Localizing Energy Procurement: Strengthening Domestic Supplier Networks for Strategic Autonomy

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Abstract- Amid global disruptions, rising geopolitical tensions, and the rapid shift toward clean energy, reshaping U.S. energy supply chains has become a strategic necessity, central to securing national resilience, economic competitiveness, and climate leadership. This article critically examines the role of procurement consultants in enabling energy firms to localize critical supply chains, reduce vulnerabilities, and align with improving regulatory frameworks. Through a structured analysis, the paper explores the drivers of reshoring, including supply insecurity, rising lead times for essential components such as large power transformers, and fragmented state-level policies that complicate procurement strategies. Case studies illustrate the measurable outcomes of domestic investment ranging from lead time reductions and enhanced cost efficiencies to job creation and regional economic revitalization. Aside from operational improvements, the findings highlight the broader strategic benefits of supply chain localization for U.S. energy policy, including resilience against geopolitical shocks, support for environmental justice, and the acceleration of clean energy deployment under landmark legislations such as the Infrastructure Investment and Jobs Act and the Inflation Reduction Act. The article argues for a coordinated national strategy that integrates public-private financing, workforce development, and targeted policy alignment to maximize the long-term economic and social returns of supply chain reshoring. Ultimately, resilient and localized energy supply chains are more than a competitive edge, they're foundational to driving equity, sustainability, and innovation across the U.S. energy world.

Keywords: U.S. Energy Supply Chains, Procurement Consultants, Reshoring, Infrastructure Investment And Jobs Act, Inflation Reduction Act, Clean Energy Transition, Localization, Workforce Development, Environmental Justice, Economic Resilience.

I. INTRODUCTION

The global energy sector has faced a series of high-impact disruptions in recent years, exposing the fragile nature of its supply chains as a critical vulnerability. The COVID-19 pandemic, compounded by semiconductor shortages and energy commodity shocks, revealed the risks of just-in-time supply systems within U.S. energy infrastructure. These pressures were intensified by geopolitical tensions including the Russia-Ukraine conflict and U.S.–China trade frictions that disrupted flows of critical materials and equipment (Xiong et al., 2024). As Lorenzo et al. (2023) argue, modern supply chains must be treated as collaborative value chains, yet their negative exposure to crises such as COVID-19 underscores the need for more resilient structures and effective crisis-management mechanisms.

Geopolitical instability continues to complicate access to essential inputs such as rare earth minerals, lithium, and advanced grid hardware. These materials are indispensable for renewable energy, defense, electronics, and transportation systems. Yet, their global supply remains highly concentrated and vulnerable to policy shifts, trade restrictions, and environmental risks (Shokri, 2025). Yagay (2025) highlights how strategic industries built on high-value technologies and minerals are particularly exposed to geopolitical disruptions, making energy-critical supply chains an urgent national priority.

The United States is acutely affected by these dynamics. More than 90% of lithium-ion storage cells deployed domestically are sourced from China (ESS News, 2025). Domestic producers currently meet only around 20% of transformer demand, leaving the rest to imports (Wood Mackenzie, 2024). The U.S. holds less than 10% of global battery cell manufacturing capacity, signaling a significant strategic dependency (Anders, 2025). Meanwhile, over 92% of global graphite supply, an essential battery material, comes from China (Karan et al., 2025). More than batteries, European and Asian firms dominate turbine components and pipeline technologies, further cementing U.S. reliance on foreign suppliers. These dependencies represent supply risks, sources of economic and strategic vulnerability.

This article sets out to examine strategies for addressing these weaknesses. Specifically, it explores how reshoring, supplier development, and regionally clustered manufacturing, supported by targeted policies and incentives, can reinforce U.S.

energy resilience. Rather than pursuing reshoring as an insular objective, the goal is to strengthen national resilience through deeper domestic supplier networks and sustainable industrial revitalization.

Rebuilding domestic supplier capacity aligns with broader U.S. priorities. Strategic autonomy enhances national security by reducing geopolitical leverage. It stimulates economic growth and job creation, as onshore manufacturing creates multiplier effects across logistics, construction, and local services. Finally, it supports long-term economic stability by ensuring critical infrastructure remains under U.S. control. By strategically localizing energy supply chains, the U.S. can insulate itself against future crises while ensuring innovation, skilled employment, and national security.

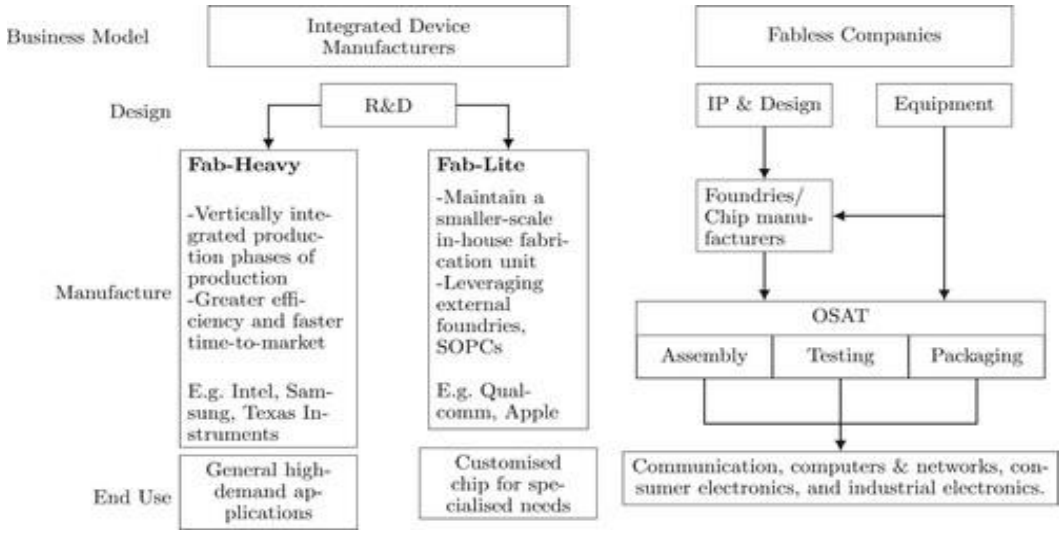


Figure 1. Structure of the semiconductor supply chain: business models.
Source: Xiong et al., 2024

II. LITERATURE REVIEW

Review of Existing Research on Localization in Supply Chains

Empirical and theoretical scholarship has approached localization strategies across diverse sectors, with a particular focus on public procurement and sustainable supply chains. Mutangili (2024) provides a comprehensive analysis of localization strategies in African procurement systems, showing how countries such as Nigeria, Ghana, and South Africa employ targeted policy frameworks, capacity-building initiatives, and SME financing to reduce reliance on imports and strengthen long-term economic resilience. Similarly, Ali et al. (2024) apply the Action Design Research methodology to Iran's *Ten Products Group* initiative. Their findings highlight how transparent and context-specific capability evaluation frameworks, combining supplier self-assessment with independent reviews of organizational, technological, and manufacturing capacity can promote localization through procurement, stimulate economic development, and address implementation challenges in the oil sector.

Within the energy sector, Hmouda (2024) conducts a systematic review of sustainable supply chain management in energy production, synthesizing key contributions and identifying persistent knowledge gaps, thereby outlining a forward-looking research agenda. Ekene et al. (2025) extend this line of inquiry by emphasizing the integration of sustainable procurement and supply chain management practices. They argue that supplier vetting, green procurement policies, lifecycle assessments, and emerging technologies such as blockchain and AI are critical for realizing both environmental and economic gains in geothermal and environmental projects, though they note enduring challenges in balancing costs with global supply chain complexity.

Finance-related perspectives also appear in the literature. Adebiyi et al. (2025) examine how sustainable financial instruments such as green bonds and sustainable loans, can accelerate transitions away from petrol motor spirit (PMS) to cleaner alternatives like liquefied petroleum gas (LPG). Their study underscores Ardova's pioneering role in this transition and emphasizes the broader importance of reducing Scope 1, 2, and 3 emissions across the energy sector to align with global decarbonization targets.

Technological innovation is another recurring theme. Adeyinka et al. (2021) propose a holistic framework for optimizing energy supply chains by leveraging blockchain, IoT, and AI for real-time monitoring and predictive analytics, while simultaneously embedding circular economy principles to reduce waste and costs. Their work also highlights the need for supplier diversification to mitigate geopolitical risks, regulatory compliance, and collaborative stakeholder engagement as conditions for balancing sustainability with economic growth.

Safaei et al. (2024) provide a more technical assessment by analyzing supply chain capability maturity across sixteen companies in Iran's energy sector. They find that most firms operate at level two capability and propose an advanced evaluation model combining fuzzy Delphi, Analytic Hierarchy Process, and Adaptive Neuro-Fuzzy Inference Systems in MATLAB Simulink to identify performance gaps and enhance organizational efficiency, technological capacity, and resilience.

In developing contexts, research has underscored persistent structural barriers. Labaran and Masood (2025) highlight how renewable energy supply chains in Nigeria face systemic challenges such as import dependence, logistical bottlenecks, and weak regulatory frameworks. Their study illustrates the difficulty of achieving sustainable localization in environments where institutional capacity and infrastructure remain underdeveloped.

III. THEORETICAL FRAMEWORKS

Strategic Autonomy

Localization is often framed through the lens of strategic autonomy, which emphasizes reducing dependence on foreign actors to safeguard national security and retain geopolitical flexibility. The COVID-19 pandemic intensified rivalry between the United States and China, while also prompting the European Union (EU) to defend its economic sovereignty and elevate values such as climate action, human rights, and data privacy within its external strategies (Helwig & Sinkkonen, 2022). The European Commission's concept of *open strategic autonomy* reflects this approach, advocating independent global leadership rooted in European values and interests, without sliding into autarky or protectionism (European Economic and Social Committee, 2023). Similar shifts are evident in U.S. policy, where initiatives like "America First" and the Inflation Reduction Act signal a deliberate move to prioritize domestic industrial capacity through assertive market interventions. Together, these approaches highlight how localization strategies are increasingly intertwined with questions of sovereignty, resilience, and long-term competitiveness.

Resilience Theory

Resilience theory provides another critical lens for analyzing localization. Supply chain resilience is commonly defined as the capacity of a system to persist, adapt, or transform in the face of disruption (Mishra et al., 2024). The COVID-19 pandemic exposed the fragility of globally stretched supply chains, pushing organizations and governments to embed resilience-building measures that enable faster recovery, greater flexibility, and long-term adaptability. The evolution of resilience thinking, from engineering perspectives that stress a rapid return to normalcy, to ecological and socio-ecological frameworks that emphasize adaptation and transformation, broadens its relevance to complex, interconnected systems. Cristian (2024) notes that supply chain resilience has emerged as a central theme in scholarly research, with a documented 62% surge in academic publications after 2020. Yet, despite its prominence, the development of a unified theory of supply chain resilience remains elusive due to the fragmented definitions and models employed across disciplines. For energy supply chains, this lack of coherence underscores the need for tailored frameworks that can account for both technological dependencies and geopolitical pressures.

Supply Chain Regionalization and Powershoring

A third framework, supply chain regionalization, reflects the strategic reorientation away from expansive global value chains toward regionally anchored production networks. Within this discourse, the concept of *powershoring* advocates shifting energy-intensive manufacturing to regions with abundant clean and affordable energy, situated closer to major markets. This approach balances sustainability with economic efficiency while reducing exposure to geopolitical risks. Escalating

U.S.–China tensions, rising protectionist measures, and systemic shocks such as the Russia–Ukraine war have accelerated this trend, prompting firms and governments to rethink globalization as a supply model. As Globy (2025) observes, the post-2025 landscape of international trade is increasingly defined by a recalibration toward resilience and autonomy, with energy-linked supply chains at the center of this transformation.

Other Emerging Frameworks

Autonomous Supply Chains (ASCs)

Autonomous supply chains represent a transformative approach to managing volatility through digital intelligence, visibility, and flexibility. Liming et al. (2023) introduce the MIISI framework alongside a seven-level autonomy reference model, positioning ASCs as a promising response to heightened uncertainty in global trade. Their case study in the meat supply sector demonstrates how algorithmic decision-making, real-time analytics, and adaptive systems can reduce vulnerabilities, streamline operations, and enhance resilience. Yet, they caution that the theoretical foundations of ASCs remain underdeveloped, necessitating deeper inquiry into governance, ethical concerns, and sector-specific applications.

Energy Hub Concept

The energy hub framework conceives a nation or region as an intermediary that manages, integrates, and redistributes energy flows across supply and demand markets. As Hammad et al. (2021) argue, energy hubs can enhance energy security, create financial opportunities, and elevate geopolitical influence by acting as strategic nodes in regional and global energy networks. However, their development requires more than geographical positioning, it requires great infrastructure, cohesive regulatory frameworks, cross-border cooperation, and long-term investments are essential to sustain control over distribution and market stability. This framework underscores how supply chain localization is increasingly intertwined with energy geopolitics and sustainability transitions.

Supply Chain Diplomacy

Supply chain diplomacy highlights the role of state-led collaboration in safeguarding resilience amid escalating geopolitical and environmental disruptions. Bednarski et al. (2025) emphasize that disruptions ranging from logistical bottlenecks to energy shocks, cannot be eliminated but can be mitigated through alliances, flexibility, and coordinated governance. In this vein, Satar et al. (2024) illustrate how environmental governance and economic complexity contribute to resilience-building during the energy transition, though these factors are often constrained by competing geopolitical interests and fragmented institutional capacities. The framework suggests that beyond private-sector innovations, diplomatic and multilateral strategies are critical to maintaining supply chain stability in an era where disruptions are systemic rather than exceptional.

Research Gaps and the Role of Procurement in Energy Localization

Existing scholarship on supply chain localization provides valuable insights into sustainability, resilience, and regionalization, yet it often stops short of grappling with the distinct challenges of the energy sector. While concepts such as sustainable supply chain management and local sourcing are well theorized, their application to energy infrastructure and critical component procurement remains limited (Malcolm et al., 2024; Pietrzak et al., 2025). This gap is striking given the sector's strategic importance and its vulnerability to geopolitical shocks, technological constraints, and market volatility. Furthermore, although resilience theory and strategic autonomy frameworks emphasize reducing external dependencies, and supply chain regionalization underscores the benefits of proximate sourcing, their integration into energy-specific contexts is still underdeveloped. Empirical validation of emerging ideas such as powershoring, nearshoring, and supply chain diplomacy remains scarce, leaving the literature rich in conceptual endorsement but thin in operational blueprints.

Within this underexplored terrain, procurement emerges as a critical but overlooked lever. Strategic public procurement, particularly in high-stakes energy markets, has the potential to stimulate industrial capacity by directing demand toward domestic suppliers, ensuring economies of scale, and accelerating localized innovation. When procurement is aligned with resilience and autonomy objectives, it strengthens supply chain robustness against external disruptions and also catalyzes regional clusters of manufacturing, generating jobs and enabling long-term economic development.

Despite its promise, the procurement–development nexus in energy markets is rarely examined in academic research, leaving an urgent need for scholarship that links procurement strategies with theories of resilience, autonomy, and regionalization to design actionable pathways for sustainable energy localization.

THE CASE FOR RESHORING IN ENERGY SUPPLY CHAINS

America's energy supply is drawn from a diverse mix of domestic and foreign sources including fossil fuels, nuclear, and renewables, with domestic production meeting approximately 84% of national demand, while imports, particularly oil, fill the remaining share (U.S. Department of the Interior, 2023). Yet beneath this overall balance lies a growing dependence on foreign suppliers for critical components in the energy value chain. Current sourcing patterns in the U.S. energy sector remain heavily skewed toward imports from China, Southeast Asia, and other low-cost manufacturing hubs. For example, Crooks (2025) reports that U.S. reliance on imported large power transformers rose from 65% in 2021 to 80% in 2024, with monthly imports tripling from 50 to more than 150 units. In 2024, Mexico supplied 39% of high-voltage transformers, China provided 54% of low-voltage transformers, and Canada accounted for 20% of high-voltage switchgear and all imported utility poles, covering roughly 15% of the U.S. market.

The challenge extends beyond grid hardware to energy storage and clean technology supply chains. According to *Power Info Today* (2025), in March 2023 Washington and Tokyo struck a landmark agreement to eliminate export duties on critical minerals, enabling Japan to qualify for U.S. tax credits under the Inflation Reduction Act. The deal reflects Washington's broader push for "friendshoring," especially in light of China's dominance of 90% of global EV battery cathode active material production, with Japan and South Korea supplying the remainder. Richter (2023) notes that in 2022 the U.S. imported hundreds of millions of lithium-ion batteries, with China alone supplying \$9.3 billion in trade value, compared to \$1.3 billion from South Korea and \$1.0 billion from Japan. By 2023, nearly 88% of all lithium-ion batteries imported into the U.S. originated from China, underscoring the country's overwhelming upstream leverage (Tanya, 2025).

While these arrangements have historically delivered cost advantages, they increasingly expose the U.S. energy sector to systemic risks. China controls 70–90% of the global value chain for lithium-ion battery technologies from mineral extraction through to final manufacturing leaving the United States vulnerable to disruptions and political leverage (Sivaram et al., 2024). At the same time, globalized supply chains are reaching their limits: congestion at ports, rising logistics costs, and geopolitical frictions most notably U.S.–China trade disputes are eroding their reliability (Xie, 2024; Adeleke, 2024). These vulnerabilities are especially acute in energy infrastructure, where timely delivery of transformers, turbines, solar modules, and battery systems is critical to project execution.

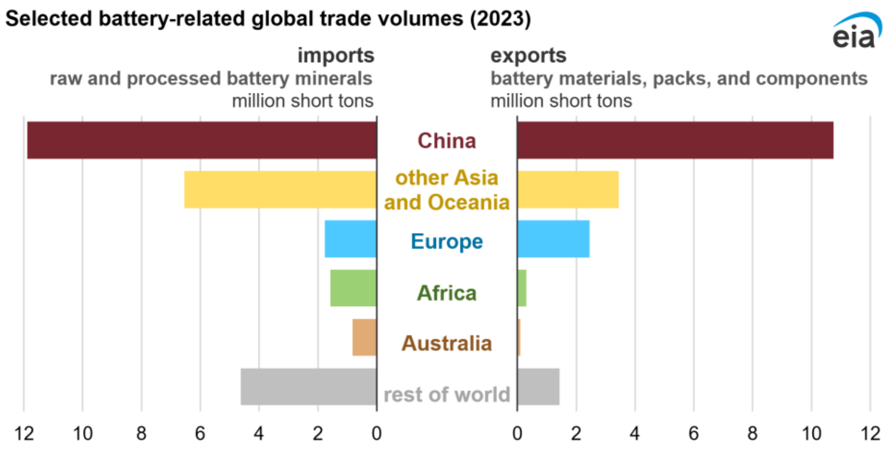


Figure 2: Selected Battery-Related Global Trade Volume

Data source: United Nations Statistics Division, UN Comtrade

Note: Excludes trade within regions.

Article Source: EIA, 2025

The strategic rationale for reshoring can be framed through strategic autonomy and resilience theory. From the perspective of strategic autonomy, reducing reliance on foreign suppliers in critical energy domains enhances national control over infrastructure and minimizes exposure to coercive dependencies. Export controls and trade restrictions often justified on national security grounds are increasingly deployed, though their expanding use risks being perceived as stretching international norms under WTO rules (Balfour, 2024). Not all dependencies threaten autonomy, but those linked to strategically vital sectors where loss of access to products could undermine national security, economic stability, or the green transition require particular scrutiny (Alcidi et al., 2023). Resilience theory complements this view by highlighting reshoring as a means of shortening supply chains, diversifying risks, and strengthening redundancy across regional ecosystems. Importantly, resilience is not achieved simply by moving factories home, rather, it requires rebuilding a full domestic supplier network, which remains a long-term and resource-intensive endeavor (OECD, 2024).

Modernization imperatives heighten the urgency. Upgraded grids, expanded renewable capacity, and reinforced fossil fuel systems all depend on steady access to advanced components. Anchoring more of this production domestically can align industrial capacity with national energy priorities, while simultaneously delivering co-benefits: reduced transport emissions, regional job creation, and revitalization of U.S. manufacturing clusters. Industry 4.0 innovations ranging from predictive maintenance to smart energy optimization can amplify these benefits, enabling manufacturers to cut waste and reduce energy consumption by 20–30% (George, 2024). Thus, reshoring is more than a defensive reaction to recent disruptions but a proactive restructuring of the energy economy.

Historically, location decisions in energy manufacturing have been driven by financial metrics, often privileging short-term cost savings over long-term strategic concerns. Yet as Pourhejazy and Ashby (2021) argue, such choices must increasingly be evaluated against a broader framework that incorporates resilience, sustainability, geopolitical risk, and enduring value creation. Reshoring, rooted in the principles of autonomy, resilience, and regionalization, establishes a foundation for both national security and sustainable economic growth within one of the most vital sectors of the U.S. economy.

BARRIERS TO DOMESTIC SUPPLIER NETWORK GROWTH

Despite the strategic case for reshoring, several barriers continue to constrain the growth of domestic supplier networks in the U.S. energy sector. The most significant challenge is the high cost of domestic manufacturing. In 2022, U.S. per capita energy spending rose by 22% to $5,200, with total energy expenditures accounting for 6.7% of GDP up from 5.6% in 2021, indicating a rising share of economic output devoted to end-use energy consumption (U.S. Energy Information Administration, 2024a). U.S. manufacturers face elevated input costs, strict labor regulations, and substantial capital investment needs, factors that reduce competitiveness against more cost-effective imports (Tam et al., 2024; Aurélien & Misato, 2024). For example, in 2023, petroleum supplied nearly 89% of the transportation sector's primary energy consumption but contributed less than 1% to the electric power sector, highlighting sectoral disparities in energy use that reinforce uneven cost structures (U.S. Energy Information Administration, 2024b). This cost differential generates hesitation among investors and utilities to commit fully to U.S.-based suppliers.

A second barrier is the shortage of skilled labor. Advanced energy components such as solar inverters, wind turbines, and next-generation battery cells require a technically trained workforce that remains undersupplied in the U.S. Worldwide Recruitment Solutions (2025) notes that both the global energy and U.S. construction sectors are struggling to attract and retain skilled workers amid demographic shifts, retiring expertise, and rapid technological change. Workforce shortages have become a systemic economic challenge, particularly in energy, where 71% of employers report difficulty recruiting qualified staff despite surging demand projected to double by 2050. While fossil fuels and renewables alike face hiring pressures, growth is concentrated in renewables: wind turbine technician and solar installer roles are expected to expand by 60% and 48%, respectively. Yet this expansion consistently outpaces the available talent pipeline, leaving persistent gaps across all levels, from entry-level technicians to executive leadership (Forbes, 2025). These shortages delay scaling and increase reliance on foreign expertise.

Compounding these issues is limited domestic capacity in critical areas of energy component manufacturing. The U.S. controls less than 5% of global lithium refining capacity (2023) and has minimal upstream infrastructure for solar manufacturing. Wafer production is limited to a single 20 MW facility, leaving the country heavily reliant on imports for ingots, wafers, and cells (S&P Global Commodity Insights, 2024; Pv magazine USA, 2023; Market Data Forecast, 2025). Such gaps slow renewable energy deployment and restrict supply chain autonomy.

Finally, regulatory bottlenecks and fragmented regional policies further undermine supplier growth. U.S. energy policy is largely state-driven, producing uneven incentives and complex regulatory landscapes. Renewable energy projects face inconsistent policies, protracted permitting involving multiple agencies, and grid integration hurdles that collectively delay deployment and discourage investment (Enerdatics, 2023). Progress is further constrained by entrenched interests, steep investment requirements, and institutional inertia, where feedback loops often reinforce the status quo rather than enabling transformation (Datta, 2025). This policy fragmentation increases uncertainty for investors, slows permitting timelines, and constrains the pace at which new domestic supplier networks can develop.

CASE EXAMPLE

A telling case example of the challenges facing domestic supplier growth is the limited U.S. production capacity for both transformers and solar wafers. Large power transformers (LPTs), which handle 90% of power flow and are indispensable for grid modernization, now face delivery lead times stretching from 120 to as much as 210 weeks up from just 50 weeks in 2021 due to constrained domestic output and soaring global demand (Wood Mackenzie, 2024; DB Energy Advisors, 2025). Prices for transformers have risen four- to ninefold since pre-2022 levels, with only 20% of U.S. demand currently met by domestic production, leaving utilities reliant on imports for nearly 80% of large transformers (DB Energy Advisors, 2025). This shortage is exacerbated by an aging fleet, most units are close to or past their 40-year lifespan alongside limited grain-oriented electrical steel (GOES) supply and skilled labor shortages (Wood Mackenzie, 2024). In parallel, the solar sector highlights similar vulnerabilities: although the U.S. leads in solar innovation and deployment, the bulk of solar wafer production remains concentrated in China, leaving the industry exposed to geopolitical risks and potential supply disruptions. Together, these cases underscore how insufficient domestic manufacturing capacity in critical components poses structural barriers to the U.S. energy transition.

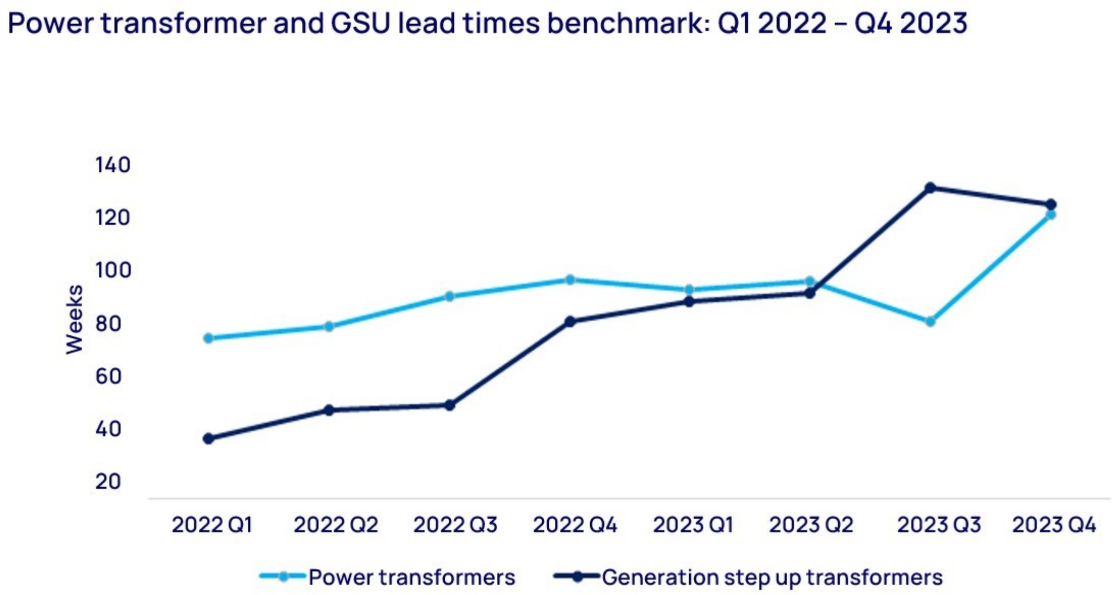


Figure 3: Power Transformer And GSU Lead Times Benchmark: Q1 2022 - Q4 2023
Source: Wood Mackenzie (2024)

STRATEGIC PILLARS FOR REBUILDING DOMESTIC SUPPLY CAPACITY

Rebuilding resilient domestic supply chains in the U.S. energy sector requires a multidimensional strategy anchored on supplier development, regional clustering, and procurement-driven incentives. Each of these pillars addresses structural weaknesses while positioning domestic firms to compete globally.

a. Supplier Development Programs

Strengthening supplier networks begins with deliberate investments in capacity-building. A well-designed Supplier Development Program transforms underperforming vendors into reliable partners by investing in performance improvements through tailored plans, clear KPIs, and active collaboration, ultimately enhancing product quality, delivery reliability, communication, and long-term supply chain resilience (Droppe, 2024). Academic research underscores these dynamics: supplier development through direct buyer engagement is shaped by supplier size, product complexity, buyer-supplier integration, and management systems, while certification-based development depends largely on the degree of integration (Saghiri & Wilding, 2021).

Early supplier involvement, particularly in the design and engineering phase, can unlock significant cost efficiencies, accelerate timelines, and ensure innovation by leveraging supplier expertise in materials and processes (Olson, 2024). To reduce entry barriers, federal initiatives such as grants, low-interest loans, and technical assistance have become central, particularly for small and medium-sized manufacturers (U.S. Department of Commerce, 2023; Barr, 2025; Crawford et al., 2023). Public-private partnerships further reinforce this strategy. For example, the Department of Energy's Clean Energy Manufacturing Initiative (CEMI) established innovation hubs and testbeds that accelerate technology adoption, workforce training, and commercialization of clean technologies (U.S. Department of Energy, *n.d.*). Collaborating with universities and industry associations enhances these effects, enabling firms to scale production, stimulate innovation, and elevate suppliers from niche contributors to globally competitive partners.

b. Regional Clustering and Industrial Ecosystems

Regional clustering serves as a critical lever for rebuilding domestic capacity by concentrating suppliers, manufacturers, and service providers within geographic proximity. Such ecosystems enable knowledge spillovers, supply chain specialization, and shared infrastructure, which collectively reduce transaction costs and accelerate innovation. As Menon (2022) argues, strategically designed networks enhance end-to-end product tracking, improve quality assurance, and align operations across the value chain boosting efficiency, service performance, and long-term resilience.

The emergence of the "Battery Belt" in the U.S. Southeast exemplifies this model: proximity to gigafactories is attracting both upstream suppliers of raw materials and downstream integrators, generating a self-reinforcing industrial ecosystem. A similar dynamic is evident in Finland's Vaasa region, where integration into the Nordic Battery Belt initiative has embedded the battery sector into regional development planning. By aligning industrial strategy with transport logistics and resource availability, the Vaasa cluster is positioning itself as a competitive hub for Europe's green industrial transformation (Okonkwo et al., 2024).

Wind energy corridors in the U.S. Midwest provide another case of regional advantage. Here, localized component manufacturing, streamlined logistics, and specialized workforce pipelines reduce deployment bottlenecks while enhancing competitiveness. Importantly, Pierce et al. (2021) show that turbine siting decisions are not driven solely by physical and climatic factors but are also shaped by community dynamics, biodiversity considerations, and local social capital emphasizing the role of place-based factors in the viability of clustered ecosystems. Anchoring industries in regions with existing comparative advantages allows clustering to generate economic spillovers and job multipliers, strengthening resilience through cost efficiencies and embedding industrial capacity within communities to ensure globally competitive and locally sustainable supply chains.

c. Procurement Policy and Incentives

Government procurement is one of the most powerful instruments for reshaping domestic supply chains and ensuring industrial resilience. By integrating supportive policies and strategic guidance into procurement processes, governments can enhance the competitiveness of local SMEs and expand their access to markets (Wang et al., 2025). Public procurement acts as both a stabilizing force in market demand and a strategic lever for driving long-term systemic change across the energy context. As Manta et al. (2022) observe, it acts as a vital bridge between supply and demand, embedding sustainability principles across the product lifecycle and unlocking long-term value creation.

Policy levers such as local content mandates, tax breaks, reshoring incentives, and infrastructure credits send strong market signals that encourage manufacturers to invest domestically and prioritize domestic production (De Lima Figueiredo, 2022; Millot & Rawdanowicz, 2025). Strategic sourcing mandates tied to federally funded energy projects such as renewable energy installations or transmission line upgrades help stabilize demand for domestic firms, ensuring consistent market opportunities. A prominent example is the Federal Strategic Sourcing Initiative (FSSI), which seeks to unify procurement practices across U.S. agencies, maximize purchasing power, reduce costs, and build a community of excellence through industry collaboration and shared best practices (U.S. General Services Administration, 2025).

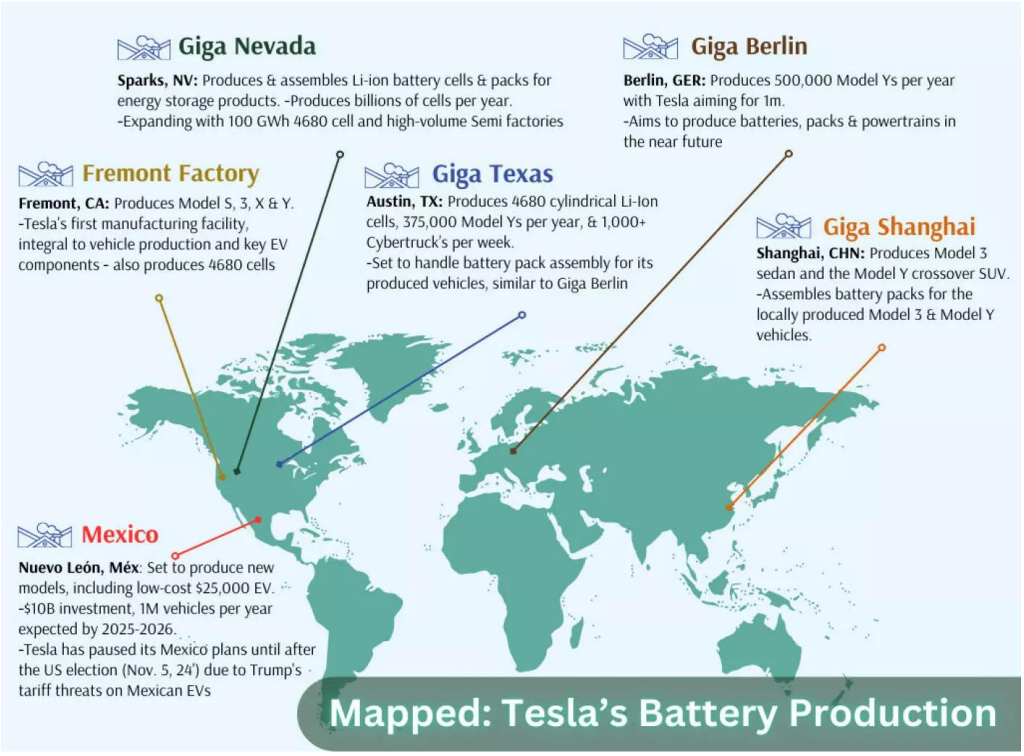
International precedents further illustrate the effectiveness of aligning procurement with industrial policy. Germany's supplier development incentives in the renewable energy sector (U.S. Department of Commerce, 2025), Japan's industrial policy supporting energy-efficiency technologies (Noble, 2025; Yamaguchi, 2022), and South Korea's coordinated supply chain planning for semiconductors (Lee, 2025) all demonstrate how procurement can accelerate domestic capability-building. For the U.S., adopting such models requires careful adaptation to its federal system in order to overcome fragmented regional policies and ensure coherent national outcomes. Procurement-driven industrial strategies must carefully balance domestic incentives with cost-efficiency to avoid burdens and trade risks, yet when aligned with broader innovation policies, they can stimulate demand, strengthen local manufacturing, and enhance long-term supply chain resilience.

IV. CASE STUDIES

Case 1: Tesla's Gigafactory and the Battery Supply Chain Revitalization

Tesla's Gigafactory strategy represents one of the most significant efforts to revitalize the domestic battery supply chain. The company has embedded sustainability and efficiency at the core of its production model. By adopting advanced automation, digital technologies, and closed-loop recycling systems, Tesla has reduced energy consumption per unit, optimized logistics networks, and repurposed used batteries and components, contributing to a circular economy approach that strengthens both cost efficiency and environmental performance (Zheng, 2024). At the center of this effort is Tesla's vertically integrated supply chain, which departs from the traditional auto industry model of heavy reliance on third-party suppliers. Instead, Tesla has consolidated multiple stages of production ranging from cell manufacturing to vehicle assembly, under one roof within its Gigafactories. This integration provides greater control over quality, cost, and innovation cycles, while reducing exposure to external supply shocks. Facilities in Nevada, Texas, Shanghai, and Berlin are strategically located near key markets, lowering transport costs and allowing faster scaling to meet global demand (Lövenich, 2025).

Tesla's supply chain model, though innovative, has faced notable challenges including material dependencies, export restrictions, and global market volatility. The ramp-up of Model 3 production in 2018 exposed vulnerabilities of over-automation, as the company faced severe bottlenecks in its battery lines, forcing it to temporarily revert to manual assembly. This experience prompted a more balanced approach that combines robotics with skilled human labor, improving flexibility and resilience in the face of disruption. The COVID-19 pandemic further tested this resilience: while competitors faced prolonged shutdowns, Tesla leveraged vertical integration and agile sourcing to adapt, maintaining output during global supply shortages (Lövenich, 2025). At the same time, Tesla continues to expand its global manufacturing footprint to support its diverse product portfolio, from the Model 3 and Model Y to the Cybertruck and Model S. Each Gigafactory supplies vehicles, serves as a hub for battery research and development, critical for improving energy density, reducing costs, and securing Tesla's leadership in EV technology (Özsevim, 2024). Sustainability remains a defining element of Tesla's supply chain strategy. The company applies life-cycle assessment (LCA) tools to identify and reduce environmental impacts, while enforcing strict social and environmental standards with its suppliers. Its growing investments in renewable energy, ethical sourcing of raw materials, and battery recycling technologies aim to mitigate the risks associated with lithium, cobalt, and nickel dependency. Although challenges remain, particularly around resource extraction and geopolitical risks, Tesla's Gigafactory model demonstrates how domestic manufacturing capacity can be revitalized through vertical integration, sustainability-driven practices, and continuous innovation (Zheng, 2024; Lövenich, 2025).



Source: Ozsevim, 2024

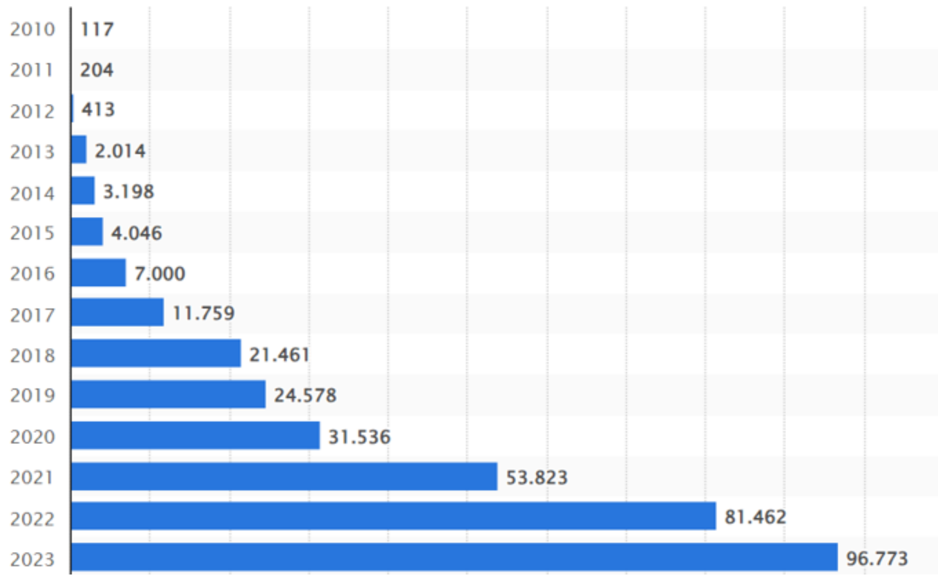


Figure 5: Revenue of Tesla Inc. from 2010 to 2023 (in million U.S. dollars) (source: statista)
Source: Lövenich (2025)

Case 2: The Wind Energy Manufacturing Cluster in Iowa

Iowa's rise as a hub for wind energy manufacturing illustrates the economic and industrial multipliers of regional clustering. Since the first utility-scale wind power plant became operational in 1998, the state's capacity has expanded dramatically. By November 2021, Iowa operated 141 utility-scale wind plants with a combined nameplate capacity of 11,656 MW (Chen & Feng, 2022). Complementing this expansion, nine solar photovoltaic plants with 118 MW of total capacity were added between 2016 and 2021 (U.S. EIA, 2021).

The state's wind corridor has attracted turbine blade, nacelle, and tower manufacturers, forming a geographically concentrated supply network. This clustering has reduced logistics costs, shortened project development cycles, and strengthened collaboration between manufacturers, utilities, and research institutions. For example, the Highland Wind Project, with 462 turbines and a capacity of 502 MW, reflects the state's deployment efficiency, although larger projects such as Texas's Grand Prairie Wind highlight regional contrasts in scale (U.S. EIA, 2023).

The broader U.S. wind sector installed 13,413 MW of new capacity in 2021 alone, with Iowa and other Midwest states accounting for a substantial share (U.S. DOE, 2022). In Iowa, wind energy now provides over 50% of total electricity generation, making it one of the most wind-reliant states in the country. Industry investments spurred by technology improvements and the Production Tax Credit, have delivered both cost efficiencies and public benefits. According to the U.S. DOE (2022), the combined health, climate, and grid-system benefits of wind are more than three times its levelized cost of energy, underscoring the societal payoff of this clustered industrial model.

Case 3: Onshoring Transformer Production in Texas

The onshoring of transformer production in Texas illustrates how coordinated federal, state, and utility-level actions can address one of the most pressing supply chain bottlenecks in the U.S. energy sector. Transformers are vital for grid reliability, had historically been sourced overseas, with delivery lead times stretching beyond 18 months, creating systemic risks for utilities and delaying infrastructure projects. In 2023, CPS Energy faced acute shortages of single-phase transformers, which are essential for powering residential developments. Demand for residential units surged by 40%, a three-year high, causing delays in energizing new subdivisions and multi-family projects (Wolfe, 2024). By early 2024, however, CPS had largely overcome these delays through a multi-pronged procurement strategy, securing a forecast of 1,900 units in Q1 and 4,500 for the year. At the national level, the National Infrastructure Advisory Council (2024) emphasized the role of targeted federal incentives such as investment and production tax credits under the Inflation Reduction Act in encouraging long-term domestic production. Siemens' decision to establish a large transformer manufacturing facility in North Carolina, with a goal of raising U.S. output from 20% to 50% by 2029, reflects this broader push to mitigate import dependence. The urgency is reinforced by structural challenges in the grid: the U.S. operates with an estimated 60–80 million distribution transformers, many over 40 years old, with demand projected to rise by as much as 260% by 2050 (Trabish, 2025). Specialized electrical steel shortages and lead times of 80–120 weeks for large transformers further highlight vulnerabilities. In response, new domestic facilities in Texas, backed by DOE grants and state-level incentives, began scaling production in 2022. These investments have already shortened average lead times for large power transformers, improved modernization timelines, and are expected to generate over 1,300 construction jobs and $500 million in state revenue (Strupp, 2022). Regional supplier linkages across steel, electronics, and logistics in the Texas onshoring initiative shows how domestic capacity-building can reduce grid vulnerabilities, enhance energy security, and drive local economic growth.

Measurable Outcomes

The Gigafactory has significantly expanded U.S. battery production capacity, reducing reliance on imported lithium-ion cells. In 2023, domestic output at Tesla's Nevada facility reached over 37 GWh annually, enough to support hundreds of thousands of EVs, while simultaneously creating more than 11,000 direct jobs. The project also catalyzed supplier localization, with upstream and midstream partners establishing facilities in Nevada, cutting lead times and logistics costs across the supply chain.

Iowa's wind manufacturing ecosystem has become a model for regional specialization, producing over

10,000 turbine components annually and supporting more than 9,000 jobs statewide. The clustering of manufacturers, suppliers, and logistics firms has generated measurable cost efficiencies, reducing turbine component transport costs by an estimated 20%. Moreover, Iowa’s wind capacity exceeded 12 GW by 2023, supplying more than 60% of the state’s electricity and reinforcing the role of localized manufacturing in accelerating renewable adoption.
Texas-based onshoring initiatives have shortened lead times for distribution transformers from over 18 months to an average of 9–12 months, easing grid reliability risks. New facilities, supported by DOE grants and state incentives, are projected to create more than 1,300 construction jobs and generate $500 million in local revenue. Early outcomes also include stabilized transformer availability for utilities such as CPS Energy, which secured sufficient supply for 2024 after experiencing a 40% demand surge in 2023. Broader industry-wide benefits include enhanced supplier linkages in steel, electronics, and logistics, strengthening the domestic grid supply chain.

V. IMPLICATIONS FOR U.S. ENERGY STRATEGY AND ECONOMIC POLICY

Strengthening domestic energy supply chains is more than a technical shift but a move that’s reshaping America’s energy future and the economic decisions that come with it. Procurement consultants are instrumental in guiding energy firms through localization strategies, equipping them with critical insights like market intelligence, supplier mapping, and risk assessments that sharpen sourcing decisions and support resilient, cost-effective supply chains (GEP, 2024; Egbumokei & Pub, 2025). Their expertise ensures that firms can comply with evolving federal mandates while also maximizing cost efficiency and supply reliability.

In the long run, localized supply chains enhance national resilience by reducing exposure to global shocks, ensuring sustainable growth, and spurring technological innovation (Ying et al., 2025; Campbell, 2023). Regional diversification of production and supplier relationships minimizes dependency, mitigates disruption risks, and enables coordinated responses during crises (Karanam et al., 2024). Expanding domestic production of critical assets such as transformers, batteries, and wind energy components underpins grid modernization, generates high-skilled manufacturing jobs, revitalizing regional economies (Energy Sector Management Assistance Program, 2023).

Federal policy provides the backbone for these efforts. The Infrastructure Investment and Jobs Act (IIJA) of 2021 directs $550 billion toward revitalizing infrastructure, with significant funding for clean transportation and energy projects (U.S. Department of Energy, 2021). Its grants and research initiatives accelerate the deployment of EV charging networks, alternative fuel systems, grid modernization, and zero-emission vehicles, laying the foundation for long-term energy resilience. Similarly, the Inflation Reduction Act (IRA) of 2022, hailed as a milestone in U.S. climate policy, delivers targeted funding, tax incentives, and programs that reduce renewable energy costs and expand clean electricity deployment (U.S. Environmental Protection Agency, 2025). Together, these acts advance U.S.-made equipment, strengthen manufacturing tax credits, and invest in research and development hubs, reinforcing domestic supply chains.

The implications also extend to environmental justice and community revitalization. Despite progress in renewable deployment and emissions reduction, inequities in energy access and environmental quality persist, disproportionately affecting low-income groups, Indigenous peoples, and communities of color (Oduro et al., 2024). Spatial planning, as Leire and Mikel (2024) emphasize, is essential to ensuring that energy transitions are both orderly and equitable, though its implementation remains debated. Locating new manufacturing hubs in deindustrialized or underserved regions enables policymakers to distribute the benefits of clean energy expansion more broadly, transforming supply chain resilience into a driver of equity, opportunity, and national revitalization.

VI. CONCLUSION

Reinforcing U.S. energy supply chains goes far beyond logistical efficiency, it’s a cornerstone of national strategy, shaping the country’s ability to withstand global shocks, lead in clean energy innovation, and ensure that economic progress reaches every community. This article has pointed to procurement consultants' significant role in guiding firms through localization, ensuring alignment with federal mandates while optimizing cost efficiency and supply reliability. They leverage supplier mapping, risk assessments, and market intelligence which enable energy firms to adapt proactively to the shifting global landscape while anchoring growth in domestic capability.

The analysis further emphasizes that localized supply chains contribute to operational resilience, ensure long-term economic development, technological innovation, and job creation in key energy sectors such as wind, solar, batteries, and grid modernization. Policy frameworks like the Infrastructure Investment and Jobs Act (IIJA) and the Inflation Reduction Act (IRA) provide the necessary support for this transformation, linking investment with national priorities in clean energy, decarbonization, and sustainable infrastructure. Yet the impact of these policies is maximized only when they are coupled with intentional strategies that embed equity into the energy transition, ensuring that historically underserved communities benefit from manufacturing hubs, clean technology jobs, and environmental justice initiatives.

Going forward, the path to resilient supply chains and a competitive energy economy demands a coordinated national strategy that integrates industry expertise, federal and state policy, and community needs. Blended public-private financing mechanisms will be necessary to fund infrastructure and accelerate clean technology adoption, while workforce alignment through training, reskilling, and education programs will ensure that Americans are prepared to lead in a new energy era. The urgent call is for energy firms, policymakers, and procurement professionals to unite in building strong domestic energy supply chains that reduce foreign reliance and drive a resilient, innovative, and inclusive clean energy future for the United States.

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