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Wired for Defense: The National Security Imperative of Transmission Expansion

SAFE | CENTER FOR Grid Security

Letter from the Co-Chair of SAFE's Center for Grid Security

Under the Eisenhower administration, leadership recognized the need for a national highway system. America's ability to swiftly move goods and people was directly tied to our national security. As the interstate highway infrastructure developed, it enabled meaningful and sustained economic growth that continues to offer benefits today.

America's power grid is now the electric highway that buttresses our economy and national security. The nation's biggest consumer of power is the Department of Defense (DoD). Our power grid is essential for force generation, communications, logistics, and sustainment. Its vulnerabilities are shared and impact our defense and economy.

"Wired for Defense: The National Security Imperative of Transmission Expansion" deftly lays out the DoD's reliance on our power grid. It establishes our current and future challenges as power demand continues to grow at a rapid pace. More importantly, the paper rightly recognizes the national security interests associated with the power grid and offers policy recommendations that would alleviate the associated vulnerabilities.

A reliable and resilient grid is a necessity for America's future security and prosperity. It is time for us to become the guarantor of America's future by becoming an independent and self-sufficient energy nation.

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Executive Summary

Every facet of the modern world depends on electric power, and its significance in daily life cannot be overstated. The power grid is the essential infrastructure bringing electricity to homes, industrial centers, and military installations—but a complex interplay of regulations, regional discrepancies, and barriers to development have created a system that is outdated, strained, and increasingly prone to outages and disruptions.

The U.S. Department of Defense (DoD) is the largest consumer of power in the nation and relies on grid infrastructure. America needs a grid that is sufficiently resilient and reliable to serve our national priorities in defense, technology, and strategic competitiveness. Power demand is currently surging from multiple sources as we advance these priorities. Not only do we need abundant and affordable power, but we also need transmission capacity to connect it to projects and installations that serve our national interests.

This report presents an overview of how current grid vulnerabilities impact the DoD, and the related needs of the commercial sector for domestic manufacturing capacity and supply chains to meet defense needs. The current state of the power grid is exacting a toll on the DoD due to outages and disruptions that are costly and divert time, attention, and human capacity from operations and warfighting.

Furthermore, emerging vulnerabilities from natural disasters, physical interference, and cyberattacks present a new constellation of challenges that require policy solutions to address. The extent of these risks is not fully known, but dependence on equipment manufactured by American adversaries—especially China—is a strategic vulnerability. For example, since 2006, the United States has imported hundreds of Chinese-made transformers used in critical high-voltage transmission infrastructure.[1] In 2020, a hardware backdoor was discovered that suggested risk of sabotage to or subversion of the grid. The U.S. Director of National Intelligence has assessed that China's role as a leading supplier of advanced grid components creates cyber vulnerability risks.[2] Such examples illustrate that re-shoring the manufacturing of these essential components must be integrated into long-term planning for grid security.

Today, grid policy, planning, and operations fail to account for the power needs of the nation's defense infrastructure, and the fragmented nature of the power grid has led to the evolution of a system that does not properly account for the needs of the nation overall.

Moreover, the system oftentimes is unaware of the needs of defense-critical supply chains and does not place any enhanced priority on serving military installations that support the DoD's most critical missions. No federal requirements exist for such loads to be given any special consideration in grid planning, reserve

[1] Joe Weiss, "The U.S. electric industry is not responding to cyber-vulnerable Chinese equipment," *Control*, February 29, 2024.

[2] "Climate Change and International Responses Increasing Challenges to US National Security Through 2040," National Intelligence Council, October 21, 2021, at 6.

margins, or interregional transfer minimums. This sets the country on a path that places our national defense infrastructure at heightened risk.

While there are many potential policy changes that would support a stronger grid for our overall economic competitiveness, there is an urgent need to integrate national security into grid power decision-making processes. SAFE's Center for Grid Security offers three policy recommendations to improve grid reliability for the DoD:

Expand the DoD Siting Clearinghouse:

The DoD Siting Clearinghouse, also referred to as the DoD Military Aviation and Installation Assurance Siting Clearinghouse, is an established body within the Department designed to evaluate potential mission impacts related to energy developments near military installations. Created by the fiscal year (FY) 2011 National Defense Authorization Act (NDAA) and codified in FY 2018, the Clearinghouse works with private industry and developers, state and local government, regulators, and non-governmental organizations to minimize adverse impacts to military training, testing, and operations. The mission of the Clearinghouse is to ensure that impacts to military readiness are considered in energy siting decisions throughout the United States, to include wind turbines, photovoltaic arrays, and transmission infrastructure.

The existing scope of the DoD Siting Clearinghouse, along with its appropriation, could be expanded in a future NDAA to include a process by which the DoD reviews transmission projects not just for adverse impacts on military missions, but for benefits to national defense. A determination from the DoD Siting Clearinghouse themselves could then be used as a tool by grid owners and operators to prioritize projects that support national security.

Provide energy expert staff at DoD to manage negotiations with utilities:

To date, the DoD has typically intervened in state utility dockets to advocate for fair and reasonable utility rates for military installations. As a major consumer of utility services, the DoD aims to protect its interests and manage costs related to energy consumption. Recently, the DoD recognized the need for more strategic interactions with utilities, specifically in rate proceedings at the state level. At present, such engagement proves to be a challenge for the DoD's existing staff structure.

To overcome this challenge, the Office of the Deputy Assistant Secretary of Defense for Energy Resilience & Optimization (ODASD(ER&O)) could be expanded to include a team of energy professionals focused solely on grid-centered interactions. This would allow for not only more effective interactions at the state level, but also with key regional stakeholders and the Federal Energy Regulatory Commission (FERC).

Account for national security in FERC's benefits assessment criteria:

FERC has established specific criteria for evaluating the benefits of energy projects, particularly in transmission planning. Current specified benefits include:

1. Avoided or deferred reliability transmission facilities and aging infrastructure replacement
2. Reduced loss of load probability or reduced planning reserve margin
3. Production cost savings
4. Reduced transmission energy losses
5. Reduced congestion due to transmission outages
6. Mitigation of extreme weather events and unexpected system conditions
7. Capacity cost benefits from reduced peak energy losses

At present, this process does not include an explicit tie to ensure energy projects support national interests or national security. The expectation that a general consideration of improved reliability and cost effectiveness for grid energy projects will support national security is flawed. To date, this approach has failed to adequately close the gap necessary to best protect the nation, as outlined throughout this report. FERC may consider adding enhanced national security or increased capacity to national security loads as an eighth required benefit to improve this process and directly support the energy needs of national defense.

Section One: The Grid is the Foundation of all Military Missions

The U.S. power grid underpins the entire spectrum of military operations, making its reliability and resilience vital for national defense. Reliable electricity is the lifeblood that powers essential defense operations, including communication, command and control, and intelligence activities, which are critical to the success of U.S. military missions. Military logistics heavily depend on electric power for manufacturing, supply distribution, and maintenance operations, ensuring personnel and equipment are adequately supported. Military installations rely on the power grid for day-to-day functions, including housing, medical facilities, and other essential services, enabling sustained operations. Modern military technology, including missile defense systems and surveillance tools, requires an abundant, stable power supply for functionality and effectiveness. Grid power is also crucial for defense training operations and simulation environments, helping to best prepare military personnel for real-world scenarios. The DoD relies on grid power to support critical cybersecurity operations, protecting sensitive information and infrastructure from potential threats. To more clearly understand how the U.S. grid is foundational to all military missions and, therefore, foundational to national defense, critical grid energy needs are best examined through the following key areas:

Logistics and Supply Chains

Efficient logistics are vital for sustaining operations. Energy is needed not just for producing materials but also for operating supply depots, maintaining equipment, and powering facilities where personnel are stationed.

Operational Readiness

Energy fuels all aspects of military readiness. From vehicles and aircraft to missile defense systems and communication infrastructure, a reliable grid power supply ensures that forces can mobilize and operate effectively.

Mobility

The ability to move personnel and equipment quickly is crucial in military operations. The DoD has made significant strides in electrifying its non-tactical and tactical vehicle fleets, increasing its orders of electric vehicles and plug-in hybrids. While initiatives such as these result in cost savings and reduced emissions, grid infrastructure is necessary to support these fleets' demand on the power grid.

Communications and Intelligence

While the U.S. military maintains significant independent communications capabilities, innovation in these sectors are predicated on technologies, including AI and advanced computing, that require large amounts of power to operate. Alongside this growing reliance is the increased need for grid power. This presents opportunities for enhanced capabilities, as well as challenges that must be carefully managed to ensure operational effectiveness and security.

Deterence & Resilience

The power grid underpins national security and resilience, making it a prime target for cyberattacks. Advanced technologies like AI enhance grid security by monitoring networks, detecting cyber threats, and enabling rapid responses. Its role in analyzing large datasets and countering disinformation demonstrates how AI safeguards critical infrastructure, including the grid, from geopolitical and cybersecurity threats.

Strategic Considerations

The U.S. military recognizes the importance of energy infrastructure as a strategic target. Attacks on the power grid amidst large-scale conflict undermine operational readiness. The targeting of energy infrastructure is a growing trend in modern warfare, exemplified by actions in Ukraine and Gaza. The buildout of transmission infrastructure creates a grid that is more resilient to disruption or attack from foreign adversaries.

In essence, energy is the backbone of military operations, enabling everything from day-to-day functions to complex combat scenarios, and its reliable supply is vital for national security. This report provides a deeper analysis of the growing grid power needs of each of these key areas in Section 1.2.1.

1.1 The DoD's Current Grid Experience: Dependence, Outages, and Costly Solutions

The DoD is heavily reliant on the local power grid for its energy needs, which, due to the grid's current state, creates significant vulnerabilities for military installations and national security. The DoD is the largest consumer of energy in the U.S. government.[3] It relies heavily on the state and regional grids surrounding each installation to provide power for its operations. Today, this dependence on external power sources creates a notable security concern, as installations require uninterrupted access to electricity to ensure readiness and maintain critical missions.[4]

The present state of the U.S. grid exposes installations to unnecessary risks and places a significant strain on military operations and budgets. Near-peer competitors like Russia and China recognize this and are working to exploit aging infrastructure to gain advantages in potential future conflicts. Rogue nations such as Iran and North Korea have also undertaken offensive cyber acts that could disrupt U.S. operations. In 2019 alone, more than 12 utility companies across the country were targeted by cyber-attacks.[5]

> National security's reliance on the U.S. grid is most evident in the impacts experienced by military installations when the grid goes down.

National security's reliance on the U.S. grid is most evident in the impacts experienced by military installations when the grid goes down. Weather-related events, such as storms and extreme temperatures, are by far the leading cause of power outages in the United States, accounting for approximately 70 percent of all outages, according to the Edison Electric Institute. Storm-related power outages have significantly impacted U.S. installations in recent years, particularly during major hurricanes.

Hurricanes Helene and Milton in 2024 caused extensive power outages across multiple military installations in the southeastern United States. The storms left many installations without electricity for days, disrupting operations and requiring substantial recovery efforts. During Hurricane Helene, MacDill Air Force Base (AFB) in Tampa experienced significant flooding and lost power to much of the installation.[6] Moody AFB in Georgia suffered severe damage from Hurricane Helene, including widespread power outages. More than 700 Airmen worked to restore essential services, with power gradually coming back online several days after the storm.[7]

Military installations have experienced numerous unplanned grid power outages for far too long. In FY 2019, the DoD experienced 2,572 unplanned utility outages, of which 542 lasted eight hours or longer.[8] Outages increased in FY 2021, with over 6,000 energy outages at DoD installations across the United States. This amounted to more than 3,000 days of lost power across all locations.[9]

Concern that the grid may not be able to provide sufficiently reliable and resilient power to meet DoD's needs has led the

[3] Joseph Clarck, "DOD Forges Clean Energy Pathway with Carbon Pollution-Free Electricity Contract," *DOD News*, June 18, 2024, *Webpage*.

[4] "Defense Critical Infrastructure: Actions Needed to Improve the Identification and Management of Electrical Power Risks and Vulnerabilities to DOD Critical Assets," GAO, October 23, 2009, at 1.

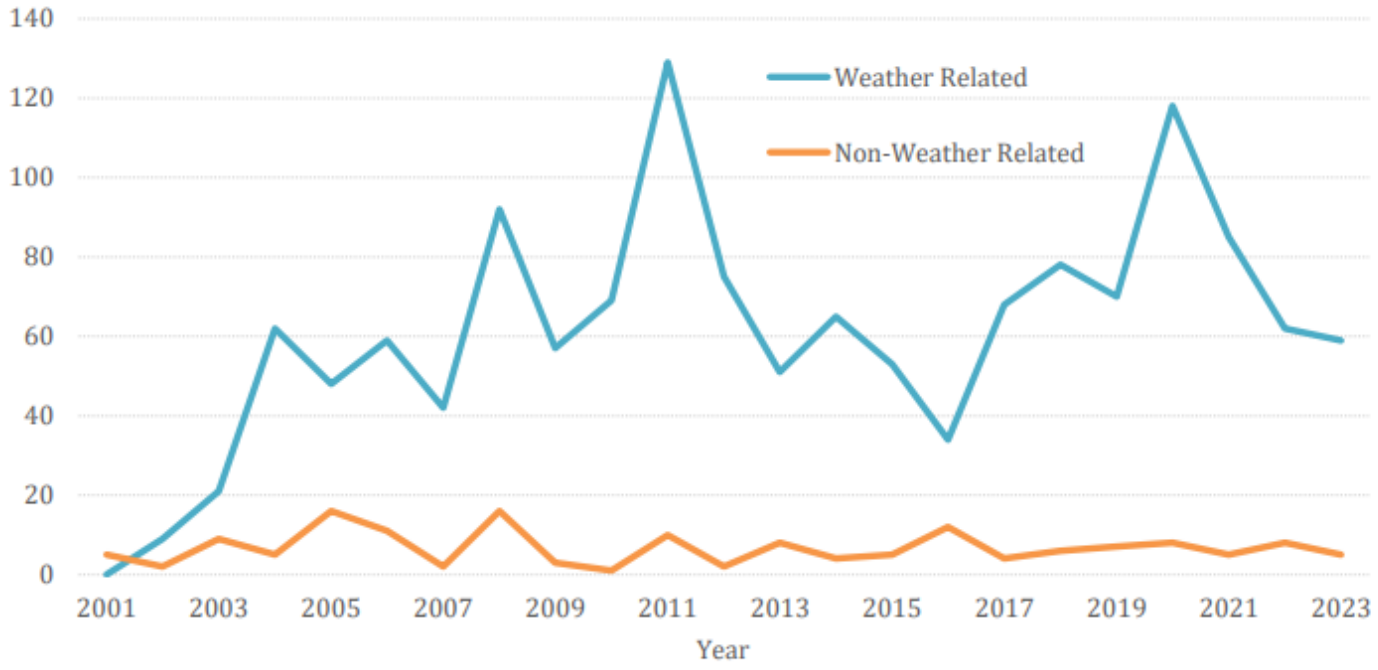
[5] Timothy Renahan, "Realizing Energy Independence on U.S. Military Bases," *Joint Force Quarterly* 103, October 14, 2021, at 63.

[6] Thomas Novelly, "Military Bases Assessing Damage After Hurricane Helene's Brutal Winds, Storm Surge Hit Southeast," *Military.com*, September 27, 2024.

[7] "Moody AFB Hurricane Helene recovery operations," 23rd Wing Public Affairs, October 2, 2024, *Webpage*.

[8] Dennis McGinn, "Mission critical: Expanding US electric grid capacity," *Stars and Stripes*, December 18, 2023

[9] Robert Walton, "As US defense facilities face rising outage risks, regional transmission could help: ACORE panel," *Utility Dive*, December 6, 2023.



Source: Office of Cybersecurity, Energy Security, & Emergency Response
Note: Major power outage is defined as an outage that affects over 50,000 customers.

Figure 1 U.S. Major Power Outages 2001 - 2023

military to rely primarily on stand-alone diesel generators to maintain power during outages. A large installation typically has 100 to 200 generator units. These generators are not interlinked, are often oversized, hard to maintain, and rely on limited fuel supplies.[10] Installations typically have diesel fuel stockpiles to run generators for only two to seven days.[11]

To address these vulnerabilities, the DoD continues investing defense funds into other strategies to pick up the slack for the grid and protect military missions. These strategies are designed to help installations operate on a self-sufficient basis separately from the grid and take the form of incredibly costly, time-consuming projects such as advanced microgrids and small modular nuclear reactors. As of 2017, the DoD's annual microgrid implementation spending was estimated at $453.4 million. However, this spending is expected to grow substantially. By 2026, annual spending on military microgrids is projected to reach $1.4 billion. This represents a more than threefold increase in microgrid spending over a 9-year period.[12]

By investing in alternative or backup power systems, the DoD aims to enhance energy security, reduce vulnerabilities, and decrease reliance on local power grids for critical operations and installations. While microgrids have the potential to provide cost savings to the DoD compared to the continued use of backup diesel generators, they still represent a significant cost burden on the defense budget that exists primarily to compensate for the shortfalls of America's aging, unreliable grid. Though the backup power systems used by military installations offer some resilience benefits, military diesel generators, microgrids, and other on-base power systems are typically not equipped to handle prolonged power outages.

1.2 The Future Force's Most Essential Tool

As the DoD moves away from vulnerable, fuel-based supply chains and instead electrifies key equipment at almost every level of military operations, the power and performance of the grid becomes increasingly essential.

This shift from fuel-based to electrified operations does not increase overall energy-related vulnerability to military operations but does increase the grid's importance for national defense. As the backbone of an increasingly electrified force, the grid's modernization and expansion become a critical national priority. Defense electrification is

[10] Jeffrey Marqusee et al., "Power Begins at Home: Assured Energy for U.S. Military Bases," Noblis, January 12, 2017, at 16.

[11] Nathan Olsen, "Microgrids: Energy Security for Overseas Bases," *Air & Space Operations Review* 2:3, October 25, 2023, at 24.

[12] Elisa Wood, "Spending on Military Microgrids Could Reach $1.4B by 2026: Navigant," *Microgrid Knowledge*, October 31, 2017, *Webpage*.

occurring primarily through the U.S. military's significant efforts to electrify its buildings, vehicles, and operations. This electrification effort is accelerated through the rapidly growing use of artificial intelligence (AI) as a leading national security tool. The U.S. power grid is critically important for AI development, especially large language models and data centers, which require significant amounts of electricity to operate.

The DoD's use of AI has grown significantly, with a major expansion in investment and strategic focus. Therefore, This growing reliance increases the electrical load of critical defense operations, emphasizing the need for a grid capable of meeting the associated growing national security power demand. While the exact load growth figure is not known, this section outlines just a few ways in which the DoD has grown its use of AI-enabled tools and systems and displays the magnitude of such activity.

In 2018, the DoD established the Joint Artificial Intelligence Center (JAIC) to centralize its AI initiatives. The JAIC was later integrated into the Office of the Chief Digital and AI Officer (CDAO) to better align AI efforts with data management, emphasizing the importance of AI in national defense.[13] Since 2018; the DoD has invested billions of dollars in incorporating AI into its warfighting operations. In FY 2024, the Pentagon requested $1.8 billion for AI and machine learning.[14] This $1.8 billion request was maintained for FY 2025.[15] In November 2023, the DoD released a new AI adoption strategy focusing on agile integration of AI across the department. The strategy aims to unify and scale AI capabilities to improve decision-making and operational efficiency.

The DoD has identified over 180 instances where generative AI could add value to their operations, from debugging software to analyzing battle damage assessments.[16] To this end, AI has been actively integrated into various aspects of military operations to enhance defense capabilities. These advancements in AI are part of a broader effort by the DoD to maintain a technological edge over adversaries and adapt to the evolving landscape of modern warfare.[17] While many more examples exist, below are some key areas where the application of AI has grown significantly in recent years.

1.2.1 The Growing Grid Power Needs of National Defense

Logistics and Supply Chains

National security logistics and supply chains are heavily dependent on the U.S. power grid. The DoD's vast logistics network relies on the continuous operation of critical infrastructure powered primarily by the grid to military installations and civilian transportation hubs like ports and airports, warehouses and distribution centers, and more. Because the DoD's supply chain is intrinsically tied to the civilian supply chain, which is almost entirely reliant on the grid, any disruption to the nation's power supply can severely impact the DoD's readiness posture. Disruptions to grid power can also cause cascading effects on other national defense operations, including manufacturing delays for military equipment and supplies, transportation and shipping interruptions, inventory management system failures, and communications breakdowns between suppliers and military logistics units.

[13] Michael Horowitz and Lauren Kahn, "Why DoD's New Approach to Data and Artificial Intelligence Should Enhance National Defense," Council on Foreign Affairs, March 11, 2022.

[14] Jon Harper, "Pentagon requesting more than $3B for AI, JADC2," *DefenseScoop*, March 13, 2023.

[15] Brandi Vincent, "Why the Pentagon didn't request higher funding for AI in fiscal 2025," *DefenseScoop*, March 11, 2024.

[16] Ibid.

[17] "DAF leaders emphasize adapting AI for warfighting success," United States Air Force, December 2, 2023, *Webpage*.

Operational Readiness

Training is the foundation for success in combat and military operations. It prepares soldiers, sailors, airmen, and marines to effectively carry out their duties in high-stress, high-stakes environments. Through rigorous and realistic training, military personnel develop the skills and knowledge needed for their specific roles, the ability to operate complex weapons systems and equipment, the mental and physical toughness required for military service, and the unit cohesion essential for combat effectiveness.

The U.S. military must continually adapt its training to address emerging challenges and evolving warfare tactics. For example, training now focuses on countering threats such as long-range missiles and area denial tactics from adversaries like China, cyber warfare and information operations, and irregular warfare and counterinsurgency operations. The ability to update training to reflect current and future threats is central to the U.S. military maintaining its technological and tactical edge.

Electrified training advancements allow the military to maximize its limited time and personnel. With only about six months of actual training time per year, commanders must carefully manage the training calendar and strategically allocate resources.[18] AI-driven experiential learning and simulations allow personnel to gain combat-like experience more flexibly and efficiently.

> The DoD actively integrates AI into its training programs to enhance soldier readiness, improve efficiency, and adapt to evolving threats.

The DoD actively integrates AI into its training programs to enhance soldier readiness, improve efficiency, and adapt to evolving threats. AI is used to create personalized learning experiences for Army soldiers through a phased AI integration plan, starting with pilot programs in specific Military Occupational Specialties (MOS) like Equipment Repair, Cybersecurity, Logistics, and Infantry. AI also analyzes performance data and tailors instructions to each soldier's needs, ensuring ongoing targeted skill development.[19]

The U.S. military is also using AI to streamline training content creation. AI assists in generating outlines, lesson plans, and supporting materials, significantly reducing the development time and burden on military leaders. This allows for the dynamic generation and adaptation of training materials based on evolving threats and tactics.
Outside of training, the DoD is developing systems like the Joint All-Domain Command and Control (JADC2), which uses AI to link sensors across all military branches, enhancing interconnectivity and data sharing among personnel and equipment.[20] AI is utilized to predict maintenance needs for military equipment, thereby maximizing readiness and minimizing costs. This involves analyzing data from sensors to forecast when and what kind of maintenance is required.[21]

Mobility

The DoD has made significant strides in electrifying its vehicle fleet over the past several years, focusing primarily on non-tactical vehicles. The Department has prioritized the electrification of its non-tactical vehicle fleet, which includes light-duty vehicles like sedans, minivans, and pickup trucks. In 2022, 27 percent of new or replacement light-duty vehicles ordered by the U.S. Army were electric vehicles or plug-in hybrids, a substantial increase from just one percent the previous year. The Army has already replaced 18,000 non-tactical vehicles with electric or hybrid alternatives. This initiative has resulted in $50 million in savings, reduced fuel consumption by 13 million gallons per year, and reduced greenhouse emissions by 12 percent.[22]
While the focus has been on non-tactical vehicles, the DoD is also exploring electrification options for tactical vehicles, with General Motors recently showcasing an all-electric version of its Infantry Squad Vehicle.[23]

Communications and Intelligence

While the U.S. military maintains significant independent communications capabilities, its integration with and reliance on civilian systems is substantial and growing. Alongside this growing reliance is a growing need for grid power. This presents opportunities for enhanced

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[18] Jim Greer, "Training: The Foundation for Success in Combat," *2019 Index of U.S. Military Strength*, Heritage Foundation, October 4, 2018, at 43.

[19] Ian Kersey, "Training Transformed: AI and the Future Soldier," *Mad Scientist Laboratory*, June 20, 2024.

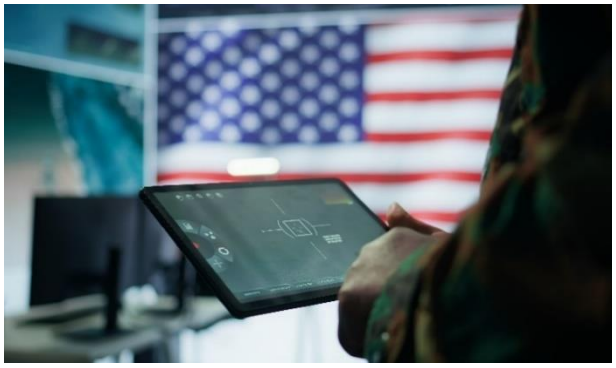
[20] "Artificial Intelligence in Electronic Warfare," TE Connectivity, *Webpage*.

[21] Michèle A. Flournoy, "AI Is Already at War: How Artificial Intelligence Will Transform the Military," *Foreign Affairs* 102:6, October 24, 2023.

[22] John Breeden, "The U.S. military operates more than 174,000 non-tactical vehicles, the second highest number in the federal government," Nextgov/FCW, June 2, 2023.

[23] Walker Mills and Ryan Wiechens, "The Lethality Case for Electric Military Vehicles," Modern War Institute, December 1, 2022, *Webpage*,

capabilities, as well as challenges that must be carefully managed to ensure operational effectiveness and security. While the DoD has its own communications networks, like the Defense Information Systems Network, it also leverages civilian fiber optic and telecommunications infrastructure.[24] Programs like the Global Information Grid aim to integrate military systems with civilian networks to enhance bandwidth and connectivity.



The DoD's AI adoption is most prevalent in data-rich areas with rigorous analytic needs, such as Project Maven, which uses machine learning and computer vision for video analysis in intelligence, surveillance, and reconnaissance activities.[25] This includes rapidly sifting through satellite images and drone video feeds to better understand battlefield conditions and make faster, more accurate targeting decisions.[26] AI is also used to bolster cybersecurity measures and improve surveillance and intelligence analysis to protect physical assets.

AI enhances the ability to process large volumes of data and derive insights that support decision-making in national security contexts. This capability allows for the automation of mundane processes, increasing the throughput of intelligence analysis and enabling analysts to focus on more complex problems.[27] For example, AI has been used extensively for data analysis to support informed decision-making by Ukrainian forces.[28] AI processes large volumes of data from various sources, including satellite imagery, drone footage, and more, to provide intelligence advantages. Such AI tools have allowed the Ukrainian military to geolocate and analyze open-source data, such as social media content, to identify Russian soldiers, weapons, systems, units, or movements. Even a step further, AI-powered facial recognition software is also employed by Ukrainian law enforcement and journalists to identify Russian war criminals and collaborators. This technology has been crucial in documenting war crimes and countering misinformation.[29]

Deterrrence & Resilience

AI plays a critical role in cybersecurity by continuously monitoring networks and swiftly detecting and responding to cyberattacks. The U.S. military uses AI to sift through vast datasets to identify potential cybersecurity threats, terrorist activities, and geopolitical developments, helping to proactively thwart attacks and respond to crises. AI has also supported Ukraine's cyber defense efforts against Russian cyberattacks. It has also been used to analyze social media activity to identify and counter disinformation campaigns linked to the Kremlin. AI tools then help organize preventive information campaigns and confront Russian propaganda.[30]

Strategic Considerations

Because of the interdependency between military installations and the civilian grid, the grid can be considered a lawful target by foreign adversaries despite its mandate to supply civilian communities with power.[31] Within the transmission system, step-up transformers are the most lucrative targets, in that attacks could disconnect one system from another, reducing the capability of the system to import power and provide emergency power.[32] In cases where transformers are targeted, the damage inflicted could disrupt power supply, water distribution, and health care, which is likely to result in significant harm well beyond the weapon's impact area. Transmission expansion creates built-in redundancies that ensure that even if one part of the grid is compromised, other areas can continue to function independently.

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[24] "Defense Acquisitions: The Global Information Grid and Challenges Facing Its Implementation," GAO, July 2004, at 10.

[25] Cheryl Pellerin, "Project Maven to Deploy Computer Algorithms to War Zone by Year's End," DOD News, July 21, 2017.

[26] Katrina Manson, "AI Warfare Is Already Here," *Bloomberg*, February 28, 2024.

[27] Brian Katz, "The Analytic Edge: Leveraging Emerging Technologies to Transform Intelligence Analysis," Center for Strategic & International Studies, October 9, 2020.

[28] Samuell Bendett, "Roles and Implications of AI in the Russian-Ukrainian Conflict," Center for a New American Security, July 20, 2023.

[29] Felipe Romero-Moreno, "Facial recognition technology: how it's being used in Ukraine and why it's still so controversial," *The Conversation*, June 14, 2022.

[30] Billal Rahman, "Ukraine deploys AI in Fight Against Putin's Disinformation," *Newsweek*, July 9, 2024.

[31] Eirini Giorgou and Abby Zeith, "When the lights go out: the protection of energy infrastructure in armed conflict," *Humanitarian Law and Policy,* April 20, 2023.

[32] Thomas E. Griffith, "Strategic Attack of National Electrical Systems," *Air University Press,* October 1994.

Section Two: The Absence of National Security in the Grid's Chain of Command

Today, grid policy, planning, and operation create a system that often does not adequately consider the power needs of the nation's defense infrastructure. The fragmented nature of the power grid has led to the evolution of a system that does not properly account for the nation's needs overall.

Moreover, the system oftentimes is unaware of the needs of defense supply chains. It does not place any enhanced priority on serving military installations that support the DoD's most critical missions. No federal requirements exist for such loads to be given any special consideration in grid planning, reserve margins, or interregional transfer minimums. This sets the country on a path that places our national defense infrastructure at heightened risk.

2.1 The Power of States

In the United States, each state operates its own public utility commission, which is typically granted the authority to regulate the activities of public utilities within the state. Utilities are regulated because they provide essential services, such as electricity, water, natural gas, and some telecommunication services. Utilities also operate as monopolies because they rely on networks that are very expensive to build. However, once built, these networks can add additional customers at minimal cost. Moreover, having multiple sets of these networks in the same area would be wasteful and inefficient. Because the average cost per unit of product decreases as the scale of operation increases, a single large utility can generally provide services more cost-effectively than multiple smaller companies. While it is most efficient to provide such utility services through monopolies, we do not want them to be able to exercise monopoly pricing power. Therefore, state commissions are tasked with the responsibility of overseeing the rates and services offered by public utilities, including electricity and natural gas. State commissions also hold the power to ensure the implementation of state energy policies and, at times, promote the development of new policies to address energy challenges.

One of state commissions' most important tasks is ensuring that utilities provide reliable services at reasonable rates. In undertaking this role, commissions typically review rate increase requests from utilities, conduct hearings, and consider input from various stakeholders, including consumer advocacy groups. Most importantly, state commissions are the primary body responsible for evaluating and approving major utility projects within their state's borders, such as the construction of new generation plants or transmission lines. They assess the project's need, environmental impact, and cost-effectiveness. Ultimately, they decide if a grid energy project deserves to exist in a state.

State utility commissions have several requirements and responsibilities related to addressing national security concerns in the energy sector:

The State Grid & National Security Nexus

State utility commissions have oversight responsibilities related to the protection of critical energy infrastructure. They typically oversee investor-owned electric and natural gas utilities' efforts to protect critical infrastructure. Commissions review utility plans and investments for physical security and cyber protection of utility systems. They may also be involved in evaluating and approving utility proposals for new facilities or power contracts from a security perspective.[33]

State commissions also have increasing responsibilities for overseeing utility cybersecurity practices. They are encouraged to include cybersecurity requirements and vendor questions in utilities' procurement processes. Many commissions are developing cybersecurity standards and guidelines for utilities to follow, often in partnership with federal agencies like the Department of Energy.[34]

[33] "An Overview of PUCs for State Environment and Energy Officials," EPA, May 20, 2010, at 6.

[34] Robert Walton, "Utility regulators take steps to raise sector's cybersecurity 'baselines'," *Cybersecurity Dive*, February 29, 2024.

Finally, state commissions play a role in ensuring utility preparedness for emergencies and disasters. They review utility emergency response and disaster recovery plans and coordinate with other state agencies on energy security planning efforts. They may be involved in exercises and drills to test utility and state preparedness for threats to critical infrastructure.

By fulfilling these responsibilities, state commissions contribute significantly to addressing national security concerns in the energy sector at the state level. Their oversight helps ensure utilities are taking appropriate measures to protect critical infrastructure, prepare for emergencies, and manage cybersecurity risks. Yet, no requirements or established processes exist in any state to include, or even consider, the needs of DoD or military installations in any critical energy decisions or plans.

This is particularly concerning given the DoD's robust energy resilience requirements for military installations, requirements that necessitate support from utilities and regulatory attention from state commissions. For example, the Secretary of Defense has established standards for energy availability for critical missions, ranging from 99.99 percent to 99.9999 percent availability per fiscal year. Such levels of reliability require varying degrees of support from grid power, depending on the installation's power setup.

Installations must also conduct required planning to promote diverse energy sources, microgrids, and installed energy sources rather than emergency generation. They often must procure energy from the commercial markets to diversify their generation portfolio.[35]

2.2 The Role of Regions

The grid consists of three major interconnections – the Western Interconnection, which covers everything west of the Rockies; the Eastern Interconnection, comprising everything east of the Rockies; and the Texas Interconnection, which includes most, but not all, of the state of Texas.[36] Each interconnection operates largely independently, although some high-voltage direct current (HVDC) links that allow limited power exchange between them do exist.

Within the three major interconnections, the grid is further divided into regions. The North American Electric Reliability Corporation (NERC) oversees the grid's reliability and works with six regional reliability councils to maintain and improve the grid's performance. NERC regions are responsible for enforcing NERC's reliability standards, coordinating with other reliability entities, forecasting electricity demand, planning for emergencies, supporting grid operators during

[35] 10 USC § 2920 (d)(2)(A)

[36] Pratima Garg, "Explainer: What Are Grid Interconnections and What Complicates Them?," Yale Clean Energy Forum, March 9, 2022, *Webpage*.

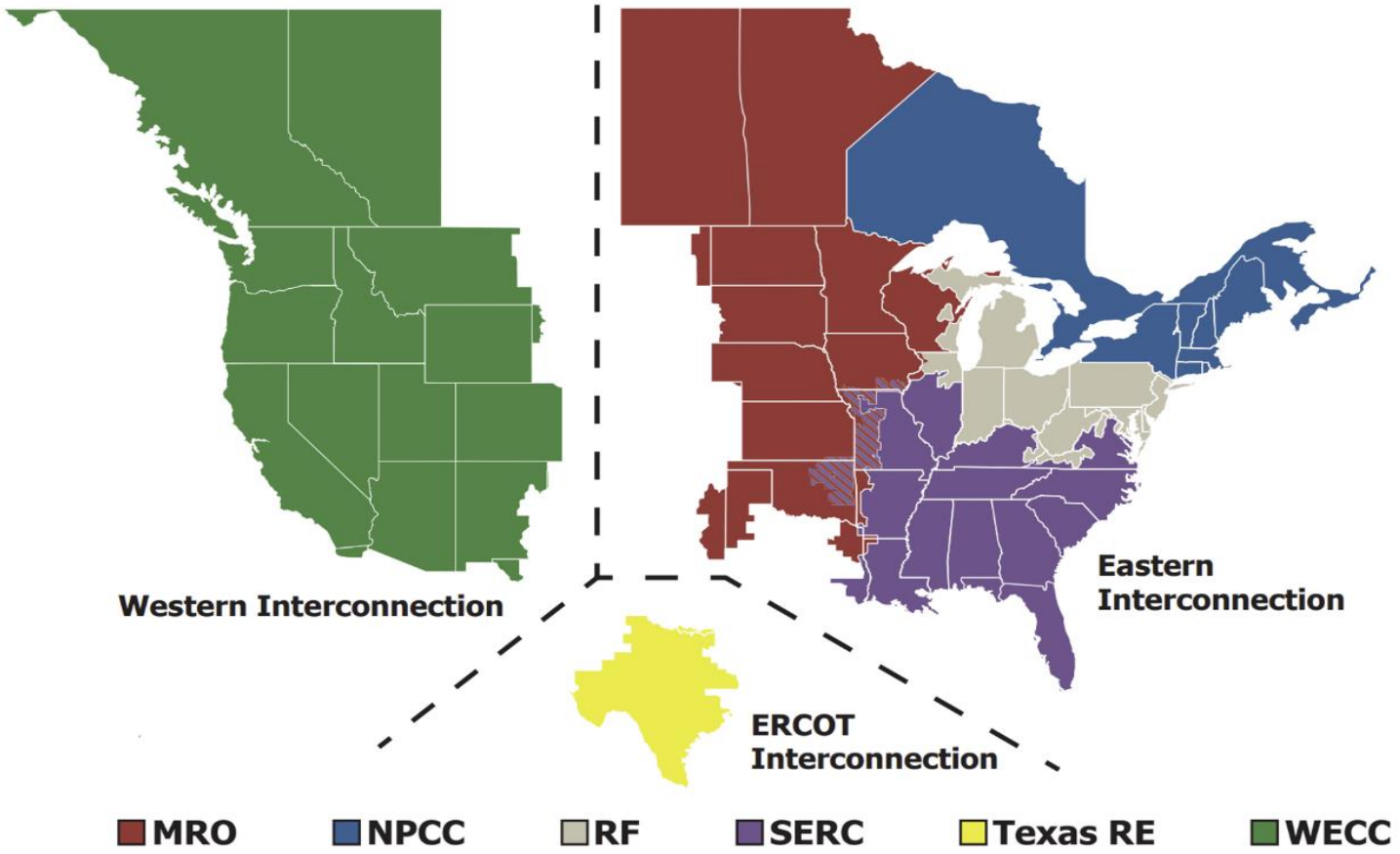

Figure 2 Source: NERC, "ERO Enterprise | Regional Entities," Webpage, Accessed November 2024.

irregular operations, and performing other standards-related functions nationwide. These regional entities include the Northeast Power Coordinating Council (NPCC), Reliability First (RF), Midwest Reliability Organization (MRO), SERC Reliability Corporation (SERC), Texas Reliability Entity (TRE), and Western Electricity Coordinating Council (WECC). Together, NERC and the regional councils share all information and resources necessary to improve the grid across their respective areas. This collaboration also includes the development of messaging and guidance for utilities and other entities.[37]

Balancing authorities are grid operators who are responsible for dispatching generation in a manner that maintains reliable service at the lowest possible price. Large parts of the grid are managed by Independent System Operators (ISOs) or Regional Transmission Organizations (RTOs) that are responsible for the real-time operation of the grid in their service area, coordinating, controlling, and monitoring the operation of the electric power system to ensure, among other things, that there is adequate supply to meet demand at all times. ISOs typically operate within a single state, while RTOs cover larger, multi-state regions. In some areas, the utilities serve as balancing authorities and are responsible for operating the grid. In addition to managing the operation of the grid in real-time, ISOs and RTOs operate wholesale electricity markets to help ensure the availability of sufficient generation resources and other services necessary for the reliable operation of the grid at the lowest cost. As grid operators, they communicate with balancing authorities and other regional entities to address any issues regarding the grid's operation. Unlike NERC, which is responsible for oversight and compliance, ISOs, RTOs, and utilities act as balancing authorities and are directly involved in the physical operation and maintenance of the transmission infrastructure.

The Regional Grid & National Security Nexus

Ensuring energy resilience means that military operations can continue without interruption, even during disruptions caused by natural disasters, cyber threats, or other emergencies. As these risks grow in size, strength, and

[37] "Who Manages the U.S. Electrical Grid?," Sun-Pull Wire, November 7, 2023, *Webpage*.

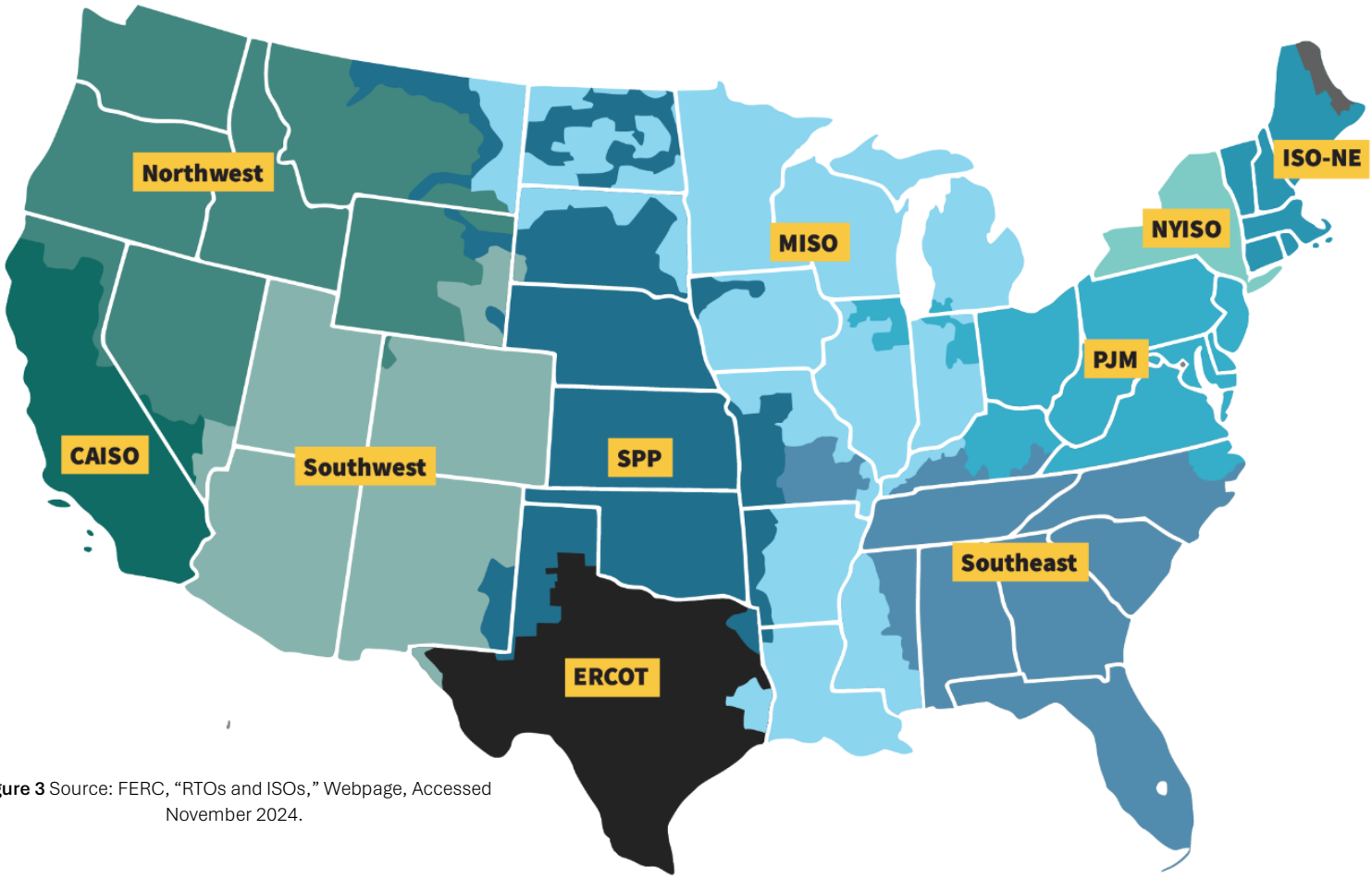

Figure 3 Source: FERC, "RTOs and ISOs," Webpage, Accessed November 2024.

severity, a regional focus is necessary for more effective planning and adaptation strategies that consider specific threats in different areas of the country. Different regions of both the grid and the DoD's installation footprint have unique energy needs and resources. A regional approach proves imperative for tailored solutions that adequately consider local geography, climate, energy infrastructure, and the needs of military missions.

As described in the above section, ISOs and RTOs coordinate, control, and monitor the electric power systems within their respective regions. This includes several actions that directly impact the energy resilience posture of installations, such as grid operation, transmission planning, and reliability assurance planning. More specifically, transmission planning regions across the United States that fall within FERC jurisdiction are required to coordinate planning, develop future scenarios, assess transmission needs, and develop long-term transmission plans. This includes working collaboratively with utilities, generation developers, state agencies, and other stakeholders, creating long-term electricity supply scenarios for the region, and developing transmission requirements based on future scenarios.

Today, no requirement exists for a planning region to solicit or consider input from the military installations within its borders. This leaves the energy needs of national security in a reactive state, at the will of large, long-term plans often created without their needs in mind.

Collaboration between regional planners and the DoD would enhance energy security and resilience for national defense operations while diversifying energy sources to a level that protects critical infrastructure and missions from potential disruptions. It would also aid in right-sizing the developing microgrids and on-site generation capabilities on installations, ensuring they are tailored to each region's resources and needs. This lack of regional collaboration is a missed opportunity to address region-specific threats and vulnerabilities, whether from natural disasters, cyber-attacks, or other risks. Addressing regional threats collaboratively could protect military missions from extended grid downtime and ensure support to all customers within a region when emergencies occur.

2.3 Above All, FERC

FERC is the key federal independent agency with regulatory authority over the electric power sector. FERC is responsible for regulating the following:

1. Interstate transmission of power
2. Wholesale power transactions
3. RTOs and ISOs
4. Power generators that sell into the wholesale power market
5. Electric power reliability organizations
6. Select other participants in the electric power system
7. Natural gas pipelines
8. Liquified natural gas (LNG) terminals
9. Non-federal hydropower projects

FERC does not regulate retail electricity sales, local distribution systems, or the generation of electricity that is not sold in wholesale markets, and the sale of which does not cross state lines; the states regulate those areas. FERC's responsibility for regulating interstate wholesale electricity transactions and transmission includes approving tariffs for the sale of power and transmission services, ensuring wholesale rates are "just and reasonable" and not discriminatory, and overseeing organized wholesale markets operated by RTOs, as described in the previous section. FERC is also responsible for regulating the reliability of the bulk power system. To accomplish this, FERC approves mandatory reliability standards developed by NERC and oversees standards for resource adequacy, cybersecurity, emergency preparedness, and transmission planning.

By exercising its broad jurisdiction, FERC plays a crucial role in the country's transmission infrastructure. It develops and approves rules to oversee the decisions regarding the construction of new transmission capacity and the allocation of its cost to customers.[38] FERC also mandates long-term transmission planning to support the clean energy transition and grid resilience and is the regulator with authority to encourage interregional transmission to move renewable energy across state lines. Recently, FERC has taken steps to facilitate the integration of such clean energy resources by directing new reliability standards to accommodate the rapid integration of inverter-based resources like solar, wind, and battery storage.[39] By undertaking these responsibilities, FERC will work to ensure a reliable, efficient, and sustainable power grid that can meet the evolving needs of the U.S. energy system.

The Federal Grid & National Security Nexus

In 2006, FERC signed a Memorandum of Understanding (MOU) with several federal agencies, including the DoD, to coordinate early in the process of federal authorizations and environmental reviews required for siting electric transmission facilities.[40]

This MOU was then superseded by a new, similar agreement signed in 2009. This updated MOU includes FERC and multiple federal agencies, including the DoD. The agreement focuses on enhancing coordination among project applicants, federal agencies, states, and tribes involved in siting and permitting electric transmission facilities.[41] This agreement aimed to streamline the approval process while addressing all relevant concerns, including those of the military. The MOU states that the DoD will determine whether proposed qualifying projects adversely impact defense activities and will work with the federal agency leading the project to identify measures to mitigate those impacts.

Another, more specific MOU between FERC and the DoD signed in 2007 focuses on determining the potential impacts of LNG terminals on defense activities. Under this agreement, FERC consults with the DoD to assess how proposed LNG projects might adversely affect testing, training, or operational activities of active military installations.[42]

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[38] Valerie Volcovici, "US overhauls electric grid to make way for more renewables," *Reuters*, May 13, 2024.

[39] "FERC Moves to Protect Grid for Transition to Clean Energy Resources," FERC, October 19, 2023, *Webpage*.

[40] FERC et al., "Memorandum of Understanding on Early Coordination of Federal Authorizations and Related Environmental Reviews Required in Order to Site Electric Transmission Facilities," August 8, 2006.

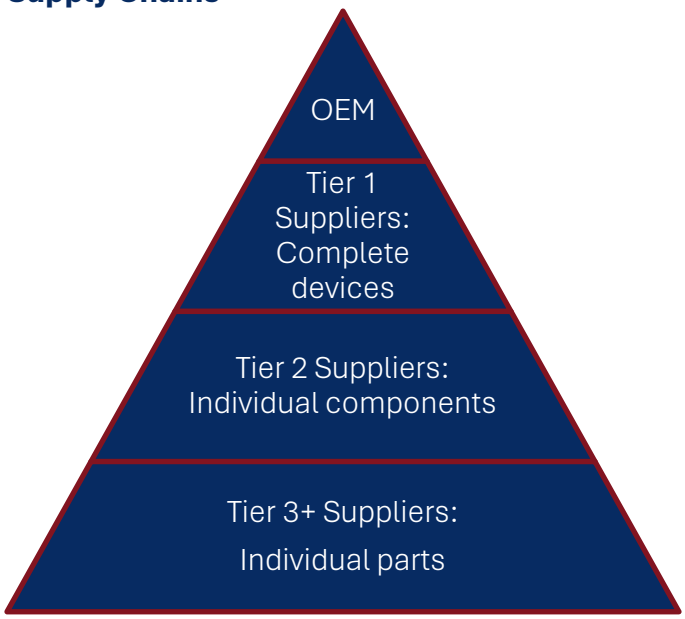
[41] USDA et al., "Memorandum of Understanding Among the U.S. Department of Agriculture, Department of Commerce, Department of Defense, Department of Energy, Environmental Protection Agency, the Council on Environmental Quality, the Federal Energy Regulatory Commission, the Advisory Council on Historic Preservation, and Department of the Interior, Regarding Coordination in Federal Agency Review of Electric Transmission Facilities on Federal Land," October 23, 2009.

[42] FERC and DOD, "Memorandum of Understanding Between the Federal Energy Regulatory Commission and United States Department of Defense to Ensure Consultation and Coordination on the Effect of Liquefied Natural Gas Terminals on Active Military Installations," August 29, 2014.

Section Three: Today's Grid, a Chokepoint for American National Security

The power grid is emerging as a significant chokepoint for growth in today's rapidly evolving technological landscape. Many regions are facing challenges with grid capacity as demand for electricity outpaces the ability to generate and distribute power efficiently. This is particularly evident in areas experiencing rapid technological growth or population increases. From the national security perspective, this constraint manifests in several key ways, including the grid as an inhibitor to the onshoring of defense critical supply chains, an enabler to China's grid power play, and a threat to America's position as the current world leader in advanced technologies.

3.1 Limiting Onshoring of Defense Critical Supply Chains



Today's grid prevents the onshoring of defense-critical supply chains and manufacturing processes. The U.S. DoD's Securing Defense-Critical Supply Chains Action Plan (the Plan),[43] published in 2022, states that supply chains worldwide have grown increasingly volatile, with interruptions occurring more frequently and with greater severity in recent years.

Defense-critical supply chains are the networks of suppliers, manufacturers, and distributors that provide essential materials, components, and services needed for national defense and military capabilities. These supply chains are crucial for maintaining military readiness and ensuring the development and sustainment of critical defense capabilities. Defense-critical supply chains are vital for national security, as they directly impact the ability to produce and maintain military equipment, weapons systems, and other essential assets. The DoD has identified several critical sectors within these supply chains, including kinetic capabilities (e.g., missiles, munitions), energy storage and batteries, castings and forgings, microelectronics, and strategic and critical materials (e.g., rare earth elements). The Plan goes on to outline building domestic production capacity in these sectors as an essential first step to securing capabilities critical to national security.

The grid is the first and most essential enabler of building domestic production capacity. Due to a lack of adequate national planning requirements, today's grid environment consists of misaligned permitting timelines and unpredictable energy costs and reliability. A key need of industry is the ability to know energy-related costs over an extended period. This is critical to industry's ability to plan and obtain financial support for onshoring, reshoring, and growth. Today's grid landscape makes this challenging—if not impossible— in some states.

The resurgence of U.S. manufacturing through onshoring has been stalled and, at times, completely halted due to several challenges related to the power grid infrastructure. Some key examples of how the U.S. grid has made onshoring industries challenging are:

Power Capacity Constraints

One of the primary issues is the lack of sufficient power capacity in many areas to support large-scale manufacturing operations. Shortages of heavy power for manufacturing exist as a major concern, potentially making the onshoring of some defense-critical supply chains unviable if the power grid cannot be improved to provide more capacity.[44]

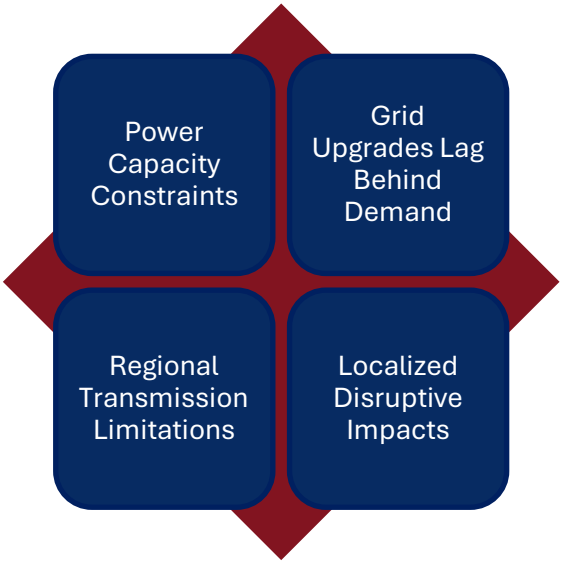
Grid Upgrades Lag Behind Demand

The U.S. power grid has not kept pace with the rapid growth in demand from electrification and domestic industrial expansion, specifically in the technology sector. The

[43] Department of Defense, "Securing Defense-Critical Supply Chains: An action plan developed in response to President Biden's Executive Order 14017," Feb. 2022.

[44] Patricia Kirk, "What Challenges Do Manufacturers Face When Looking at Onshoring?" *Wealth Management*, May 5, 2022.

installation of new high-voltage transmission miles has decreased significantly, dropping from an average of 1,700 miles per year in the first half of the 2010s to only 645 miles per year in the second half.[45] This lag in grid upgrades creates challenges for handling growth demand and meeting the needs of growing load demands for the future.[46]



Regional Transmission Limitations

The ability to transfer power between regions is limited, posing an unacceptable risk for reliability to defense-critical industries. Low transfer capability between regions is a key risk if load growth outpaces the deployment of new generation in some areas. This limitation necessitates significant upgrades to the RTOs' ability to move power from areas with excess capacity to areas in need.

Localized Disruptive Impacts

The demand growth created by industrial onshoring, including defense-critical supply chains, can have significant localized effects due to inadequate transmission and power generation. Like new data centers, onshoring industries can create disruptive impacts at localized levels, challenging grid planners and necessitating proactive stakeholder outreach. These "point loads" often require grid service on faster timetables than typical transmission and distribution upgrade projects can accommodate.[47]

To address these challenges, increased coordination among electricity providers, manufacturers, system operators, development agencies, regulators, and other stakeholders is essential to ensure that significant new demand can be met efficiently and in a timely manner. Additionally, higher-resolution modeling and analysis are required to account for the impacts of place-based demand growth in load forecasting and integrated resource planning.

3.2 Leaving Space for China's Grid Power Play

Over the next six years, China is set to allocate more than $800 billion towards upgrading its electricity grid. This substantial investment in transmission infrastructure underscores a fundamental difference in approach between China and the United States regarding energy development strategies. China's energy policy is characterized by a strong emphasis on national interests and swift action. The country views robust energy infrastructure as a critical necessity that demands immediate attention and implementation rather than prolonged deliberation. This approach reflects the failure of the present U.S. grid to recognize that reliable, affordable, and abundant power is essential for economic growth and national security.

The rapid pace of China's energy sector expansion demonstrates its commitment to securing a strong energy foundation. By prioritizing large-scale infrastructure investments and streamlined decision-making processes, China aims to position itself advantageously in the global energy landscape. This strategy stands in contrast to the more protracted planning and approval processes often seen in the United States for major energy projects.

> The presence of Chinese-made components in critical areas of the U.S. power grid poses significant national security risks that demand immediate action.

Accelerating Transmission Expansion to Support Economic Security

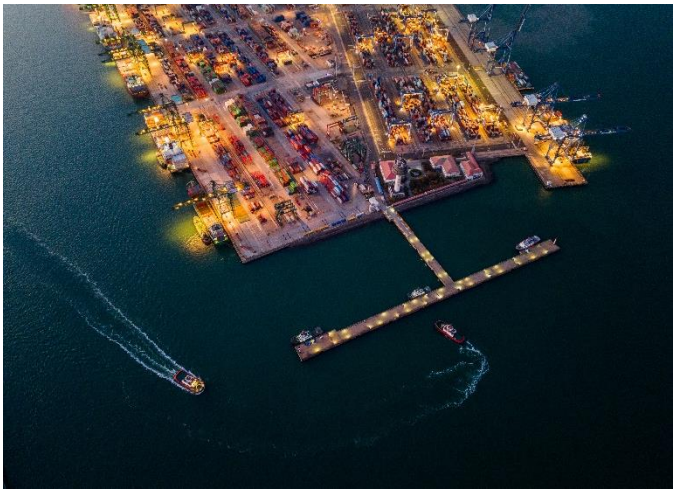
China's continued economic growth has required and enjoyed the benefits of equally rapid increases in energy production. The main driver of China's energy consumption is their industrial sector, which accounts for a significant portion of the country's electricity and overall energy consumption. In 2023, the Chinese industrial sector was

[45] John Wilson and Zach Zimmerman, "The Era of Flat Power Demand is Over," Grid Strategies, December 2023, at 3.

[46] Id., at 5.

[47] "Reindustrialization, Decarbonization, and Prospects for Demand Growth," Electric Power Research Institute, July 2023, at 19.

responsible for 58 percent of electricity consumption.[48] The United States' industrial energy consumption in the same year was 35 percent.[49] Moving forward, Chinese industrial consumers are expected to be the primary driver of the country's electricity demand growth beyond 2030, contributing 40 percent of the total growth.[50]



Recent Transmission Investments

China continues to make notable investments in its transmission grid to meet this demand, providing numerous benefits for its power generation sector and the overall reliability and affordability of energy in the country. Between 2014 and 2021, China significantly expanded its interregional transmission capacity, developing more than 80 times the high-voltage transmission interconnections than the United States currently possesses—where only 3 gigawatts (GW) of such capacity was developed over the same period.[51] In 2022, China invested $166 billion in its transmission grid, surpassing the combined grid investments of all other countries, which totaled $118 billion.[52] Their ability to meet this demand is further underscored by the commissioning of as much solar photovoltaic capacity in 2023 as the entire world did in 2022, along with a 66 percent increase in the installations of wind turbines compared to 2021.[53]

Leading the Manufacturing of America's Critical Grid Components

China's role in the global grid components supply chain is extensive and remarkably influential, affecting American energy security by controlling our ability to maintain independent and resilient energy infrastructure. China has deployed a long-term strategy for several decades to benefit from American energy vulnerabilities while strengthening its energy security posture. China's growing power over the global grid component supply chains provides a great source of leverage over friends and competitors alike as the country develops a near-monopoly on the production processes for transformers, solar and wind energy components, including the mining and processing of essential minerals.[54]

China controls a sizable portion of the production of electronic components, high-powered magnets, printed circuit boards, and other essential items needed for modern grids. This includes nearly every element of the technology-based digital smart grid, making many countries, including the United States, dependent on Chinese-made components.[55]

China sits as the global leader in the manufacturing of transformers, a critical component of the U.S. power grid. These transformers are essential for changing alternating current to direct current and vice versa and ensuring power distribution to end-users. China's ability to manufacture specialized components for these transformers underscores its significant role in the supply chain.[56] In 2022, China accounted for approximately $54.1 billion in exports of electrical transformers, significantly outpacing other countries such as Germany, which exported roughly $12.2 billion, and the United States, with an estimated $6.63 billion in exports the same year.[57]

China has made rapid advancements to dominate the renewable energy manufacturing sector, holding over 80 percent of the global manufacturing capacity in several segments. This includes components for solar, wind, and

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[48] "China Energy Information," Enerdata, *Webpage*.

[49] EIA, "U.S. energy facts explained," *Webpage*.

[50] "China's Electricity Demand Increases Thanks to Economic Growth and a Shift from Fossil Fuels," Global Sustainable Electricity Partnership, *Webpage*.

[51] James McCalley, "Interregional transmission: The US is the tortoise, China is the hare," *Utility Dive*, August 1, 2023.

[52] Nick Ferris, "Weekly data: grid investment in China more than every other country combined," *Power Technology*, March 15, 2024.

[53] IEA, "Massive expansion of renewable power opens door to achieving global tripling goal set at COP28," January 11, 2024, *Webpage*.

[54] Isabel Hilton, "How China Became the World's Leader on Renewable Energy," *Yale Environment 360*, March 13, 2024, *Webpage*.

[55] Brien J. Sheahan, "Chinese supply chains for critical infrastructure threaten the US power grid," *Utility Dive*, April 14, 2023.

[56] Justin Sherman and Tianjiu Zuo, "Energy Grid Supply-Chain Risks and U.S.-China Entanglement," *Lawfare*, June 8, 2020.

[57] "Electrical Transformers," The Observatory of Economic Complexity, *Webpage*.

Figure 4 Renewable electricity capacity growth by country/region

battery technologies.[58] This production capability supports domestic energy needs and facilitates profitable international exports. China's exports of fully assembled solar panels increased by 38 percent in recent years, with exports of key components almost doubling. This export strength has solidified China's position as a leader in the renewable energy sector.[59] The result is heavy involvement by Chinese companies in providing critical components for wind, solar, and energy storage projects in other nations, establishing themselves as an almost unavoidable partner in the global energy transition.[60]

Making America's Grid

The extent of Chinese-made components in the U.S. power grid is not fully known, but significant concerns exist about China's involvement in critical U.S. grid infrastructure. From 2006 to 2023, the United States imported nearly 450 large power transformers over 10,000 kilovolt-amperes (kVA) from China. More than 360 of these Chinese-made transformers exceeded 100,000 kVA, indicating they are likely used in critical high-voltage transmission infrastructure.[61]

In 2020, a hardware backdoor was discovered in a large Chinese-made transformer installed in a critical U.S. substation, leading to an executive order addressing the issue. That executive order enabled the Secretary of Energy to prohibit the import of bulk power system electric equipment that poses an undue risk of sabotage to or subversion of the grid, could undermine the security or resiliency of critical infrastructure, or otherwise poses an unacceptable risk to the national security of the United States or the security and safety of Americans.[62] The U.S. Director of National Intelligence has assessed that China's role as a leading supplier of advanced grid components creates cyber vulnerability risks.[63]

[58] Jennifer Dlouhy, "China Extends Clean-Tech Dominance Over US Despite Biden's IRA," *Bloomberg*, April 16, 2024.

[59] Keith Bradsher, "How China Came to Dominate the World in Solar Energy," *The New York Times*, March 7, 2024.

[60] Faris Al-Sulayman and Jon B. Alterman, "China's Essential Role in the Gulf States' Energy Transitions," Center for Strategic & International Studies, December 11, 2023, at 6.

[61] Joe Weiss, "The U.S. electric industry is not responding to cyber-vulnerable Chinese equipment," *Control*, February 29, 2024.

[62] "Executive Order on Securing the United States Bulk-Power System," Trump White House Archives, May 1, 2020, *Webpage*.

[63] "Climate Change and International Responses Increasing Challenges to US National Security Through 2040," National Intelligence Council, October 21, 2021, at 6.

The U.S. Department of Energy is examining the extent of Chinese-made components in the power grid, but the full analysis is incomplete. National laboratories have been testing electrical equipment down to the chip/software level to identify countries of origin.[64]

Tracing the origin of subcomponents is difficult, as parts may be linked to American or allied-country manufacturers, while subcomponents are sourced from China.[65] While the exact percentage of U.S. grid infrastructure made in China is not available, it's clear that Chinese-made components are present in critical areas of the grid, raising significant national security concerns. The government and the power sector must, however, remain committed to ensuring that the supply chain for the electric power system remains secure. We cannot risk allowing China or other possible adversaries an opportunity to undermine our grid security, either through control of its supply chain or malicious attempts to interrupt the routine operation of the electric power system.

3.3 Threatening Our Position as the World Leader in Advanced Technology

Our present power landscape places the United States at risk of losing its position as a world leader in AI, a national security imperative. The United States has faced significant challenges in accommodating data centers' necessary, rapid growth. Current complex processes for bringing generation assets online and near ten-year time horizons for expanding transmission are the root causes of this challenge. As a result, the country has struggled to onshore AI capabilities and declined in its ability to power semiconductor manufacturing capacity. This has perpetuated a reliance on foreign sources for advanced chips and cutting-edge AI systems and slowed our progress. Our geopolitical adversaries, especially Russia and China, have made significant investments in AI and machine learning to augment the capabilities of their weapons systems. Without a conscious effort to expand transmission and support the grid power needs for AI, the United States will struggle to maintain pace with the developments of our adversaries.

3.3.1 Understanding AI's Transformation of National Defense

Strategic competitors like China and Russia continue to invest heavily in AI, making it imperative for the United States to stay ahead in the technological race to ensure security and maintain a strategic advantage. AI promises to transform national security by enhancing warfighting capabilities on and off the battlefield. Today, the DoD has prioritized actions to integrate AI into defense systems, which include automating tasks, predicting mechanical failures, and analyzing intelligence information such as facial recognition and targeting recommendations. Recognizing the importance of our domestic expansion of AI and the associated necessary grid power expansion will be crucial if the United States is to maintain its position as a leader in national defense. Therefore, understanding how AI has already influenced war and conflict operations is essential.

> AI is the decisive factor for achieving decision superiority in modern warfare—America must lead in AI to maintain its strategic edge over global competitors.

Throughout all the key areas of national defense discussed in this report, decision superiority plays a pivotal role in achieving victory and completing successful missions. Decision superiority enhances a warfighter's ability to perceive, comprehend, and respond effectively across all stages of conflict, spanning multiple domains and collaborating with allied forces to rapidly deliver crucial intelligence. This is also referred to as a servicemember's ability to "sense, make sense, and act." AI emerges as the key enabler for decision superiority, as it significantly mitigates specific risks inherent in the intricate landscape of modern warfare.[66] The DoD relies on AI to aid in strategic decision-making processes by analyzing vast amounts of information to provide actionable insights. This includes applications in warfare systems, combat simulation, and target recognition.[67] AI-powered decision support systems are being developed to assist military leaders in evaluating multiple courses of action and assessing potential outcomes of different scenarios. By conducting probabilistic risk assessments and simulations, AI helps commanders more rapidly weigh the risks and benefits of various available options. Such AI enhancement allows for

[64] "Extent of Chinese-made components in U.S. electrical grid still unknown," *Power Transformer News*, March 28, 2023.

[65] Ibid.

[66] Tim Stewart, "AI and the OODA loop: How AI enhances strategic decisions for today's warfighters," *Military Embedded Systems*, June 21, 2024.

[67] "Artificial Intelligence in Electronic Warfare," TE Connectivity, *Webpage*.

more informed decision-making, especially in high-pressure situations with limited time.[68]

3.3.2 The Energy Needs of AI

The energy needs of AI are significant and growing rapidly, driven by the increasing computational requirements of AI models and the expansion of data centers. AI is expected to drive a 160 percent increase in data center power demand by 2030, with an estimated additional consumption of 200 terawatt hours (TWh) per year. Data centers consume about 1-2 percent of global power, which could rise to 3-4 percent by the end of the decade.[69] Data centers specifically could require approximately 47 GW of incremental power generation capacity by 2030.[70]

Meeting the increased energy demand will require significant investments in new generation and transmission capacity, including renewable energy sources. Tech companies are beginning to invest in renewable energy to power their operations, but more efforts are needed to align AI development with environmental sustainability goals.

Although AI technologies are energy-intensive, advancements in energy efficiency and the development of hyperscale data centers have helped mitigate some of the energy demands. However, efficiency gains are slowing, and overall power consumption continues to rise.
The industry will also have to agree on how to pay for the increased generation and transmission capacity, an issue being addressed, for one instance, at ongoing regulatory proceedings in Ohio. Over 50 tech companies have a queue requesting more than 30,000 megawatts (MW) of supply in central Ohio. Building the transmission capacity to supply such volumes of power and maintain reliable service will cost at least hundreds of millions of dollars, if not more. The utility proposed a tariff requiring data centers to pay a minimum of 90 percent of the costs of the new capacity, concerned that if the demand does not materialize, other ratepayers in Ohio will be stuck paying for expensive capacity they do not need.[71] The tech companies do not believe that they should have to pay such a high rate and should be treated like all other customers. They argue that expecting them to forecast how much power they will require with a high degree of accuracy is unreasonable because their demand will depend on factors such as future technological advancement, customer demand for their services, and volatile weather.[72]

Energy Intensity of AI Training and Inference Compared to Traditional Computing

Training AI models, especially large ones, consume much more electricity than traditional data center activities. For example, training a large language model is estimated to use just under 1,300 megawatt hours (MWh) of electricity, which is about as much power as is consumed by 4.3 billion Google searches or the electricity consumed annually by 130 U.S. homes. Once an AI model is trained, the energy required for inference using the model is less than training but still significant.

Hardware and Cooling Needs

AI computing often uses hotter-running micro-processing chips, which require more energy for computation and cooling than traditional computing hardware. About 50 percent of the energy used by traditional data centers is consumed by their equipment and 25-40 percent by HVAC systems, while AI data centers may have higher cooling demands due to the intensive processing.[73]

3.3.3 AI's Current U.S. Power Grid Outlook

The rising energy demand from AI data centers is expected to significantly impact the reliability of the U.S. power grid. The Electric Power Research Institute (EPRI) estimates that data centers could consume up to 9 percent of U.S. electricity generation by 2030, double the amount

[68] Tim Stewart, "AI and the OODA loop: How AI enhances strategic decisions for today's warfighters," *Military Embedded Systems*, June 21, 2024.

[69] "AI is poised to drive 160% increase in data center power demand," Goldman Sacks, May 14, 2024, *Webpage*.

[70] Carly Davenport et al., "AI, data centers and the coming US power demand surge," Goldman Sachs, April 28, 2024, at 3.

[71] Caroline O'Donovan, "Tech giants fight plan to make them pay more for electric grid upgrades," *The Washington Post*, September 13, 2024.

[72] "Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption," Electric Power Research Institute, May 28, 2024, at 7.

[73] Dylan Martin, "With AI Chips Getting Hotter, Liquid Cooling Vendors See Big Channel Play," *CRN*, September 23, 2024.

consumed today. AI data centers are expected to comprise a substantial portion of this increase.[74] This surge in demand could potentially overload the grid, leading to outages and reliability issues if transmission is not expanded.

In addition to the burden of power outages and grid power reliability issues imposed on all other customers, they contribute to operational losses, increased costs, data corruption, severe safety risks, and mission failures at data centers. As AI becomes increasingly integrated into various services, particularly in sectors requiring high reliability, such as national defense, nations must develop a strong and resilient power grid infrastructure. This infrastructure is essential to support the evolving AI landscape and other technological advancements.

Strained and Insufficient Infrastructure

The existing grid infrastructure cannot handle the increased load required to adequately scale domestic AI to protect national security. Constraints on current demand already exist due to insufficient grid generation and transmission capacity and lengthy permitting and interconnection timelines for new projects to support onshoring and expansion. For example, Virginia has struggled to construct new energy infrastructure to support data center growth. In a 2022 letter to state regulators asking for permission to build new substations and power lines, Virginia's largest utility provider stated it had experienced 18 load relief warnings that year. Such warnings occur when the grid operator communicates that it may need to shed load, a technical term for the controlled interruption of power, which often includes rotating outages.[75]

Unmet Needs for Transmission Expansion and Grid-Enhancing Technologies

Presently forecasted data center growth is also predicted to face limitations associated with the amount of power that can be carried through existing U.S. transmission lines. This means that even if generation solutions begin to better match the timeline of necessary domestic AI expansion for national security, transmission expansion will also need to occur to deliver power safely, affordably, and reliably.[76] Similarly, grid-enhancing technologies (GETs), which include sensors, power flow control devices, and analytical tools that maximize the transmission of electricity, can increase the capacity of the existing grid infrastructure in the near term while new transmission lines are built. GETs are generally considered a cost-effective technology that can double the amount of renewable energy connected to the grid and save billions in annual energy production costs.[77] Despite these benefits, the adoption of GETs in the United States has been limited due to their relative newness and existing utility incentive structures that favor large capital projects on which utilities can earn a rate of return.

GETs 101:

Dynamic Line Ratings adjust the carrying capacity of transmission lines based on real-time data.

Advanced Power Flow Controls push power away from lines with capacity constraints and pull power to those with extra capacity.

Topology Optimization automatically routes power flows around congested areas.

Lagging Renewable Energy Integration

As AI data centers demand more power, developers are pushing to integrate more renewable energy sources into the grid to limit the carbon footprint from the increased load. This includes building new wind and solar plants and entering into power purchase agreements to secure renewable energy for data centers.[78] However, the transition to renewables also requires significant upgrades to the grid to handle the intermittent nature of renewable energy generation. Today, the United States lacks a centralized planning authority for the grid, leading to fragmented grid expansion and modernization efforts. This results in delays and increased costs for renewable energy projects due to complex permitting processes and disagreements over cost allocation for new infrastructure in

[74] Robert Walton, "US data center electricity demand could double by 2030, driven by artificial intelligence: EPRI," *Utility Dive*, May 30, 2024.

[75] Josh Saul et al., "AI is already wreaking havoc on global power systems," *Bloomberg*, June 21, 2024.

[76] Ibid.

[77] Daniel Moore, "Grid Upgrades Gain Favor to Meet Power Demands of AI, Clean Tech," *Bloomberg Law*, June 12, 2024

[78] "AI's Power Consumption Could Put the Grid — and Energy Regulators — to the Test," Vinson & Elkins, May 30, 2024, *Webpage*.

states and regions.[79] This structure prevents a renewables-led development of AI onshoring and expansion in the United States.

Wars waged to date share a common theme—the party with the most resources often wins. The advent of AI-supported defense appears to pull the world in a different direction, facilitating a streamlined, more efficient military force that requires fewer soldiers and traditional warfighting capability. The opposite of this is true. The exponential power of AI-warfare applications means that tens of thousands of targets can be identified at once, prompting the need for tens of thousands of weapons to execute the strike. The scale of capability offered by AI in wartime applications means industrial strength and sheer military mass will become even more critical to the future of national security.[80]

[79] Nadja Popovich and Brad Plumer, "Why the U.S. Electric Grid Isn't Ready for the Energy Transition," *The New York Times*, June 12, 2023.

[80] "AI will transform the character of warfare," *The Economist*, June 20, 2024.

Section Four: Transforming the Grid into a Force Multiplier through Transmission Expansion

This section presents possible actions for transforming the grid from a growing chokepoint for national security into a force multiplier that enables highly effective defense operations. As outlined in this report, the fundamental need for transmission to this shift cannot be overstated. The concepts below focus on building upon existing systems and processes to close the present divide between grid planning and meeting our national interests.

4.1 Expanding the DoD Siting Clearinghouse

As outlined in this report, there is an urgent need to integrate national security into grid power decision-making processes. Continued failure to do so will result in a grid that is unable to support American national interests. One path to effectively begin this integration could be to expand the existing DoD Siting Clearinghouse (the Clearinghouse), a key entity responsible for evaluating the potential impacts of 'outside the fence line' non-DoD energy projects on military operations and readiness.

The Clearinghouse, also referred to as the DoD Military Aviation and Installation Assurance Siting Clearinghouse, is an established body within the Department that is designed to evaluate potential mission impacts related to energy developments near military installations. Created by the FY 2011 National Defense Authorization Act (NDAA) and codified in FY 2018, the Clearinghouse works with private industry and developers, state and local government, regulators, and non-governmental organizations to minimize adverse impacts to military training, testing, and operations. The Clearinghouse has reviewed thousands of projects since its inception, providing a structured approach to evaluating energy projects that helps balance the needs of national defense with the development of grid energy infrastructure in the United States.[81]

Today, the Clearinghouse focuses mainly on aviation-related impacts and operates through three integrated focus areas for grid energy projects. These include a mission compatibility evaluation process, active development of technical solutions, and stakeholder engagement with state, federal, and tribal governments. The mission of the Clearinghouse is to ensure that impacts on military readiness are considered in energy siting decisions in the United States, including wind turbines, photovoltaic arrays, and transmission infrastructure.

The existing scope of the Clearinghouse, along with its appropriation, could be expanded in a future NDAA to include a process by which the DoD reviews transmission projects not just for adverse impacts on military missions but for benefits to national defense. A determination from the Clearinghouse themselves could then be used as a tool for grid owners and operators to prioritize projects that support national security. This could be especially useful for transmission expansion throughout the country, helping to ensure that abundant, affordable, resilient power has a secure path to flow to DoD critical load centers. To be most effective in this expansion, the Clearinghouse should be integrated into, or required to coordinate with, the ODASD (ER&O). This would be essential to ensure projects align with the grid priorities of the Department.

4.2 Better Integrating the DoD into the Grid's Chain of Command

To date, the DoD has typically intervened in state utility dockets to advocate for fair and reasonable utility rates for military installations. As a major consumer of utility services, the DoD aims to protect its interests and manage costs related to energy consumption. Recently, the DoD recognized the need for more strategic interactions with utilities, specifically in rate proceedings at the state level. In a memorandum issued in February 2024, the Assistant Secretary of Defense for Energy, Installations, and Environment (ASD(EI&E)) directed that two new strategic objectives shall guide all interactions between DoD and regulated electric utilities alongside the existing priority of securing fair and reasonable pricing. These strategic objectives include the promotion of energy resilience and the advancement of carbon free electricity.[82]

> Transforming the grid into a force multiplier for national defense requires integrating national security into energy planning—by expanding the DoD's role and including national security benefits in FERC's project evaluations.

[81] "Clearinghouse Factsheet," DOD Military Aviation and Installation Assurance Siting Clearinghouse.

[82] Brendan Owens, "Memorandum for Secretaries of the Military Departments," February 23, 2024.

While this more strategic engagement with states and utilities could better support mission requirements for military installations, executing such engagement proves to be challenging for the DoD's existing staff structure. To overcome this challenge, ODASD (ER&O) could be expanded to include a team of energy professionals focused solely on grid-centered interactions. This would allow for more effective interactions not only at the state level but also with key regional stakeholders and FERC.

4.3 Expanding FERC's Benefits Assessment Criteria

FERC has established specific criteria for evaluating the benefits of energy projects, particularly in transmission planning. These criteria were finalized in FERC Order No. 1920, issued on May 13, 2024. Order No. 1920 mandates that transmission providers must consider at least seven specified economic and/or reliability benefits when evaluating long-term transmission projects.[83] Today, these specified benefits include:

1. Avoided or deferred reliability transmission facilities and aging infrastructure replacement
2. Reduced loss of load probability or reduced planning reserve margin
3. Production cost savings
4. Reduced transmission energy losses
5. Reduced congestion due to transmission outages
6. Mitigation of extreme weather events and unexpected system conditions
7. Capacity cost benefits from reduced peak energy losses

While consideration of these seven benefits is required, transmission providers also retain flexibility to consider other benefits. Some additional factors that may be considered include mitigation of weather and load uncertainty, generation capacity investments, access to lower-cost generation, increased competition, and increased market liquidity.

By implementing these criteria and processes, FERC aims to ensure that energy projects, particularly transmission projects, are evaluated comprehensively for their economic and reliability benefits while considering long-term needs and cost-effectiveness. What this process does not include is an explicit tie ensuring energy projects support national interests, namely national security. The expectation that a general consideration of improved reliability and cost-effectiveness for grid energy projects will support national security is flawed. To date, this approach has failed to adequately close the gap necessary to best protect the nation, as outlined throughout this report. FERC may consider adding enhanced national security or increased capacity to national security loads as an eighth required benefit to improve this process and directly support the energy needs of national defense.

[83] Daniel Hagan et al., "Transmission Planning Reforms Finalized in FERC Order No. 1920," White Case, May 14, 2024.

SAFE

SAFE is an action-oriented, nonpartisan organization committed to transportation and energy policy solutions that advance the economic and national security of the United States, its partners, and its allies. Since 2004, SAFE has convened business and former military leaders to advocate for secure, resilient, and sustainable energy solutions. SAFE relies on the knowledge and experience of four-star retired military officers, Fortune 500 CEOs, and its expert staff to produce high-quality, fact-based analysis and policy recommendations for lawmakers, regulatory agencies, and the public.

CENTER FOR Grid Security

SAFE's Center for Grid Security provides policy analysis and recommendations to build out the national power grid, as more reliable and affordable power will be necessary to support America's reindustrialization and our national security.

Our major goals include:

Increase the amount of competitively built transmission lines to solve the overloaded grid and protect it as more technology comes online. Specifically, research indicates that around 50,000 miles of transmission lines are needed by 2035.

Develop interregional transfer capability to allow power to be moved from one system to another, across the United States and across seams. This would allow one part of the country to take advantage of power surpluses created by others.

Establish a streamlined permitting process to make it easier and faster to build transmission lines. Regulatory decision-making, planning, permitting, and paying processes all need to be rationalized to ensure that adequate transmission is built to connect and transport the megawatts needed to support the U.S. economy and ensure national security.

Support a diverse generation portfolio as a critical step to meet the growth in power demand. Nuclear energy, advanced reactors, and small modular reactors are necessary to support the energy transition and national security.

Identify critical power grid parts and components, and mandate that those parts be manufactured and sourced in the United States and allied nations.

Increase cyber and physical counterintelligence to meet the growing threats of cyber and physical attacks.

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