Recommendations of the 21st Century Energy Workforce Advisory Board, July 2025

The U.S. energy sector faces unique challenges of rising energy demand and variable prices. To address these challenges, the U.S. Department of Energy (DOE) has outlined a strategy to unleash a Golden Era of American Energy Dominance. Each aspect of this vision to enable energy additions and innovation, while also promoting affordability, will require a historic number of workers.

In March 2025, the 21st Century Energy Workforce Advisory Board (EWAB) was tasked with developing recommendations for DOE to implement its strategy and the presidential memorandum on Delivering Emergency Price Relief for American Families and Defeating the Cost-of-Living Crisis. This report outlines priorities for implementation to increase affordability and economic prosperity by creating "employment opportunities for American workers, including drawing discouraged workers into the labor force."

The EWAB recommends that the DOE adopt an "all-of-the-above strategy" or approach to foster a diverse resource mix for the US energy industry workforce to quickly, safely, and cost-effectively develop greater energy resources to power American life and increase the availability of millions of jobs for the domestic workforce.

The DOE has a central role to play in addressing the energy sector's workforce needs. The most recent data from the 2024 U.S. Energy and Employment Report (USEER) found that 76% of employers experienced at least some difficulty hiring as the energy workforce has continued to grow. [1] That report highlights that 8.35 million people work in the energy sector in 2023, representing more than 5% of jobs in America. [2] To grow new talent and implement ambitious energy policy requires a coordinated strategy. In its prior report, EWAB emphasized the need to build on the historic strengths of the DOE in research and development to continue training engineers and scientists while also expanding and investing in sector-focused, broad occupational training to build pathways into energy careers. This includes fostering direct connections to trade, technical, and operations jobs through proven pathways of career and technical education (CTE), registered apprenticeship, and on-the-job training (OJT) to prepare Americans, including those without a four-year college degree, for high-paying skilled trade jobs of the future.

The DOE can lead in a sector-based strategy by **1) providing significant support to scale pathways for high-paying, high-quality energy careers, strengthening focus on career and technical education, apprenticeship and other earn-and-learn models, for new and incumbent workers; 2) increasing awareness and excitement of - and connections to - energy careers for career-ready adults and students, and their influencers; and 3) positioning DOE as the leader for innovative, effective, non-siloed solutions to support development of the workforce for 21st century energy needs, prioritizing place-based and industry sectoral strategies.**

This is a historic opportunity, but there are headwinds to growing and sustaining full employment in the energy sector, sentiments that were repeatedly reinforced by industry and workforce stakeholders that were interviewed to inform this report. The Executive Order Unleashing American Energy highlights key industries including oil, natural gas, coal, hydropower, biofuel, critical mineral, and nuclear energy resources. Many of these areas, and others, are highlighted in the report.

With a commitment to supporting the development of the energy workforce, members of the EWAB offer these recommendations for cross-cutting priorities to build talent pipelines across the sector (beginning on page two) and, beginning on page five, industry specific recommendations are suggested.

1. Provide significant support to scale pathways for high-paying, high-quality energy careers, emphasizing apprenticeship and other earn-and-learn models, for new and incumbent workers.

Why: The Bureau of Labor Statistics projects that employment in selected energy related industries will grow by 4% between 2023 and 2033, including for burgeoning jobs for which minimal education currently exists. Many training providers are not equipped to develop and deliver education at scale. DOE must continue its long-standing support to develop researchers, scientists, and engineers and expand its programming to ensure that critical needs for the craft and labor workforce are met.

How:

1.1. Encourage the establishment of regional state-led **Energy Apprenticeship Centers of Excellence** to prioritize deployment of broadly accepted Registered Apprenticeship Programs in the sector and support mobilization of action by:
- Partnering with the U.S. Department of Labor to enhance **support for Registered Apprenticeships throughout the energy sector** and seek their commitment to expedite processes for apprenticeships related to new, emerging, and prioritized energy technologies.
- Promoting **Registered Apprenticeships** that will offer portable credentials, and updating existing programs, especially for new and emerging energy jobs.
- Convening and facilitating **public-private partnerships to advance career-long learning** for the energy workforce to keep pace with technological advancements.
- Providing leadership for **skills mapping** for evolving jobs and worker transition programs.
- Developing strategies to **increase the completion rates of apprenticeship programs**, especially those that can assist early-stage apprentices and prioritize mentorship programs that significantly impact completion rates.

1.2. Assist **community colleges, technical and secondary schools, schools, community-based organizations, and other training providers** with guidance on and strategies to:
- Secure training equipment, trained and qualified instructors, and curriculum for high-demand careers.
- Develop career exploration, pre-apprenticeship, and apprenticeship readiness programs that prepare people for energy careers, especially essential jobs to protect energy security and support a diversified grid.

1.3. **Call on the Department's National Laboratories to create or expand appropriate technical training** for educators and incumbent workers for in-demand energy jobs in their communities and/or spaces of influence.

1.4. **Create a free, virtual "Energy Academy"** to offer widely accessible education resources to help individuals navigate subjects that are often barriers to energy employment. Modeled after the Khan Academy, the Energy Academy would offer free instruction on disciplines including math and field assessment skills, often deterrents for prospective utility and construction employees.

1.5. Support **talent development strategies for rural and Tribal communities** reflective of their unique geographical and demographic characteristics.

1.6. Incentivize **energy employers to support work-based learning**, internships, upskilling, and supportive services, and encourage **financial support for students to pursue energy careers**, including expenses related to work-based learning programs and earning post-secondary credentials.

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2. INCREASE AWARENESS AND EXCITEMENT ABOUT - AND CONNECTIONS TO - ENERGY CAREERS FOR CAREER-READY ADULTS AND STUDENTS, AND THEIR INFLUENCERS.

Why: The lack of awareness and understanding of energy careers are consistently cited by industry as significant impediments in attracting talent. Without heightened focus to raise the profile of energy careers and pathways to young learners and incumbent workers, none of the strategies recommended herein will be effective.

How:

2.1. Grow awareness through **communications campaigns** that increase excitement about energy careers and lead individuals to tools that identify career paths, training opportunities, and job access.
2.2. Educate career influencers, including workforce boards, high school counselors and parents, and One Stop Centers, about energy careers to **encourage prioritization of energy industry employment**.
2.3. Partner with the U.S. Departments of Defense and Labor to **prioritize energy sector employment for transitioning service members**, drawing upon the continued mission of national security and incentivize Skill Bridge preparation.
2.4. Establish **career navigators to help jobseekers** understand how to access energy training and employment opportunities.
2.5. Develop **approaches for K-12 energy and STEM education**, building youth awareness of and exposure to energy careers, and ensuring resources for educators:

- **Encourage adoption of and support for energy curriculum and the new Energy and Natural Resources Career Cluster in Career and Technical Education** (CTE), seizing the watershed opportunity created by the recent adoption of the Energy and Natural Resources Career Cluster. The 12.5 million CTE students [3] - many of whom do not or are unable to follow the four-year college pathway and could be excellent candidates for technical and skilled trade careers – have not been broadly exposed to energy curriculum in their classrooms for 25 years. The adoption of the National Energy and Natural Resources Career Cluster [4] late in 2024 changed that landscape.
  - Establish a broad **energy curriculum adoption strategy**, prioritizing Middle School classrooms and above.
  - Incentivize the industry to develop more certifications and industry-recognized, stackable credentials to **make curriculum adoption more appealing to educators and attractive to students** and establish standardized competencies and frameworks for training to provide more uniform educational standards.
  - Ensure **Middle and High School educators secure knowledge about the energy industry, especially related to high-demand careers, to comfortably incorporate relevant curriculum in their classrooms** (e.g. paid externships and enrichment programs.)
  - Encourage creation of **energy-focused youth apprenticeship programs** that will arm learners with technical aptitudes for energy careers.

2.6. Ensure **scholarships are available in high-need fields** like nuclear engineering, mining engineering, and metallurgy to increase enrollment.

3. POSITION DOE AS THE LEADER FOR INNOVATIVE, EFFECTIVE, NON-SILOED SOLUTIONS TO SUPPORT DEVELOPMENT OF THE WORKFORCE FOR 21ST CENTURY ENERGY NEEDS, PRIORITIZING PLACE-BASED AND INDUSTRY SECTORAL STRATEGIES.

Why: With historic hiring, training, technology and innovation required to support all industries in the energy sector ecosystem, greater national and state-wide coordination, driven by DOE leadership, must be provided to spur immediate action and disrupt outdated and status quo approaches to workforce development.

How:

3.1. Establish a clear energy strategy that enables **effective workforce development planning** and development:
- **Address the energy workforce in all DOE investments** (e.g. have a standard workforce section in all Notices of Funding Opportunities).
- Establish a **plan for workforce training and talent development needs** for increasing power generation capacity in areas where supply chain challenges threaten electrical grid reliability, energy cost, and security.
- Prioritize **siting, permitting, and equipment needs** across industries that are expected to expand quickly and need to train and recruit workers with haste to unleash urgently needed and diversified energy.
- Ensure **funding from the Workforce Investment and Opportunity Act** (WIOA) to support in-demand positions to support critical jobs in energy.
- Position the Department to **serve as an energy workforce data hub**, offering 5-year forecasts on the energy workforce, identifying expected regional hiring demands, and identifying skillsets and competencies required for critical jobs to support efficient workforce planning.

3.2. Competitively **fund a variety of entities** (e.g. workforce intermediary organizations, trade associations, non-profits, etc**.) to be the Department's key implementer(s)** of sector workforce strategies, which could include (non-exhaustive):
- **Convening industry, employers and labor,** to assess shared workforce needs, standardize and establish credentials and industry training requirements, and chart career pathways.
- **Enhancing earn-and-learn programs** (e.g. those that connect graduates of two-year postsecondary engineering-related programs to apprenticeship programs that also provide credit toward four-year degrees.)

3.3. Convene **"tiger-teams"**[5] to work with DOE to address workforce priorities to lead regional economic development, support communities impacted by evolving energy production needs, and respond quickly to moving workforce needs and real-time disrupters. Focus areas should include:
- Communities with high-priority energy projects.
- Communities with a high concentration of discouraged workers.
- Communities with coal plants and legacy manufacturing firms that have closed.
- Remote and rural areas with Artificial Intelligence (AI) infrastructure awards.
- Economic transition resources for communities impacted by evolving energy production needs.

3.4. Prioritize **removing barriers and creating pathways for discouraged and displaced workers** to enter high-priority energy industries through targeted employer engagement, industry partnerships, and place-based strategy by:

- Incentivizing sector solutions and establishing funding for innovative approaches to eliminating and minimizing workforce impediments, including lack of internet access for training, family care, and transportation, especially in rural communities. Provisions for emergency funds to support early-stage apprentices and individuals in early stages of post-employment that experience unexpected circumstances should be considered.
- Incentivize employers to hire individuals with criminal records. Research by the Rand Corporation found that more than one-quarter of persons in the active workforce have been convicted of a crime.[6] Many employers (falsely) believe they are not permitted to hire from the re-entry community; movement in this area has the potential to expand the industry's talent pool significantly.
- Support income-based tuition scholarships for high-wage, high-need occupations.

Recommendations for Unique Workforce Development Needs by Specific Energy Industries

Note: Some of the recommendations below for workforce development needs in various industries within the sector may appear duplicative to general sector recommendations above and to each other, particularly those related to retirement-based attrition, training and recruitment/retention in remote areas, lack of awareness of industry careers, and research and workforce capacities. They are included for emphasis and acute representation of the observations, opportunities, and challenges prioritized by industry practitioners.

Nuclear Energy Workforce Recommendations

In order to "unleash commercial nuclear power in the United States" and begin "the long-awaited American nuclear renaissance," (Secretarial Order, February 5, 2025), the Department must help remove barriers that impact nuclear employers' abilities to deploy new nuclear technologies, including: 1) an aging workforce; 2) high retirement rates; 3) a shortage of skilled professionals entering the industry; and 4) lack of training infrastructure to prepare individuals for highly technical positions. These challenges are expected to be exacerbated by rapid advancements in technology and advanced training required to manage next-generation reactors and small modular reactors. Projected needs are to triple the nuclear workforce by 2050 [7]. The speed, scale, and nature of deployment are imprecise and are expected to remain so until there is a clear and consistent demand signal for new reactor deployment. To support the unique workforce development needs for the industry to deploy more nuclear power, the Department is encouraged to:

1. Provide clarity on policy support and new reactor deployment timelines to address talent pipeline development needs.

2. Complete the Advanced Reactor Demonstration Program (ARDP), validating that demonstration reactors are essential to catalyzing targeted workforce development. (Without federal perspective on these reactor demonstrations, stakeholders lack the justification to invest in nuclear-specific education and skills pipelines.)
3. Explore a DOE supported traveling nuclear talent pool to address needs for critical knowledge positions required for short term assignments.
4. Fast-track training programs in high-demand fields, including instrumentation and control and reactor operations, that can accelerate entry into the workforce. Increasing financial support through scholarships, tuition reimbursement, and nuclear-specific funding is critical.
5. Prioritize revitalization of the Nuclear Uniform Curriculum Program that has experienced falling enrollments, resulting in suspension of programs vital to the nuclear workforce pipeline.
6. Support regional nuclear workforce hubs, using as models those that are delivering results, like the Nuclear Innovation Hub, the Tennessee Valley Nuclear Energy Workforce Center, and the University of Wyoming's Nuclear Energy Research Center.
7. Support the enhancement of DOE's Nuclear Energy University Program (NEUP) funded academic programs by allocating resources for hands-on nuclear training, including expanded student access to university-based research reactors, radiological laboratories, and advanced simulation technologies that replicate reactor operations and emergency response environments.
8. Prioritize NEUP-aligned partnerships that create apprenticeships and cooperative education in specialized fields (e.g. radiation protection, nuclear plant maintenance, and reactor operations) ensuring graduates are equipped with both theoretical knowledge and applied experience to meet near-term workforce needs.
9. Encourage states to sponsor training programs specifically for ex-Navy nuclear personnel as these programs could help cover the costs of additional certifications or licensing requirements needed to enter the civilian nuclear workforce. Additionally, fast-tracked certification pathways should be developed to recognize and validate the extensive training and operational experience that Navy nuclear personnel possess.
10. Establish a pilot program to transition employees who work in coal plants that are closing or being phased out into nuclear energy jobs in their communities. These pilots should accelerate workforce pipelines for next-generation nuclear deployment while implementing a targeted transition program to retrain workers from the coal sector for careers in nuclear energy.

Power Generation and Distribution, Grid Resiliency and Security, and Critical Supply Chain Workforce Recommendations

Modernizing the electrical grid is a necessity driven by escalating power demands from increased electrification needs, including data storage, heating, and transportation as well as the growing reliance on digital technologies. A 2023 report from the Energy Information Agency (EIA) projects global electricity demand will increase by about one-third by 2050 [8], with additional findings from NREL suggesting that growing AI infrastructure load growth will double or triple by 2028. [9]. Beyond the requirements for daily living, a resilient, distributed, and intelligent grid is paramount for national

security, safeguarding critical infrastructure against cyberattacks and natural disasters, ensuring the continuous operation of essential services. Further, a secure supply chain, bolstered by adequate domestic manufacturing capabilities for critical components like transformers, conductors, and advanced grid technologies, is vital to ensure the timely and cost-effective modernization of the US electrical grid and to mitigate potential vulnerabilities. There are unique talent considerations for Power Generation and Distribution, Grid Resiliency and Security, and the Supply Chain, which include:

1. Request funds under Title III of the National Defense Production Act to accelerate the manufacture of products that are currently compromising delivery of safe, cost-effective, reliable energy, including transformers and electric steel.
2. Invest in programs to train and recruit workers to meet the increasing demand on grid systems with the anticipated expansion of AI infrastructure.
3. Strengthen regional coordination for "sharing workers" during mutual assistance requirements as catastrophic events are increasing.
4. Utilize research within the Department, such as that from the Office of Electricity, that addresses grid vulnerabilities and modernization requirements and identifies related talent needs to ensure proactive workforce strategies.
5. Invest in research to understand how to use AI effectively to make better informed choices about grid control and management of distributed energy resources and identify associated workforce competencies. Similarly, identify where and how AI tools can be used to enhance human skills (e.g. virtual power plants where automation is needed for non-critical decision-making.)

Oil, Natural Gas, and Geothermal Workforce Recommendations

Many families in the US today are in danger of falling below the modern energy minimum, lacking access to reliable, affordable energy. This danger tends to limit economic opportunities, education, and health outcomes. It is essential that we respond to these challenges with a future-ready workforce.

Survey research by the Society for Human Research Management (SHRM) indicates that more than one-quarter of the workers in the US Oil, Gas and Mining Industry are 55 years of age or older. [10]

There are several factors that must be prioritized to ensure production strength for the oil, natural gas, and geothermal industries and accordingly, the Department is encouraged to:

1. Encourage the development of programs that help retain aging workers as mentors and trainers to support this critical juncture of knowledge transfer and those to better capture the unwritten knowledge of workers.
2. Evaluate which jobs are most likely subject to AI-induced displacement, and plan workforce resilience/transition accordingly.
3. Establish Geothermal Centers of Excellence to train oil and gas workers for geothermal jobs, replicating existing oil and gas training programs in geographies where geothermal energy plants exist. Establish partnerships between current training providers in the oil and gas industry with technology developers in the geothermal industry.

4. Promote policy-certainty and tech-neutral incentives. Ensure that energy policy does no harm to domestic producers and upstream sectors.
5. Facilitate interstate energy transport and market access to maintain a resilient supply chain.

Critical Minerals and Materials

According to the Society for Mining, Metallurgy & Exploration (SME), "more than half the current workforce will be retired and replaced (~221,000 workers)" by 2029. [11] Demand for workers is surging across the critical minerals supply chain, but interest in mining careers is low. In 2023 only 162 bachelor of science degrees in mining engineering were awarded in the US. In contrast China "is far outperforming the United States in terms of number of mining engineering graduates. China's 45 mining engineering programs currently enroll about 12,000 students and graduate approximately 3,000 per year—about 16 times that of the United States …" [12]

The U.S. rare earth element (REE) industry is small, with limited drilling and employment. The U.S. once led REE technology but now lags far behind in expertise and infrastructure. There is much work to be done to address the challenges before us, beginning with broadening awareness of jobs in these areas and dispelling misunderstandings and perceptions. [13]

To support the unique workforce development needs for developing the critical minerals and materials (CMM) and derivative products workforce, the Department is encouraged to:

1. Expand upon DOE investments in regional CMM initiatives (e.g., the CORE-CM Initiative [14]) to develop regional workforce ecosystems that will move from company-specific hiring to broader industry-wide approaches for workforce management and retention across all aspects of the CMM supply chain. (See Rio Tinto's community workforce activities [15] as a model.)
2. Support industry in identifying solutions for project lifecycle coordination, so there is better management of workforce development and project phase needs.
3. Enhance nation-wide research and innovation capacity by bolstering the DOE National Laboratories, academic research institutions, and their coordination with private entities, building upon DOE programs like the Critical Materials Innovation (CMI) Hub [16] and Minerals to Materials Supply Chain Research Facility (METALLIC) [17].
4. Provide resources to US colleges and universities to reinvigorate U.S. leadership in REE and CMM technologies. This should include funding for research and student training, as well as funding for career awareness outreach to draw attention to mining careers and change widespread misconceptions of opportunities in the industry.
5. Work with Congress to enhance DOE's ability to stack grants and loans with other federal support to better enable capital formation for projects and improve project viability, across the REE and CMM supply chain, reducing administrative burdens and accelerating funding processes, tying to long-term national strategies and international standards to avoid piecemeal efforts and ensure international market access.
6. Collaborate with the U.S. Department of Commerce, U.S. Trade Representatives, and others on the design of targeted and time-based Section 232 and Section 301 tariffs and trade agreements to ensure that international strategies complement domestic investments and enable U.S.

manufacturing production capacity to scale with access to necessary equipment and markets, while countering malign actors and foreign entities of concern.

7. Create a long-term, systems-based workforce strategy by avoiding fragmented, grant-based approaches, mapping the full supply chain and fill the gaps systematically.

Endnotes

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