale.
- Establish and leverage public-private partnerships to support the development and stimulate the supply chains for realizing commercial fusion energy.
- Build a robust fusion technology manufacturing network to produce innovations and scale essential fusion technologies to make fusion economically competitive at scale.
- Bold investment is needed to realize the potential of fusion energy.

Status

- DOE's Fusion Energy Sciences Advisory Committee, one of four Committees chartered under the Federal Advisory Committee Act, issued a Long Range Plan in December of 2020. DOE is building a U.S. fusion science and technology roadmap aligned with the fusion industry, creating new innovative funding mechanisms that can build and deepen public-private partnerships, and realigning the Fusion Energy Sciences program Long Range Plan.
- With the rise of globalization and budget and resource constraints, it has become increasingly important to build partnerships with public and private entities in like-minded countries. Strategic international partnerships with the United Kingdom and Japanese governments have been announced and we continue dialogue with Canada, Germany, France, and Korea.
- The International Thermonuclear Experimental Reactor (ITER) project in Cadarache, France is another international effort, a multi-national collaboration to construct a complex scientific facility that will help usher an industrial scale burning plasma experimental platform. The ITER Organization

and Members are currently updating the cost and schedule baseline for the international project and will present it to all the Members at the next ITER Council meeting in November 2024.

- The entire U.S. Contributions to ITER project was baselined (CD-2) on December 12, 2023, in response to Congressional direction. The approved Total Project Cost is \$6.5B with a completion date of December 2040. As of July 2024, DOE and the U.S. have invested more than \$2.2 billion in the U.S. Contributions to ITER project. The U.S. part of the project is forty-seven percent complete.

Milestones

- Negotiations are complete for the Milestone-Based Fusion Development Program and all eight private-sector led teams are working on their ambitious projects. Several teams have already reported on their milestones and requested payments. In the next eighteen months, the teams will produce technology roadmaps and fusion pilot plant preconceptual designs for a diverse array of fusion concepts.
- In early FY 2025, DIII-D National Fusion Facility in San Diego, California, an Office of Science user facility, will celebrate its 200,000th fusion plasma shot, achieved in mid-August. DIII-D is the world's best diagnosed machine and one that is leveraged to design experiments on Long Pulse large-scale facilities around the world including KSTAR (Korea) and JT60-SA (Japan). DIII-D continues to be a critical platform for: 1) workforce development in fusion energy, 2) validation and verification of multi-scale computational codes that are helping guide designs for fusion pilot plants of the future, and 3) design and development of advanced fusion plasma diagnostics. DIII-D is undergoing a strategic mission action to support fusion materials and technology activities and convergence of artificial intelligence/machine learning and fusion energy.

- In FY 2025, the final control solenoid magnet module for ITER will complete fabrication.

Background

- Over the past decade, the fusion energy research and development landscape has evolved significantly, especially in the U.S., building on decades of public investments in fusion science and technology. Major advances have been achieved both domestically and globally by public and private sector entities, such as the achievement of fusion ignition at the National Ignition Facility at Lawrence Livermore National Laboratory in December 2022.
- A significant number of private fusion efforts funded via venture capital, or other non-governmental sources have emerged. According to the Fusion Industry Association, ~\$6.7 billion in private capital has been invested in companies working to commercialize fusion power, with seventy-five percent of these investments in U.S. fusion companies.
- ITER is an international facility being built in France under an international agreement that includes China, European Union, India, Japan, Korea, Russia, and the U.S.
- As a partner in construction and operations, the U.S. receives full benefit from the R&D at ITER while providing only a fraction of the financial resources. Methods to demonstrate plasma control and extract heat will be tested and developed during ITER operations. U.S. industry is building major systems for ITER and thereby gaining expertise in fusion engineering science and building up industrial capabilities.

GRID-SCALE ENERGY STORAGE SAFETY AND RELIABILITY

As storage technologies continue to be deployed in unprecedented amounts, increasing numbers of Energy Storage System (ESS) fires have introduced questions on how these installations can operate safely and reliably. In localities across the country, uncertainty over proper response procedures to security threats and ESS failures can delay or even prevent deployment.

Summary

The widespread deployment of energy storage requires confidence across stakeholder groups (e.g., manufacturers, regulators, insurers, and consumers) in the safety and reliability of the technology. The Office of Electricity (OE) leads efforts to enhance the safety and reliability of energy storage systems (ESS). OE's national laboratory-based ESS safety Research and Development (R&D) spans safety guidelines and standards, performance, testing and validation protocols; incident response and analysis; and ESS demonstration projects. The output from these activities empowers developers, first responders, and communities to make informed, data-driven ESS deployment decisions.

Issue

Compared with the batteries used in personal devices, behind-the-meter (BTM) - and grid-scale ESS add new risks. The large quantities of stored energy, the potentially hazardous nature of

storage failures, and the proximity of these technologies to communities and critical infrastructure increases the need for safety. ESS deployments continue to accelerate at an exceptional rate, with cumulative installed battery capacity projected by the Energy Information Administration ([EIA](#)) to exceed 30GW in 2024. DOE action is needed to increase the safety of existing Li-ion battery (LiB) deployments while also facilitating the safe deployments of non-LiB chemistries.

Many LiB chemistries are vulnerable to uncontrolled, energetic failures. An analysis of the over 25,000 LiB incidents (some fatal) between 2017 and 2022 underscores the importance of addressing LiB safety.¹ High visibility examples of these incidents and their responses include:

- Arizona Public Service ESS fire and explosion in 2019 that led to multiple first responder injuries²
- Creation of an Inter-Agency Fire Safety Working Group in New York in 2023 in response to multiple LiB fire incidents across the state³
- A fire at a San Diego Gas & Electric LiB facility that forced the evacuation of community members in the surrounding Escondido, CA area⁴

Currently, the most lucrative storage market opportunities exist for short duration (less than 4 hours) applications, so most of these new installations are based on LiBs. As longer duration markets emerge, and as LiB supply-chain constraints become more prominent, it will be increasingly important to maintain a technology agnostic approach for ESS safety and reliability so that safety standards do not unintentionally impede the adoption of emerging non-LiB technologies.

Status

The DOE maintains active programs and facilities to assess energy storage safety, particularly under abusive conditions. Major ongoing activities that the program supports include:

- Safety and reliability testing at cell, module, and system levels of different ESS technologies leveraging advanced testbeds and capabilities at Sandia National Laboratory, Pacific Northwest National Laboratory (PNNL), and Oak Ridge National Laboratory (ORNL) to better understand failure mechanisms, system reliability under realistic duty cycles, and behavior of materials, components, and systems during failure.
- Development of novel thermal runaway detection methods (ORNL)
- Maintaining publicly accessible database of safety testing results of different batteries. (ORNL)
- Support for lab expert contributions to the development of codes and standards that guide and facilitate safe, routine, and predictable deployments of ESS.

These activities have made tremendous impact in the energy storage ecosystem as the results and findings are highlighted at key events such as the Energy Storage Safety and Reliability Forum, hosted by PNNL and Sandia, and are shared in targeted outreach efforts with communities, state and local authorities, industry, and international organizations.

Milestones

- OE released the Blue-Sky Training Program request for information in April 2024 to solicit feedback on training programs for first responders, law enforcement agencies, local communities, utilities, and authorities having jurisdictions on how to respond to ESS incidents.⁵
- OE and Sandia released the Energy Storage Safety Strategic Plan in May 2024 which showcases over a decade of OE-funded investments in safety research, now encoded in more than thirty industry standards. Future

outreach with the guide will help stakeholders deploy safer, more reliable energy storage systems.

- Sandia will host the next Annual Energy Storage Safety and Reliability forum in April 2025.
- OE supports PNNL experts to lead many of the task groups under National Fire Protection Association (NFPA) 855, Standard for the Installation of Stationary Energy Storage Systems. The NFPA 855-2026 revision, scheduled for release in fall 2025, is expected to contain enhanced provisions for explosion prevention, fire containment, and prevention of fire propagation.
- The new Grid Storage Launchpad at PNNL that opened in August 2024 is expected to welcome its first cohort of large-scale, non-lithium battery systems to its Testing and Validation program in 2025. This milestone will mark a significant expansion of DOE lab abilities to evaluate non-LiB performance.

Background

LiBs are attractive candidates for ESS, owing to high energy density, high power, high efficiency, and low self-discharge. While non-Lithium batteries can have more desirable safety characteristics, they are not yet commonplace, widely available, or cost-effective at present. The lack of available commercial alternatives leads to LiB use in ESS deployments where a safer alternative might be preferred. Many of the relevant codes and standards for ESS have traditionally been targeted LiB given their relative maturity. As emerging non-LiB technologies become more prevalent, codes and standards must also be considered so industry can develop and deploy them with established guidance. Input from experts (including from the National Labs) working on these newer technologies helps inform codes and standards committees about failure mechanisms as well as design and emergency response best practices.

Furthermore, Energy Storage Codes and Standards such as the International Fire Code (IFC), plays a crucial role in ensuring fire safety and public well-being and it is the go-to guide for deploying LiB ESS. While this supports manufacturers and integrators in developing and deploying LiB projects, it inherently provides clarity around hazard mitigation analysis, and guidance that can inform a non-LiB manufacturing process that ultimately unlocks a new chapter for alternate technologies.

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1. <https://www.ajg.com/gallagher/-/media/files/gallagher/global/insights/lithium-ion-fires.pdf>
 2. [McMicken investigation \(aps.com\)](#)
 3. [Governor Hochul Convenes Inter-Agency Fire Safety Working Group Following Fires in Jefferson, Orange, and Suffolk Counties | Governor Kathy Hochul \(ny.gov\)](#)
 4. [Update on Escondido Battery Storage Incident - Sept. 7 | SDG&E Today \(sdgetoday.com\)](#)
 5. [Energy Department Seeks Input on Energy Storage Training Program | Department of Energy](#)



LIQUEFIED NATURAL GAS (LNG) REGULATORY UPDATE

In January 2024, DOE announced it was temporarily pausing permitting decisions on exports of LNG to non-free trade agreement (FTA) countries while the analysis used to help support regulatory decisions is updated. While a district court has issued a preliminary injunction preventing DOE from “halting and/or pausing the approval process,” DOE is still separately pursuing the update to its regulatory analyses and has stated that it anticipates the update process to be complete by the end of the first quarter of 2025. It plans to release the final study for public comment before the end of 2024.

Issue

DOE is required under the Natural Gas Act to evaluate whether applications for export of U.S.-produced natural gas to non-FTA countries are in “the public interest.” The LNG Update of all the analyses that helps DOE support its public interest determinations, which are developed by the Office of Fossil Energy and Carbon Management (FECM), has been a matter of intense interest and scrutiny among various stakeholders (community groups, non-governmental organizations (NGOs), industry, Congress) since it was announced in January 2024.

This analytic update does not affect prior decisions or certain types of export decisions

(e.g. applications to export LNG to FTA countries that are considered nondiscretionary, and exports of small scale/containerized LNG).

As of September 2024, cumulative long-term authorizations of natural gas as LNG to non-FTA countries (where the majority of global LNG demand comes from) are for over 48 billion cubic feet per day (Bcf/d). This represents over forty-five percent of current domestic natural gas production. Of that amount authorized, approximately 15 Bcf/d of capacity is built and operating, and another 11 Bcf/d is expected to come online by the end of this decade once it is complete.

Status

FECM, along with DOE staff across multiple program offices as well as the National Energy Technology Laboratory and Pacific Northwest National Laboratory, are currently working to issue the updated analyses for a public comment period in late 2024.

Milestones

On January 26, 2024, FECM announced that it would update the economic and environmental analyses that inform public interest determinations. FECM expects to publish the updated analyses in late 2024. A sixty-day comment period is planned, and DOE will review the comments before it issues more decisions on pending authorizations. DOE has indicated to the public that it expects the entire process will be completed by the end of the first quarter of 2025.

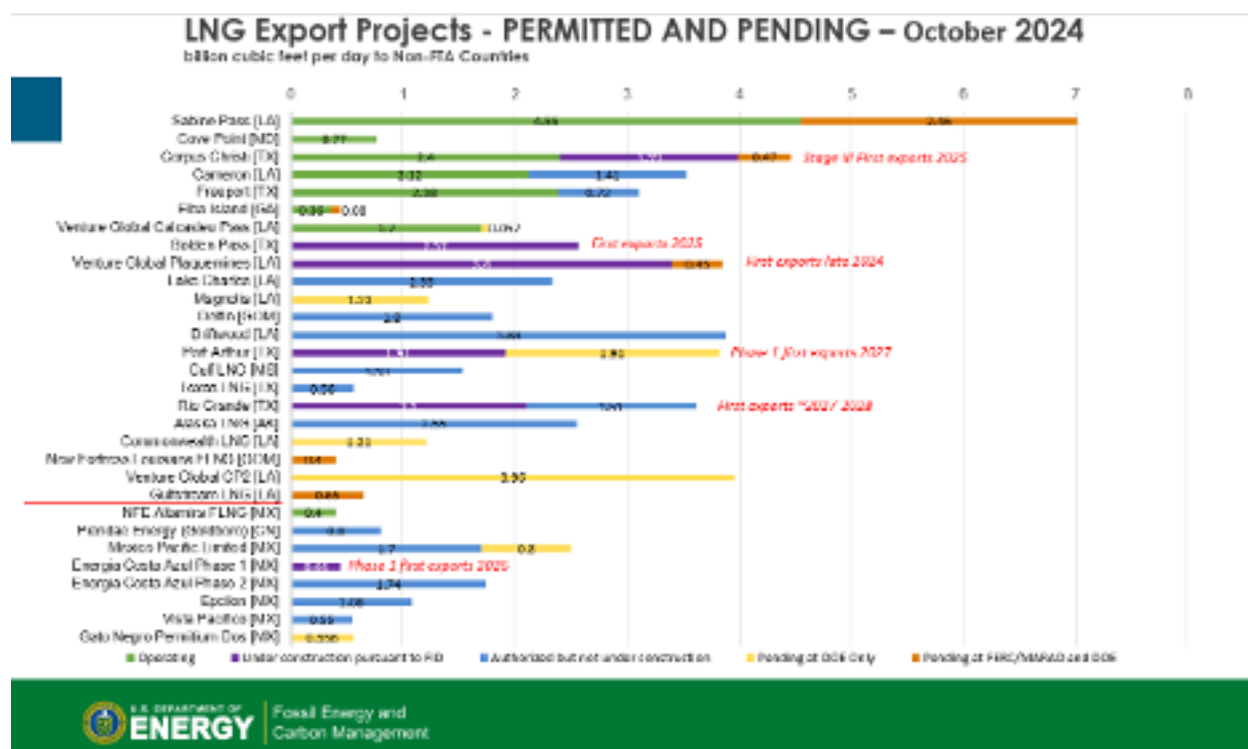
Background

Regulatory Authority. FECM carries out DOE’s regulatory responsibilities over natural gas imports and exports under Section 3 of the Natural Gas Act of 1938. The majority of the authorizations DOE issues are for imports and exports of natural gas via pipeline between the United States and Canada and are considered non-discretionary as exports to free trade countries are considered consistent with the

public interest. In recent years, given the large volumes of natural gas that have resulted from shale production, the U.S. has begun exporting LNG and since starting LNG exports in 2016, the U.S. has since become the largest global exporter of LNG. Since the Russian invasion of Ukraine, the majority of U.S. LNG exports have gone to Europe, with Asia being the second-largest import region.

State of Play. Currently, there are seven large-scale export terminals operating, five along the Gulf Coast and one each in Maryland and Georgia. Several additional projects along the Gulf Coast are under construction or expanding,

and there are also several projects authorized for non-FTA exports but not yet under construction. DOE's authority over natural gas exports also includes applications to export U.S.-sourced gas as LNG from facilities in Canada or Mexico, and there is currently one LNG export project operating in Mexico and a second under construction. As of November 2024, there are currently thirteen pending non-FTA applications for 14.23 billion cubic feet per day (Bcf/d) of exports. Of those applications, six applications for 4.51 Bcf/d are still pending at FERC, and the remaining seven applications for 9.72 Bcf/d do not need review by any other agency before DOE can make a decision.



Sensitivities. In recent years, there has been increased opposition to LNG exports from environmentally-focused NGOs, some community-based organizations along the Gulf Coast, consumer groups, and some domestic industrial manufacturers who are concerned about increased prices of domestic natural gas

from increasing levels of exports. Conversely, the oil and gas industry, natural gas producing states, and foreign partners who import LNG are concerned with any limits to LNG exports.

Litigation. DOE's announcement that non-FTA export decisions would be paused while DOE

completed its regulatory update is the subject of two challenges in federal court. In the *State of Louisiana v. Biden* (5th Cir.), the Government is appealing the district court's (W.D. La.) order granting the plaintiffs' request for a preliminary injunction enjoining DOE from "halting and/or pausing the approval process" for non-FTA export applications and denying the Government's motion to dismiss. In this case, the plaintiffs (sixteen State Attorneys General) challenge DOE's temporary pause of final determinations on non-FTA export applications. Both the district court and appellate court case remain ongoing. In *Oil and Gas Workers Association v. Biden* (W.D. La.), the plaintiff brings a substantially similar challenge as the plaintiffs in *State of Louisiana v. Biden*. The Government filed its answer and the administrative record on September 10, 2024, and this case remains ongoing.

DOE has resumed review of non-FTA applications and in August, issued an order authorizing exports for a five-year term from an offshore terminal in Mexican waters in the Gulf of Mexico that recently came online. Separately, DOE has maintained that it is committing to completing the regulatory update.

Additional resources:

[DOE FECM Fact Sheet: The Temporary Pause on Review of Pending Applications to Export Liquefied Natural Gas \)](#)

[DOE FECM LNG Snapshot \(Updated June 2024\)](#)

LONG BASELINE NEUTRINO FACILITY/DEEP UNDERGROUND NEUTRINO EXPERIMENT (LBNF/DUNE)

LBNF/DUNE reached a critical milestone in completing underground excavation. Continued support is needed to ensure project success.

Summary

- The LBNF/DUNE project is a federal, state, private, and international partnership developing and implementing the technologies of particle accelerators and detectors aimed at unraveling the mysteries of neutrinos, fundamental particles that could hold the key to understanding the universe's existence. LBNF/DUNE-US refers to the DOE line-item construction project funded by appropriations.
- The updated 2023 High Energy Physics Advisory Panel Particle Physics Project Prioritization Panel Report reaffirmed the importance of completing the LBNF/DUNE as its first priority recommendation.

Issue

- Funding to date has been below the funding profile established in the critical decision (CD)-1 Reaffirmation (CD-1RR,

further information under Status). This may result in schedule delays and cost increases. The project will work to mitigate impacts, but it is critical to reach funding goals in FY 2026 to minimize impacts on the project.

- Senators from Illinois and South Dakota have expressed regular interest in this project since it started in 2015.

Status

- The LBNF/DUNE-US project has been organized into five subprojects for improved planning and management control. CD-1RR was approved on February 16, 2023, and established a cost range of \$3.16 billion to \$3.677 billion. At the time of CD-1RR approval, the Total Project Cost (TPC) Point Estimate was \$3.277 billion. The five subprojects are in descending order of design maturity:
 - Far Site Conventional Facilities – Excavation (FSCF-EXC)
 - Far Site Conventional Facilities – Buildings and Site Infrastructure (FSCF-BSI)
 - Far Detectors and Cryogenic Infrastructure (FDC)
 - Near Site Conventional Facilities and Beamline (NSCF+B)
 - Near Detector (ND)
- The FSCF-EXC subproject was approved for CD-2/3 in August 2022, allowing the completion of the full scope of the excavation work initiated in 2016 with a CD-3a action. The FSCF-BSI subproject will outfit the spaces being excavated by FSCF-EXC so that they are ready to receive detector components in a timely manner and operate the far detectors and cryogenics systems. FSCF-BSI received DOE CD-2/3 approval in March 2023.

- The NSCF+B and FDC subprojects received CD-3a approval on some long lead procurements and limited site preparation work scope in March 2023. FDC CD-3a was revised in February 2023 to include additional long-lead cryogenic scope and in March 2024 FDC received CD-3b approval to continue activities related to the manufacturing of the Nitrogen refrigeration plant for the DUNE Far Detector modules among other long-lead procurements.
- In August 2024, the project marked the completion of excavation work on two seven-story caverns for housing particle detectors and a smaller central utility cavern, all one mile beneath the surface of the Earth. This subproject will be completed below the baselined total project cost and with an impressive safety record.
- In order to reach its science goals, LBNF/DUNE is dependent on two other projects: an upgrade to the Fermilab Accelerator Complex to provide a higher intensity proton beam to produce the neutrinos (Proton Improvement Plan II, PIP-II) and a project to maintain and improve the reliability of the accelerator complex (Accelerator Control and Operations Network, ACORN). PIP II is in the construction phase (post CD-3) and proceeding normally. ACORN was reviewed by SC in 2024 and should be ready for CD-1 in FY 2025.

Milestones

- All the sub-projects are working toward reaching CD-3 (completion of preliminary design and approval of construction) in calendar year (CY) 2025-2027. Completion of the FSCF-EXC subproject (CD-4) is expected by the end of CY 2025. Completion of the overall project (CD-4) is expected in FY 2035, with the completion of the last subproject. However beamless science is expected to start in FY 2029 and beam science in FY 2031.

Background

- LBNF and the U.S. contributions to DUNE form a single DOE project (LBNF/DUNE-US) consisting of construction of a new neutrino beam at Fermilab, pointed at the Sanford Underground Research Facility (SURF) at Lead, South Dakota, as well as a large, modular liquid argon neutrino detector, consisting of up to four separate detector cryostats, to be located 1.5 km underground at SURF to shield the detectors from cosmic rays that would otherwise interfere with the experiment. In addition, a smaller neutrino detector will be built at Fermilab to measure the properties of the beam near the neutrino production point.
- DOE is building the facility with international contributions and the experiment is being built by an international collaboration with DOE contributions. Fermilab, in its role as the host lab, will oversee all LBNF/DUNE construction. Fermilab's oversight of the neutrino detectors includes technical coordination to ensure the various pieces will fit and operate together and arrive on time.
- LBNF/DUNE is receiving in-kind international contributions valued at approximately \$260 million for the facilities and approximately \$400 million for the detector.

NATIONAL LABORATORY CORE INFRASTRUCTURE

Core infrastructure for the Office of Science's National Laboratories requires modernization to execute DOE's ambitious goals and maintain the safety of our workforce.

Summary

An assessment by the Laboratory Operations Board in 2024 concluded that core infrastructure at the Department of Energy's (DOE) seventeen national laboratories, particularly for those labs under the Office of Science (SC), is increasingly unstable, deteriorating past its serviceable life, and creating safety hazards that put individuals and the entire workforce at risk, as well as hindering mission execution.

Issue

The National Laboratories continue to successfully accomplish science, engineering, and national security missions despite approximately thirty-eight percent of infrastructure assets being in inadequate or substandard condition. DOE's successes under the suboptimal conditions must not obscure the real infrastructure risks that exist throughout the complex.

DOE's ambitious goals often overlook the dependence on enabling infrastructure, resulting in chronic underfunding of the core assets (power, water, emergency services facilities, offices and light laboratory space, storage, IT, roads and grounds, trade and craft shops, and waste management). Current conditions require higher levels of investment and more strategic planning to mitigate the growing risks to the

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mission resulting from unplanned outages, costly emergency repairs, expensive labor-intensive solutions, and shutdowns following safety incidents. Modernization of DOE enabling infrastructure will reduce risks to mission success, decrease safety hazards, increase safety-by-design, further sustainability goals, and enhance the resilience of all capabilities and assets.

Status

Degrading enabling infrastructure creates single-point failures that are serious risks to mission work. From 2017 to 2022, several SC National Laboratories reported multiple impacts resulting from disabled core infrastructure. Some examples include:

- **Argonne National Laboratory (Lemont, Illinois):** More than forty-one utility outages involving failures of water (canal, chilled, fire and potable) and electric utilities, resulting in an estimated \$1.2 million of direct (i.e., repair/replacement/temporary facility support) costs and an estimated \$1.4 million of indirect costs incurred by science/research. Thirty-eight outages required immediate repairs and led to extended outages to critical scientific facilities.
- **Brookhaven National Laboratory (Brookhaven, New York):** Eighty-two utility outages, primarily involving failures of potable water and electric utilities, resulted in approximately 46,000 total outage hours. In one example, an outage caused the loss of compressed air which in turn caused a shutdown of the National Synchrotron Light Source, resulting in a shutdown of scientific work for approximately two days while the affected systems were restored.
- **Lawrence Berkeley National Laboratory (Berkeley, California):** Sixteen major outages in electrical and natural gas systems, resulted in 142,000 hours of lost research time (including two site-wide Pacific Gas and Electric (PG&E) safety shutdowns to prevent wildfires lasting a total of five days and 125,000 hours lost).

- **Oak Ridge National Laboratory (Oak Ridge, Tennessee):** One hundred thirty-nine faults to utility systems. These were primarily to electrical and potable water systems, but steam, storm, chilled water, wastewater, natural gas, and compressed air systems also experienced outages. These faults required over \$5.1 million for repairs and had an impact of \$2 million to science operations.
- **SLAC National Accelerator Laboratory (Menlo Park, California):** At least thirteen faults/outages requiring \$3.7 million in repairs and resulting in \$4.2 million of indirect operational impacts.
- Respond to emerging needs to improve worker safety and reduce annual maintenance costs, such as roof and window replacements to improving roads to upgrading HVAC systems.

Background

DOE is responsible for a vast portfolio of world-leading science and technology innovation. DOE is the steward of critical national scientific facilities, instrumentation, production assets, and the corresponding mission enabling support infrastructure. DOE's seventeen national laboratories are among the largest Federal Government holdings by square footage and include facilities that predate the Manhattan Project.

The Laboratories are national treasures for innovation and science discovery that directly contribute to American prosperity. A combination of new construction, revitalization, maintenance, and disposition investments must be planned and executed to avoid high risk disruptions from failures of enabling infrastructure to allow for delivery of DOE's world-renowned capabilities and attracting/retaining highly skilled workforce.

Milestones

Under the leadership of SC, the National Laboratories and the stewarding Program Secretarial Offices, an assessment by the Laboratory Operations Board (LOB) identified significant funding needs to support core infrastructure improvements across the National Laboratories complex. The Inflation Reduction Act (IRA) appropriated \$2 billion dedicated to National Laboratory Infrastructure through various DOE program offices, but those funds were largely directed to support scientific and state-of-the-art equipment, not basic building and utility infrastructure. Prioritizing an increased funding level for core infrastructure will allow the Department to invest in a variety of infrastructure projects, including projects that will:

- Modernize site-wide infrastructure by correcting reliability issues impacting mission operations, single points of failure, inefficiencies in operations, and costly maintenance.
- Provide new general-purpose space for Laboratory operations that is safe, modern, and efficient.

OPERATIONAL RELIABILITY

Operational reliability of the U.S. grid is being challenged by rapid changes on the system. OE is leading research and development to create the needed technologies to integrate new loads and resources reliably and efficiently.

Summary

Operational reliability of the grid is the cornerstone of modern society, serving as the foundation to our digital economy, national security, and public health and safety. The concept refers to the grid's capability to meet customers' demand in real time while maintaining stability and minimizing disruptions. Key tenets of operational reliability include (i) balancing supply and demand, (ii) maintaining system stability, (iii) resilience to disruptions, (iv) leveraging risk-informed operational procedures, (v) managing variability and uncertainty, and (vi) maintaining effective coordination among key stakeholders.

Issue

Operational reliability of the U.S. electric grid is being challenged by rapid changes on the system. Current challenges in operational reliability include:

- Rapid shifts in demand due to factors such as electrification, decarbonization, and shifts in weather patterns and socio-demographic patterns and preferences.
- Increased intensity and frequency of extreme weather and climate events expose the electric grid to physical failures.

- Growing interdependencies between the electric power grid and other critical infrastructure can jeopardize grid security and reliability including more vulnerability to potential cyber-attack.
- Integration of distributed assets and renewable resources, while pivotal for achieving decarbonization goals, add intermittency and variability to grid operation.
- Lack of visibility at the grid edge can hinder utilities' ability to manage the grid effectively.

Status

Currently, there are insufficient technologies to continue to maintain the reliability of the system in the context of anticipated widespread distributed energy resources and dramatic shifts in electrification. Investment in research, development, and demonstration is critical to create the necessary technology pipeline.

The Office of Electricity (OE) is strategically investing across a spectrum of Technology Readiness Levels (TRLs) to catalyze collaboration among industry, academia, and national laboratories to accelerate innovation and capabilities across various domains including probabilistic demand forecasting, anomaly detection, risk analytics of extremes, data curation, analysis for enhanced grid visibility, uncertainty-informed visual dashboards to facilitate decision making under uncertainty, and grid modeling.

Milestones

Major OE investments to address operational reliability are:

- OE is bridging the gap between engineering prototypes and user ready tools for grid operators, creating new methods for generating valuable information from system data, and ensuring grid reliability in the face of new system challenges. This includes modernizing transmission system tools

through human factors and cognitive science research for workforce training and development, control room application improvements, and robust decision making

- With the addition of next-generation sensors (data sent at milli- to micro-seconds intervals) in the grid, we can get a lot of data in a short period of time that needs to be analyzed and processed. OE has been investing in new analytics, algorithmic, and computational capabilities to process the large amount of data in real time to assist operators with a viable response to improve operational reliability.
- One aspect of operational reliability is to design a future grid that can handle a large number of inverter-based resources (IBRs) while maintaining reliability. A tool is being developed to conduct swift system vulnerability assessments and identify critical weak points, informing the design of innovative control and protection schemes to boost system reliability.
- OE is advancing standard practices with the development of distribution grid codes, including a Distribution Services Contract structure with the North American Energy Standards Board, to address distributed energy resources (DER) performance issues so that all participants involved in the delivery of services from DER understand their respective roles and responsibilities, and so they can institute the appropriate supporting infrastructure to enable visibility and control of DERs through the appropriate coordination frameworks.
- The North American Energy Resiliency Model (NAERM) initiative is used to study how the electric power grid will be impacted by changes in other infrastructures due to natural and manmade events. NAERM has developed and is developing use cases focused on operational reliability and is working to expand additional functionalities.

- Weather and climate related risks have been increasing the stress on the electric power grid and impacting operational reliability. OE has developed decision support tools for utilities to identify climate-change related impacts to their systems, facilities, and assets, as well as evaluate the economic costs and benefits of adaptation action and investments.
- OE provides training, technical assistance, and guidance development for integrated system planning (ISP) practices with states and utilities. ISP processes enable regulators and utilities to prioritize investments under tight budgets that address reliability and resilience issues and incorporate best practices for ensuring interoperability and security at the grid edge.
- OE is working with Lawrence Berkeley National Laboratory and both regulators and utilities to update the Interruption Cost Estimator (ICE) Calculator to help them identify and prioritize investments to improve grid reliability based on determining the impacts of outages. In addition, OE is working with the National Rural Electric Cooperatives Association (NRECA) and regulators to advance such practices in their respective territories.

Background

In the electric power sector, conceptualizing, assessing, and managing engineering system reliability¹ has a relatively long history, dating back to the late 1960s and the establishment of the North American Electric Reliability Corporation (NERC)². NERC's definition of reliability aligns with the established definition of engineering reliability and has two key components of operating reliability and adequacy. The substantial body of engineering research and development, standards and practice dedicated to grid reliability has undeniably bolstered the reliability of the U.S. power system.

The grid is increasingly stressed due to aging infrastructure, exposure to more intense and frequent extreme weather events, and regulatory and policy uncertainties. Innovations in artificial intelligence, energy storage, and distributed energy resources challenge the existing operational and planning paradigms due to technological and policy uncertainties and the shifting landscape of stakeholders.

Considering these emerging trends, OE strategically invests in (i) Research, Development, and Demonstration (RD&D) activities, and (ii) provides technical assistance to enable risk-informed decision making. In other words, OE's vision is to build capabilities in contemporary risk science, equipping the industry with tools to enable (i) anticipation of potential disruptions, (ii) rapid response and recovery post disruptions, and (iii) adaptive decisions for enhanced resilience in the face of future disruptions and uncertainties. By focusing on these areas, OE seeks to ensure a reliable, resilient, secure and equitable grid that can meet the evolving needs of society in a proactive and risk-informed manner.

¹ Engineering reliability dates back to the 1950's where it was defined as "the probability of performing without failure, a specific function under given conditions for a specified period of time. From: Handbook, M., 1988. Electronic reliability design handbook. In MIL-HDBK-338, DoD.

² Nateghi, S. D. Guikema, Y. G. Wu, and C. B. Bruss. Critical assessment of the foundations of power transmission and distribution reliability metrics and standards. Risk analysis, 36(1):4–15, 2016.



SECURING A COMMERCIAL URANIUM SUPPLY CHAIN

A reliable uranium supply chain is essential to powering our existing nuclear reactor fleet and deploying new advanced reactors that can support job creation and reduce carbon dioxide emissions.

Summary

The United States maintains the largest fleet of nuclear reactors in the world operating ninety-four reactors located in twenty-eight states. A reliable uranium supply chain is essential to powering our existing fleet and deploying new advanced reactors that can support job creation and reduce carbon dioxide emissions. The U.S. Congress and the Administration have supported investments to build out a secure nuclear fuel supply chain through legislation and funding. The U.S. government is also working with like-minded partners to expand uranium production and availability from secure sources.

Issue

The current U.S. commercial nuclear reactor fleet uses low-enriched uranium (LEU) to fuel their operations. Until August 2024, when the Prohibiting Russian Imports Act became effective, Russia was supplying over twenty percent of the LEU used by U.S. commercial reactors. This dependence on Russian-sourced uranium undermines the security of our supply chain and the reliability of nuclear power as a U.S. energy source. Additionally, most of the upcoming advanced reactor designs will require

high-assay LEU (HALEU, pronounced HAY-loo) to achieve smaller designs, longer operating cycles, and increased efficiencies. However, HALEU is not available from domestic suppliers at a commercial scale. Gaps in HALEU supply could delay the deployment of advanced reactors in a timeframe that supports the nation's climate goals.

Status

In the near term, the U.S. needs to increase commercial production of LEU to replace imports from Russia. In the longer term, the U.S. needs to establish a commercial supply chain for HALEU to support the deployment of advanced reactors. As of Fall 2024, Request for Proposals (RFPs) for LEU enrichment from new production capacity; HALEU enrichment; and HALEU deconversion have been released. The Department is working on additional procurement actions and funding opportunities to meet these goals:

- HALEU Transportation and Funding Opportunity Announcement (FOA).
- HALEU Innovative Technology FOA.

Milestones

- Over the next five years, the Department will make available more than twenty metric tons of HALEU to advanced reactor developers.
- On September 9, 2024, the Department received proposals in response to an RFP to purchase LEU from new domestic enrichment capacity. Selections may be made as soon in early 2025.
- Construction of new capacity could begin in 2026, with new capacity coming online in the early 2030s.

Background

To ensure that the U.S. commercial light water reactor fleet has a secure supply of LEU for continued operation, the Department is working to select and award new projects to build and operate new enrichment production capacity to expand the domestic production capacity for LEU. Additionally, HALEU is needed for the development, demonstration, and deployment of advanced reactor technologies. To make HALEU available to these projects, the Department is producing small quantities of HALEU from limited uranium inventories at our national laboratories and at a small, demonstration-scale enrichment facility in Piketon, Ohio. To help initiate a commercial market supply of HALEU, the Department is working to select and award projects to establish new domestic production capacity for HALEU.

Important activities include:

- **Waivers allowing Russian uranium imports.** The Prohibiting Russian Uranium Imports Act prohibits Russian uranium imports as of August 11, 2024, but authorizes DOE to issue waivers for imports satisfying certain conditions. These waivers can remain valid up to January 1, 2028. The Department has received several waiver requests, some of which have been granted while others are under evaluation.
- **HALEU Allocation.** Over the next five years, approximately twenty MTU will be made available from limited DOE uranium inventories. However, thirty-two MTU have been requested by advanced reactor developers. An allocation process has been established with the two demonstration reactors, Natrium and XEnergy, having the highest priority.

- **HALEU Consortium.** Membership is free and open to U.S. nuclear fuel cycle entities and has about seventy members that meet with DOE to provide their individual input on issues including pricing for HALEU. The Consortium is to partner with the Department to support the availability of HALEU for civilian domestic commercial use by providing information for purposes of surveys to estimate the quantity of HALEU needed for domestic commercial use for the next five years, purchasing HALEU made available by the Department for commercial use, and carrying out demonstration projects using HALEU provided by the Department.
- **Sapporo 5.** Established in 2023, the Sapporo 5 includes the United States, United Kingdom, France, Japan, and Canada. These countries are working together to establish a secure and resilient global nuclear fuel supply chain to support the growth of nuclear energy deployment around the world, free of Russian influence.

Legislation and Funding Sources:

- **Energy Act of 2020.** Established the HALEU Availability Program to support the availability of HALEU for civilian domestic research, development, demonstration and commercial use.
- **Inflation Reduction Act.** Appropriated \$700 million for the HALEU Availability Program.
- **Nuclear Fuel Security Act of 2023** (part of FY 2024 NDAA). Established the Nuclear Fuel Security Program to increase the quantity of HALEU and LEU production in addition to HALEU production.

- **FY 2024 Energy & Water Development Appropriations.** Repurposed \$2.72 billion from the Civil Nuclear Credit Program to carry out the National Fuel Security Act. Established the American Energy Independence Fund and authorized the Department of Energy to deposit therein funds received from the sale of LEU and HALEU as offsetting collections. The money in the Fund will be available for the Department of Energy to use to carry out the Nuclear Fuel Security Act of 2023 to the extent and in the amounts provided in advance in appropriations Acts.
- **Prohibiting Russian Uranium Imports Act.** Bans Russian uranium imports as of August 11, 2024, which was a requirement to unlock the \$2.7 billion provided by the FY 2024 Energy and Water Development Appropriations Act. Authorizes DOE to issue waivers that can remain valid until January 1, 2028.
- **Annual Energy and Water Development Appropriations for NE.** Annual appropriations to fund HALEU enrichment at Piketon, Ohio and HALEU recovery at the Savannah River Site. The Department requested \$150 million in its FY 2025 Budget Request, and as of September 2024, both the House and Senate marks reflect that number.

SOLAR TRADE ISSUES

The United States has been heavily dependent on imports for most of the solar hardware that is currently installed. A combination of subsidies and trade mechanisms is now helping to establish a domestic solar supply chain.

Summary

In 2023, the United States imported \$17 billion in solar hardware in 2023, mostly solar panels. While domestic solar panel production capacity has grown six-fold since 2020, we exported only \$0.3 billion in solar hardware in 2023 -- mostly high-purity polysilicon. An additional \$3 billion in solar hardware was produced and deployed in the United States. After the U.S. led the world in developing solar technology in the 1970's, this trade imbalance developed gradually over the past forty years as the cost of solar products fell by a factor of 100 and the global industry grew by a factor of 10,000. Today, solar power provides nearly seven percent of the nation's electricity, making dependence on foreign suppliers a potential threat to national security. American companies are preparing to supply the majority of U.S. demand for solar hardware, albeit at a higher price. Sustaining this growing domestic industry requires both incentives and trade policies.

Issue

Not enough home-grown technology to meet demand – The United States has developed a unique solar power technology (cadmium telluride) that supplies about thirty percent of the domestic market. The remainder of the U.S. solar market is supplied by silicon technology, but the United States has had relatively little manufacturing capacity for the silicon supply

chain illustrated below. Globally, this supply chain is dominated by China; however, anti-dumping/ countervailing duties (AD/CVD) and tariffs on imported Chinese goods have shifted production for ingots, wafers, cells and panels for the U.S. market to Southeast Asia.



Higher manufacturing costs – The cost of manufacturing solar hardware in the United States is higher than in other countries. To help domestic solar products be competitive with imported products and onshore the supply chain, the U.S. has provided incentives to domestic manufacturers as well as employed tariffs on imports.

Status

Polysilicon – Domestic producers of solar polysilicon in the United States have the capacity to supply about half of domestic solar demand. Currently, excess capacity in China has pushed polysilicon spot prices to a quarter of the U.S. cost. The U.S. employs tariffs on Chinese silicon, but a domestic polysilicon industry exists largely because solar products made using domestic polysilicon are less likely to have challenges showing compliance with the Uyghur Forced Labor Prevention Act.

Ingot/Wafer – Crystalline silicon ingots, which weigh half a ton, are grown from molten polysilicon and sliced into paper-thin wafers. Ingot/wafer production does not currently exist in the United States.

Cells – Processing silicon wafers to make high-efficiency solar cells is a high-tech operation with similarities to semiconductor chip fabrication. Silicon solar cells in the United States are mostly imported from Southeast Asia and South Korea, but a few domestic companies are building factories in the United States.

Panels – There has been over \$10 billion investment in new domestic factories for solar panel assembly, enough to meet domestic demand within two years. Domestic production of input materials including solar cells, glass, and metal frames, is growing, but imports will likely continue to be necessary for several years.

Mounting – Large solar installations use mounting systems called trackers that point the panels towards the sun. Trackers are assembled on-site using components from a new U.S. supply chain.

Inverters – The power produced by solar panels must be converted into the form used by the power grid. The inverters that do this have historically been imported from Europe and China.

Milestones

As of August 2024, U.S. solar manufacturing capacity includes approximately fifteen gigawatts (GW) polysilicon, forty GW panels, twelve GW inverters and sixty GW mounting. Manufacturers have announced ten+ GW of additional capacity they intend to build in all supply chain segments.

Background

[Solar Photovoltaics: Supply Chain Deep Dive Assessment, DOE, February 2022](#)

[Building a Bridge to a More Robust and Secure Solar Energy Supply Chain, DOE, February 2023](#)

[Domestic Content Bonus Guidance, Internal Revenue Service, May 2024](#)

[Federal Tax Credits for Solar Manufacturers, DOE, July 2024](#)

[Quarterly Solar Industry Update, National Renewable Energy Laboratory, July 2024](#)

[Uyghur Forced Labor Prevention Act, June 2022](#)

[Countervailing Duties Investigation, DOC, May 2024](#)

[Section 201 Solar safeguard measures, Presidential Proclamation, June 2024](#)

[Section 301 Four-Year Review, Federal Register Notice, September 2024](#)



SUPPLY CHAIN FOR GRID COMPONENTS

Longer lead times of critical grid components, including distribution transformers, are impacting the ability of the utility industry to expand and maintain electricity infrastructure, as well as connect and serve new customers. Supporting and scaling domestic manufacturing, improving traditional manufacturing methods, and identifying new approaches in component design can enhance supply chain resilience.

Summary

Demand for critical electric grid components is increasing due to a major transformation underway in the nation's electric grid. Supply chain constraints for many grid components are creating challenges and causing significant delays in efforts to both upgrade and expand the grid.

Issue

The grid is going through a major transformation. Demand for electricity, which has been stable for decades, is now increasing and is expected to accelerate over the next decade due to the expansion of industries like data centers, robust investment in new and existing manufacturing sectors like semiconductors and batteries, and electrification in different sectors including the deployment of electric vehicles. At the same time, the grid is aging, and utilities are investing to upgrade grid systems to be more resilient to address extreme weather events such as wildfires, flooding and hurricanes. Grid buildout, replacement, and resilience efforts are putting unprecedented strain on the supply for critical grid components, including transformers. Utilities

seeking to add or replace transformers and other components are currently facing high prices and long lead times, resulting in delayed projects and economic losses. At the same time, grid component manufacturers report labor shortages and challenges finding critical components, such as electrical steel. Supply chain challenges have the potential to seriously affect energy accessibility, reliability, and affordability.

Status

DOE is leading a whole-of-government approach to address the challenges and risks raised by grid supply chains. Working in partnership with domestic manufactures and major U.S. utilities, the Office of Electricity (OE) is working to research advanced grid components and identify opportunities to [streamline the supply chain process](#) for existing components. The Office of Manufacturing and Energy Supply Chains (MESC) conducts analysis to identify specific gaps and vulnerabilities in grid component supply chains and, through its partnership with the Internal Revenue Service (IRS) to implement the 48C Qualifying Advanced Energy Credit program, has prioritized projects that [domestically manufacture critical grid components](#). The Department is also partnering closely with the Department of Commerce, Department of Treasury, and the Made in America Office to strengthen domestic supply chains for critical grid components.

Milestones

- OE's [Transformer Resilience and Advanced Components \(TRAC\) Program Vision and Framework](#), developed by over 64 utility, vendor, academic, and national laboratory representatives in 2020, helped identify research gaps and hardware challenges facing the grid which frequently aligned with the supply chain constraints of grid components.
- OE's Energy Storage program is supporting the research and development of grid-scale, long-duration energy storage technologies based on abundant domestic materials, as

well as addressing challenges that domestic energy storage technology developers face at the pre-production manufacturing stage that impact scaling the technology for production.

- The world's first Flexible Large Power Transformer was energized in September 2021 and can adapt to a range of voltage ratios and impedance levels, which can cut down on manufacturing costs and time needed to build today's transformers.
- A robust insulation for transformers and power electronics is under development through work at OE; it is key to longer equipment lifetime which assists supply chain security.
- Advanced transformer health monitoring technology can increase current equipment reliability, thereby helping to mitigate the effects of the supply chain challenges facing the grid. This technology won an R&D 100 award in 2023.
- MESC, through its partnership with IRS to implement the 48C Qualifying Advanced Energy Credit program, [prioritized projects in Round 1 that domestically manufacture critical grid components](#). Allocations to projects under Round 2 of 48C credit program will be selected no later than January 15, 2025.
- MESC's Advanced Energy Manufacturing and Recycling Grants Program invested in projects by [CorePower Magnetics and TS Conductors](#), helping ease the component bottlenecks for electrical steel and advance conductors.
- OE's \$18 million Flexible Innovative Transformer Technologies (FITT) Funding Opportunity Announcement (FOA) was released in February 2024 to fund research, development, and demonstration of advanced transformers across a range of

distribution to transmission applications, improving grid reliability and easing transformer supply chain constraints.

- OE, in collaboration with the Energy Sector Coordinating Committee (ESCC), facilitated discussions with utilities and manufacturers to look for opportunities to address the distribution transformer shortage. This effort looked at reducing the estimated 80,000 different types of distributions through a common configuration matrix. The group also identified recommendations for the interchangeability of accessories should original components be unavailable.

Background

The U.S. electric grid is a complex system of systems built primarily from equipment provided by U.S. manufacturers but is now predominantly reliant on global supply chains. The global community, like the U.S., is seeing the advantages of increased electrification, which in turn stresses global supply chains in specific areas. The shortages of materials and components today will worsen under traditional trends in utility purchases and equipment manufacturing.

Mitigations for these supply chain issues could be improved through strategic planning and research and development in manufacturing processes, advanced materials, innovative equipment solutions, analysis to identify specific gaps in vulnerabilities in grid supply chains, and the targeted buildout of domestic manufacturing, enabled through dialogue with the over 3,000 utilities to identify and understand concerns and communicate and demonstrate the solutions developed.



