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Electrification of Industrial Processes & Grid Implications

High-capacity electrified loads, grid planning, and the economics of the U.S. industrial energy transition

WHITEPAPER

SCAN TO EXPLORE

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Abstract

As electrification expands beyond transportation and buildings into heavy industry, the United States power system faces a new class of very large electrified loads. This white paper examines the emerging demand created by **industrial electrification** in steel, cement, and chemical manufacturing, and evaluates its implications for grid planning, transmission development, and resource adequacy. It assesses the technologies driving the shift, quantifies the scale of new **electrification power demand**, and analyzes the policy drivers and economic trade-offs that will determine how quickly the **industrial energy transition** unfolds. The paper concludes that **heavy industry electrification** is durable and strategically significant, but that realizing its benefits without eroding reliability will require faster transmission expansion, reformed interconnection, disciplined resource planning, and market and policy frameworks that reward flexible, well-sited electrified load.

About this Paper

This paper examines the future role of **electrified manufacturing** in a lower-carbon, higher-demand U.S. power system. It is intended for utility leaders, regulators, industrial developers, investors, and system planners who must weigh high-capacity electrified industrial loads alongside data-center growth, renewables, storage, and transmission. It focuses on the demand these loads create, the conditions under which electrification is economically and operationally viable, and the planning and policy frameworks needed to align industrial decarbonization with grid reliability.

Audience and Use Cases

Readers can use this paper to inform integrated resource planning, load forecasting, transmission and interconnection strategy, industrial procurement decisions, and policy development. It is a decision-support document rather than an engineering specification or market forecast. Its purpose is to frame the strategic choices surrounding industrial electrification as the grid becomes more electrified, more capital-intensive, and more emissions-constrained.

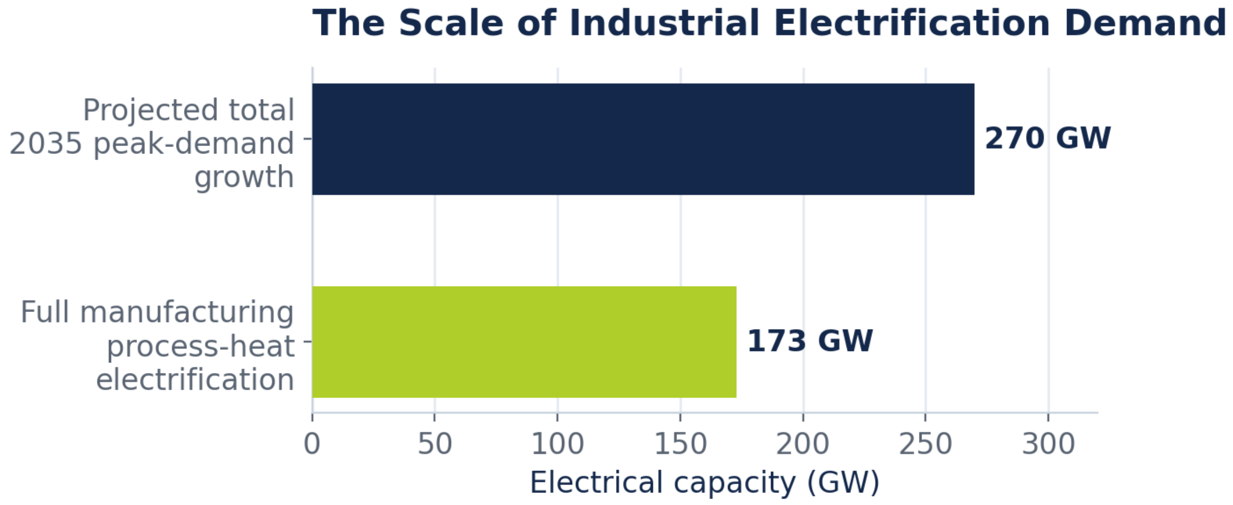
Executive Summary

After nearly two decades of flat consumption, U.S. electricity demand is climbing again, driven by artificial-intelligence data centers, the reshoring of manufacturing, and a quieter but more structural force: the electrification of heavy industry.

Industrial electrification refers to the replacement of fossil-fueled equipment, particularly combustion-based process heating, with electrically powered alternatives across heavy industry. Steel, cement, and chemical manufacturing sit at the center of this transition because they are simultaneously among the largest sources of industrial greenhouse-gas emissions and among the hardest sectors to decarbonize by means other than electrification or hydrogen. As electrified manufacturing scales, it introduces a new class of very large, capital-intensive, and sometimes highly variable electricity loads onto a transmission system already straining to accommodate data-center growth.

The implications are substantial. Complete electrification of U.S. manufacturing process heat alone could require on the order of 173 gigawatts of new capacity, a figure approaching the entire projected national peak-demand increase through the mid-2030s. Meeting this demand alongside computing and transportation growth will require the transmission network to expand several times faster than it has over the past twenty years, will tighten resource-adequacy margins, and will test the interconnection processes that govern how new loads and generators attach to the grid.

This paper examines the emerging demand from heavy industry electrification, its implications for grid planning, transmission development, and resource adequacy, and the policy drivers and economic trade-offs that will shape the pace of the industrial energy transition. The central conclusion is that industrial electrification should be planned for deliberately: as a durable source of load growth whose flexibility, siting, and timing can either strengthen or strain the grid depending on the choices utilities, regulators, and industry make in this decade.



Full electrification of manufacturing process heat approaches the scale of total projected 2035 peak-demand growth.

01

Introduction: A New Frontier for the Electron

Electrification as a decarbonization strategy first gained traction in transportation and buildings, where electric vehicles displaced internal-combustion engines and heat pumps supplanted furnaces. These applications share a convenient characteristic: the underlying energy service operates at modest temperatures and scales, and mature electric technologies were already available to deliver it. Heavy industry is a different proposition. Blast furnaces operate above 1,600°C, cement kilns approach 1,500°C, and steam crackers run continuously at enormous scale. For decades, the conventional wisdom held that such processes were effectively impossible to electrify economically.

That consensus is now eroding under the combined pressure of climate policy, corporate decarbonization commitments, maturing technology, and competitive strategy. A wave of new electric technologies, from ultra-high-temperature resistive and plasma heating to electrochemical production routes and industrial-scale heat pumps, is expanding the boundary of what can be electrified. At the same time, purchasers of steel, cement, and chemicals are beginning to pay premiums for low-carbon materials, creating a demand pull that did not exist a decade ago. Industrial electrification has moved from the margins of energy policy to a central pillar of the broader industrial energy transition.

It is worth defining terms precisely. Industrial electrification denotes the substitution of electricity for fossil fuels in industrial energy services, encompassing both direct electrification, in which electric equipment performs a task previously done by combustion, and indirect electrification, in which electricity produces an energy carrier such as hydrogen. Electrified manufacturing refers to the resulting production systems in which the primary energy input is electricity. Each concept ultimately resolves, from the grid's perspective, into a single quantity of consequence: the electrification power demand that the system must generate, transmit, and deliver.

This shift carries profound consequences because industry does not consume energy the way homes or offices do. Industrial facilities draw power at scales measured in tens or hundreds of megawatts, operate around the clock, and cluster geographically near raw materials, ports, and legacy infrastructure. When such a facility electrifies, it does not add a marginal increment of demand; it can single-handedly reshape the load profile of an entire utility service territory. Understanding the grid implications of this transition therefore requires understanding both the technologies driving it and the physical and institutional characteristics of the power system that must absorb it.

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KEY TAKEAWAY

Electrifying heavy industry adds a fundamentally new class of very large loads to the grid — grasping it means understanding both the technology and the power system that must absorb it.

Electrifying heavy industry introduces an entirely new class of very large loads onto the power grid.

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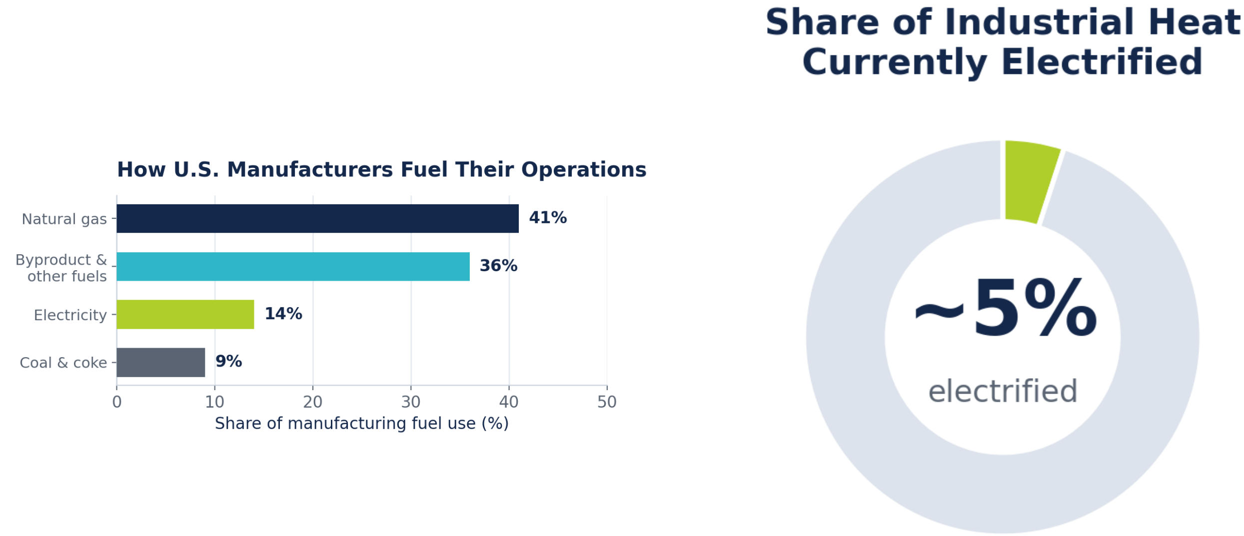
02

The Industrial Energy Landscape & the Scale of the Opportunity

To appreciate the magnitude of what electrification implies, it helps to begin with how industry currently uses energy. The U.S. industrial sector is dominated by manufacturing, which accounts for roughly three-quarters of industrial end-use energy consumption. Within manufacturing, the single largest use of energy is process heating, the thermal energy required to melt, react, dry, distill, and transform raw materials. Process heating represents the majority of manufacturing energy demand, and the overwhelming share of it is supplied today by burning fossil fuels, principally natural gas. Electricity has historically accounted for only about 14 percent of manufacturers' energy use, confined largely to motors, lighting, and specialized electric processes such as electric-arc steelmaking.



Natural gas dominates manufacturing fuel use, and only about 5% of industrial heat is currently electrified — defining the size of the opportunity.

This imbalance defines the opportunity. Natural gas supplies close to 40 percent of total manufacturing energy, and roughly a third of all natural gas consumed in the United States flows to industry. Only a small fraction of industrial heat, on the order of four to five percent globally, is currently generated with electricity. Every unit of that thermal demand that shifts from combustion to electric technology represents new electrification power demand added to the grid. Because process heat is so dominant, the theoretical ceiling for new electric load is enormous: analysts estimate that electrifying the entire manufacturing sector's process-heating needs would require approximately 173 gigawatts of electrical capacity, excluding additional demand from electrifying feedstock chemistry and on-site transportation.

The commercial momentum is already visible in market data. The U.S. industrial electrification market was valued at roughly 11 billion dollars in 2024 and is projected to roughly double to more than 22 billion dollars by 2034, an annual growth rate near eight percent. The sectors leading adoption are precisely those with intense heat or power requirements: food processing, chemicals, steel, cement, and automotive manufacturing. This growth reflects a structural reorientation of capital toward electric equipment, signaling that industrial electrification is transitioning from pilot demonstrations to commercial deployment across a widening range of applications.

173 GW
process-heat electrification potential

~14%
electricity share of mfg. energy today

~5%
industrial heat electrified today

★ **KEY TAKEAWAY**

Because process heat dominates industrial energy and is barely electrified today, the ceiling for new electric demand is enormous — about 173 GW for manufacturing heat alone.

Process heating dominates manufacturing energy use, and only a sliver of it is electrified today.

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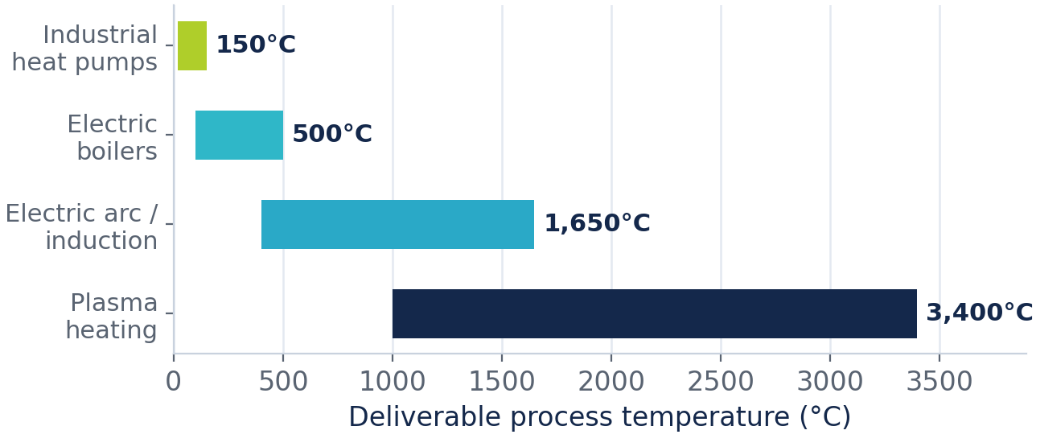
Technologies Reshaping Heavy Industry

The technical feasibility of heavy industry electrification varies sharply by process temperature and by whether combustion serves only to supply heat or is chemically embedded in production. For low- and medium-temperature applications, the tools are mature and often superior to their fossil-fueled counterparts. Industrial heat pumps can deliver process heat up to roughly 150°C while achieving a coefficient of performance between three and five, meaning they produce three to five units of useful heat for every unit of electricity consumed. This efficiency advantage is decisive, and the commercial scale is no longer trivial: the world's largest industrial heat pump, a 162-megawatt system, now demonstrates that electrified process heat can be deployed at grid-relevant scale.

For higher temperatures or simple drop-in replacement of gas boilers, electric resistance boilers can match the temperature range of conventional boilers, delivering steam up to roughly 500°C. When paired with thermal energy storage, or heat batteries, these systems gain the ability to consume electricity when it is cheapest and abundant, transforming an inflexible industrial load into a potentially grid-friendly, dispatchable one, a characteristic that becomes increasingly important as variable renewable generation grows.

Temperature Reach of Electrified Heat Technologies



Electrified heat technologies now span the full temperature range of industrial processes, from heat pumps to plasma.

Sector	Conventional route	Electrified pathway	Status
Steel	Coal-fired blast furnace	Hydrogen direct reduction + electric-arc furnace	Commercial / scaling
Cement	Fossil-fired rotary kiln	Electric / plasma kilns; electrochemical cement	Pilot / first-of-a-kind
Chemicals	Gas-fired steam crackers & boilers	Electric boilers, e-crackers, electrochemistry	Emerging
Low/med heat	Natural-gas boilers	Heat pumps + thermal storage; e-boilers	Mature

Table 1. Electrified pathways for the principal heavy-industry sectors.

Steelmaking illustrates both the promise and the complexity of electrification. The electric-arc furnace, which melts scrap using electrical energy, already accounts for a large and growing share of production, and the overwhelming majority of new global steelmaking capacity now favors electric-arc routes. The frontier lies in primary steelmaking, where the emerging pathway couples hydrogen-based direct reduction with electric-arc melting, using green hydrogen from electrolysis to strip oxygen from iron ore, leaving water as the byproduct. Sweden's Stegra, formerly H2 Green Steel, is constructing a flagship facility anchored by a 690-megawatt electrolyzer, targeting five million tonnes of steel by 2030 with emissions up to 95 percent below the blast-furnace baseline. The project demonstrates that primary steelmaking can be reconceived as an electricity-intensive enterprise, though the enormous electrolyzer load underscores the grid burden such facilities impose.

Cement presents perhaps the sternest challenge because a large share of its emissions arises not from combustion but from the chemical decomposition of limestone during calcination. Electrification alone cannot eliminate these process emissions, which is why the most promising approaches combine electric heating with novel chemistry. Electric and plasma-based kilns can replace fuel combustion, while electrochemical routes such as those pioneered by Sublime Systems produce reactive cement at ambient temperature using electricity in place of a combustion-driven kiln. Across steel, cement, and chemicals, the common thread is that decarbonization increasingly means electrification, and electrification means new, large, and often continuous demands on the power grid.

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KEY TAKEAWAY

Across steel, cement, and chemicals, decarbonization increasingly means electrification — and electrification means new, large, and often continuous demands on the grid.

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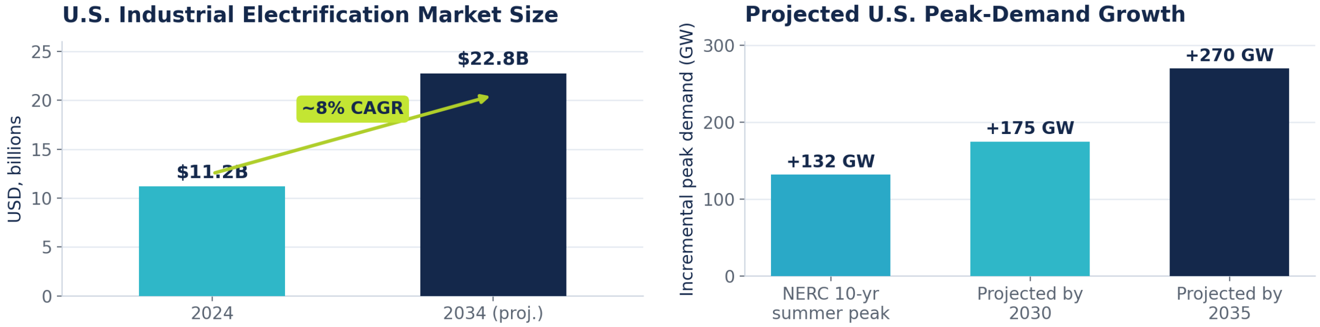
Quantifying the New Electrification Power Demand

The aggregate effect of these technology shifts, layered atop growth from data centers and transportation, is a projected surge in electricity demand without recent precedent. After nearly twenty years of flat consumption, U.S. electricity generation set consecutive annual records in 2024 and 2025, and demand is now expected to climb across all customer classes. Grid planners have responded with sharply upward forecast revisions: reliability assessments indicate summer peak demand could rise by well over 130 gigawatts over the coming decade, and some independent forecasts place the increase in peak load at roughly 175 gigawatts by 2030 and 270 gigawatts by 2035.



A rapidly growing market for electrification equipment (left) accompanies unprecedented projected peak-demand growth (right).

Industrial electrification is a meaningful and growing component of these projections, and its contribution is qualitatively distinct from that of data centers. Where a hyperscale data center might add tens of megawatts at a single site, an electrified steel mill, chemical complex, or green-hydrogen facility can add hundreds of megawatts, and the electrolyzers that feed hydrogen-based processes present some of the largest loads on any system. The 173-gigawatt estimate for manufacturing process heat, if realized over the coming decades, would by itself approach the scale of the entire projected national peak-demand increase.

Attribute	Electrified industrial load	Hyperscale data-center load
Siting	Dispersed; tied to existing plants, ports, resources	Concentrated in a few favored hubs
Timeline	Multi-decade equipment replacement cycle	Compressed 2-4 year build cycles
Profile	Steadier; some fast-ramping electrolyzers	High, steady; sharp AI training swings
Price sensitivity	High — thin industrial margins	Lower — well-capitalized developers
Flexibility	Buffered by thermal / H_2 storage	Emerging via curtailment & workload shifting

Table 2. Industrial electrified load differs from data-center load in siting, timing, and flexibility.

This new demand differs from historical industrial load in another respect: its temporal and spatial characteristics can be more variable and concentrated. Electrolyzers and some electric heating processes can ramp quickly, and when clustered they create steep local demand gradients that stress equipment designed for smoother profiles. At the same time, processes coupled with thermal storage or hydrogen buffering can be operated flexibly. Whether industrial electrification aggravates or eases grid stress therefore depends heavily on how these loads are designed, sited, and operated.

$11B → $22B
U.S. electrification market, 2024–2034

+270 GW
projected peak-demand growth by 2035

173 GW
full process-heat electrification

★

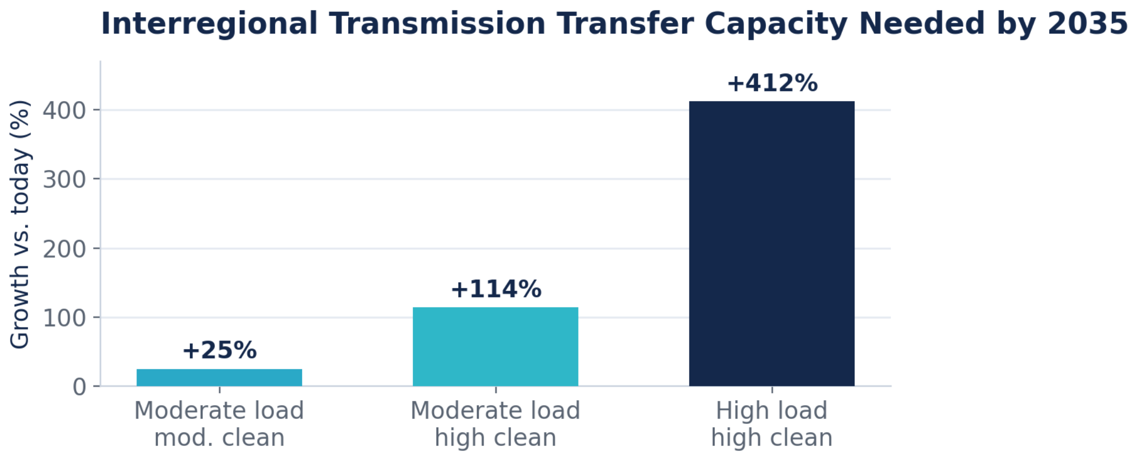
KEY TAKEAWAY

Industrial electrification is steadier and more dispersed than data-center load, yet at ~173 GW of potential it rivals the entire projected national peak-demand increase.

05

Grid Planning & Transmission Development

The transmission system is the sinew connecting generation to load, and it is emerging as the binding constraint on both industrial electrification and the wider load-growth phenomenon. Federal transmission studies conclude that the contiguous network will need to at least double in size by mid-century to maintain reliability at least cost, and that in scenarios combining high electrification with high clean-energy penetration, interregional transfer capacity may need to expand several-fold. Estimated investment reaches well beyond two trillion dollars by 2050 in electrification-intensive futures. To meet even moderate load growth, the grid may need to expand more than five times faster than it did over the previous two decades.



Interregional transfer capacity may need to grow modestly or dramatically by 2035, depending on load and clean-energy trajectories.

Compounding the challenge, much of the existing network is aging, with a substantial share of transmission infrastructure at or beyond its intended service life. New industrial loads therefore arrive on a system that must simultaneously be expanded and renewed. Building transmission is notoriously slow: major lines routinely require a decade or more to advance through planning, siting, permitting, cost allocation, and construction, timelines that sit uneasily against industrial investment cycles measured in a few years. Given these constraints, attention is turning to grid-enhancing technologies, including dynamic line rating, advanced power-flow control, and reconductoring with advanced composite conductors, which can raise the throughput of existing corridors at a fraction of the cost and time of new construction.

The interconnection process, by which new loads and generators secure the right to connect, has become a particular bottleneck. Queues at regional grid operators ballooned over the past decade, with projects facing delays of three to five years or longer. The rapid arrival of very large loads has exposed the absence of clear, standardized rules for connecting industrial and data-center demand. In late 2025 the Department of Energy directed the Federal Energy Regulatory Commission to consider reforms to how large loads, generally those exceeding 20 megawatts, interconnect to the interstate transmission system, with a final rule directed for the spring of 2026. How these reforms resolve will materially shape the speed at which electrified manufacturing can come online.

2×
transmission network needed by 2050

$2.2T+
transmission investment by 2050

>20 MW
FERC large-load interconnection threshold

★ **KEY TAKEAWAY**

Transmission and interconnection — not technology — are the binding constraints; the grid must expand several times faster than it has in decades.

High-voltage transmission is the binding constraint on delivering new industrial load.

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Resource Adequacy in an Era of Large, Variable Loads

Resource adequacy, the assurance that enough capacity and demand-side resources exist to meet demand at all times, is under renewed pressure as load growth outpaces new supply. Many utilities report robust demand growth while lacking the ability to bring new resources online quickly, and the option of purchasing capacity from neighbors is narrowing because available headroom is shrinking across broad regions simultaneously. The result is a tightening of reserve margins and a growing risk that the pace of electrification, if unmanaged, could erode reliability.

Large industrial and computing loads also introduce novel operational risks. In 2025 the North American Electric Reliability Corporation's large-load task force issued a formal alert highlighting grid disturbances, inadequate modeling, insufficient technical interconnection requirements, and a lack of operating protocols for the influx of very large loads. Certain electrified processes, particularly electrolyzers and some arc-based heating, can exhibit rapid fluctuations that, at scale, affect bulk-system stability. Planners accustomed to the smooth, predictable profiles of traditional heavy industry must now account for load behavior that can shift within seconds, and interconnection standards are being rewritten to require that such loads ride through disturbances rather than tripping offline en masse.

The most promising path through these constraints lies in load flexibility. Rather than treating every new industrial load as a fixed obligation requiring firm capacity at all hours, operators and large customers are exploring arrangements in which loads curtail or shift during system stress. Research by the Brattle Group suggests that integrating flexible large loads could unlock more than 100 billion dollars in customer savings and allow systems such as PJM to absorb tens of gigawatts of additional demand without commensurate new generation. For electrified industry, flexibility is often a natural fit: processes buffered by thermal storage, hydrogen inventory, or intermediate product stockpiles can modulate their electricity draw with limited disruption to output. Co-location of large loads with dedicated generation, together with behind-the-meter storage, offers a complementary route that can relieve interconnection pressure while insulating other ratepayers from the cost of serving new demand.

KEY TAKEAWAY

Load flexibility is the pivot: electrified processes buffered by thermal or hydrogen storage can shift demand, easing resource adequacy and unlocking large system-wide savings.

07

Policy Drivers & the Shifting Federal Landscape

Public policy has been a powerful accelerant of industrial electrification, though the federal posture has grown less certain. The Inflation Reduction Act established a suite of incentives relevant to heavy industry, most notably the expanded Qualifying Advanced Energy Project Credit under Section 48C, which provided 10 billion dollars in allocations for clean-energy manufacturing, critical-materials processing, and industrial decarbonization. Projects qualifying under the industrial-decarbonization category must install equipment that reduces facility emissions by at least 20 percent, and can receive a credit worth up to 30 percent of eligible investment. The related Section 45X production credit, Department of Energy loan authority, and the Industrial Demonstrations Program created a layered architecture of support for firms investing in electrified and low-carbon production.

Instrument	Mechanism	Scale & relevance
Section 48C	Investment tax credit up to 30%	$10B allocated; retrofits cutting emissions ≥20%
Section 45X	Production tax credit	Supports clean-equipment manufacturing
Industrial Demos	Cost-shared grants (OCED)	Multi-billion; steel, cement, chemicals first-of-a-kind
DOE loans	Loan guarantees (LPO)	De-risks large capital projects

Table 3. Principal federal instruments supporting industrial electrification and decarbonization.

The Industrial Demonstrations Program was designed to channel several billion dollars into first-of-a-kind projects in the highest-emitting industries, precisely the iron and steel, cement, chemicals, and other energy-intensive sectors at the heart of electrification. These programs reflected a recognition that initial commercial deployments carry substantial technology and market risk, and that public co-investment could bridge the gap between demonstration and self-sustaining adoption.

The policy environment, however, has become more volatile. In 2025 the Department of Energy moved to terminate funding for a slate of advanced-manufacturing projects, including prominent low-carbon cement ventures, and subsequent legislation altered the trajectory of several clean-energy tax credits. This reversal introduced significant uncertainty for developers and investors, some of whom scaled back plans after losing anticipated backing. Yet the underlying drivers, corporate decarbonization commitments, customer demand for low-carbon materials, and state-level policy, persist independently of any single administration, suggesting the direction of travel is durable even if the speed is contested.

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KEY TAKEAWAY

Policy has powerfully accelerated industrial electrification, but as federal support wavers, its durability now rests on corporate commitments, customer demand, and state-level policy.

Federal incentives accelerated industrial decarbonization; corporate and state demand now carry it forward.

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The Economics & Trade-offs of Industrial Electrification

Ultimately, the pace of heavy industry electrification will be governed less by technical feasibility than by economics. The central concept is the spark gap: the difference between the cost of producing heat with electricity and the cost of producing the same heat by burning natural gas, adjusted for conversion efficiency. In much of the United States, abundant and inexpensive natural gas has kept the spark gap wide, meaning that on a simple operating-cost basis, electrified process heat remains more expensive than combustion despite the superior efficiency of technologies like heat pumps. This explains why low- and medium-temperature applications, where efficient heat pumps can partially close the gap, are electrifying faster than high-temperature ones.

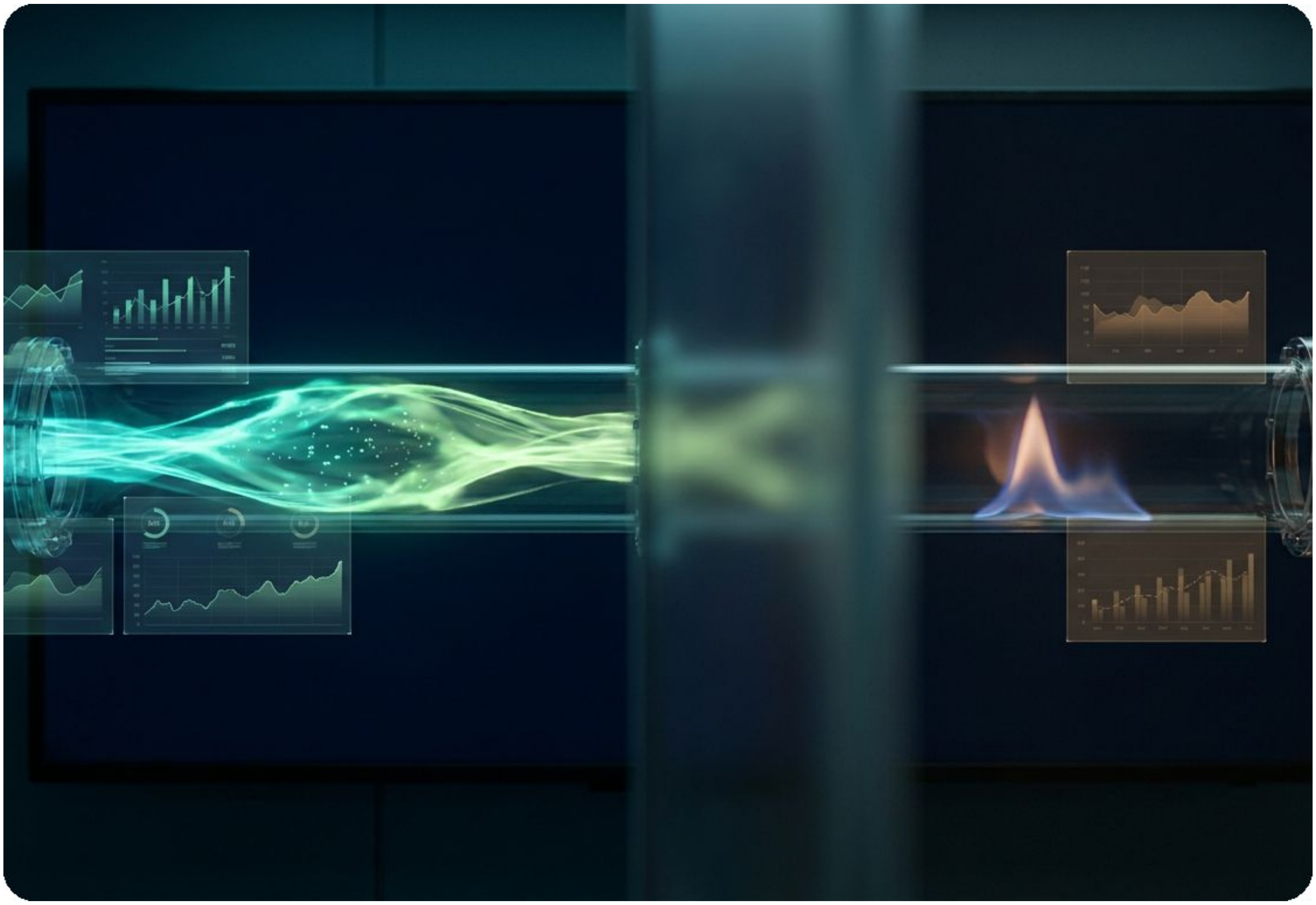
The efficiency of the electric technology is decisive in determining whether the spark gap can be bridged. A heat pump delivering three to five units of heat per unit of electricity can be competitive with gas even when electricity costs several times more per unit of energy. Electric resistance heating, by contrast, converts electricity to heat at roughly one-to-one, so the full price differential falls directly on the operating budget, making resistance-based process heat difficult to justify on operating cost alone in gas-rich markets. This efficiency hierarchy explains the observed pattern of adoption and points to where policy support, carbon pricing, or thermal-storage integration will be most needed.

Evaluating electrification decisions requires looking beyond fuel prices to the levelized cost of heat, which incorporates capital, operating, maintenance, and financing costs over an asset's lifetime. Electric equipment often carries higher capital costs but can offer lower maintenance, improved process control, higher product quality, and freedom from on-site combustion emissions. When carbon pricing, avoided compliance costs, customer premiums for low-carbon products, and the efficiency advantage of heat pumps are incorporated, the economic case strengthens considerably.

An important and somewhat paradoxical dynamic is emerging in the relationship between electricity and gas prices. Even as natural gas has remained relatively cheap, retail electricity prices have risen, driven by the very load growth and capital-investment pressures described in this paper. A widening gap between electricity and gas prices signals a system in which the costs of expanding and reinforcing the grid are being passed through to rates faster than cheap fuel can offset them. For industrial electrification, this cuts both ways: rising electricity prices can lengthen payback periods, yet they also reflect a grid whose expansion is essential to accommodating the very loads that electrification creates. Regulators face the delicate task of allocating this enormous capital investment fairly, so the transition does not impose undue costs on residential and small-commercial ratepayers.

KEY TAKEAWAY

The spark gap sets the pace: efficient heat pumps, thermal storage, and carbon pricing close it, while fair cost allocation keeps rising electricity prices from overburdening households.



The cost gap between electricity and natural gas determines how fast heavy industry electrifies.

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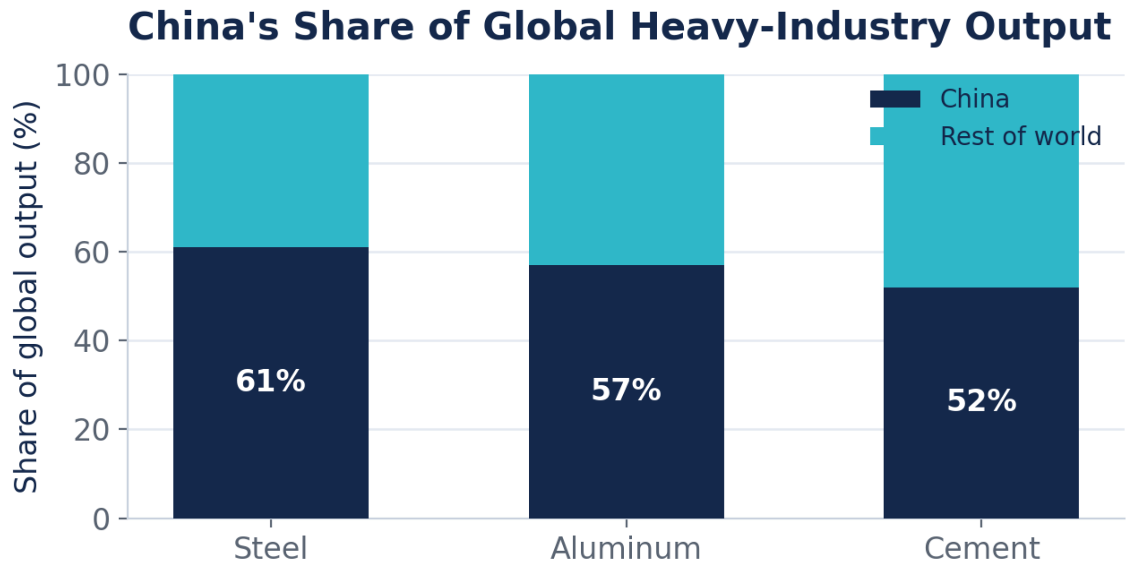
Global Context & Competitive Dynamics

Although this paper focuses on the United States, industrial electrification is a global phenomenon shaped by international competition and cross-border technology flows. Europe has moved aggressively, motivated by ambitious climate targets and a desire to reduce dependence on imported fossil gas. Heat pumps and electric-arc furnaces already satisfy a majority of Europe's industrial heat demand, and industry groups project that share could rise toward 90 percent by the mid-2030s. Europe's flagship projects, including Sweden's Stegra green-steel plant, demonstrate that primary heavy industry can be rebuilt around electricity and hydrogen.



China produces the majority of the world's steel, aluminum, and cement, making its electrification trajectory decisive for global outcomes.

China occupies a pivotal position by virtue of its scale, accounting for the majority of global production of steel, aluminum, and cement. Because its industrial base is so large and, in the case of steel, still heavily reliant on coal-based blast furnaces, the trajectory of Chinese industrial electrification will substantially determine the global emissions outcome. China's dominance in manufacturing electric equipment, from electrolyzers to heat pumps, positions it to be both a major adopter and the world's principal supplier of electrification technology. For the United States, this raises a strategic dimension: industrial electrification is not only an environmental and grid-planning question but a matter of manufacturing competitiveness and supply-chain security.

The competitive logic is straightforward. As global customers and regulators increasingly favor low-carbon materials, manufacturers that electrify early may secure access to premium markets and insulate themselves from future carbon costs, while laggards risk stranded assets and trade disadvantages, particularly where border-adjustment mechanisms penalize carbon-intensive imports. For American heavy industry, the electrification decision is therefore entangled with questions of long-term market access and industrial strategy, not merely energy cost.

61%	57%	52%
China's share of global steel	global aluminum output	global cement output

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KEY TAKEAWAY

Because China makes most of the world's steel, aluminum, and cement, its electrification path — and America's response — will shape both global emissions and industrial competitiveness.

China's dominant share of global heavy industry makes its electrification path decisive worldwide.

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10

Strategic Outlook & Recommendations

The trajectory of industrial electrification and its grid implications will be determined by choices made over the next several years. For grid planners and utilities, the imperative is to modernize planning to treat large industrial loads as a first-order variable rather than a rounding error. This means integrating credible electrification scenarios into long-term forecasts, accelerating transmission development through improved planning and cost-allocation frameworks, and reforming interconnection so that both large loads and the generation to serve them can attach to the grid on timelines compatible with industrial investment. It also means embracing load flexibility as a core planning resource.

For industrial firms, the strategic calculus increasingly favors early and deliberate engagement with electrification, even where near-term economics remain marginal. Facilities that begin electrifying low- and medium-temperature processes now can build operational experience, capture efficiency gains, and position themselves for a marketplace that is progressively rewarding low-carbon production. Coupling electrified processes with on-site or contracted clean generation and with storage can mitigate exposure to volatile electricity prices and ease the interconnection burden.

For policymakers and regulators, the central task is to provide durable, predictable signals that reduce the risk borne by first movers while ensuring the costs and benefits of the transition are distributed equitably. Stable incentives for industrial decarbonization, streamlined permitting for transmission and generation, and market rules that value flexibility and reliability would together lower the cost of capital for electrified manufacturing and accelerate grid expansion. Equally important is protecting ratepayers by ensuring the substantial investments required to serve new industrial load are allocated in proportion to the benefits received.

KEY TAKEAWAY

Industrial electrification is a durable source of load growth; whether it strengthens or strains the grid depends on the planning, transmission, and market choices made this decade.

Key Findings

The analysis yields four principal findings for decision-makers evaluating high-capacity electrified industrial loads in a lower-carbon, higher-demand grid.

- → Industrial electrification is a durable, structural source of load growth. Complete electrification of manufacturing process heat alone could add roughly 173 GW, approaching the scale of total projected peak-demand growth through the mid-2030s.
- → Transmission and interconnection, not technology, are the binding constraints. The grid must expand several times faster than in the past two decades, and large-load interconnection rules must be reformed for electrified manufacturing to come online on industrial timelines.
- → Flexibility determines whether new load strains or strengthens the grid. Electrified processes buffered by thermal or hydrogen storage can shift consumption, easing resource-adequacy pressure and unlocking large system-wide savings.
- → Economics and policy set the pace. Closing the spark gap through efficient heat pumps, thermal storage, carbon pricing, and stable incentives is decisive, and equitable cost allocation is essential as grid investment raises electricity prices.

Method and Scope

This paper is based on a review of public reliability assessments, government energy statistics, market and policy materials, and industry and technical literature. It is qualitative and strategic rather than a production-cost study or engineering specification. The discussion emphasizes U.S. market conditions and selectively draws on international examples that illustrate broader lessons about industrial electrification, grid planning, and decarbonization. All figures are drawn from the sources listed in the references.

Conclusion

Industrial electrification is a grid-planning imperative, not merely a decarbonization goal

Electrification is escaping the confines of transportation and buildings and entering the domain of heavy industry, where its consequences for the electricity system will be larger and more structural than anything seen to date. Steel, cement, and chemical manufacturing, long regarded as immovable bastions of combustion, are beginning to electrify as technologies mature, demand for low-carbon materials grows, and the strategic logic of the industrial energy transition takes hold.

The resulting electrification power demand, layered atop growth from data centers and transportation, confronts a transmission system that must expand faster than at any time in living memory, resource-adequacy margins that are tightening, and interconnection processes straining to keep pace. None of these challenges is insurmountable, but none will resolve itself. The grid can accommodate heavy industry electrification only through deliberate investment in transmission, disciplined resource planning, reformed interconnection, and the intelligent deployment of load flexibility.

The United States can lead in electrified manufacturing, but only if it treats the build-out of its grid and its clean-industrial supply chains as the strategic priorities they have become. The decisions made in this decade about how to plan, finance, and operate the power system will determine whether industrial electrification becomes a source of competitive strength and reliable, decarbonized production, or a bottleneck that constrains the nation's industrial future.

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