



**CONGRESSIONAL
PROGRAM**
aspen institute

Powering America: Affordability and Reliability in a New Energy Era

August 23-28, 2026 | Seward and Utqiagvik,
Alaska



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AGENDA¹

SUNDAY, August 23

U.S. participants arrive in Anchorage, AK throughout the day.

3:30 – 5:30 PM: Travel from Anchorage to Seward

6 – 7:30 PM: Pre-Dinner Remarks

Welcome to Alaska and Indigenous Life and Leadership in Alaska

Alaska Native peoples have inhabited this land for thousands of years and today play a central role in the state's economy, governance, and decisions about land and resources. This conversation will introduce Members to the perspectives and priorities of Alaska Native leadership, including the role of Alaska Native corporations, tribal governance, subsistence traditions, and the partnerships between indigenous communities and federal, state, and private actors in shaping Alaska's future.

Speakers:

Willie Hensley, *former AK State Legislator*

Senator Lisa Murkowski, *United States Senator for Alaska*

7:30 – 9 PM: Working Dinner

Seating is arranged to expose participants to a diverse range of views and provide the opportunity for a meaningful exchange of ideas. Scholars and lawmakers are rotated daily.

MONDAY, August 24

8 – 8:45 AM: Breakfast

9 – 9:15 AM: Introduction and Framework of the Conference

This conference is organized into roundtable conversations, working lunches, site visits, pre-dinner remarks and working dinners. This segment will highlight how the conference will be conducted, how those with questions will

¹ Congressional Program Executive Director Charlie Dent moderates the discussion sessions, recognizes members of Congress who have questions, and is assisted by a timekeeper to ensure the conversation is quick paced and every member of Congress has an opportunity to ask questions and discuss the issues.

be recognized and how responses will be timed to allow for as much engagement as possible.

Speaker:

Charlie Dent, *Executive Director and Vice President, Aspen Institute Congressional Program*

9:15 – 10:45 AM: Roundtable Discussion

The Rising Stakes – Demand, Competition, and the New Energy Build-Out

For the first time in decades, U.S. electricity demand is growing — and growing fast. Data centers, manufacturing reshoring, federal incentives for domestic production, and the electrification of transport and buildings are converging to create load growth that the system was not planned for. But this is not just an infrastructure challenge. The countries that can deliver abundant, affordable, reliable power will attract the industries that define the next economic era — AI, advanced manufacturing, semiconductors. The question of who becomes an “electrostate” is as consequential as the question of who controlled oil in the 20th century, and the United States faces serious competition from China on multiple fronts: grid buildout speed, clean energy manufacturing, critical mineral supply chains, and the willingness to deploy industrial policy at scale. This session lays out what is at stake — the scale and geography of new demand, the competitive landscape, and the gap between what the U.S. energy system is being asked to do and what it can currently deliver.

Speakers:

Amos Hochstein, *Former United States Assistant Secretary of State for Energy Resources & Managing Partner, TWG Global*

Sec. Ernest Moniz, *Former US Secretary of Energy, Founder and Chief Executive Officer, Energy Futures Initiative*

Gretchen Watkins, *former President, Shell USA*

10:45 – 11 AM: Break

11 AM – 12:30 PM: Roundtable Discussion

Future of U.S. Energy Security: Natural Gas, Oil, LNG, and Emerging Technologies

Natural gas remains central to the U.S. energy system, providing affordable baseload electricity at home and serving as a significant export commodity abroad. Oil continues to play a defining role in the American economy and in

global markets. Speakers will address the future of domestic production and infrastructure, the role of LNG in global markets and geopolitical strategy, and the policy considerations surrounding continued development of domestic supply.

Speakers:

Jason Bordoff, *Founding Director, Center on Global Energy Policy, Columbia University*

Bob McNally, *Founder & President, Rapidan Energy*

12:30 – 1:15 PM: Working Lunch

Discussion continues between members of Congress and scholars on U.S. Energy Security. Seating will be arranged to create conversation centered around Amos Hochstein, Sec. Ernest Moniz, Gretchen Watkins, Jason Bordoff, and Bob McNally to dive deeper into conversations discussed at the roundtables earlier.

2 – 3:30 PM: Exit Glacier Tour

As one of the most accessible glaciers in Alaska, Exit Glacier has been retreating over the past century due to rising global temperatures. Along the trail, signs mark where the glacier was located in previous years, making it easy to observe how much it has changed over time. This helps visitors understand the long-term impact of environmental changes on glaciers and ecosystems.

4:45 – 5:40 PM: Pre-Dinner Remarks

Natural Resources in Alaska

Alaska's identity, economy, and place in the national energy conversation are inseparable from the scale of its natural resources. This conversation will introduce Members to Alaska's energy and mineral landscape — oil, natural gas, hydropower, timber, fisheries, and critical minerals — and the role these resources have played, and continue to play, in the life of the state and in broader American energy and economic security.

Speakers:

Dr. Gwen Holdmann, *Chief Scientist, ACEP*

6 – 7:45 PM: Working Dinner

Seating is arranged to expose participants to a diverse range of views and provide the opportunity for a meaningful exchange of ideas. Scholars and lawmakers are rotated daily. Discussions will focus on energy and natural resources.

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TUESDAY, August 25

8 – 8:45 AM: Breakfast

9 – 11 AM: Roundtable Discussion

The Grid of the Future – Modernization, Interconnection, and Permitting Reform

The U.S. power system is being asked to absorb unprecedented demand growth at the very moment it confronts aging infrastructure, severe weather, and a shifting generation mix. Meeting this moment requires action on multiple fronts simultaneously: modernizing the grid with advanced technologies, clearing the interconnection queue that has become a bottleneck for new generation, reforming transmission planning and siting to enable interregional buildout, and overhauling permitting processes that add years to project timelines. This session addresses the investments, technologies, and regulatory reforms needed to build the grid the country needs — covering grid-enhancing technologies, interconnection and queue reform, transmission siting, natural gas pipeline permitting, and the federal-state dynamic in energy infrastructure governance.

Speakers:

Doug Arent, *Global Fellow, Columbia University Center on Global Energy Policy*

Vilas Dhar, *President, McGovern Foundation*

Rob Gramlich, *President, Grid Strategies*

11 – 11:15 AM: Break

11:15 – 1 PM: Roundtable Discussion

The Decline of Globalization & The Rise of Security in Supply Chains

The United States is an energy superpower in production but faces serious vulnerabilities in the supply chains that underpin its energy system — critical minerals, battery manufacturing, solar components, enriched uranium, and the industrial inputs required for grid buildout. China dominates many of these supply chains, and the question of how to reduce that dependence has become one of the most consequential policy debates in Washington. This session examines the supply chain landscape, the competitive dynamics with China, and the industrial policy toolkit: why, where, and how should the United States use targeted intervention to bolster certain supply chains over others? Discussion

will consider what has worked (CHIPS Act), what has struggled (battery supply chains), the FORGE framework for allied mineral coordination, and the tradeoffs between speed, cost, and strategic autonomy.

Speakers:

Robin Millican, *Director of Research Programs and Strategic Partnerships, Columbia University*

Dave Turk, *Former US Deputy Secretary of Energy*

1 – 2 PM: Working Lunch

Discussion continues between members of Congress and scholars on globalization and supply chains. Seating will be arranged to create conversation centered around Sec. Dave Turk, Robin Millican, Doug Arent, Rob Gramlich, and Vilas Dhar to dive deeper into conversations discussed at the roundtables earlier.

2 – 4 PM: Discussions with Scholars

Scholars will meet with members of Congress for in-depth discussion of ideas raised in the morning sessions, including Doug Arent, Vilas Dhar, Rob Gramlich, Robin Millican, and Dave Turk.

4 – 5 PM: Pre-Dinner Remarks

The Economics of Energy – Affordability, Cost Allocation, and Who Pays

Americans are paying more for electricity, and the pressures behind those increases are multiplying — aging infrastructure, tight supply chains, higher capacity prices, and the challenge of allocating costs when a hyperscaler or chip fab lands in a utility's territory. This fireside examines the federal and state policy tools that can keep energy affordable for households and businesses: rate design, cost allocation for new interconnection, utility incentive structures that may favor capital investment over grid optimization, tax policy, and demand flexibility. The conversation will also drill into Alaska's specific affordability challenges — the cost of serving remote communities and the fiscal tradeoffs that come with energy-dependent public finances.

Speakers:

Alex Flint, *Executive Officer, Alliance for Market Solutions*

Clay Koplin, *Chief Executive Officer, Cordova Electric Cooperative*

5 – 9 PM: Working Dinner

Seating is arranged to expose participants to a diverse range of views and provide the opportunity for a meaningful exchange of ideas. Scholars and

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lawmakers are rotated daily. Discussions will focus on energy affordability.

WEDNESDAY, August 26

8 – 9:30 AM: Working Breakfast

Seating is arranged to expose participants to a diverse range of views and provide the opportunity for a meaningful exchange of ideas. Scholars and lawmakers are rotated daily.

9:30 AM – 11:30 AM: Travel from Seward to Anchorage Airport

2:02 – 4 PM: Flight from Anchorage to Utqiagvik, Alaska

4:30 – 6 PM: Welcome Remarks with Local Community Leaders

Visitors will hear from local community leaders in Utqiagvik, AK about daily challenges and what life is like on the Arctic.

Speakers:

Nagruk Harcharek, *President & CEO, Voice of the Arctic Iñupiat*

Josiah Aullaqsruaq Patkotak, *Mayor, North Slope Borough*

6 – 7 PM: Arctic Circle Site Visit

Tundra Tour with Northern Voices

Visitors can see evidence of thawing permafrost, changes in vegetation, altered drainage patterns, and coastal erosion. These observations help explain how rising temperatures affect Arctic ecosystems and contribute to global environmental changes.

7 – 9 PM: Working Dinner

Seating is arranged to expose participants to a diverse range of views and provide the opportunity for a meaningful exchange of ideas. Scholars and lawmakers are rotated daily. Discussions will focus on Arctic security.

THURSDAY, August 27

7:30 – 8:30 AM: Breakfast

9 – 11 AM: Roundtable Discussion

The Arctic: Energy, Climate, and Geopolitics

The Arctic is rising in strategic importance. Retreating ice is opening new shipping routes and access to energy and mineral resources, drawing sustained attention from the United States, its allies, and its competitors. This session examines how energy policy, environmental change, and national security intersect in the Arctic, including the roles of the United States, Russia, China, and Arctic allies; the implications for energy infrastructure and resource development; and the opportunities for American leadership in a region whose importance to global affairs continues to grow.

Speakers:

Bridget Anderson, *Senior Vice President of External Affairs, Arctic Slope Regional Corporation*

Heather A. Conley, *Nonresident Senior Fellow, American Enterprise Institute*

Amb. Mike Sfraga (ret.), Ph.D., *University of Alaska Fairbanks*

11 – 11:15 AM: Break

11:15 AM – 12:45 PM: *Policy Reflections for Members of Congress*

This time is set aside for members of Congress to reflect on what they have learned during the conference and discuss their views on implications for U.S. policy. Drawing on the full range of conversations throughout the week, members will seek to identify for each other the most promising takeaways for the United States policy process, with a special focus on opportunities for bipartisan cooperation. This is a members-only conversation.

12:45 – 1:15 PM: Working Lunch

Discussion continues between members of Congress and scholars on Arctic policy. Seating will be arranged to create conversation centered around Amb. Mike Sfraga and Heather Conley to dive deeper into conversations discussed at the roundtables earlier.

1:30 – 3:30 PM: Educational Site Visits on Native Communities in Utqiagvik

Visiting community facilities and local energy infrastructure for participants to learn how energy is generated, delivered, and used in a community where fuel must often be transported over long distances. This highlights the high cost of energy in remote Arctic communities and the importance of energy efficiency in reducing household expenses and improving quality of life.

10:30 PM – 12:22 AM: Flight from Utqiagvik to Anchorage, Alaska

FRIDAY, August 28

Participants begin to depart for home districts.

CONFERENCE PARTICIPANTS

MEMBERS OF CONGRESS AND THEIR SPOUSES:

Sen. John Curtis and Sue Curtis

Rep. Madeleine Dean and PJ Cunnane

Rep. Lizzie Fletcher and Scott Fletcher

Rep. Laura Gillen and Christopher Gillen

Rep. Tim Kennedy

Rep. Brad Knott and Joanna Knott

Rep. Darin LaHood and Kristen LaHood

Rep. Rick Larsen and Tiia Karlén

Rep. Nicole Malliotakis

Rep. Tracey Mann and Audrey Mann

Sen. Lisa Murkowski and Verne Martell

Rep. Donald Norcross and Andrea Doran

Rep. Frank Pallone

Rep. Deborah Ross and Stephen Wrinn

Rep. Greg Stanton

Rep. Tom Suozzi and Helene Suozzi

SCHOLARS AND EXPERTS:

Bridget Anderson	<i>Senior Vice President of External Affairs, Arctic Slope Regional Corporation</i>
Douglas Arent	<i>Global Fellow, Center for Global Energy Policy, Columbia University</i>
Jason Bordoff	<i>Founding Director, Center on Global Energy Policy</i>
Heather Conley	<i>Senior Fellow, American Enterprise Institute</i>
Vilas Dhar	<i>President, Patrick J. McGovern Foundation</i>
Alex Flint	<i>Executive Director, AMS Research</i>
Rob Gramlich	<i>President, Grid Strategies</i>
Nagruk Harcharek	<i>President & CEO, Voice of the Arctic Iñupiat</i>
Willie Hensley	<i>Chair, First Alaskans Institute</i>
Amos Hochstein	<i>Managing Partner, TWG Global Former Senior Advisor to the President for Energy and Investment</i>
Gwen Holdmann	<i>Chief Scientist, Alaska Center for Energy and Power, University of Alaska Fairbanks</i>
Clay Koplin	<i>Chief Executive Officer, Cordova Electric Cooperative</i>
Robert McNally	<i>Founder & President, Rapidan Energy Group</i>
Ernest Moniz	<i>Founder and Chief Executive Officer, Energy Futures Initiative</i>
Josiah Aullaqsruaq Patkotak	<i>Mayor, North Slope Borough</i>
Mike Sfraga	<i>Amb. (ret), Sr. Advisor, Arctic and National Security Policy, University of Alaska Fairbanks</i>
Gretchen Watkins	<i>Non-Executive Director, Rolls-Royce and Mosaic Co., Former President Shell USA, Inc.</i>

FOUNDATION REPRESENTATIVES:

John Dedrick	<i>Executive Vice President and COO, Charles F. Kettering Foundation</i>
Rachel Jackson	<i>Chief Operating Officer, American Flood Coalition</i>
Willow Latham-Proenca	<i>Associate Program Officer, Abundance & Growth, Coefficient Giving</i>
Ray Long	<i>President and Chief Executive Officer, ACORE</i>
Amber Miller	<i>President, The Hewlett Foundation</i>
Hillary O'Brien	<i>Managing Director - Clean Power, Natural Resources, and Research, ClearPath</i>
Rich Powell	<i>Chief Executive Officer, Corporate Energy Buyers Association</i>
Dan Schory	<i>Vice President of Infrastructure, Energy and Permitting, Arnold Ventures</i>
Dave Turk	<i>Environment Program Director, Hewlett Foundation</i>
Maura Weaver	<i>Associate Director of North American Advocacy, Eleanor Crook Foundation</i>

CONFERENCE RAPORTEURS:

Robin Millican	<i>Director of Research Programs and Strategic Partnerships, Columbia University</i>
Matthew Rojansky	<i>Rapporteur and Counselor to the Aspen Institute Congressional Program</i>

ASPEN INSTITUTE CONGRESSIONAL PROGRAM:

Sarah Agnew	<i>Scheduler</i>
Charlie Dent	<i>Executive Director, Congressional Program and Vice President, Aspen Institute</i>

Tyler Denton	<i>Deputy Director</i>
Jessie Frank	<i>Senior Conference Manager</i>
Jennifer Harthan	<i>Associate Director of Congressional Engagement</i>
Tess Madnick	<i>Program Assistant</i>
Thomas Tang	<i>Finance and Grants Associate</i>

RAPPORTEUR'S SUMMARY

Matthew Rojansky

Rapporteur and Counselor to the Aspen Institute Congressional Program; President and CEO, The U.S.-Russia Foundation

with **Robin Millican**

Director of Research Programs and Strategic Partnerships, Columbia University

Introduction

From August 23 to 28, 2026, the Aspen Institute Congressional Program convened a bipartisan, bicameral group of Members of Congress and leading energy experts in Seward and Utqiagvik, Alaska, for a conference on “Powering America: Affordability and Reliability in a New Energy Era.” The conference took up an agenda of increasingly converging challenges. After nearly two decades of relatively flat U.S. electricity demand, artificial intelligence, data centers, manufacturing, and electrification are driving renewed load growth just as the country confronts aging infrastructure, higher costs, supply-chain vulnerabilities, and geopolitical shocks to global oil and gas markets.

Being in Alaska made those connections uniquely visible. The state has immense oil, natural gas, critical mineral, hydroelectric, wind, and geothermal resources, yet many communities face some of the highest energy costs in the country and remain disconnected from roads or larger electric grids. Alaska Native institutions have developed distinctive models of land ownership, self-government, and resource management, while the state’s geography places it at the center of a rapidly changing Arctic that sees increased competition for shipping, resource development, scientific research, and national security. Members heard repeatedly that the same infrastructure investments can serve several purposes at once, helping lower local costs and strengthen supply chains, enable resource development, and improve U.S. security and resilience in the Arctic.

Discussions addressed the core question of how the United States can turn its resource and technological advantages into energy that is affordable, reliable, secure, and available at the speed global competition now demands. Among the approaches considered were modernizing transmission and permitting, protecting ratepayers from price surges as large new loads enter the grid, building resilient supply chains linked with allies, and sustaining an “all of the above” openness to natural gas, nuclear, renewables, battery storage, geothermal, and emerging technologies. Alaska also reinforced the lesson that durable energy policy requires local participation, long-term infrastructure investment, and a level of bipartisan support that will ensure stable policies around which communities and companies can plan.

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Indigenous Life and Leadership in Alaska

A Member from Alaska opened the conference by placing the state's resource wealth in a broader geographic and human context. Alaska makes the United States an Arctic nation, yet nearly 200 communities in the state are disconnected from the road system and depend on boats or aircraft for basic supplies like food and fuel. Fuel may arrive only twice a year by barge, most food and materials pass through the Port of Alaska, and even much of the refined fuel consumed in this oil-producing state comes from elsewhere. The Member described Alaska as an "islanded state," where distance and infrastructure shape nearly every policy question.

An Alaska Native leader and former state legislator grounded the discussion in the lived history of Indigenous communities. He recalled growing up in a one-room sod home, traveling by dog team, and subsisting on seal oil, fish, roots, and other traditional foods. Even today, hunting, fishing, and whaling are essential to food security and identity for Alaska's native communities, rather than mere cultural remnants. The Iñupiaq and related Inuit languages also connect communities across an enormous region extending through Canada to Greenland. He challenged the familiar story that the United States simply bought Alaska from Russia, noting that tens of thousands of Native people occupied distinct homelands and had no voice in the 1867 transfer.

The central issue for much of the past two centuries has been land. When U.S. statehood gave Alaska authority to select more than 100 million acres, Native leaders organized to protect lands they had long used and occupied. The discovery of oil at Prudhoe Bay increased both the threat and their need to find leverage. The state and industry needed a pipeline, and Native leaders feared their claims would disappear once development proceeded. The resulting Alaska Native Claims Settlement Act of 1971 conveyed roughly 44 million acres and nearly \$1 billion to regional and village corporations owned by Native shareholders. Rather than creating reservations managed through the Bureau of Indian Affairs as in the lower 48 states, the system gave Native corporations direct control of land and commercial resources. A revenue-sharing provision also distributes much of the income from timber and subsurface resources among regions, spreading the benefits of development beyond the places where particular resources are located.

Members asked how this model relates to Alaska's federally recognized tribes. The leader explained that tribes govern people, while village and regional corporations own and manage land and economic assets. Essentially, the institutions are separate but they do often work together. Native organizations also provide jobs, scholarships, elder support, cultural programs, and in some cases services that federal agencies provide more directly in the lower 48. The resulting structure is complicated, but it reflects a deliberate effort to combine self-government with control over economic resources.

The discussion ended with the affordability pressures that make these institutions consequential today. In remote villages, gasoline can exceed \$20 per gallon and food flown north can cost several times Anchorage prices. Heating oil, electricity, and transportation consume a large share of household income, making programs such as nutrition assistance and bypass mail important to sustaining village life. Thus, land rights and indigenous control in this discussion connected directly with the conference's broader themes of energy, infrastructure, and affordability.

The Rising Stakes: Demand, Competition, and the New Energy Build-Out

Scholars opened the first roundtable by arguing that decarbonization, energy security, affordability, supply-chain resilience, and economic competitiveness now have to be treated as one conversation. Russia's 2014 invasion of Ukraine helped establish the idea that lower carbon domestic energy can also be an energy security tool, but experts cautioned that faster transitions can impose real costs on workers and households that are least able to absorb them.

The most immediate challenge is expected sharp growth in demand for electricity after years of relative stagnation. AI, data centers, manufacturing, and electrification could push U.S. demand up by more than 20 percent over the next decade. Scholars described competition with China as an "electrons race," in the sense that frontier technology matters only if the United States can build the generation and transmission needed to deploy it. Data centers are especially difficult because they can create very large, relatively constant loads on a system accustomed to more flexible loads and much slower planning cycles. Several participants also noted that the public case for this buildout is weak if communities hear only that data centers will use more power and water while AI threatens jobs.

Several supported an "all of the above" response. Natural gas has helped quickly displace coal with lower emissions, while wind, solar, and battery storage have also expanded rapidly. Nuclear power drew particularly strong bipartisan interest, but Scholars stressed that the United States still has more enthusiasm for new approaches than actual projects under construction. Risk tied to bringing "first of a kind" solutions to market remains difficult for the private sector to bear, suggesting a potential federal government role in risk sharing, stable tax treatment, or government procurement. The Department of Defense was discussed as a plausible early customer for microreactors and other advanced nuclear technologies, since larger order books could help drive down unit costs for small modular reactors.

Energy security was also at the center of the discussion. The wars involving Russia and Iran have strained oil, refined fuel, and LNG markets, while refineries are operating at high utilization and strategic inventories have been drawn down. Members discussed the Strategic Petroleum Reserve, with Scholars calling for a physical "health check," and

recommending refilling the reserve with a clearer understanding of the minimum inventory needed to keep the system functional. Refined products such as diesel were described as especially important because virtually every part of the U.S. economy depends on trucking and logistics. Higher costs for diesel will be felt everywhere, from the grocery store to the hospital operating room.

Permitting and infrastructure repeatedly surfaced as practical bottlenecks. Rather than waiting for one comprehensive reform bill, Scholars urged Congress to reduce duplicative reviews, create more predictable timelines, work on transmission between regions, and preserve existing assets that are costly or impossible to replace once closed. A complementary logic applied to data centers: companies should be pre-qualified for their ability to make serious, long term commitments to finance the additional generation and grid capacity required for their data center projects, thus protecting existing ratepayers from having to subsidize the expansion on the front end, while companies merely ink speculative deals.

Participants repeatedly emphasized the United States' significant advantages: abundant resources, robust capital markets, innovative companies and universities, and a deep talent pool. The limitation has been in translating invention into demonstration, deployment, and infrastructure at scale. Scientific and technological leadership is cumulative, and Members were urged to preserve the research base while easing pathways to commercialization. Meeting new energy build out needs for AI and electrification will require a framework in which there is competition among multiple technologies and approaches, but also fast enough time to deployment to meet our current and imminent future needs.

Future of U.S. Energy Security: Natural Gas, Oil, LNG, and Emerging Technologies

A Scholar opened by invoking King Canute, the powerful Danish ruler who nonetheless could not command the tide, as a warning about the limits of U.S. energy policy. Governments can shape incentives and build resilience, but geology, markets, human behavior, and innovation ultimately impose constraints. Years of confidence that global oil and gas demand would peak by 2030 contributed to underinvestment just as geopolitical risk and electricity demand began rising again.

The Iran conflict has now broken what the Scholar called a “load-bearing assumption” that no adversary could sustain a closure of the Strait of Hormuz. The vulnerability is acute for oil and even greater for LNG, because Qatar has no alternative export route. Even if the war ends, buyers are likely to attach a lasting security premium to supplies dependent on a single chokepoint. Participants noted that this may increase the

strategic value of supplies and infrastructure located outside the Gulf, including potentially Alaskan LNG.

Scholars identified three basic avenues for resilience. The first is efficiency: the U.S. economy is roughly four times larger than it was during the 1973 oil shock while it uses only slightly more oil. The second is buffers and redundancy, including strategic reserves, alternative routes, refining capacity, and diverse generation. Third is integrated global markets, which allow supplies to move toward shortages rather than being trapped behind national restrictions. The United States is also better protected than in earlier crises because it is a major producer and exporter and because domestic natural gas prices remain far below those in Europe and Asia.

Members asked whether the new risk to Gulf LNG could improve the economics of Alaska's proposed long distance natural gas pipeline. Scholars said that a prolonged or permanently repriced Qatari risk factor could make more expensive alternative supplies attractive, although projects of this scale still require confidence in decades of demand. They also noted a wider credibility issue: allies and customers must believe the United States itself will remain a dependable supplier. European and Canadian efforts to diversify away from U.S. dependence were cited as a reminder that political reliability affects investment as well as physical supply.

The surprisingly muted crude price response to months of Hormuz disruption does not mean the system is secure. China temporarily reduced its stockpiling, strategic reserves were released in several countries, and repeated predictions that the war would soon end discouraged traders from maintaining bets on higher prices. Those buffers are weakening, while refined product margins remain historically high. Scholars warned that export bans or price controls could create brief local relief but would ultimately discourage production, raise costs, harm allies, and damage U.S. credibility. U.S. refineries are also configured for a mix of crude grades, meaning a simple ban would not eliminate the need for imports.

Finally, the session connected traditional energy security to critical minerals and clean energy supply chains. China's large reserves, domestic power buildout, and the changeover of most new car sales in China to electric, have increased its resilience while its willingness to restrict critical minerals exports demonstrates the risks of dependence for the United States. Participants supported expanding mining, refining, processing, recycling, and manufacturing with allies rather than attempting to achieve complete self-sufficiency in isolation. Modern energy security, they concluded, depends on the right mix of efficiency improvements, production increases, resilient infrastructure and buffers, flexible and open global markets, and "friendshoring" to allies.

Natural Resources in Alaska

A Scholar described how living off grid in Alaska for roughly two decades led her from work in space physics to work in the energy research sector and eventually to developing a model for geothermal power at Alaska's low temperatures. As she explained, Alaska is exceptionally rich in resources but infrastructure constrained. It has major undeveloped oil, gas, critical mineral, hydroelectric, wind, and geothermal resources, yet many deposits and communities remain far from roads, ports, transmission, or affordable power. More than 60 percent of the state is federally owned, and Alaska missed much of the large-scale infrastructure buildout that connected the lower 48 in the 20th century. Roughly 200 communities operate isolated microgrids, many using imported diesel despite the state's own energy abundance. Rural households can devote a large share of income to heating and transportation, while electricity consumption in some communities is closer to levels in developing countries than in a typical community in the lower 48.

The Scholar pointed to Nome, Alaska as an example of the opportunity. The region combines high-quality graphite deposits with growing strategic importance as an Arctic port, but both are constrained by energy and transportation. A microreactor or another reliable local power source could help unlock development. She compared the situation in Alaska with her experience in Iceland, where strategic investment in hydro and geothermal power has enabled energy intensive industries like aluminum smelting, as well as broader economic growth, potentially even a data center construction boom in the future. By contrast, electricity in places such as Seward itself remains exceptionally expensive.

Members asked how federal support should be prioritized. The Scholar emphasized partnership rather than handouts: Alaska has developed local microgrid and cold weather solutions, including a university cold weather test facility, because technologies designed elsewhere often fail under Arctic conditions. But the state needs federal and private investment to scale infrastructure that can serve both communities and national goals. Better power, ports, roads, and transmission could lower costs, unlock minerals and industry, and strengthen U.S. Arctic capacity, provided that development works in partnership with local communities and Native corporations, not as a top-down imposition.

The Grid of the Future: Modernization, Interconnection, and Permitting Reform

Scholars opened by proposing new transmission capacity as one of the higher leverage investments available to accommodate new demand, strengthen reliability, and support economic growth. The U.S. electric system was designed around thousands of utilities serving customers within defined territories, not the sudden arrival of individual data

centers whose loads can exceed the output of entire power plants. The resulting mismatch has exposed how slowly the system plans, permits, finances, and builds infrastructure compared with competitors such as China.

At the same time, participants cautioned against blaming data centers for every rate increase. Recent rate rises are driven by other factors such as fuel prices, storm and wildfire damage, legacy maintenance costs and upgrades, and steep inflation in components like transformers, switchgear, wires and cables. Load growth should actually reduce unit costs where generation and transmission are abundant. It becomes expensive where the system is constrained. Average grid utilization is also relatively low because the system must be built for peak conditions, suggesting substantial opportunity to use existing assets more efficiently.

Scholars proposed treating very large loads differently from ordinary customers. Utilities should not build around speculative projects that may never materialize. A “pay or don’t play” approach could require applicants to demonstrate financial readiness and contribute to infrastructure costs up front, before even entering the queue. Large load tariffs could protect residential customers, while flexible demand could reduce the amount of new capacity required. Despite the initial presentation of AI inference and training as “full load, full time” demand, some AI training can be shifted to off-peak hours, and data centers can sometimes curtail load temporarily without affecting service. Virtual power plants and other forms of flexible demand could similarly aggregate millions of devices across the distribution system.

Members focused heavily on the public backlash they are seeing in their communities. People worry about rates, water consumption, increased heat, noise, and harm to property values. All this is turbocharged by the broader discomfort of the American public with AI’s potential impact on jobs. Participants discussed solutions such as baseline standards and a LEED-like certification for data centers. These would depend on independent analysis by national laboratories, and could also feature community benefit agreements to make local costs and benefits more transparent. Members and experts agreed that the goal should not be to freeze data center construction across the board, but rather to distinguish responsible projects from speculative or poorly designed ones and to give communities credible information rather than asking them simply to trust industry projections.

The broader grid remains fragmented across regional systems, balancing authorities, state regulators, and utility territories. Scholars supported incremental permitting reform, stronger interregional planning, and a larger transmission role for FERC or another national authority. They also emphasized making better use of existing infrastructure through grid enhancing technologies before assuming that every

constraint requires a new line. Larger regional power pools can themselves act as shock absorbers by sharing generation and reserve capacity.

The conversation expanded from affordability to resilience. Much of the grid is more than 50 years old, and utilities often simply react to events, rather than being required to plan for extreme physical, cyber, or weather risks. Members asked about vulnerabilities to drones, shooting attacks, and cyberattacks and discussed treating the grid explicitly as critical infrastructure. The discussion suggested a challenging but potentially transformative agenda: pre-qualify large loads, prioritize protecting ratepayers, improve permitting and transmission planning, and use the current wave of AI investment as an opportunity to build a more modern, capable and resilient grid rather than merely add stress to the old one.

The Decline of Globalization & The Rise of Security in Supply Chains

Scholars described an energy economy moving from an era dominated by efficiency and globalization toward one increasingly shaped by security and resilience. The postwar trading system generated enormous prosperity, but it assumed that economic interdependence would not routinely be weaponized. Russia's attack on Ukraine and China's restrictions on critical materials amid geopolitical tensions have challenged that premise. Meanwhile, energy security now includes not only fuels and shipping chokepoints, but critical minerals, storage batteries, transformers, semiconductors, and other advanced technologies.

One Scholar, recently returned from China, described both the strengths and weaknesses of its model. China has built coal, solar, electric vehicle, data center, and transportation infrastructure all at extraordinary speed. At the same time, China now faces overcapacity and a dependency on exports that is exacerbating domestic economic and social problems. The overcapacity problem actually illustrates how the Chinese system is not perfectly centralized, since local officials often pursue national priorities in ways that create inefficiencies. A local official may engage in a crash building program that makes his area look highly successful, securing party accolades and promotion but leaving behind a mess of inefficiency and overcapacity. Still, as one scholar memorably warned, even a flawed strategy pursued consistently can beat no strategy or a strategy that flip-flops every four years.

Participants argued that the United States should not imitate China or attempt to reshore everything. The U.S. maintains big advantages in entrepreneurship, deployment of private capital, university and laboratory research, and the ability to attract talent. U.S. industrial policy should focus on genuinely strategic vulnerabilities and match the tool to the problem: loans, grants, or equity investments can help mitigate first-mover risk, while government procurement can stabilize uncertain demand expectations.

When China or others engage in dumping, trade measures are appropriate. And where the U.S. lacks sufficient skilled workers, the government should invest in training and education. The CHIPS and Science Act was cited as a useful example of targeted intervention tied to a clear security objective, while fostering healthy private competition.

The vulnerabilities are nonetheless real. The United States produces only part of the transformer capacity it needs, it depends heavily on foreign extracting and critical mineral processing, and China is clearly dominant in battery and photovoltaic panel manufacturing. Batteries were described as of special strategic import because they support vehicles, grid storage, drones, and defense uses. Participants also distinguished “dumb” imported products from digitally connected components such as inverters and control systems that can pose cyber or sabotage risks. The former can be imported without too much concern, while the latter should be subject to targeted audits by DOE, CISA, and other technical agencies.

Domestic mining and manufacturing are part of the answer, scholars explained, but not the whole solution. New mines take years to develop, and some energy-intensive or polluting activities may make more sense to continue outside the United States. Other options may be to improve design efficiency, recycling of critical mineral components, and to research substitutes, as well as to explore friend-shoring supplies to reduce dependence while preserving the benefits of trade. Members emphasized the importance of intellectual property protection and the immigration talent pipeline as core elements of U.S. competitiveness. America’s universities and laboratories remain an advantage that China is actively trying to reproduce.

There were concerns about overly stove-piped regulation in Washington. Energy and industrial policy is split among DOE, Commerce, USTR, DoD, USGS, NSF, and other agencies. Scholars favored better coordination rather than necessarily creating one giant authority. They also warned that permits, grants, and projects cannot be repeatedly reversed with changes of administration without raising the cost of investment throughout the system. Bipartisan policy is therefore an economic asset as well as a political one.

The United States also has allied relationships that China cannot easily replicate, but tariffs and policy reversals have weakened them. Rebuilding allied trust is therefore key. Participants discussed a NATO-like allied response to economic coercion and stressed that the goal should not be autarky or protectionism under a national security label. It should be a disciplined strategy for deciding which capabilities are needed at home, one that can be shared with trusted partners or friend-shored, and where truly open global markets remain the most efficient and secure answer.

The Economics of Energy: Affordability, Cost Allocation, and Who Pays

Aspen Institute Congressional Program

A Scholar who leads an independent electric cooperative in Alaska offered his region as a case study in affordability through governance and long-term investment. The local system had once been an inefficient municipal utility subject to rolling blackouts. Residents used low interest financing to buy it and create a cooperative which they and other customers owned. Over decades, the utility buried power lines, installed advanced metering and automation, modernized generation, and repaid debt. Its guiding principle was to make investments, like burying power lines or conduit for future lines, and designing them to last for decades.

The results were significant: rates increased at roughly one quarter the pace of inflation, dependence on state subsidies declined, and the cooperative now regularly returns roughly 7 to 8 percent of annual revenue to members. Grants are used to reduce customer costs, and the utility's experience with DOE and national laboratory modernization projects reinforced the lesson that high rural costs are not entirely inevitable, but can be controlled with thoughtful incentives and wise investment in durable infrastructure.

A second Scholar contrasted this example with the current fragmented U.S. electric system. Roughly 3,000 utilities operate under different state, federal, and regional rules, unlike in far more centralized systems such as China's. The United States cannot unscramble that institutional structure, so reform has to work within and alongside it. Some problems are national, including interstate transmission siting and environmental review; others require regional approaches. Giving FERC stronger authority over transmission of national importance was discussed as one possible step, analogous in some respects to the national highway system.

Cost allocation is especially important as data centers and other large loads arrive. Large industrial customers can help spread fixed costs, but only if regulators ensure that the benefits flow to the broader system rather than being shifted entirely to shareholders or infrastructure spending. At the same time, participants warned against making cost allocation rules so complicated that needed transmission never gets built. The Alaskan model participants examined involves testing innovations locally, sharing successes and failures across communities, and scaling what demonstrably lowers costs and improves reliability.

Indigenous Governance and Self-Determination on Alaska's North Slope

As the group arrived in Utqiagvik, local leaders welcomed them, explaining the institutions through which Iñupiat communities govern themselves, manage resources, and preserve a culture centered in part on subsistence whaling. The North Slope covers an area larger than Utah, with small communities separated by enormous distances. Nearly every local leader in the discussion was connected to a whaling crew,

underscoring that these practices remain part of everyday life rather than symbolic traditions.

The governance structure can be confusing from outside because tribes, municipalities, the North Slope Borough, and Alaska Native corporations all play distinct roles. Tribes represent and govern people; village and regional corporations own and manage much of the land and commercial resources; cities and the Borough exercise powers under state law, including taxation, zoning, and public services. The Borough derives substantial revenue from taxing oil and gas infrastructure and operations. The NGO Voice of the Arctic Iñupiat was created in 2015 to bring roughly 30 North Slope regional organizations together around shared priorities.

Leaders emphasized that this system emerged from repeated efforts to prevent decisions about land and development from simply being imposed from elsewhere. The discovery of oil at Prudhoe Bay raised the stakes dramatically, and many in the region opposed the 1971 Alaska Native Claims Settlement Act even though the corporations ANCSA created later became major economic institutions. That history continues to shape attitudes toward development today. Speakers expressed strong concern about conventional offshore drilling because of spill risks to the health of marine ecosystems, while taking a more conditional approach to onshore projects such as Willow. Their view was that development can proceed but local communities expect consultation, mitigation, and shared benefits.

Education and infrastructure were also presented as tools of self-determination. Iñisaġvik College, Alaska's only tribal college, combines academic programs with workforce training and Iñupiat studies tailored to local needs. Leaders asked for greater federal support for institutions such as the college, but stressed that their broader request was not simply for resources. It was for national leaders to come north, understand local conditions, and ensure that people who live on the North Slope have a seat at the table. In this context, self-determination means having the institutions, infrastructure, and economic capacity to make consequential choices locally while remaining fully engaged with Alaska and the United States.

The Arctic: Energy, Climate, and Geopolitics

Scholars urged Members not to view the Arctic as a distant edge of the map, but instead to recognize that Alaska sits at the intersection of domestic and foreign policy, energy and homeland security, and the Atlantic and Pacific worlds. Maps centered on the Arctic dramatically illustrate this, in the short distances between the U.S. and its European allies, and even shorter distance to Russia, and to various cross-polar shipping transit routes. Shrinking sea ice is lengthening seasons for shipping, research, resource development, and military activity. Crossing the Arctic can shorten distances for

commercial or military ships and aircraft, but also missiles, submarines, and communications signals.

Historically, the United States has focused on the Atlantic Arctic, but activity around the Pacific Arctic is increasing. Russia remains the dominant geographic Arctic power, with more than half the coastline, major military assets, icebreakers, ports, and ambitions for the Northern Sea Route. China is a newer presence. Its strategic literature treats the Arctic as an emerging “strategic commanding height,” and Chinese research vessels, icebreakers, and joint naval activity with Russia are appearing more often around Alaska and the Bering Sea. China’s persistent investigations into seabed resources and ocean conditions can serve legitimate scientific purposes but it can also support more nefarious purposes, including grabbing resources and preparing for future military operations.

Alaska gives the United States major advantages if it invests in them. The Bering Strait is the gateway between the Pacific and Arctic oceans. The three principal Arctic shipping routes, the Northern Sea Route along Russia, the Northwest Passage through Canada, and an eventual transpolar route, all underscore the growing importance of the Bering Strait. Meanwhile, mainland Alaska and the Aleutians are key locations for logistics, early warning and maritime domain awareness. Scholars called for investment in the Port of Nome as well as domain awareness capabilities, infrastructure for research, and transportation and communications links. Members also emphasized that Arctic science itself has strategic value as China expands its own research presence.

Allies are essential to U.S. success in the Arctic. Canada, the Nordic countries, Denmark/Greenland, Japan, and South Korea all have growing Arctic interests. Several Members and Scholars noted the damage caused by recent U.S. rhetoric about Greenland and argued that sustained investment and partnership would be both more feasible and more valuable than coercion. Homeland defense in the Arctic cannot be achieved without allied credibility and cooperation, and participants called for a bipartisan Arctic strategy durable across administrations. The Arctic Council remains useful for scientific, environmental, and Indigenous cooperation even though Russia’s invasion of Ukraine has constrained its full functioning at present.

Local leaders stressed that Arctic strategy must also include the people who permanently inhabit the region. Alaska Native organizations maintain circumpolar relationships with Inuit communities in Canada, Greenland, and Russia, and Indigenous residents have historically contributed directly to U.S. security, from territorial defense during World War II to protecting and helping build Cold War early warning infrastructure like the Distant Early Warning line on the North Slope. Participants discussed whether modern territorial guard or domain awareness roles

could again combine local knowledge with national defense while preserving subsistence hunting and community life.

The session tied together themes that had arisen throughout the week, including energy and infrastructure in Alaska, access to minerals, climate resilience, the importance of alliances for energy and national security, and local self-determination. The United States is blessed with considerable geographic and political advantages, but Members and Scholars warned that without sustained investment in Alaska, Arctic communities and U.S. alliances in the region, growing Russian and Chinese activity could turn longstanding U.S. neglect into strategic vulnerability.

Members' Policy Reflections and the Way Forward

The final session focused on practical conclusions. Members agreed that the pieces of the policy puzzle are interconnected. Electricity policy affects AI leadership; supply chains affect grid and defense readiness; distant conflicts affect fuel and food costs in Alaska and the lower 48; and Arctic infrastructure can serve both local communities and national objectives. The policies we adopt need to be both carefully balanced and durable enough to guide investment across administrations.

Alaska helped to make the stakes concrete. Members saw immense resources alongside isolation, aging infrastructure, high energy and food costs, and communities dependent on programs such as bypass mail, SNAP, and Head Start. Several said they would return to Washington viewing Arctic ports, research, energy systems, and rural infrastructure not simply as regional spending but as national investments. Members proposed holding hearings focused on the Arctic and conducting future congressional visits with attention to Anchorage and Nome port development and the changing strategic role of the Pacific Arctic.

To advance energy resilience, Members proposed to assess and modernize the Strategic Petroleum Reserve, rebuild supply buffers while also prioritizing efficiency and seeking diverse supply routes and energy sources. They warned against export restrictions that might provide short term relief but do long term harm to investment and U.S. global credibility. Members also favored an “all of the above” electricity strategy. Existing nuclear plants should be preserved where that can be done safely, while recognizing that new nuclear technologies may require federal procurement or other support to create a large enough initial order book to reduce costs. One Member highlighted the idea that several dozen firm SMR orders could turn a technology problem into a solvable business problem. Geothermal, fusion, battery storage, and continued research investment were also cited as areas of potential advantage for the United States.

Grid and data center policy are still difficult, and subject to enormous public scrutiny and pressure especially in an election year. However, Members identified some practical

principles. Permitting and interconnection clearly need to become faster and more predictable without discarding environmental or community protections. Members pointed to ongoing Clean Water Act and other permitting discussions as opportunities for bipartisan progress. Large technology companies, many agreed, should bear the incremental infrastructure costs their projects create, while community benefit agreements and rigorous independent standards could address concerns about water, local impacts, and affordability. Members generally favored conditions for responsible development over blanket bans, recognizing that data centers are important to America's AI competitiveness even when public anger reflects broader anxiety about the technology.

On supply chains, the consensus was similarly selective rather than protectionist. Congress should identify genuinely strategic vulnerabilities such as batteries, transformers, critical minerals, and connected grid components and then apply the appropriate policy tool, such as domestic production, recycling, procurement, R&D, security audits, or sourcing from trusted allies. Friendshoring also matters because the U.S. alliance network is a major competitive advantage, and several Members emphasized repairing damaged trust with European partners. Members cited the earlier discussion which concluded that while China may have a flawed strategy, even a flawed strategy can beat no strategy if American policy remains inconsistent.

Finally, Members returned to the value of proximity and bipartisanship. Seeing the North Slope's remote infrastructure and local communities changed their understanding in ways Washington briefings could not, while hearing directly from people affected by federal decisions reinforced the need for local participation. The same was true of spending sustained time with colleagues across party lines. Many of the problems discussed are difficult but not abstract: update the strategic petroleum reserve, create a market for advanced nuclear technologies, reform permitting, protect electricity ratepayers, strengthen strategic supply chains, and invest in the Arctic. Members concluded that progress depends on predictable bipartisan policy capable of surviving elections and on the political bravery to challenge one's own party when necessary to solve problems.

POLICY ACTION MEMORANDUM FOR MEMBERS OF CONGRESS²

Strategic Vision

- Treat affordability, reliability, national security, climate, industrial competitiveness, and energy security as parts of one energy agenda rather than separate policy silos.
- Prioritize policy durability. Energy infrastructure and industrial investments operate over decades. Thus policies with bipartisan support that survive changes in administration are important for both economic success and national security.
- Recognize that U.S. technological leadership is insufficient without the ability to permit, finance, build, and deploy future energy infrastructure at scale.
- Adopt an “all of the above” approach that preserves U.S. strengths in oil and natural gas while expanding nuclear, renewables, storage, geothermal, and emerging technologies.

Grid Modernization, Transmission, and Permitting

- Advance permitting reform incrementally where bipartisan agreement is possible rather than waiting for one comprehensive bill. Priorities include reducing duplicative federal and state reviews, improving the National Environmental Policy Act (NEPA) and Clean Water Act processes, creating more predictable decision timelines, and addressing uncertainty over executive branch authorities to rescind permits after approval.
- Regarding NEPA, consider building on the two-year deadline set by the 2023 Fiscal Responsibility Act for environmental impact statements, to (1) narrow reviews of federal actions to reasonably foreseeable, direct effects, rather than indirect or remote downstream effects; (2) clarify the circumstances under which federal financial assistance constitutes a “major federal action” triggering NEPA review, and (3) reform judicial review processes for litigated reviews that establish narrower statutory “shot clocks” and require litigants to demonstrate meaningful participation in the review process in addition to substantive harms.

² These are policy principles and proposals that emerged through conversations among Members of Congress and Scholars during the Aspen Congressional Program conference in Alaska in August 2026. These ideas do not reflect any position endorsed by the Aspen Institute or the Aspen Congressional Program. They are presented here as a nonpartisan summary of potential legislative and policy approaches.

- Strengthen federal authority for interstate transmission of national importance, including potentially siting or eminent domain authority for FERC comparable to that available for interstate natural gas pipelines.
- Develop a stronger national transmission planning function, potentially through FERC, that builds on its existing long-term regional planning framework to overcome institutional seams among regional grids and enable more interregional power transfer.
- Require transmission planners and utilities to evaluate grid enhancing technologies, advanced conductors, demand response, and other ways to increase use of existing infrastructure to address near-term demand needs that new buildout may not come online fast enough to address.
- Treat grid resilience as a core infrastructure responsibility, including planning for risks of cyber attacks, physical attacks, wildfires, severe weather, and extended outages rather than relying principally on post-crisis recovery.
- Consider whether a broader “Grid Modernization Act” or equivalent framework is feasible to guide long term investment in transmission, distribution, cybersecurity, and resilience.

Data Centers and Large New Loads

- Encourage FERC to strengthen its first-ready, first-served interconnection framework by tightening readiness requirements, enforcing study deadlines, and improving transparency so that speculative projects do not consume interconnection queue capacity or delay viable projects.
- Consider federal guidance requiring states to evaluate ratepayer protections while preserving traditional state authority over retail electricity rates. For example, encourage state regulators to adopt large load tariffs ensuring that data centers and other very large customers pay the incremental generation, transmission, and distribution costs required to serve them rather than shifting those costs to existing ratepayers.
- Create federal incentives that reward flexible data center demand. Use federal procurement, tax, or other appropriate incentives to encourage data centers and other large loads with flexible operations to shift consumption away from periods of grid stress or curtail demand when necessary, reducing the need for new generation and transmission investment.
- Develop common baseline standards for data center impacts, including electricity, water, local temperature rise, noise, and community engagement. Explore a credible LEED style certification or independent rating system for data centers. National laboratories or another trusted technical institution could

evaluate industry claims about energy requirements, environmental impacts, and community costs.

- For federally supported data-center or grid infrastructure projects, condition federal funding or other federal support, where appropriate, on commitments that provide tangible benefits to host communities, including infrastructure investment, workforce opportunities, or other locally negotiated benefits.
- Avoid blanket moratoria on data centers; instead pursue policies that distinguish serious, responsible projects from speculative or poorly designed proposals.

Nuclear Power and Advanced Energy

- Use federal policy to preserve current nuclear generating capacity where safe and economically viable, including through stable tax treatment, federal financing tools such as loan guarantees and existing tax credits, and other measures that address market or regulatory barriers to continued operation. Premature shutdowns can increase both electricity costs and dependence on fossil generation.
- For new nuclear reactors, including the light water reactor design as well as next-generation small modular reactors, maintain existing technology-neutral tax credits to provide certainty and stability for capital-intensive projects, as well as consider creating a federal cost-overrun insurance backstop for initial projects to help manage first-of-kind costs where utilities and state regulators cannot reasonably bear the risk alone.
- Use federal procurement or other government backed commitments to create assured customer demand and an order book for new nuclear, including considering the Department of Defense as an early customer for microreactors and potentially other advanced nuclear systems where energy security and resilience justify deployment.
- Sustain federal R&D, demonstration, and commercialization support for areas of potential U.S. comparative advantage, including enhanced geothermal, fusion, advanced storage, and advanced nuclear.
- Preserve the research university and national labs ecosystem that underpins U.S. innovation and ensure the United States remains able to attract leading scientists, engineers, and technical talent.

Oil, Natural Gas, LNG, and Energy Resilience

- Treat energy efficiency as a national security tool: reducing energy required per unit of economic activity is one of the most durable protections against global supply shocks. Use federal efficiency standards, procurement, and R&D to reduce energy intensity as a national security and economic resilience strategy.

- Assess the strategic value of geographically secure U.S. LNG supplies and infrastructure, including Alaska resources, in light of evolving global energy security risks such as prolonged disruption of the Strait of Hormuz.
- Develop a comprehensive modernization plan to improve the long term health and functioning of the Strategic Petroleum Reserve (SPR) that evaluates expanding and geographically diversifying storage capacity; adding refined petroleum products alongside crude oil; and strengthening SPR infrastructure to withstand sustained, repeated drawdowns and to increase both fill and withdrawal capacity.
- Protect SPR sale proceeds so they remain available to replenish the reserve when market conditions are favorable rather than requiring new appropriations or allowing funds to be diverted for unrelated purposes.
- Rebuild strategic and commercial energy buffers depleted by recent crises and reassess whether existing reserve structures adequately cover refined products as well as crude oil.
- Resist export bans on crude oil or LNG as a response to temporary price pressure, as such measures could discourage domestic production, distort refinery markets, harm allies, and undermine the United States' credibility as a reliable long term supplier.
- Preserve and modernize strategically important refining capacity where feasible, recognizing that once a refinery is closed it may be prohibitively expensive to restart or replace.

Critical Minerals, Batteries, and Strategic Supply Chains

- Identify which energy supply chains are genuinely strategic rather than treating every imported product as a national security vulnerability.
- Prioritize domestic or allied capacity in areas with high security significance or limited substitutes, including batteries, transformers, selected critical minerals, semiconductors, and digitally controlled grid components.
- Match industrial policy tools to the specific market failure, e.g. procurement for uncertain demand, grants or loans for first mover capital risk, trade measures for dumping, and training or immigration policy for shortages of expertise.
- Use the CHIPS and Science Act experience as a model for targeted intervention with a clear security objective, measurable milestones, and multiple competing private sector participants.
- Use federal procurement, financing, tax, trade, and other industrial-policy tools to expand domestic transformer manufacturing and the specialized industrial inputs required for grid buildout and modernization.

- Similarly, support U.S. battery manufacturing and storage deployment, recognizing batteries' dual use role in grid reliability and transportation, but also drones and national defense.
- Expand recycling, material efficiency, substitution, and advanced processing as complements to new mining.
- Employ trade cooperation, financing, and diplomatic tools to build resilient mineral, processing, and manufacturing supply chains with trusted allies in “friendshoring” arrangements, where domestic production is uneconomic or strategically unnecessary.
- Distinguish between relatively passive imported products and network-connected “smart” components that can create greater security risks.
- Direct DOE, CISA, and other appropriate agencies to audit foreign made digitally connected energy equipment, including inverters and grid-control components, for cyber vulnerabilities or potential remote-disable capabilities.

Allies and Economic Security

- Treat alliances as a central element of energy and supply chain strategy. The United States does not need to produce everything domestically if critical capabilities can be shared reliably among trusted partners.
- Explore an allied economic defense mechanism similar to NATO, so countries can coordinate responses when China or another actor weaponizes critical supply chains against an individual member.
- Rebuild trust with European and other allies after recent tariff and political disputes, recognizing that credibility as a long-term partner affects investment and supply chain decisions.

Arctic Infrastructure, Research, and Security

- Consider Alaska and the Arctic as core homeland security and national security priorities and assets.
- Accelerate development of the Port of Nome as a strategic Arctic deepwater port supporting Coast Guard operations, military logistics, commerce, research, emergency response, and resource development.
- Expand Arctic domain awareness capabilities, including communications, sensors, surveillance, early warning, and maritime monitoring in Alaska and the Aleutians.
- Maintain an enduring Arctic research portfolio tied to national security, energy development, infrastructure standards, climate and permafrost change, maritime operations, and seabed mapping.

- Support the U.S. Arctic Research Commission, universities, national laboratories, research vessels, and icebreaker capabilities needed to sustain American scientific presence in the region.
- Deepen Arctic cooperation with Canada, Greenland, the Nordic states, Japan, and South Korea. Consider sustained joint research and infrastructure initiatives with Greenland as a constructive alternative to coercive rhetoric.
- Preserve channels for circumpolar Indigenous cooperation, including relationships among Inuit communities in Alaska, Canada, Greenland, and Russia, such as the Inuit Circumpolar Council.

Alaska Infrastructure, Affordability, and Local Partnership

- View strategic infrastructure investment in Alaska as serving national as well as state interests, including ports, roads, communications, energy, critical minerals, and Arctic security.
- Support local microgrid innovation and deployment in remote communities, including advanced storage, geothermal, renewables, and potentially microreactors where technically and economically appropriate.
- Preserve programs that address the extraordinary cost of remote living, including bypass mail, nutritional assistance, and other tools that help keep Alaska communities viable.
- Ensure Alaska Native communities and corporations have a meaningful role from planning through execution in resource, infrastructure, and national security projects affecting their lands and livelihoods.
- Recognize and support Iñisuk College and other local institutions that develop the skilled workforce necessary for Arctic infrastructure, energy, health, and public service.
- Apply a “partnership, not handouts” approach: leverage federal investment alongside state, local, Native corporation, and private sector resources to unlock projects that serve both local communities and national priorities.

The Unique Role of Congress

- Hold dedicated congressional hearings on Arctic energy, climate, infrastructure, and geopolitics to increase understanding of Alaska’s national significance among Members who do not routinely work on Arctic issues.
- Encourage relevant committees to conduct field visits and CODELs to Alaska, including the North Slope, Nome, and the Port of Alaska, so Members can see infrastructure and community challenges firsthand.

- Build bipartisan coalitions around permitting reform, grid modernization, advanced nuclear, critical supply chains, and Arctic infrastructure so policies survive changes in political control.
- Use oversight to press agencies for clear timelines, consistent implementation, and accountability for major energy and infrastructure decisions.
- Resist governing major energy policy solely through partisan reconciliation or executive action where possible; the long investment horizons involved make bipartisan statutory policy especially valuable.
- Maintain direct engagement with communities affected by federal energy decisions. A repeated lesson of the conference was that policy works better when Congress hears from the people who host infrastructure, live alongside resource development, and bear the costs and benefits of national choices.

SCHOLAR ESSAYS

SUNDAY, AUGUST 23

Willie Hensley

Alaska Native Land Claims Task Force Plan

MONDAY, AUGUST 24

Amos Hochstein

The Hormuz War Will End

The Oil Shock is Coming for America

Sec. Ernest Moniz

The Rising Stakes – Demand, Competition, and the New Energy Build-Out

Appendix 3: The Iran Challenge Is Big. The Solution Must Be Bigger

Appendix 2: The Economist By Invitation

Jason Bordoff

Once Again, Energy Is Power

The Return of the Energy Weapon

The Long Shadow of the Iran Shock

Bob McNally

Chokepoints and Energy Security: When Load-Bearing Assumptions Collapse

Gwen Holdmann

Looking North: Alaska's Strategic Resources and America's Future

TUESDAY, AUGUST 25

Dr. Douglas Arent

Electricity Affordability and Load Growth: Diagnosing and Fixing the Problem

Rob Gramlich

US Power Grid Status and Modernization Opportunities

Alex Flint

The New Economics of Energy: America has the fuel. Infrastructure increasingly determines cost

Clay Koplin

A Tale of Two Cities: Then and Now in Cordova, Alaska

THURSDAY, AUGUST 27:

Heather A. Conley

A Dangerous Game in the Arctic

Amb. Mike Sfraga (ret.), Ph.D.

*Framing the Arctic: Geographic and Policy
Frameworks for the New Arctic*

Alaska Native Land Claims Task Force Plan

Submitted to Gov. Walter J. Hickel (January 22, 1968)

By Rep. William L. Hensley, Chair, First Alaskans Institute

Beginning with the regional land claim of the Arctic Slope Native Association in January of 1966, followed by the regional land claim of the Northwest Alaska Native Association in July, Alaska Natives soon had laid claim to most of the 365 million acres that comprised their homeland until the incursion of the Russians in 1741.

When Walter J. Hickel took office in January of 1967, he was the first governor to face the question of who actually owned Alaska since the Treaty of Cession the Russians signed with the United States in 1867. A century had passed since the approximately 500 Russians returned to their homeland after over a century of taking furs for the empire. Russia had not subjugated the 50,000 or so Alaska Natives that occupied Alaska, other than the Unangan in the Aleutians and the Suqpiak of the Kodiak area. They lived in an uneasy relationship with the Tlingit who had destroyed their fort in 1802 but had returned with cannon blazing to retake it.

Other than a few trading posts in the Yukon-Kuskokwim area and at Fort Saint Michael at the mouth of the Yukon, the Russian presence was mostly in the form of the fur trade and efforts to establish the Russian Orthodox church. The Third Charter of the Russian American Company in 1844 specifically stated that "The colonial government shall not forcibly extend the possessions of the company in regions inhabited by tribes not dependent on the colonial authorities" (sec. 281). Thus, most of Alaska had not been colonized by the Russians but that did not deter them from selling their interests in Alaska to the United States.

The Treaty of Cession left open the question of the rights of the indigenous populations to the land they had inhabited and controlled for over ten thousand years. The treaty left it to Congress to determine the issue by stating "The uncivilized tribes will be subject to such laws and regulations as the United States may, from time to time, adopt in regard to aboriginal tribes of that country." (Art. 3)

Even the Organic Act of 1884 left open the question of land ownership and control by stating "Indians or other persons in said district shall not be disturbed in the possession of any land actually in their use or occupation *or now claimed by them, but the terms under which such persons may acquire title to such lands is reserved for future legislation by Congress*".

Even the Statehood Act of 1959 left the question of Native land rights open by the disclaimer clause in Article 12 when it provided that "The State and its people further disclaim all right or title in or to any property, including fishing rights, the right or title to

which may be held by or for any Indian, Eskimo or Aleut...”and left the issue for future disposition by Congress. Needless to say, the new state was completely dependent on the 103 million acres they were allowed to select. But without a definition of what indigenous land was, there was a conflict that began to consume the state between 1966 and 1971. This issue had languished for a century without resolution.

The Alaska Federation of Natives was organized in October of 1966 in the midst of a tight election between Walter Hickel and William Egan. From the beginning, the AFN was immersed in political and public policy issues. It was conflict over land that propelled Alaska Natives to organize. Hickel won by a slim margin and promptly began to attack the “land freeze” that Alaska Natives sought from the Secretary of Interior who had the obligation under the Statehood Act to convey state selections. The Secretary was the trustee of indigenous land be they reservations, allotments, Rancherias or restricted deed homesites. AFN appealed to the Secretary (Udall) to not convey any more lands to the state until Congress acted to determine which lands were owned by Alaska’s 60,000 indigenous people.

Alaska was in a precarious financial position with a small population, high costs and little industry. The Congress had agreed to give it 90% of receipts from federal lands to give it a chance to sell and lease lands that, in effect, were being taken from Alaska Natives without compensation.

The so-called “land freeze” initially was bureaucratic inertia as the Bureau of Land Management was uncertain about the underlying claims of Alaska Natives and the legal basis they made to prevent the state “illegal taking” through that administrative process. As trustee of Native American landholdings, the Secretary of Interior may have felt that it was his duty to protect those depending on him and to seek Congressional resolution of the conflict.

Unfortunately, the Alaska Federation of Natives initially had no funds, no office, no lawyers and no experience whatsoever in dealing with a crisis that began to engulf the state and the country. The discovery of oil in 1968 at Prudhoe Bay further put pressure on all the parties to come up with some solution. AFN was a loose coalition of tribes, regional non-profit associations, and urban Native societies. It had no funds to pay for plane tickets or hotel and meeting rooms.

Realizing that the stalemate needed to be broken, the AFN and Gov. Hickel agreed to the formation of the Rural Affairs Commission and the

The governor appointed the entire AFN board to it, calling it the “Governor’s Task Force on Native Land Claims”. I was chosen Chairman of the Task Force by the membership and they authorized me to appoint an executive committee to draft a proposal for the Governor and the State’s consideration to move the state forward to find a solution to the land conflict. The time frame was very tight and the issues for all were tremendously significant.

The State needed the oil to survive, the Alaska Natives desperately sought to secure control of as much land as possible for their peoples continued use and the federal government needed to be seen as fair in dealing with its original inhabitants. The world was watching.

In retrospect, it is clear that for any legislation to be enacted in Congress on the land issue, the State had to be a willing party to the settlement and the Alaska Natives needed to be as united as possible. So it was incumbent on both to do everything possible to agree on an outline of a settlement that our delegation could work on as well as finding a solution that the Department of Interior and federal administration could support. It was a daunting task that was compressed in time and work was done under pressure.

I signed the Task Force Report and made it a part of the House of Representatives record, as I was a legislator at the time. During the times we met, there was always a representative of the State as well as a representative of the Interior Secretary's office. It was as close to a tripartite gathering as we could get—to propose some ideas that could inch this gargantuan conflict forward to some kind of solution.

As Alaska Natives, we were deathly afraid of some federal action that would undermine our effort to get a Congressional settlement—such as a Presidential Order that would give the oil companies and the state a route for the pipeline from Prudhoe Bay. Or, some action by Congress that would extinguish our underlying aboriginal title and send us off to the Court of Claims or Indian Claims Commission—in which case we would spend the rest of our lives seeking a few pennies an acre and no land conveyed.

As it turned out, the Land Claims Task Force came up with some ideas that indeed moved the state needle in a positive direction. Our recommendations became part of the superstructure of the settlement by Congress three years later. We recommended to Governor Hickel and the State:

- A grant of 40 million acres to Alaska Natives
- A ten per cent royalty interest in Outer Continental Shelf Revenues with an immediate payment of \$20 million by the federal government
- A 5% royalty interest in state selected lands
- Surface rights to utilize Alaska lands for 100 years
- That the land freeze be maintained until six months after a Congressional settlement is reached
- “Some objectives of the Task Force were: avoidance of courts and litigation, simplification of the administrative process, early accomplishment of the settlement, the grant of present property rights, the avoidance of state and federal control, the need to avoid “freezing the villages in history”, the spreading of the royalties widely, but recognizing private property concepts, and utilizing modern corporate forms for engaging in business enterprise by Native groups”

- We recommended “in lieu” selections if lands were not available to the villages in their vicinity
- We recommended that the villages could receive their lands in fee or in trust (or they could select the Secretary or a regional or statewide corporation as trustee)
- Lands should be made available to villages from forest lands • Royalties should not be completely distributed until village or regional corporations are successfully in business
- Federal and state programs would continue to serve villages • Up to 20 regional corporations could be formed under Alaska law and the existing IRA corporations could continue to function if desired

In my opinion, this Task Force enabled the State to work toward a settlement rather than to find ways to scuttle the “land freeze” and jeopardize a possible Congressional settlement. It provided a means by which opponents of the land claims effort could see benefits to Alaska. The legislature even passed a bill to contribute \$25 million towards a settlement although it was pegged to a repealing of the land freeze and became a dead letter. However, it did result in even the most ardent opponents of the land claims to see that there was a potential way forward on the issue that was consuming Alaska.

In 1968 Richard Nixon won the Presidency and chose Walter J. Hickel as his Secretary of Interior. He understood the issue but we knew he was heading to Washington to dispatch the land freeze and build the pipeline that would assure Alaska’s survival as a state. In the end, we were able to convince Chairman Henry Jackson and his Interior Committee that the freeze must remain until a bill was passed. He agreed and secured Secretary designate Hickel’s agreement to work with him towards a settlement. With President Nixon’s support, a bill was signed and became effective on December 18, 1971.

The work of the Land Claims Task Force, in my opinion, contributed key ideas while maintaining the pressure of the land freeze. Otherwise Congress and the State may have decided to send the Natives off to the Court of Claims—in which case, we would still be in court waiting for a few cents an acre and no land would have been conveyed.

The Hormuz War Will End

By Amos Hochstein

Whatever the outcome of the war with Iran, it has already delivered a lesson the world cannot afford to ignore. A single regime has decided to exert control over a 21-mile passage. As a result, we are living through the worst energy crisis the world has ever seen.

The near-closure of the Strait of Hormuz has removed 9 million to 10 million barrels of crude oil from global markets each day, but that is only the beginning of the economic damage. The present crisis is worse than the Arab oil embargo of 1973, and broader than the Russian gas cutoff that followed the 2022 invasion of Ukraine. Roughly 20 percent of the world's daily supply of liquefied natural gas is gone. Five million barrels a day of refined products—the diesel that moves goods, the jet fuel that keeps aircraft flying—are missing. So are the fertilizers on which farmers rely to feed billions, the helium used to manufacture semiconductors and run hospital MRI machines, and the petrochemical feedstocks that underpin modern manufacturing.

The governments of Sri Lanka, Thailand, and Pakistan have already adopted a four-day workweek to conserve energy, and others will follow. Malaysian and Indonesian factories are reducing capacity. Airports across Asia are limiting flights—not because fuel is unaffordable, but because there is so little to be had. The petroleum derivatives that form the materials of daily life are disappearing.

The vulnerability of the global energy supply to Iranian coercion cannot be remedied by any military operation, diplomatic cease-fire, or drawdown of strategic reserves. The only long-term solution is new infrastructure—making a massive, internationally coordinated investment in energy corridors that bypass the Strait of Hormuz entirely.

Just two major pipeline systems are currently capable of moving Gulf energy to global markets without going through the Strait of Hormuz, and they are running near or at their maximum capacity. Both carry crude oil, but not the refined products the world is running out of. And a substantial portion of the Gulf, possessing some of the world's most significant hydrocarbon reserves, has no bypass route at all.

If the United States—and the world—wants to avoid a recurrence of the present crisis, it will need to help double the capacity of the two pipelines that exist, build refined-product infrastructure alongside them, and construct a new corridor for the producers who have none.

Saudi Arabia's Petroline is today the single most important piece of energy infrastructure on the planet. The 746-mile pipeline, running from the eastern oil fields to the Red Sea port of Yanbu, was built during the Iran-Iraq War precisely to avoid an Iranian embargo, and it is performing as intended. But this single pipeline, even operating at maximum capacity, cannot meet demand. It requires additional trunk lines, expanded pump stations, and greater port capacity at Yanbu.

More importantly, the world is short not only on crude oil; it is desperately short on petroleum products. Crude pipelines do not move diesel or jet fuel or the liquefied petroleum gases that hundreds of millions of people use to cook their food. Those products will require their own dedicated infrastructure built alongside the expanded crude pipeline—separate lines, separate terminals, and separate investment.

The United Arab Emirates' Abu Dhabi Crude Oil Pipeline (ADCOP) connects inland oil fields to the port of Fujairah on the Gulf of Oman, completely circumventing Hormuz. The vision behind the project, which became operational in 2012, has been vindicated every day of this crisis. But with a capacity of roughly 1.7 million barrels a day, it leaves some 40 percent of UAE production without a bypass option. Fujairah already has the geographic advantages and port infrastructure to become the world's most consequential energy hub outside the strait. But first, the pipeline would need to have its capacity doubled, along with new lines added for refined products.

The third infrastructure challenge is the most urgent and the least discussed. Kuwait's and Iraq's southern oil fields, which contain enormous reserves that are crucial to global supply, do not have access to any bypass route. They are entirely exposed; almost every barrel they produce must transit Hormuz. The solution is constructing a modern, high-capacity pipeline corridor of oil, natural gas, and products from southern Iraq and Kuwait northward through Iraqi Kurdistan to the Ceyhan export terminal on Turkey's Mediterranean coast. A version of this route—the Kirkuk–Ceyhan pipeline—already exists, but it is aging, its capacity is far below what is required, and its administration is politically fractured.

In both the Obama and Biden administrations, I spent years on diplomatic efforts to advance this concept, shuttling between Baghdad, Erbil, and Ankara, and producing little progress. Today's crisis presents an opportunity to resolve the political differences that blocked such efforts in quieter times. The project is technically achievable but requires the political will, international financing, and American diplomatic leadership necessary to bring Turkey, the Iraqi central government, the Kurdistan Regional Government, and Kuwait to the table.

The current energy crisis is a problem for the whole world, so finding a solution cannot be left to the Gulf States alone. Saudi Arabia and the UAE have already demonstrated extraordinary foresight—the Petroline and ADCOP exist because their governments made long-horizon investments against risks that markets would never have funded. The nations

of Europe, Asia, and the Americas that depend on Gulf energy have an interest in ensuring that similarly forward-looking investments are made today.

And it's specifically in the interest of the United States to take the lead in such efforts, rather than lead a void that other actors—in particular, China—may seek to fill. The U.S. can help convene the Gulf States, the nations that consume energy, multilateral development banks, sovereign wealth funds, and private capital. The goal would be to make a strategic investment in shared global infrastructure—the same logic that animated the Marshall Plan, which was driven not by charity but by a recognition that a stable and prosperous world benefits America. Working through the U.S. International Development Finance Corporation in coordination with the World Bank, the U.S. could help anchor a broader coalition. When America puts capital on the table and sets the terms, others follow.

Consider what years of patient, unglamorous infrastructure investment have delivered in the recent past. When Russia invaded Ukraine in February 2022, a long-predicted energy crisis failed to become catastrophic thanks to a decade of little-noticed work: The Southern Gas Corridor brought Caspian gas through Georgia and Turkey into Southern Europe; LNG terminals built in Poland, Lithuania, and Greece ramped up imports; pipelines had their flows reversed to move gas in new directions. The infrastructure built before the crisis made the difference when it finally came. The same logic produced the U.S. Strategic Petroleum Reserve after 1973 and the International Energy Agency, which have helped buffer every major supply shock since, including this one.

The U.S. has already recognized the utility of building infrastructure through the region, helping to launch the India–Middle East–Europe Economic Corridor (IMEC) to bypass choke points and connect rail, energy, fiber-optic cables, and hydrogen pipelines from India through the Gulf to Europe. Building the capacity to bypass Hormuz could be seen as IMEC's most urgent energy component.

Some environmentalists oppose this sort of massive new investment in fossil-fuel infrastructure, arguing that it will slow the clean-energy transition. That objection misreads reality. Over the past 20 years, the world added more renewable-energy capacity and electric transport than almost anyone predicted possible—and yet fossil fuels still represent roughly 80 percent of the global energy mix, the same share as in 1980. Energy demand is growing faster than the supply of renewables can meet.

More fundamentally, oil is not simply a fuel. It is the feedstock for plastics, pharmaceuticals, fertilizers, and synthetic materials that electricity cannot replace. Natural gas is the backbone of the petrochemical and fertilizer industries. Airlines do not run on wind power. Hospital MRI machines do not run on solar panels. Accelerating the transition is not only necessary; it is vital and worth pursuing—and the supply chains of the present must be secured simultaneously. They are not competing priorities.

Sooner or later, the Hormuz war will end, and a rare window for bold collective action will open. The question then will be not just what infrastructure gets built—but also on whose terms and through what alliances. The United States knows how to build the infrastructure of a more resilient world, and has helped do so before: in the Caspian, in the decade of European energy-security work that preceded and then survived Russia’s invasion, in IMEC, and in Central Africa’s Lobito Corridor. And now it also knows, more vividly than ever, what it costs not to do so.

The Oil Shock is Coming for America

By Amos Hochstein

In June 2022, I was serving as the White House's senior energy adviser when the national average for gasoline prices crossed \$5.02 per gallon for the first time in American history. I know precisely what that number does to an administration: the calls, the scramble, the acute political anxiety that descends when a price that every American sees crosses a threshold that feels symbolic as much as economic.

That moment is coming again. And, by coincidence, it is arriving at the same point in the political calendar — in June of a midterm election year. This time, however, the toolkit that worked before is largely spent.

The crisis that took place in 2022 was something that happened to us. Russia's invasion of Ukraine was an external shock, entirely outside American control. Gasoline prices remained elevated from March through to August, a four-month ordeal with \$5.03 as its apex. What lowered prices was the release of 180mn barrels of oil from the Strategic Petroleum Reserve, a production response from domestic drillers, and critically, the unwinding of the fear premium once markets stabilised. By late August, the national average price had fallen back below \$4.

This time, it is the administration that has made the decision to launch military operations against Iran. Whatever the strategic rationale, the economic consequences were not unforeseeable. What is increasingly clear is that they were not adequately planned for before the first strike was launched.

The national average gasoline price has now surpassed \$4.50 per gallon. Two simultaneous crises are compounding in ways we did not experience four years ago.

The first is physical disruption. The closure of the Strait of Hormuz has removed more than 12mn barrels per day from the global supply. The IEA has called this the greatest global energy security challenge in history. This is not hyperbole.

The second is the refinery conundrum. Jet fuel crack spreads — the difference in price between jet fuel and crude oil — have reached a record \$80 per barrel, well above the \$60 peak in 2022. Because a barrel of crude oil yields only three to four gallons of jet fuel versus 19 to 20 gallons of gasoline, that extraordinary margin is pulling refinery capacity towards aviation fuel. The result defies normal market logic: gasoline production has declined by approximately 340,000 barrels per day compared with a year ago, even as prices rise and refineries run near full capacity.

According to the Energy Information Administration, US motor gasoline stocks have been drawn at approximately 4mn barrels per week in recent weeks, with the deficit to the five-year average now nearly 11mn barrels. The all-time record low, not seen since the EIA began tracking in 1990, could be reached as early as mid to late June.

The tools that worked in 2022 have already been deployed. The US committed to releasing 172mn barrels from the reserve as part of the International Energy Agency's co-ordinated response. It has already released approximately 80mn barrels, leaving stocks at approximately 374mn barrels. With refineries skewed towards jet fuel, additional crude releases will not translate into more gasoline with the same efficiency they once did. The reserve is not just smaller. It is a blunter instrument.

The production response has also already occurred. US crude and petroleum product exports reached a record 12.9mn barrels per day in late April, with daily oil product exports hitting an all-time high of 8.2mn barrels in May. There is no incremental surge waiting. That lever has been pulled.

Last week's inflation numbers signal that consumer energy prices are running hotter and longer than the Federal Reserve had assumed. What they do not capture is what comes next. Energy prices feed into the core consumer price index with a lag of several weeks. The pump pain of May will translate into inflation figures in July and August. The 30-year Treasury yield has risen to the highest level since the financial crisis and the 10-year Treasury yield is already rising. Mortgage costs, corporate borrowing rates and the cost of financing national debt all move with it.

A ceasefire is already in place in Iran. Yet the strait remains closed. Only a resolution of the underlying conflict will change the situation driving every economic variable outlined above.

In the US, the \$5 per gallon price threshold is days away. What follows, and for how long, depends almost entirely on whether this administration is prepared to pursue a political resolution with Iran on nuclear, missile and security arrangements before the economic arithmetic falls off a cliff.

There is one solution to all this. It is not military. It is diplomatic. And the clock is running.

The Rising Stakes – Demand, Competition, and the New Energy Build-Out

By Ernest J. Moniz

Ernest J. Moniz served as the 13th U.S. Secretary of Energy and is founder and CEO of the EFI Foundation and MIT Cecil and Ida Green Professor of Physics and Engineering Systems, Emeritus.

This briefing paper and its appendices summarize some of the discussion anticipated in “The Rising Stakes – Demand, Competition, and the New Energy Build-Out.”

1. The energy sector is undergoing rapid profound change, driven by several intertwined factors: global warming and decarbonization, energy security, social equity, and affordability. These seemingly diverse drivers are really threads of **one conversation**. Addressing any in isolation is doomed to failure, since dedicated constituencies exist for each and real people have real stakes in the outcomes.
 - A. *Global warming and decarbonization*: The increase in global temperature is alarming, particularly in the Arctic. While global surface temperature has increased 2.4 degrees Fahrenheit relative to pre-industrial levels, the temperature rise on the Alaskan North Slope has been closer to 6 degrees. The scientific community links this to the increase in extreme weather events and ominous signs of climate tipping points. Extreme weather is already imposing enormous fiscal and social costs, and climate tipping points could require extreme responses soon. One would likely be a dramatic acceleration of the low-carbon transition, risking significant economic dislocation.
 - B. *Energy security*: Geopolitical events have demonstrated the fragility of global supply chains for oil, LNG, and associated commodities. Prices have gone up substantially amid the recent conflict with Iran, with fluctuations seemingly based on how “hot” the war is on any given day. Market volatility has, conversely, provided more impetus to low-carbon alternatives while also compelling the switch back to coal in several Asian countries priced out of LNG.
 - C. *Social equity and affordability*: The impact of increased energy prices on those least positioned to bear them has not received sufficient attention. Yet failure to address energy affordability has consistently impeded progress. For example, the French “yellow vest” protests in 2018, which rolled back a presidentially directed motor fuel tax increase intended to cut emissions and decrease energy imports, demonstrates the risks of ill-timed charges. In the U.S., electricity and gasoline prices have become major political flashpoints. Yet, extreme weather heavily

impacts society's most vulnerable, moving public opinion in the direction of greater climate action.

Pragmatic approaches to address all three issues as part of *one conversation* is essential for tackling the world's toughest energy challenges. It's a balancing act, with near-term and long-term costs at the center of the calculation.

2. Energy security came into sharp relief when Russia first invaded Ukraine in February 2014. The Rome G7 Energy Initiative for Energy Security of May 2014 acknowledged that the pillars of energy security had not been revisited in an organized fashion since the oil shocks of the 1970s, when energy markets and technologies were markedly different.

The communique (Appendix 1) emphasized many traditional approaches to energy security, such as diversifying supplies and delivery routes. However, it broke new ground by explicitly declaring, in an official multilateral communication, that decarbonization is an energy security measure. Whereas oil and gas imports are vulnerable to geopolitical disruption, deployed low-carbon sources are largely immune.

The importance of decarbonization has been reinforced by the 2022 Russian full-scale invasion of Ukraine and the 2026 closure of the Strait of Hormuz and Bab el-Mandeb. European countries that doubled down on renewables and storage have been far more resilient in the face of oil and LNG price hikes. Energy security has motivated a number of European and Asian states to accelerate their commitment to renewables, battery storage, nuclear energy, and electric vehicles. China, which dominates these industries and retains substantial spare manufacturing capacity, stands to benefit.

3. The recently signed U.S.-Saudi civil nuclear agreement has raised significant nonproliferation concerns (Appendix 2). The agreement aligns well with the U.S. aspiration to reclaim its role as a global supplier of nuclear technology and the Saudi intention to build a nuclear energy supply chain with indigenous uranium resources.

The concern is that the Saudi supply chain is likely to eventually include enrichment, and the same technology that enriches uranium for energy can be used to make nuclear bomb material. Providing Saudi Arabia a path to enrichment is not necessarily inconsistent with maintaining high nonproliferation standards. However, that would require extraordinary verification and transparency measures, such as the IAEA Additional Protocol (or an equivalent bilateral arrangement) that permits inspectors to access nondeclared nuclear sites to clarify whether covert activity is taking place.

That approach was used in the 2015 Iran nuclear agreement, which has unraveled since the U.S. withdrew in 2018. Under the deal, Iran retained a limited enrichment capability while agreeing to join the Additional Protocol permanently, together with a unique 24-day period to provide inspectors access after a request was made to visit an undeclared site. The U.S.-Saudi agreement reportedly does not contain this requirement, a significant step back from U.S. nonproliferation standards given the salience of nuclear weapons issues in the region. In 2018, the Saudi crown prince said that the Kingdom will “follow suit as soon as possible” if Iran obtains a nuclear bomb. These issues must be discussed as the agreement sits with Congress for 90 working days before going into effect.

Once military activities cease, Congress could encourage Saudi Arabia, the UAE, and Iran to become core parties to a regional nuclear energy fuel cycle (Appendix 3). The idea is that these states would have a full supply chain only together, not individually, thereby limiting proliferation concerns. Going big may be the only way to stabilize the Gulf, permitting the region to focus on economic diversification and growth.

4. Electricity decarbonization is the lead horse for the energy transition. Significant progress has been made with the rapid growth of renewable energy and storage in industrialized economies, as well as China and India. However, the speed-to-power requirements of AI and data centers are escalating electricity demand. Impediments to new electricity supply and transmission, such as permitting, are contributing to more natural gas generation and an overall shortfall in response to renewed load growth. Policies to modernize and expand the electricity grid are needed.

The U.S. is falling behind in the “electron race” to meet AI needs. China is building both electricity supply and transmission at a significant annual multiple of the U.S., adding nearly 10 times more generation capacity and at least 20 times more high voltage transmission each year. U.S. federal and state leaders must articulate the overarching need for a modernized electric grid, employing the newest technologies up and down an integrated system of generation, demand management, transmission, and distribution.

5. Much about the energy competition landscape with China is not favorable. The Trump administration emphasizes dominance in oil and natural gas, where the U.S. already leads the world. However, critical markets and therefore potential U.S. export opportunities are growing rapidly in low-carbon technologies. China is poised to profit handsomely from the energy security pressure to decarbonize. In addition, trade relationships are beginning to incorporate product carbon intensity metrics—most prominently under the European Union’s Carbon Border Adjustment Mechanism—a reality that multinational corporations must deal with.

To compete globally, the U.S. must revert to an “all of the above” energy philosophy that builds on America’s historical advantages in science, technology, and innovation, supplemented by smart industrial policy that guides technology demonstration and deployment. Except for oil and gas, the U.S. is well behind in the energy race.

Appendix 3: The Iran Challenge Is Big. The Solution Must Be Bigger³

By Ernest J. Moniz

The recent snapback of international sanctions marks the formal—and final—end to the 2015 Iran nuclear deal. That deal, officially known as the Joint Comprehensive Plan of Action, or JCPOA, was working at keeping Iran’s program contained until the United States withdrew in 2018. In the years since, it had eroded beyond any reasonable repair.

Snapback was more than warranted. The sunset date for exercising this unique feature of the JCPOA was rapidly approaching, and Iranian nuclear escalations were ongoing. Particularly worrying was Tehran’s production of uranium enriched to 60 percent purity—a level that can be used directly in a nuclear bomb—and lack of cooperation with international inspectors. Bluntly, even though Iran was not the first to abandon the JCPOA’s requirements, these provocations crossed the line.

The Israeli and U.S. military strikes on Iran’s nuclear facilities in June severely degraded its nuclear program but did not end the country’s ability to make a nuclear bomb. Achieving this goal will require diplomacy.

In fact, this is an ideal moment for the United States to shape the trajectory of Iran’s nuclear ambitions by forging a new cooperative approach to nuclear energy in the Middle East. Under this plan, Washington and its partners would help the region build a nuclear fuel cycle that was spread across multiple countries or potentially developed jointly by them. This approach, combined with enhanced international inspections, would make it very difficult and costly for any country to build a bomb—while still promoting the use of nuclear technology for energy, medicine, and other peaceful purposes.

If done right, this plan would accelerate nuclear development, bolster guardrails against nuclear proliferation, and enhance regional security and economic growth.

The idea of regional fuel cycle approaches is not new. In fact, Iranian officials raised the possibility during the 2015 JCPOA negotiations. It was not practical then, but times have changed in ways that make it more feasible today. The United Arab Emirates has successfully completed the construction of four large nuclear reactors, and it is looking to apply its nuclear-building skills beyond its borders. Egypt and Turkey are well on their way to constructing their first power reactors. Saudi Arabia has expressed a strong interest in nuclear energy, as has Jordan.

³ This article was originally published by Foreign Policy on October 9, 2025:
<https://foreignpolicy.com/2025/10/09/iran-nuclear-condominium-gulf-reactor-energy-agreement/>

At the same time, international support for nuclear energy expansion has grown substantially. More than 30 countries have committed to triple nuclear energy globally by 2050. International financial institutions, such as the World Bank, have reversed bans on investing in nuclear energy, clearing the way for new financing opportunities. Within the United States, the Trump administration has also committed to nuclear energy deployment domestically and internationally. These developments position the international community to help realize a safe and secure regional fuel cycle in the Persian Gulf.

A regional nuclear condominium would have obvious benefits. Most importantly, it would provide assurance that no country in the region is pursuing a nuclear weapon. Why? Because under this approach, the fuel cycle would be spread across multiple countries, sensitive technologies would be subject to multinational control, and adoption of enhanced transparency measures would be required. All countries in the region could contribute to and benefit from an economically attractive clean nuclear energy initiative. The United States and European countries, for their part, could benefit from helping to strengthen markets in the Gulf region. If all parties agree, they might also participate in various regional fuel cycle activities.

This arrangement would rest on four pillars. First, that Iran, Saudi Arabia, the United Arab Emirates, Jordan, and other regional parties have access to all aspects of a peaceful nuclear program. Second, the international community must have rock-solid confidence that Iran and all other parties are not pursuing nuclear weapons. Monitoring from the International Atomic Energy Agency (IAEA) would provide the foundation for that confidence.

These first two pillars are consistent with the essential bargain of the Nuclear Nonproliferation Treaty (NPT): States without nuclear weapons have access to peaceful applications of nuclear technologies in exchange for not pursuing nuclear weapons. Almost every country in the Middle East is already a party to the NPT as a nonnuclear-weapon state.

But countries signing up to this new arrangement must go further. This leads to pillar three: Only those countries that are in good standing with their NPT commitments and willing to accept additional robust monitoring and verification measures can be part of this new framework. Crucially, this includes short deadlines for inspector access and further measures designed to detect work on a nuclear weapon.

Fourth, the United States and its partners would provide technical and financial support to expedite the regional scaling of nuclear energy and underpin the necessary supply chain. The heart of U.S. assistance would require regional reactor “order books,” or group orders, for a small number of specific types of utility-scale reactors to be determined through negotiations.

To supply the fuel for these reactors without raising proliferation concerns, parties would divide and conquer the fuel cycle, with each taking responsibility for a particular step in the chain. This arrangement would make it much harder for a party to build a nuclear arsenal.

Moreover, if a country were caught cheating, it could be removed from the program, thereby cratering its nuclear energy program.

Ultimately, it will be up to the countries involved to decide who hosts which part. That said, current interests and capabilities suggest a few leading contenders: Saudi Arabia's emerging mining and milling capabilities could make it a strong candidate for hosting a facility to convert uranium to a form suitable for enrichment. The United Arab Emirates would be a logical option for fuel fabrication given its successfully completed reactors and plans to build a fuel fabrication facility on Emirati territory.

Enrichment is clearly the most sensitive fuel cycle capability given that it can be misused to create weapons-usable nuclear materials. The fact that Iran enriched more than 400 kilograms of uranium to 60 percent for no plausible civilian purpose underscores this point. To prevent this from happening again, no enrichment would occur in mainland Iran. Instead, the United Nation could be given a 99-year lease to administer either a Gulf island—possibly an Iranian one—or land in another Middle Eastern country, such as Oman.

The IAEA would closely monitor all enrichment activities. The facility could be based on a consortium model, chosen through a competitive technology-selection process. This might resemble Europe's Urenco enrichment corporation, a cooperative arrangement governed by the United Kingdom, Germany, and the Netherlands, with strict controls on technology access. Either the IAEA or an alternative organization deemed acceptable to the international community would need long-term rights and access control to the location.

In addition, the creation of new regional fuel banks could reassure countries that their access to nuclear fuel won't be denied or disrupted. The banks would hold a secure supply of nuclear fuel for each country in accordance with the reactor types that had been selected. Each fuel bank would operate as a business, supplying fuel and restocking on a rolling basis. The existing IAEA Low-Enriched Uranium Bank in Kazakhstan could provide the material for fuel fabrication.

As the condominium's parties embark on building a new regional nuclear supply chain, they must also strengthen their nonproliferation standards. To close off the other route to a nuclear weapon—producing plutonium—countries should commit to not reprocessing spent fuel.

Monitoring and verification would need to be significantly enhanced as well—and updated in accordance with evolving nuclear proliferation challenges. In addition to having an Additional Protocol (which provides international inspectors with access to undeclared sites), all states should accept supplemental, enhanced monitoring and verification techniques aimed at quickly detecting undeclared activities. This would include specific timelines for inspector access to sites and an adjudication process of the sort that was included in the JCPOA.

Countries receiving or developing nuclear energy technology as part of this framework would also need to accept monitoring and verification to detect weaponization-related activities. This would require additional funding for the IAEA so that it has the financial and technical resources to carry out this work.

The benefit of incorporating other countries—and not just Iran—into this framework is that all would be required to sign up to the same restrictions on nuclear activities and accept the same transparency measures. Iran has long objected to being singled out and forced to accept onerous limits and inspections (even if these measures were more than justified by Tehran’s behavior). This approach would avoid that problem by raising the bar for everyone, and indeed, it could eventually provide a model for expanding the scope of IAEA safeguards more broadly.

So what is the diplomatic path for realizing this ambitious plan? With U.N. sanctions snapped back, all parties can start from a clean slate.

First, Iran would be required to eliminate its 60 percent uranium through either dilution or shipment out of the country and restore cooperation with the IAEA at least to the levels seen under the JCPOA. In return, the United States and its European allies would commit to facilitating public and private sector investment in Iran following the completion of a new agreement. This commitment would also involve facilitating investment in nuclear energy projects.

While those steps would not magically restore mutual trust, they would prepare the way for fruitful negotiations with the United States, Europe, and other key players. The other partners in the original Iran deal, including Russia and China, would also be invited to play a constructive role (as they did in those negotiations) in structuring a regional nuclear initiative, but the process should proceed with or without their involvement.

Given Iran’s distrust of the international community, it is unlikely to abandon enrichment on Day 1 of the new deal. Iran could be allowed to temporarily continue with tightly controlled enrichment activities (such as limiting its domestic enriched uranium stockpile to 300 kilograms of uranium enriched to less than 5 percent purity). Once the new regional fuel cycle is online, Iran would end domestic enrichment in favor of regional enrichment.

In exchange for Tehran’s willingness to end enrichment on the Iranian mainland and accept strong transparency measures, the United States, Europe, and perhaps others would commit to helping Iran build its civilian nuclear energy program, including through facilitating direct investment from the private sector. U.S. foreign direct investment would be available to all regional parties to the agreement. Investments in other sectors of the Iranian and regional economies could also be part of a broader agreement that advances global economic integration with the Gulf countries.

Other Gulf states would benefit considerably from this approach by gaining Western support for developing their nuclear capacities. Perhaps even more important, resolving the

Iran issue would allow other Gulf states to focus on ambitious plans for diversifying their economies beyond hydrocarbon production.

This endeavor would not be easy and would require all countries involved to make tough choices. But ultimately, it would put the security and economic well-being of the United States, Iran, and the entire Middle East on a more positive and sustainable path.

Appendix 2: The Economist By Invitation⁴

By Sec. Ernest J. Moniz

Enrichment Technology is needed to supply fuel for nuclear reactors, but the same technology can make the fuel for a nuclear bomb. It should be no surprise, then, that the recent civil nuclear co-operation agreement between America and Saudi Arabia raises big questions about American non-proliferation policies and “norms”—the rules and understandings which, if shared with other states, discourage the spread of weapons of mass destruction.

The US-Saudi deal is, potentially, the biggest development in nuclear diplomacy for years. President Donald Trump has signalled it may be contingent on the Saudis normalising relations with Israel. That seems unlikely. But if the deal does come off it will shake up the Middle East’s nuclear dynamics. In Iran, nuclear-weapons risks loom large in the current conflict because of the Islamic Republic’s uranium-enrichment capability. The United Arab Emirates (UAE) has successfully developed a substantial nuclear-energy programme and made strong non-proliferation commitments, including a renunciation of domestic uranium enrichment. Saudi Arabia aspires to join Iran and the UAE in generating nuclear power, but remains reticent about its possible military nuclear ambitions.

America calls deals such as that with Saudi Arabia “123 agreements”, after Section 123 of the 1954 Atomic Energy Act, which requires a deal in order to export American nuclear technology or materials. These agreements have been used by America to promote the highest nuclear non-proliferation standards. So one in a region as geopolitically complex as the Gulf quickly leads to questions about possible proliferation.

The US-Saudi agreement appears to be part of a bid by America to regain its position as a major purveyor of global nuclear technology and services, thereby reinforcing its traditional role as arbiter of non-proliferation norms. For their part, the Saudis want advanced technology for generating electricity, in time using their own uranium deposits. But the agreement also gives Saudi Arabia a path to uranium enrichment, albeit one with hurdles.

With this capability, Saudi Arabia would become a nuclear-weapons threshold state, capable, if it chose, of accomplishing the most difficult step in building a nuclear bomb, namely production or acquisition of the required nuclear material. Iran has already mastered the enrichment needed to produce bomb material, and demonstrated it by producing almost half a tonne of highly enriched uranium, enough for several bombs. As far back as 2018, the Saudi crown prince blurted out the truth: “Without a doubt...[we will] follow suit as soon as possible” if Iran has a nuclear bomb. The conditions are ripe for a Gulf nuclear-arms race, unless negotiations put sufficient safeguards in place for all to have confidence that no one is pursuing a nuclear bomb.

⁴ This article was originally published by The Economist on August 7, 2026
Aspen Institute Congressional Program

I suggest two approaches to address this situation outside the usual tired debates around enrichment. First, it should be noted that precluding enrichment is desirable but not essential for retaining strong non-proliferation norms. This was shown in the JCPOA, the nuclear agreement in 2015 between Iran and several world powers, including America, which permitted limited uranium enrichment for a time, combined with extraordinary verification and transparency requirements. Among them, Iran agreed to join the IAEA Additional Protocol in perpetuity, allowing international inspectors to uncover possible covert activities at undeclared nuclear sites. Iran also agreed to the unique requirement that access to undeclared sites be provided within 24 days. The US-Saudi deal should allow uranium enrichment only if it is coupled with similarly strong verification measures. There is no indication that the signed document includes such provisions. There may be other ways to achieve this objective but, one way or another, it must be met.

Second, America should promote a regional nuclear-fuel cycle. The idea is that the Gulf rivals would agree that each would host some part of the fuel cycle—the steps involved in producing electricity from uranium—but none would control the entire supply chain needed for civilian or military nuclear-energy use. Saudi Arabia, the UAE and Iran would be the core members, but others in the region might play a role, as could America. A precedent exists for this: in 1970 Britain, the Netherlands and West Germany formed the Urenco company to produce enriched uranium for peaceful applications.

During the negotiations in 2015, in which I was deeply involved, Iran raised this regional fuel-cycle possibility, but it was premature at that time—a first agreement with world powers needed to be reached before this could be considered seriously. Recently, senior officials from Arab states have expressed interest in reviving the idea.

Today, with little serious negotiation about a long-term solution, such an approach would constitute a big step towards a peaceful arrangement between Iran, Arab states in the Gulf and others. In light of the ongoing military tensions, going even bigger—by supplementing a nuclear deal with a regional arrangement to finance Iran’s reconstruction, structured as an investment that can produce reasonable returns—should be on the table, too. This would, of course, involve confronting ideological leaders of Iran’s Revolutionary Guards who have tightened their grip on the levers of power in Tehran, but also have huge commercial interests in a functioning Iranian economy. Crafting such a proposal would be difficult and involve many parties. The current American administration is not known for patience, but its transactional nature could, in this instance, be an advantage.

Once Again, Energy Is Power⁵

by Meghan O'Sullivan and Jason Bordoff

At the start of this decade, optimism abounded. Environmental, social and governance issues, and net-zero dominated many government energy policy agendas, and capital markets were reorienting around decarbonization. It was broadly assumed that the world was moving beyond traditional energy security risks of the past, thanks to more abundant and diversified energy supplies and optimism about a transition away from oil and gas. In 2026, energy has reemerged as a central force shaping our world—both a geopolitical weapon and an economic fault line.

The evidence has been unmistakable in just the first months of this year. Iran has used asymmetric tactics to disrupt traffic through the Strait of Hormuz, the world's most critical oil chokepoint, sending prices sharply higher and rattling markets worldwide. The United States has gone beyond traditional sanctions to physically interdict Venezuelan oil shipments, asserting control not just over finance, but also over the movement of energy itself. In Cuba, U.S. restrictions on fuel imports have created shortages—driven in part by constraints on Venezuelan supply—that have contributed to widespread blackouts and renewed political pressure. And in December, China imposed additional restrictions on the export of rare earths used in defense and energy technologies, signaling China's continued willingness to weaponize its dominant position in clean energy supply chains.

These are not isolated episodes. They are part of a broader shift: the return of energy as a central instrument of geopolitical competition. What is new is not simply that energy is being used for political purposes again, but that it is happening across more actors, more tools, and more parts of the energy system than ever before. This modern era of energy competition will be broader and more persistent: the very interdependence that has made countries more energy secure over the past decades is now creating new vulnerabilities in light of the deteriorated geopolitical landscape.

Energy, Back in Plain Sight

Energy is the foundation of modern life in ways that become visible only when it's gone. There was a reason Bad Bunny danced atop a power pole during the Super Bowl while singing a song entitled “El Apagón,” or “The Blackout;” he sought to highlight how repeated power outages have devastated the island of Puerto Rico. Energy has always been the backbone of prosperity.

Energy is also now the key determinant of which country claims leadership in the technologies—especially artificial intelligence—that will define the future. And it is a leading source of voter angst as power prices soar in some parts of the U.S., as electricity use surges

⁵ This article was originally published by TIME on April 4, 2026:
<https://time.com/article/2026/04/03/energy-geopolitics-united-states-iran-china/>
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to meet rising demand for data centers and other needs. Energy use also remains the leading cause of global climate change, even if that issue seems to have receded from focus for many businesses and governments.

Despite its centrality to economic, geopolitical, and environmental concerns, for much of the past several decades—especially in advanced economies—energy was assumed to be abundant, affordable, and secure.

That complacency was understandable. The U.S. shale revolution dramatically increased the world's supply of oil and gas, helping keep global oil prices relatively stable—and keeping U.S. natural gas prices low even when prices abroad soared. Power demand barely grew across much of the developed world, and electricity was abundant. And a broadly cooperative geopolitical environment reduced fears that energy might once again be used as a weapon, as it had been during the Arab Oil Embargo of 1973.

But that era is over.

The 2022 energy crisis, triggered by Russia's invasion of Ukraine and its subsequent cutoff of most gas exports to Europe, marked a turning point. It exposed the fragility of even highly developed energy systems and reminded policymakers that secure access to energy is never assured. Instead, it must be protected and nurtured. Since then, a confluence of forces—rising geopolitical tensions, surging demand for electricity, and slowing growth in U.S. oil and gas supply—has pushed energy prices back to the front pages, and pushed energy back to the center of global affairs.

Energy is once again about power in every sense of the word.

From Markets to Muscle

For decades after the oil shocks of the 1970s, globalization and international cooperation helped blunt the use of energy as a geopolitical weapon. In the wake of the Arab Oil Embargo, in 1974, advanced economies came together to form the International Energy Agency (IEA) to jointly hold strategic oil reserves and to coordinate in case of emergency supply disruptions. The IEA sought to improve the quality and transparency of energy data and integrate the global oil market, enabling oil to become the most easily traded commodity in the world.

The resulting integrated oil market brought tremendous benefits to consumers and producers. No longer were consumers limited to the oil for which they had negotiated long-term contracts with particular suppliers; an integrated global oil market created additional, more flexible options for securing oil and, as a result, helped countries cope with supply disruptions and diminished the appeal of using oil for political purposes. A country could no longer target an oil embargo at an adversary without hurting friends as well as

foes; if it ceased exporting, all countries would be affected by an increase in the price of oil set in a global market.

More recently, the growth of liquefied natural gas (LNG) has brought similar benefits to natural gas markets. Imagine the pain Europe would have experienced when Russia stopped its piped natural gas had Europe been unable to rapidly increase its consumption of sea-borne LNG.

What has changed is not that energy is being used as a weapon—history is full of blockades, embargoes, and battles over supply—but that in a less cooperative and more conflict-prone world, the risks of interconnectedness are now rising. And today’s toolkit to weaponize energy is broader and more varied. Countries are no longer relying solely on production cuts or physical disruptions to supply. They are also using a wider array of instruments—control over infrastructure, shipping routes, financial systems, trade, and critical supply chains.

A World Upended

The resurgence of energy as a geopolitical weapon is not simply the result of opportunistic behavior by individual leaders. It reflects deeper structural changes in the international system.

The first is the return of great-power competition. Relations between the United States, China, and Russia are no longer defined by cautious cooperation but by persistent rivalry. That competition is unlikely to be resolved quickly. Instead, it will shape global politics for years to come.

At the same time, globalization is giving way to fragmentation. Trade and investment continue, but increasingly within politically defined blocs. Governments are intervening more directly in markets—through industrial policy, export controls, tariffs, and sanctions—to advance strategic goals.

This still interconnected, yet more contested, world creates new vulnerabilities. The same networks that enable efficiency also create chokepoints—points of concentration that can be exploited for leverage. The crisis today in the Strait of Hormuz reminds us how control over these key nodes can give asymmetric advantage to otherwise weak actors.

Control over shipping lanes, processing capacity, or critical inputs can be turned into strategic advantage. U.S. dominance of the global financial system to enforce sanctions is a familiar feature of the international system, but it is now expanding to include a greater American willingness to use military force to advance energy-related national security agendas, as seen with the U.S. operation in Venezuela. It is not only the United States using energy this way: Beijing is leveraging its dominance in energy supply chains by restricting exports of rare earths and other critical minerals to its competitors, including the U.S., Europe, and Japan, which depend on the materials for energy, automotive, and defense technologies.

Energy sits at the center of this shift because it is indispensable. Every economy depends on it. Every military requires it. Every advanced technology—from semiconductors to artificial intelligence—relies on it.

The Price of Disruption

Today's tensions have pushed oil prices well over \$100 per barrel from around \$70 before the crisis; gasoline has climbed over \$4 per gallon. As painful as these prices are for consumers, oil prices will rise far more if the Strait of Hormuz remains largely shuttered for an extended period or if the conflict widens and puts other chokepoints at risk. At least 10 million barrels per day of global oil supply is currently disrupted, and there are no policy responses sufficient to cope with a supply loss that large.

IEA countries agreed March 11 to the largest ever release of strategic oil stocks, 400 million barrels, but the release rate is only two to three million per day. Unless transit through the Strait of Hormuz resumes, oil prices will continue marching upward until enough consumers, businesses, and governments are motivated to change their behavior, idle factories, and otherwise curb economic activity sufficiently to bring supply and demand back into balance. Moreover, if there is more lasting damage to the Gulf's core production and export infrastructure, a crisis now measured in weeks or months could extend years.

Households in the U.S. may feel bewildered and misled by the pain at the pump since they were told that America was now “energy independent.” Thanks to innovations unlocking massive increases in shale oil and gas production, the U.S. has shifted from importing 60% of its oil use two decades ago to exporting more than 3 million barrels per day on a net basis. It is now the world's largest oil producer and largest exporter of LNG.

Yet even though the United States produces far more crude and oil products than it consumes, America is still very much connected to the global market. As a result, the price spikes created due to the disruption in the far-off Strait of Hormuz reverberate throughout the American economy. Oil is priced in a global market, and gasoline and diesel prices in the United States respond to global supply disruptions regardless of whether the country is a net importer or exporter.

In a more positive sense, higher oil prices no longer primarily represent a transfer of wealth from the United States to foreign producers. But they do redistribute income within America from consumers to producers. This shift means the overall hit to GDP is lessened, even as households and energy-intensive industries still suffer from higher fuel costs.

New Vulnerabilities

History suggests that the return of energy insecurity may accelerate the transition to cleaner energy systems. The oil crises of the 1970s triggered a wave of policy responses aimed at reducing dependence on imported oil. At the time, oil generated roughly one-fifth of U.S.

electricity, and cars were far less efficient than today. In response, governments improved fuel economy, built strategic reserves, shifted power generation away from oil toward coal, nuclear, and natural gas, and invested in alternatives.

Such measures have helped the United States manage this current crisis. But if today's crisis worsens, the consequences could still be profound. A deeper, more prolonged disruption—one that meaningfully constrains global supply—could trigger the same kind of structural response seen in the 1970s. Faced with sustained volatility and risk, countries would accelerate efforts to reduce exposure: improving efficiency, electrifying transport and industry, and expanding domestic sources of energy, from renewables to nuclear.

Many are optimistic such a rethink could accelerate the transition to clean energy. Energy security—not climate policy—could become the most powerful driver of transformation. But there is a catch. For many countries, especially in the developing world, a secure and affordable alternative to oil or gas is often coal. And even where countries pursue clean energy, they encounter a new set of dependencies and geopolitical exposure. The supply chains for critical minerals—lithium, cobalt, nickel, rare earths—used in clean energy are highly concentrated, with China playing an outsized role especially in processing and manufacturing. China likewise dominates production of solar components, parts of wind turbines, batteries, and electric vehicles.

This creates a paradox. Efforts to reduce dependence on oil and gas can increase dependence on new forms of supply chain concentration. The shift toward electrification also introduces new forms of risk beyond supply chain concentration. Grids, pipelines, and other infrastructure are increasingly digital and becoming a prime target for cyberattacks. Because electricity powers not just homes and factories, but also data centers and communications networks, disruptions can cascade across entire economies.

The New Energy Reality

The events of just the past three months in Venezuela, Cuba, and Iran illustrate a simple but unsettling reality: energy is once again shaping not just markets, but determining who has leverage, who bears costs, and who is left exposed.

Crises like today tend to leave a mark. Today's disruptions are likely to prompt a new round of strategic reassessments. For developing countries, the lesson may be the dangers of dependence—on a single supplier, a single fuel, or a single geopolitical partner. For advanced economies, it may be the limit of assuming that markets alone can deliver security in an increasingly contested world.

In the United States, the implications may be especially far-reaching. The current moment could accelerate a shift toward a more pragmatic energy strategy—one that leans into the country's strength as a major oil and gas producer, reinforcing the push for “energy dominance,” while also recognizing that resilience requires more than hydrocarbons alone. The same forces that are driving renewed investment in fossil fuels are also underscoring

the need for diversification across renewables, nuclear, critical minerals, and the infrastructure that ties them together.

Whatever the outcome, one thing is certain. Energy is back in the driver's seat, shaping outcomes, motivating strategies, and empowering new actors. Ignoring this reality—or assuming that the playbook of the 1970s offers ready-made solutions—is folly. Tackling it without energy ideologies or preconceived ideas is the only way to manage this new, more contested energy system—one in which access, control, and reliability are increasingly determined by politics as well as markets.

The Return of the Energy Weapon⁶

by Meghan O'Sullivan and Jason Bordoff

Throughout much of the modern era, limiting or disrupting the flow of energy was a highly effective tool of global power. In 1923, Admiral Reginald Bacon of the Royal Navy declared that the United Kingdom's oil blockade of Germany in World War I was the powerful economic weapon to which "the ultimate collapse of that nation and her armies was mainly due." A generation later, Soviet leader Joseph Stalin attributed the Allied victory over Nazi Germany to the Red Army's success in denying Hitler access to oilfields in the Caucasus. Then there was the 1973 Arab oil embargo, which caused a nearly 300 percent rise in the price of gas in the United States and miles-long lines of cars at gas stations, an experience that has remained seared in national memory.

For much of the next 50 years, however, the use of energy as a coercive tool of statecraft largely subsided. The disastrous effects of the Arab oil embargo on the global economy led both producer and consumer countries to think differently. Over the years that followed, consumer countries sought to make their energy flows more resilient and build stronger and more transparent international markets, while producers reined in their propensity to use their energy prowess as a geopolitical cudgel. The end of the Cold War and the subsequent acceleration of globalization boosted reforms that further integrated oil markets and diversified energy supplies. In the early years of the twenty-first century, even soaring prices and fears about peak oil—the notion that global oil production was close to its maximum and would soon begin an inexorable decline—proved short-lived as the American shale-drilling revolution brought unprecedented new volumes of oil to the market. Oil prices continued to fluctuate during major conflicts such as the first Gulf War and the Libyan civil war and global crises such as the Great Recession and the COVID-19 pandemic. But throughout this era, consumers, particularly in advanced economies, were increasingly confident that markets would deliver the energy they needed. Over time, many countries were lulled into complacency about energy security.

Today, that complacency has been upended. Following its 2022 invasion of Ukraine, Russia inflicted enormous economic pain on Europe by slashing its natural gas deliveries to the continent and sparking an energy crisis with global reverberations. As part of its larger trade confrontation with the United States, China has periodically restricted the export of key critical minerals and rare-earth elements—parts of a supply chain that is crucial to semiconductors, military applications, batteries, and renewable energy. The United States itself has also politicized the flow of energy, demanding that Europe buy more American energy to gain relief from threatened trade tariffs. Even countries such as Canada have entered the fray, with Ontario imposing a surcharge on electricity exports to the United States in retaliation for President Donald Trump's sweeping new tariffs on Canadian goods.

⁶ This article was originally published by Foreign Affairs on October 21, 2025:
<https://www.foreignaffairs.com/united-states/return-energy-weapon-bordoff-osullivan>
Aspen Institute Congressional Program

As producers wield the energy weapon that was largely sheathed for the last several decades, the United States and others are also rebrandishing their influence over the production and purchase of energy, as seen in Washington's recent moves to prohibit most American oil and gas firms from operating in Venezuela and to consider steeper sanctions on countries buying Russian and Iranian oil exports.

In a world that had grown accustomed to relatively stable and secure energy markets and was under the illusion that the clean energy transition would neutralize energy geopolitics, the return of the energy weapon has caught many by surprise. Yet this trend is unlikely to end soon for two broad reasons. First, at a time of renewed great-power competition and economic fragmentation, energy has once again become an attractive instrument of geoeconomic coercion. Second, significant developments within the energy sector are creating new opportunities for weaponization even as they mitigate some others.

Fortunately, there are a variety of policy tools to address these threats—most of which are compatible with and enhanced by the clean energy transition. Indeed, by making a faster shift toward zero-carbon sources of energy, countries can eventually build a strong form of resilience against energy weaponization, especially if such a push is coupled with efforts to diversify clean energy supply chains. To mount an effective response, however, policymakers need to recognize the forces driving weaponization and the broader risks they pose to national security and the global economy. With more countries threatening to make coercive use of more different kinds of energy flows, the world could be at the dawn of a new age of energy weaponization.

Global Entry

Throughout much of the twentieth century, controlling the flow of oil was considered an essential component of foreign policy and military strategy. Countries endowed with energy riches used those resources as a means to achieve objectives outside the energy realm. And those whose geology was lacking often saw the need for energy as an end—a reason to harness military, economic, and diplomatic power in its pursuit. For decades after oil became the dominant global energy source, producers were in a strong position. By the 1970s, oil supplied about half the world's energy needs. And since it was typically sold in long-term contracts at administered prices set by a small number of governments, producers could assert control over both supply and price. With such levers, countries with major oil reserves could seek to sway international policies in the realm of politics. In 1973, after the outbreak of war between Israel and its neighbors, the Arab members of OPEC restricted oil exports to countries supporting Israel and incrementally curtailed global supply to compel the United States and other Western powers to cease support for Israel and force Israel to withdraw from captured territories. The move triggered what one adviser to U.S. President Richard Nixon called an “energy Pearl Harbor.” By the end of the year, the price of a barrel of oil, which three years earlier had been \$1.80, reached \$11.65—the equivalent of more than \$80 today.

Yet the Arab oil embargo proved to be a turning point. It produced a wide array of negative consequences, including stagflation in advanced economies and a massive debt burden in the developing world. It also failed to compel the West to abandon Israel. It did, however, drive many countries to launch an intense effort to conserve energy, boost oil production outside OPEC, reduce imports, and prioritize energy security. In 1974, advanced economies came together to form the International Energy Agency (IEA), the centerpiece of which was an agreement to build strategic oil reserves for coordinated release in times of emergency. As it became clear that price controls and energy rationing had exacerbated the effects of the embargo, U.S. leaders and policymakers also realized that more flexible, integrated, and well-functioning global oil markets could disperse the impact of supply disruptions—spurring efforts to liberalize the oil trade. In the early 1980s, governments sought to improve the quality and transparency of energy data and to deregulate oil pricing, helping pave the way for the inclusion of crude oil futures on the NYMEX commodity futures exchange. Thereafter, oil went from being largely traded in long-term contracts at fixed prices—an approach that made it difficult for buyers to find alternative sources of supply during disruptions and thus vulnerable to producer pressures—to the most traded commodity in the world.

Although the process was slower and looked very different, natural gas markets were also becoming more globally integrated. After the first shipment of liquefied natural gas sailed from Louisiana to the United Kingdom in 1959, successive waves of supply growth—including from Algeria in the 1980s, Qatar in the 1990s, and the United States in the last decade—transformed the natural gas trade. They contributed to a more integrated and flexible LNG market that could better respond to changes in supply and demand than fixed gas pipelines, since tankers can deliver to many destinations and are easily redirected. Starting in the 1980s, despite Europe’s growing dependence on Soviet—and later Russian—gas, policymakers and buyers became more confident that competitive markets and mutual dependence would shield the continent from geopolitical vulnerability. Indeed, for much of the Cold War, many leaders perceived the energy trade between western Europe and the Soviet Union as a moderating influence on the larger geopolitical rivalry.

The end of the Cold War only accelerated these positive trends. The collapse of the Soviet Union in 1991 paved the way for the 1994 Energy Charter Treaty, which created a multilateral legal framework for energy cooperation. Initially intended to provide a legal structure for energy trade, transit, and investment between western Europe and post-Soviet states, the treaty later expanded to incorporate countries from other regions. Investments began flowing into Russia and former Soviet republics from Western energy companies such as Exxon, BP, and Total, further increasing interdependence and the breadth and depth of global markets. In this new era of cooperation, the United States and Russia created a Megatons to Megawatts program, in which the United States purchased excess highly enriched uranium from Russia’s defense sector and turned it into low-enriched uranium for civilian reactors; for years, policymakers seemed unfazed that the United States was dependent on Russian fuel to operate its nuclear power plants.

The integration of global energy markets was given a huge boost by China's accession to the World Trade Organization in 2001. To fuel its staggering industrial and manufacturing expansion over the decade that followed, China had to quadruple its oil imports, forcing it to rely heavily on the markets of the Middle East and Central Asia. Over time, Beijing moved away from a "going out" strategy that focused on physical control over energy resources in Africa and beyond to an approach that sought to ensure access to energy from a diverse group of suppliers. Later, through its Belt and Road Initiative, the Chinese government financed pipelines, ports, refineries, and power plants overseas, investing in a network that could help it obtain a consistent supply of energy from multiple points around the world.

As economic relations became more globalized and energy markets became more interconnected, exporters largely set aside the energy weapon. Certainly, there were notable exceptions, as when Russia cut off gas exports to Ukraine in 2006 and 2009. Yet the ensuing European debate over whether the cuts were commercial or political in nature weakened the collective European response to coercion. At the time, most producers seemed to recognize that well-integrated global energy markets limited the impact of withholding or denying energy deliveries to a particular country or region—making calculations about embargoes unattractive. As fiscal budgets ballooned in the Gulf and other OPEC countries, producers were reluctant to take action that could jeopardize their revenue streams, and the threat of another oil embargo by the cartel faded. The net result was that by the early years of this century, there was a general sense among advanced economies that energy security had improved significantly since the 1970s, even as reliance on oil imports continued to grow.

To be sure, energy weaponization did not entirely go away during this era of relative stability, although the sort exercised in the decades after the Cold War was of a different variety. Whereas the globalizing economy and integrated markets made trade sanctions on oil producers less effective, economic interdependence and the dominance of the U.S. dollar made the financial system ripe for weaponization. Consumer countries, particularly the United States, politicized their consumption and deployed financial sanctions against some of the world's largest oil producers, such as Iran. Energy thus remained a means for advancing foreign policy in this surprising way.

Power Play

In the last several years, the circumstances that set the stage for this extraordinary period of energy cooperation have begun to shift. Perhaps most important, by 2020, the era of closer cooperation among great powers, unfettered trade, and faith in markets was coming to an end. The integration of global markets that had been central to the energy security of so many countries was no longer assured; shifting geopolitical forces were creating economic fragmentation, and governments were beginning to intervene in private enterprise in more far-reaching ways. Major powers are now pivoting toward state capitalism, using trade restrictions and industrial policy to achieve economic and national security aims. In the United States, this shift began during Trump's first term, continued under the Biden

administration, and has expanded further under the second Trump administration, with the government using tariffs as a form of economic coercion in far more aggressive ways. China, which has long engaged in state capitalism, is both pulling back from global markets in many commodities and honing its ability to use sanctions and other state interventions to advance its interests. In this increasingly uncertain geoeconomic environment, countries in Europe and other parts of Asia are finding it harder to assume that markets alone will deliver the energy supplies they need.

Paradoxically, perhaps, the pullback from the integrated global markets that have long helped stabilize energy flows has been partly driven by policymakers' growing concerns about energy security. In many countries, escalating geopolitical threats, great-power rivalry, high energy bills, risks of supply shortfalls caused by underinvestment in oil and gas, competition for leadership in power-hungry artificial intelligence, and worsening climate impacts have all contributed to a sense that energy security is on the line. Rather than leaning into global markets, governments may be more inclined to reduce their energy trade and curb their exposure to volatile international forces. Consumer countries increasingly seek to produce more domestic energy and import less, and producer countries may be tempted to curb exports to prioritize their own needs. In early 2025, Norway's two governing parties pledged to cut power exports to Europe amid concerns about soaring electricity prices at home. Similar pressures may soon arise in the United States. Voters confronting higher utility prices could pressure the government to restrict the country's burgeoning exports of natural gas in the belief that doing so will lower their bills. In fact, any such moves could undermine the very integration that has helped tame energy weaponization in recent decades.

Alongside a fragmenting global economy, changes in the energy landscape will encourage renewed use of the energy weapon, even if other developments will cut the other way. Take the oil sector, in which two of the main conditions for past weaponization could reemerge in the years ahead: the tightening of markets and the concentration of supply. Discussions about the implications of global oil demand peaking are gradually being replaced by questions about the consequences of the shale oil boom coming to an end. In September 2025, the oil giant BP acknowledged that oil demand, which it had previously forecast would peak this year, will continue climbing for the rest of the decade. According to a report published by Bloomberg, in a draft of the IEA's forthcoming 2025 World Energy Outlook, the agency presents a scenario based on current policy alongside one reflecting policies and measures that have been formally announced or are under development. In previous IEA reports, the latter scenario projected global oil demand to peak by the end of this decade; in the draft, the former scenario shows it continuing to grow through 2050. Meanwhile, oil executives and analysts are becoming skeptical that U.S. shale oil production, which met most of the growth in global demand over the last decade, will continue to rise. The U.S. Energy Information Administration has projected that U.S. oil production will decline next year. Major oil companies have also scaled back exploration efforts worldwide, with investment in upstream oil and gas projected to fall in 2025 to its lowest level since the

pandemic. As more of today's existing production capacity is called on to meet rising demand, the amount of spare capacity in the global system will shrink, leaving less of a buffer to cope with price shocks. As a result, the oil market may tighten significantly toward the end of this decade, creating more chances for countries to target the oil supply—through infrastructure attacks, export restrictions, sanctions, or other steps—in ways that inflict economic pain.

In addition, the renewed concentration of supply in the hands of fewer countries will exacerbate the risk of coercion. By 1985, OPEC's share of the world's oil production had fallen from about half before the Arab oil embargo to just 27 percent, as huge volumes of non-OPEC oil came to market from the North Sea and other areas. But with the U.S. shale boom slowing and other non-OPEC producers experiencing only modest supply growth, the IEA now projects that the cartel's share of the global market will rise again to at least 40 percent by 2050, a level not seen since the 1970s. If demand continues to be strong, this concentration of supply will make OPEC countries even more geopolitically influential.

The global gas market may also soon experience changes, including further concentration, that make politicization more likely. It is true that over recent decades, the rise of liquefied natural gas and the emergence of a more globally integrated gas market have greatly reduced opportunities for coercion. When Russia cut off most of its pipeline gas exports to Europe in 2022, for instance, European countries were able to cushion the loss by securing supplies of globally traded LNG, albeit at much higher prices. Nonetheless, shifting dynamics in global gas markets suggest that new dangers may lie ahead. In the coming years, supplies will be more concentrated among a handful of producers, even if Russia's plan to triple its LNG export capacity by 2030 does not materialize. The sharp growth in LNG exports from Qatar and the United States—in combination with growing European and Asian dependence on LNG—means that more gas will travel through the Strait of Hormuz and from the U.S. Gulf Coast, creating new geopolitical targets. Moreover, although the rise of the United States as an LNG superpower was once seen as a salve for geopolitical risk, the Trump administration's use of economic coercion against allies and adversaries has stirred fear among energy importers that the United States may no longer be a reliable, apolitical supplier.

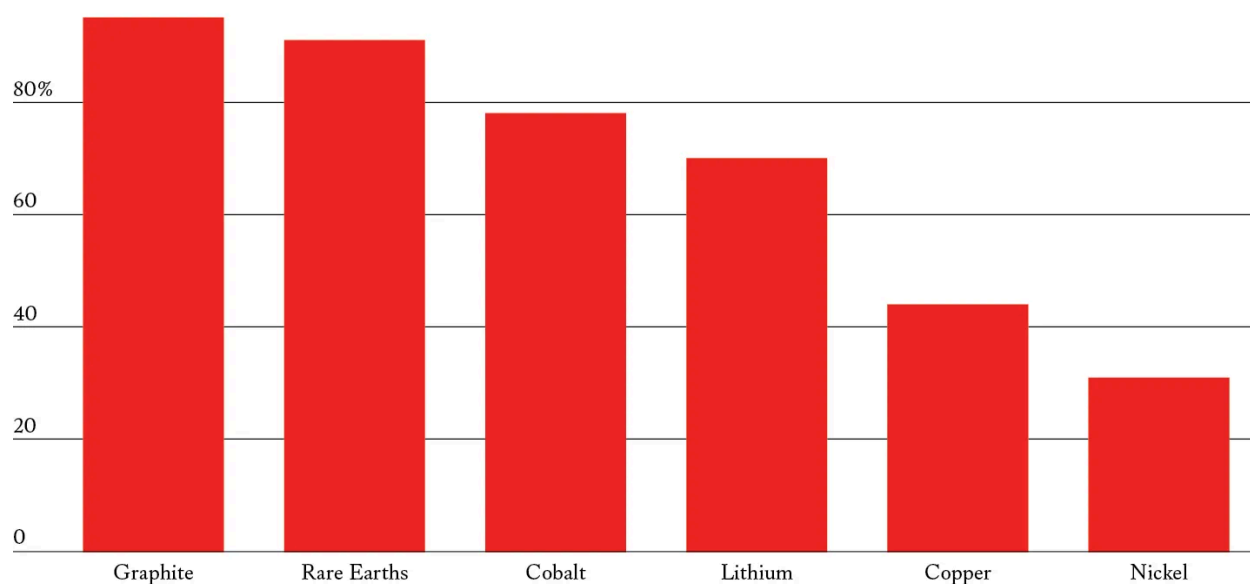
Meanwhile, the rise in clean energy across the globe has become a double-edged sword when it comes to energy security. Increases in wind, solar, and other new sources of energy have helped the world meet burgeoning demand and have diversified the energy mix of large economies, most notably China. But the clean energy transition could introduce new threats, particularly in relation to the rush toward electrification. Spurred by the massive power needs of the data centers that enable artificial intelligence, the growing use of air-conditioning and electric vehicles, and rising industrial activity around the world, electricity's share of global energy use will rise from 20 percent today to 25 percent in 2035, according to IEA projections.

To some extent, a more electrified world will help reduce the risk of energy coercion, since most countries can produce much of their electricity from domestic sources. But wherever electricity crosses borders, electrification carries new risks. Importers of electricity are even more vulnerable than oil importers, as these countries tend to have few if any alternative sources of supply, and electricity is far more difficult to hold in strategic stockpiles than oil. Today, only a tiny fraction of global electricity supply is traded across borders. Yet plans to develop many more long-distance transmission lines to connect countries in many parts of the world, including in the Asia Pacific as well as Europe and North Africa, could make this concern more potent.

Of greater concern on a global level is the dominant role that China and a few other countries play in supplying the inputs needed for widespread electrification. Transmission lines, solar panels, wind turbines, and batteries for cars, trucks, and the electric grid all depend on critical minerals, such as copper, nickel, lithium, graphite, and rare earths. Demand for these minerals is projected to surge in the coming years, with lithium use increasing fivefold and graphite and nickel use doubling by 2040. China is the top producer of 19 of the 20 critical minerals assessed by the IEA to be key to the energy sector, and it accounts for more than 70 percent of global refining capacity for these metals and minerals. The global minerals supply is also dominated by a few other countries, such as Indonesia for nickel, the Democratic Republic of the Congo for cobalt, and Russia for enriched uranium. In fact, the mining of certain metals and minerals is even more concentrated than the production of oil. According to the IEA, when the leading producer of each of the key battery metals and rare earths is excluded, other remaining suppliers will, on average, be able to meet only half the remaining global demand in 2035.

PRODUCER POWER

China's share of global processing of key minerals



Source: International Energy Agency. Data as of 2024.

Spurred by the clean energy transition, energy flows are also shifting to include not only the transport of commodities—oil, gas, coal, or critical minerals—but also the trade of manufactured goods such as solar panels, wind turbines, batteries, and electrolyzers. The production of these goods is also firmly dominated by China, which now accounts for more than 80 percent of solar manufacturing capacity and nearly as much for key parts of the wind supply chain. In batteries, China's role is even greater, accounting for more than 85 percent of all steps of the battery value chain and up to 95 percent for anodes—the part of the battery that stores energy when it is charging. All of which raises questions about whether these goods could become hostages to politics or conflict in the future.

Real-world developments give us reason to take such concerns seriously. In 2010, during a standoff over the Diaoyu/Senkaku Islands in the East China Sea, Beijing temporarily suspended the export of rare-earth minerals to Japan, causing significant concern in Japan's high-tech industries. In late 2024 and early 2025, amid tensions with the United States over the flow of technology, China restricted the export of graphite, certain critical minerals, and rare earths, leading to price spikes and supply chain disruptions that put significant constraints on U.S. manufacturers. Ford Motor Company, for instance, had to temporarily

idle some of its American plants because of shortages of Chinese-supplied rare-earth magnets.

The potential for Chinese weaponization of clean energy, given Beijing's production dominance in minerals as well as in solar panels and batteries, is a key element of this new age of intense geopolitical rivalry. Particularly in light of future scenarios in which Washington and Beijing are at odds over the future of Taiwan, policymakers must consider China's ability to flood the market for critical minerals, rare earths, or clean energy products and undercut the competition, or to restrict exports to deter or blunt Western responses and peel off U.S. allies that are economically dependent on Chinese inputs. Such a move could create price spikes and shortages, not just in energy supply chains but also in materials needed for defense readiness and weapons production.

Concerns over the weaponization of electricity also extend to energy infrastructure. In 2024, the FBI warned that state-sponsored Chinese hackers had penetrated critical networks across the United States in what then FBI director Christopher Wray characterized as a "broad and unrelenting" threat. Power grids can be an especially attractive target for weaponization. Given that electricity is the key energy input in the highest-value-added sectors, such as advanced manufacturing and artificial intelligence, electricity disruptions can cause outsize economic harm. Greater electrification, renewables, and extreme heating and cooling needs will require grids to handle more frequent periods of peak electricity demand, creating more opportunities to attack networks at moments of maximum strain and vulnerability.

More Efficiency, More Security

With the return of the energy weapon, policymakers will need to think differently about energy policy, as well as foreign policy and national security. Given the transformative shifts in the energy landscape, the retreat of globalization, and the return of great-power rivalry, the opportunities for countries to use energy as a means to gain influence or achieve foreign policy goals are intensifying and go well beyond oil. The old antidote of integrating into well-functioning, interconnected global markets still provides benefits, but it may offer less protection as markets themselves fragment and energy is weaponized in new ways. Policymakers and others will need to find ways of protecting citizens and businesses from the volatility that energy weaponization will undoubtedly bring.

A few obvious prescriptions, applicable to all countries, are to reduce exposure to volatile energy supplies, build up buffers against potential shocks, and increase energy efficiency. Some countries, based on their geology, may also have the option of boosting domestic supplies of oil and gas to curb their reliance on imported energy. In the United States, for example, policymakers may be tempted to seek greater or even total energy self-sufficiency to limit the threat of weaponization. But energy independence in this sense is a myth. Today, the United States produces more energy than it consumes, but it still imports and exports significant amounts of oil and is therefore enmeshed in global markets and

susceptible to any volatility in them. In a more weaponized world, true energy security will require not just producing more oil or gas but also and especially consuming less.

Leaders of countries in Europe or East Asia that have long depended on oil and gas imports—even more so than the United States—can protect themselves from volatile markets by reducing their energy trade, nearly all of which today is in fossil fuels. Although “replacing” some of these imports can be accomplished by increasing efficiency, paring down most will require more intense electrification with energy that is generated domestically, for instance from solar, wind, nuclear, or geothermal sources. (For some countries, for example in South Asia, it can also mean domestically produced coal.) Given the risks posed by clean energy supply chains, one might ask how much protection such a shift provides. Former U.S. Senator Joe Manchin has lamented the dilemma of trying to “replace one unreliable foreign supply chain with another.”

But the risks posed by the oil and gas sectors are of a different order than those of the clean energy sector. The possibility that China could weaponize clean energy supply chains is real, bringing with it the potential to limit the ability of many countries to deploy new EVs, solar panels, or battery storage for the grid. Unlike with oil or gas, however, such tactics would not jeopardize the flow of energy itself. China’s weaponization of supply chain concentration would not quickly cause lights to go out, cars to sit idle, or homes to freeze. Instead, it would lead to higher costs and delays for products that produce and store energy. And although such supply chain risks could have significant economic impacts, these would be easier for most countries to address over time. Unlike the production of fossil fuels, which depends on the good fortune of geology, manufacturing capacity can be ramped up in most places. For those reasons, on energy security grounds alone, the United States should reconsider its current retreat from policies that seek to modernize and expand the electric grid and to develop more domestic clean energy generation and manufacturing.

Using clean energy to mitigate the weaponization of fossil fuel markets makes sense for other reasons, as well. By offering subsidies, eliminating excessive regulation, and streamlining permit processes, mineral-rich countries can encourage more domestic production and investment in manufacturing, mining, and grid construction. But all consumer countries can build manufacturing capacity such as mineral refining and processing. They can also reduce their dependence on Chinese-dominated supply chains by investing in energy projects in a more diverse set of places, such as the mining, refining, and processing of critical minerals in Africa and Latin America. Governments can also make their national energy infrastructure more resilient against attacks by hardening power grids, managing periods of peak demand more efficiently, and implementing better protections against cybersecurity threats. Finally, to cushion against future shocks, policymakers will need to create and expand emergency stockpiles, such as for certain critical minerals and natural gas, along the lines of what the U.S. Strategic Petroleum Reserve has done for oil.

Beyond such direct policy action, decision-makers will need to think more creatively about state intervention in the energy sector. Already, the quest for energy security in today's fractious environment is leading governments to seek solutions to problems that would have been left to the market to resolve in an age of greater international cooperation. In some cases, these interventions, such as a recent equity investment by the Trump administration in a domestic rare-earth company, will make sense and even be necessary to make the United States and other countries less vulnerable to energy coercion. Such moves toward state capitalism, however, introduce significant risks and require guardrails to prevent political or ideological interference with corporate decision-making.

The All-In Defense

The idea that a new era of energy weaponization has begun may seem counterintuitive in the face of a global energy market that seems mostly in balance. The sweeping return of this potent form of coercion is dependent on a variety of trends playing out in geopolitics and in the global energy system. In view of the uncertainty surrounding these trends, more weaponization is not inevitable. But the emerging reality of great-power competition, economic fragmentation, tightening energy markets, and a greater concentration of both fossil fuels and clean energy supplies among a small number of countries increases the odds that the energy weapon will be used.

To protect their countries from the new risks, policymakers will need to summon the political courage and pragmatism to make massive new capital investments. This effort will be especially challenging given severe fiscal constraints and burgeoning debt crises in many advanced economies. Rather than rely on market forces to develop and deliver the cheapest flows of energy, policymakers will need to pursue more secure sources, even if they come at a higher cost, and build redundant and more resilient infrastructure to protect against and better handle potential energy crises. Spending at this scale will cause energy prices to rise, particularly in an era of higher capital costs. It will also lead to a more active role for the state in the energy economy, a development that will create more investment opportunities but also significantly more uncertainty for private capital. Deployed wisely, such government investments can enhance energy security and stave off the worst forms of coercion.

Counterintuitively, these very same policy responses could also provide a powerful push for clean energy. The renewed threat of weaponization means that there is more common cause between champions of a Trump-style energy dominance agenda and clean energy advocates who seek a more rapid pivot toward a less carbon-intensive economy. To be truly energy secure, particularly at a time of rapidly rising demand, the United States should invest not just in its own oil and gas sector but also in solar and wind power, batteries, electric vehicles, critical minerals, nuclear fuels, and other energy technologies, while in parallel diversifying energy supply chains. Given that oil is still priced in a volatile global market, reducing the country's exposure to energy shocks and more overt weaponization means not just producing more but, even more important, using less.

Ultimately, the imperative to bolster energy security could be an even stronger motivator of clean energy deployment and reduced fossil fuel use than the threat of climate change itself. The coming era of weaponization could thus have a silver lining. It will create a powerful new incentive, for those concerned with energy and climate alike, to invest in the multifaceted energy and supply chain strategies that will be essential for a secure future.

The Long Shadow of the Iran Shock⁷

Jason Bordoff and Meghan L. O'Sullivan

By almost any measure, the world should be suffering a far more severe energy crisis. The Strait of Hormuz, through which roughly one-fifth of global oil and liquefied natural gas supplies normally passes, has been largely closed for months. Yet when considered against the nightmare scenarios contemplated at the war's outset, oil prices have remained low and natural gas markets have proved resilient. The global economy has so far avoided the kind of recession that many past energy shocks produced.

It would be tempting to conclude that the dangers of energy supply disruptions have been overstated, but such complacency would be misguided. The Hormuz crisis has so far led to only modest oil price spikes thanks to an unusual combination of favorable market conditions and years of investment in energy security measures. Before the war began, oil markets were oversupplied, inventories were relatively high, Saudi Arabia and the United Arab Emirates had built pipelines around the strait, and governments and companies had amassed emergency and commercial stocks. In addition, China helped stabilize the global oil balance by reducing its imports, drawing on its immense capacity to curb how much oil it buys for stocks, holds in inventory, refines for export, and consumes domestically.

These conditions may not endure. If the conflict enters a new phase of intense fighting that threatens to spill across borders and continues to block the strait, oil markets, now stressed by shortages of refined products such as diesel and jet fuel, could see crude oil prices surge higher. But even if hostilities in the region de-escalate, a persistent risk to traffic through the strait will likely remain, with passage either outright controlled by Iran or, at the very least, subject to Iranian disruption at any time. A more optimistic scenario in the next several months seems a chimera, barring major and unlikely change in Tehran.

In preparing for these scenarios, as well as new crises in the more distant future, the world should not take solace in the relatively benign outcome of the last five months for energy markets. The cushions that helped the world manage those months are now more threadbare: inventories have been depleted, demand is recovering, alternative routes are becoming more vulnerable, and infrastructure continues to come under fire and, in some cases, will take years to repair. A second phase of the Hormuz crisis could prove substantially more damaging than the first.

Moreover, the first phase of the crisis was not as painless as headline global oil prices suggested. The relatively modest movement in global benchmark prices concealed a

⁷ This article was originally published by Foreign Affairs on August 14, 2026:
<https://www.foreignaffairs.com/iran/long-shadow-iran-shock>

strikingly uneven distribution of pain, as countries in Asia and Europe endured high prices, shortages, rationing, fiscal strain, and forced reductions in consumption, while the United States and China demonstrated newfound levels of insulation and influence. Delayed effects also loom on the horizon. Because of the crunch in refining, diesel and other crude products are priced much higher than they normally would be at current headline oil prices. And the shock is making it harder and more costly for Europe to replenish its natural gas inventories, leaving the continent with lower-than-usual storage levels and more vulnerable to energy and geopolitical coercion in the coming winter.

The past five months have revealed not that the world has become immune to energy crises but that market forces, policy, and government investments in energy security have paid off. Without renewed efforts to rebuild, in today's geopolitically fractured world that resilience will quickly erode. Before a next phase of this crisis unfolds, therefore, policymakers must analyze how this resilience came to be. Moreover, they must acknowledge that, as the energy system has changed since the 1970s, so too has the way energy shocks reverberate around the world, and the measures needed to safeguard against them. Understanding these dynamics will better position the world for the next inevitable energy shock.

WHAT COULD HAVE BEEN

When Tehran closed the Strait of Hormuz days after U.S. and Israeli attacks in late February, the head of the International Energy Agency (IEA) called it the “the largest supply disruption in the history of the global oil market.” But even as the strait remained almost entirely closed for nearly four months—until Washington and Tehran signed a memorandum of understanding in mid-June—Brent crude averaged just over \$100 per barrel, up from around \$70 per barrel when the war began. The peak of \$126 per barrel, in April, was far below the \$200 per barrel that veteran analysts had warned was possible. Even after Tehran closed the strait to oil traffic again in July, after the cease-fire collapsed, the barrel price fell into the \$80 range.

Many factors contributed to this relatively muted price response. As would be expected, oil demand was forced to decrease, to match available supply. It fell by roughly five million barrels per day in the second quarter of 2026, according to the IEA, as shortages and price spikes led consumers to cut back and many governments imposed emergency measures to ration fuel. But the price-induced demand adjustment was not nearly as severe as might have been expected. This was in part because it was a relatively favorable moment in the oil cycle. Supply was projected to well exceed demand this year, oil inventories were relatively flush, OPEC countries had been boosting supply at a

quicker pace than expected, and tighter sanctions on Russia meant that more Russian supply was floating in tankers, ready to be tapped.

Psychology and political rhetoric also played a role in keeping the geopolitical risk premium down. President Donald Trump's repeated claims, in public statements and social media posts, that a resolution to the conflict was imminent often came at market-sensitive moments and prompted prices to fall. The possibility that millions of barrels per day would suddenly return to a market that had already been oversupplied before the crisis made it riskier for traders to maintain large bets on still higher prices. Those conditions weakened the link, at least temporarily, between prices and the underlying shortage of oil.

More important than these dynamics in dampening the oil crisis that might have ensued was past government investment in infrastructure. Saudi Arabia and the UAE quickly maximized the capacity of pipelines that bypass Hormuz, which they built years ago precisely as insurance against this kind of disruption. These routes collectively moved over five million additional barrels per day to global markets. Combined with Iranian oil exports, which continued through late April, the pipelines reduced the shortfall in Gulf oil exports to around 13 million barrels per day rather than the entire 20 million per day that flowed through the strait before its closure.

Effective deployment of oil in storage alleviated the strain, too. Traders and energy firms drew down high levels of commercial oil products they had in stock. Even more important, the IEA, which was created in the aftermath of the 1973 oil crisis, coordinated the largest release ever of its members' emergency oil stocks. Combined commercial draws and government releases offset roughly five million to six million barrels per day of the supply disruption.

In the United States, increased oil production and commercial and strategic stock draws caused U.S. crude and petroleum product exports to surge to historic levels, transforming the country's role in the global energy market. During the spring, the United States became the world's largest oil exporter and briefly became a net exporter of crude oil for the first time since World War II.

Perhaps the most surprising buffer in the crisis was China. Beijing reduced its oil imports by roughly five million barrels per day through June, easing pressure on the global market. Although exact figures are difficult to establish because China doesn't publish official data on its inventories, Beijing stopped buying oil to fill its strategic reserve and even released some oil from its inventories (more commercial stocks rather than strategic reserves). It restricted exports to neighboring countries of refined petroleum products, such as gasoline, diesel, and jet fuel, thereby reducing the need for crude imports to feed its domestic refineries and shielding the global crude market, even as it imposed pain on East Asian countries reliant on its product exports. Moreover,

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domestic Chinese oil demand fell in response to higher prices and conservation measures.

Liquefied natural gas followed a similar path to oil despite being a very different commodity. The closure of the Strait of Hormuz and Iranian attacks on LNG facilities cut off most Qatari LNG exports, which account for roughly one-fifth of global LNG supply. But natural gas and power prices rose by less than many had anticipated; European benchmark gas prices doubled from roughly \$35 to \$70 per megawatt-hour—still far below the peaks above the around \$350 per megawatt-hour reached in 2022 in the fallout from Russia’s full-scale invasion of Ukraine. New liquefaction projects, especially in the United States, were ramping up, offsetting an estimated 40 to 50 percent of lost volumes from the Gulf. Established exporters such as Nigeria and Malaysia also delivered more LNG than expected, and Asian demand adjusted; some utilities switched from gas to coal while some industrial users curtailed consumption altogether. Europe benefited from the LNG import capacity it had built since 2022 as well as from more renewable energy sources, although it still had to compete with Asia for scarce cargoes, draw down already low storage, and suffer significant demand destruction as high prices forced businesses to cut output.

A NEW GEOGRAPHY

The events of the last five months have shed light on more than how the global energy system managed to endure the closure of Hormuz. They have also revealed how gradual but real changes in that system have created new geopolitical realities and risks—in particular, how shifts in the sources of energy supply and demand have redrawn the geography of oil shocks. The countries best able to absorb disruptions, and those forced to bear the greatest costs, are no longer the same.

The United States is far more resilient to oil shocks today than it has been in at least a half century. Because oil is priced in a global market, Americans were not insulated from higher gasoline prices. But the United States weathered the disruption far better than it would have a decade ago, both because it uses less oil per unit of economic output and because it produces much more oil. The U.S. economy is nearly four times larger than it was in 1973, but domestic oil demand is only slightly higher than it was in the 1970s. And whereas the country imported 60 percent of its oil use only two decades ago, it is now the world’s largest producer and a major net exporter. This shift means that although higher prices raise costs for American consumers, they also generate income for American producers, workers, and shareholders. Economists at the Dallas Federal Reserve have estimated that an oil shock comparable to this year’s would have reduced U.S. real GDP growth by 5.6 percentage points in 1980, compared with only 0.3 percentage points today.

The elevated prices caused by the Hormuz crisis were, moreover, less pronounced in the United States than in Asia and Europe, where shortages drove the price for the delivery of oil far above the price traded in the futures market for periods of time. In a global market, the United States will eventually face similar pressures, but this episode suggests that abundant domestic production gives the United States a valuable period of insulation from disruptions that more import-dependent economies lack. This contrast with the rest of the world was even more pronounced in natural gas. Disruptions to LNG flows through the Strait of Hormuz pushed prices in Europe and Asia toward \$20 per million British thermal units (BTUs), while U.S. benchmark natural gas prices remained below \$3 per million BTUs. The United States' abundant domestic gas production and relatively self-contained market largely shielded it from the global shock. The economist Lucas Davis calculated, earlier this year, that the disconnect between U.S. and global natural gas prices has saved American consumers roughly \$5 trillion over the last two decades.

Americans' greater insulation from global oil and gas shocks creates an uncomfortable dichotomy: a country that is generating significant upheaval in the international system is also comparatively insulated from the consequences of its actions. For decades, Washington's use of economic and military coercion was constrained, at least in part, by the damage that such actions could inflict on the United States, including through oil shocks. As that constraint weakens, so, too, may an incentive for restraint.

China's role in global energy crises has also shifted. The country's dramatic reduction in oil imports demonstrated the central part it now plays in supply shock absorption. As the largest oil importer and by far the largest holder of oil inventories, China can alter the global energy balance by adjusting how much it buys, exports, stores, or releases, an ability that may become even more important in the next phase of this crisis. Whereas inventories in OECD countries have been depleted, China appears to have drawn only modestly from its estimated stock of 1.4 billion barrels. Avoiding a much sharper price spike over the next several months may depend in part on Beijing's willingness to use those reserves.

This new dynamic gives China a potentially powerful source of geopolitical influence in the future. For decades, U.S. presidents have called Saudi leaders during oil crises to ask them to release spare production capacity, which Riyadh maintains at a cost in part because of the influence it provides. If Chinese inventories become one of the last lines of defense against damaging global price spikes, Beijing may come to occupy a comparable position.

Whereas the new geography of oil shocks improves the strength of the United States and China relative to other countries, the burden of balancing the oil market has now shifted toward poorer importing countries. In past decades, the reductions in demand needed

to counterbalance shortages in supply came primarily from advanced economies, which consumed the most oil. Today, however, OECD countries make up less than half of global oil demand, compared with three-quarters in 1970. Now, oil demand is higher in emerging and developing economies, which have thinner fiscal buffers and less capacity to absorb higher prices, meaning that the destruction of demand comes sooner and at lower prices, with rationing and forced reductions in consumption.

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CLEAN BREAK?

One possible upside of the war in Iran—and of the renewed concern about energy security it has supercharged—is that it could hasten the shift toward a lower-carbon energy system. As the IEA chief, Fatih Birol, put it in April: “Perception of risk and reliability will change. Governments will review their energy strategies. There will be a significant boost to renewables and nuclear power and a further shift towards a more electrified future.”

There are good reasons to hope that this might be the case. The 1973 oil shock catalyzed investments in nuclear power, renewable energy, and efficiency that reduced the fossil-fuel intensity of the global economy even more rapidly than climate policy did in the years following the 2015 Paris Agreement. In 2022, following Russia's full-scale invasion of Ukraine, solar generation in Europe rose by 24 percent, more than twice the rate of growth in previous years. Countries exposed to the current oil shock will have powerful incentives to electrify more of their transportation and industry and to generate that electricity from secure domestic sources, including wind, solar, bioenergy, and nuclear power. Even the United States, already relatively secure in its energy prowess, could come to better understand that true energy security is rooted in efficiency as well as adding more energy supply, not just oil and gas but also renewable sources such as solar and wind power.

Such an outcome, however, is far from automatic, and there are reasons to expect that it could even become less likely. The relative resilience of global markets during the first five months of the Hormuz disruption could reinforce confidence in the adaptability of the global oil and gas system rather than exacerbate fears about it. Some importing countries will undoubtedly see the disruption as a reason to reduce their dependence on oil, but many may draw the opposite lesson. If the nightmare scenario of energy security planning proved relatively manageable, governments may conclude that the oil and gas system is quite secure compared with the alternatives and that the most practical course is to continue investing in the resilience of the oil and gas system rather than to move beyond it.

Initial responses suggest a focus as much on building this resilience as on diversifying away from fossil fuels. Several Gulf countries have already announced plans to expand or build new pipeline capacity to evade the Strait of Hormuz, likely diminishing its importance as a chokepoint within several years. Emerging-market economies such as those of India, South Africa, and in Southeast Asia have announced plans to increase commercial oil inventory requirements, build government strategic oil and gas reserves, and expand domestic refining capacity.

After this crisis, some governments may also be even more hesitant to increase their dependence on China, which dominates clean energy supply chains, particularly for critical minerals, batteries, solar panels, and electric vehicles. Countries will have to decide not whether they are willing to accept import dependence but which forms of dependence they consider least dangerous. Beijing's response to the Hormuz crisis may make that tradeoff appear less attractive. Whereas the United States has so far resisted calls to restrict oil and gas exports, which are based on a misguided belief that doing so would protect American consumers and businesses, one of China's first moves was to prioritize Chinese interests, restricting exports of refined petroleum products, which imposed significant costs on countries across Asia. Governments in the region

considering greater reliance on Chinese clean energy supply chains may view this episode as a warning, and seek to invest more in the resilience of their oil and gas systems and diversify their oil and gas imports rather than increase their reliance on Chinese energy technologies and products.

Finally, energy security is not synonymous with clean energy. The search for secure and affordable domestic supplies can lead governments toward coal as readily as toward solar, wind, geothermal, or nuclear power. At least in the short term, coal has been a part of the emergency response measures in several Asian countries: Japan allowed greater use of older, less efficient coal plants, South Korea lifted limits on coal-fired generation, China increased coal consumption in its chemical sector, and India accelerated its plan to spend \$4 billion to develop a coal-to-chemicals industry. The energy consultancy Rystad has projected that the region's additional coal demand resulting from the LNG shortfall will be roughly 70 million tons in 2026. According to the IEA, global coal consumption will reach a record this year.

The changes that will come in the wake of this energy crisis will create openings for the transition to greener energy. But it is not inevitable that countries will make the most of them. Governments around the world must steer toward that end with intention, setting policies that create the right incentives, lower the cost of clean energy solutions, and mitigate the new reliability, infrastructure, cybersecurity, and geopolitical risks that accompany a lower-carbon and more electrified energy system.

LESSONS FOR THE FUTURE

Although the Hormuz crisis is far from over, it has already provided lessons for how governments can prepare for the next energy shock. The overarching takeaway, however, is more a warning than a lesson. The complacency that has developed around the huge disruption of oil flows in the last five months should not be carried into the months ahead. If renewed fighting in Iran results in another period of prolonged disruption, the global economy will struggle much more mightily to contain its damage. Escalating threats in the Red Sea could compromise the Saudi pipeline that has been essential in mitigating the Hormuz crisis. Global oil inventories are now significantly depleted, leaving the stockpiled barrels held by China as one of the main defenses against continued supply disruption. The need to refill inventories and build up stronger strategic reserves of oil may also boost demand. Five pillars that proved essential in softening the blow of the Hormuz crisis will be essential to cushioning future shocks, whenever they come: energy efficiency, diversified supply, integrated markets, increased domestic production, and help for countries whose vulnerabilities create risks for all.

The first and surest line of defense against an oil shock is to use less oil in the first place. The world was able to absorb the initial Hormuz disruption partly because it requires far

less oil to generate each dollar of economic output than in the past. Measured in constant 2015 dollars, the global economy consumed just under one barrel of oil for every \$1,000 of GDP in 1973. By 2019, the final year before pandemic distortion, that figure had fallen by more than half. Because many economies are now less oil-intensive, prices today would have to rise roughly fourfold in inflation-adjusted terms to reproduce the economic shock that followed the Iranian Revolution in 1979, according to the former BP chief economist Christof Ruhl.

Fifty years after the physicist Amory Lovins made the case in Foreign Affairs for a “soft path” to energy security, focused on efficiency and distributed technologies, one of his central insights remains just as true: policymakers seeking to dampen the effects of future shocks should redouble their efforts to reduce the economy’s exposure to oil. The case for reducing oil dependence is not only environmental but also strategic. Stronger efficiency standards, wider adoption of electric vehicles, and better public transportation all reduce vulnerability to oil shocks; the Trump administration’s efforts to roll back these policies weaken long-term U.S. energy security.

Energy security also requires strong buffers against supply disruptions. These instruments come at a cost and function as a sort of insurance policy against energy shocks. Because no single firm bears the cost to society of energy price shocks, the private sector tends to underinvest in these safeguards, making their formation dependent on government action. As geopolitical dangers expand, energy resilience will require additional investment in strategic stockpiles, alternative pipelines and ports, domestic refining capacity, and other redundant investments that may seem inefficient in normal times but become indispensable in a crisis. In the United States, these efforts should begin with a congressional appropriation of funds to refill and modernize the depleted Strategic Petroleum Reserve, now at its lowest level in nearly five decades.

Diversification of markets and supply routes is a similar, necessary buffer. In addition to Saudi and Emirati pipeline expansions around the Strait of Hormuz, Iraq and Kuwait are exploring new routes to exit the Gulf, and other producers are seeking to store oil closer to customers outside Hormuz. As Houthi threats to the Bab el Mandeb Strait increase, so, too, may interest in developing pipeline capacity through the Red Sea. Outside the Middle East, Canada is pressing to expand oil and LNG infrastructure capable of serving markets in both Asia and Europe, in part to reduce dependence on the U.S. market. Asian buyers are seeking greater supply security through new long-term LNG contracts with exporters such as Australia, Malaysia, and the United States.

Integrated energy markets are also a source of security, not a luxury to be suspended when prices climb. Governments should resist pressures to retreat from them, as China did when it moved to curtail its refined product exports. Market forces have cushioned

the blow of lost energy flows: when shortages through Hormuz drove up energy prices in certain regions, trading firms and energy companies rerouted their tankers to buyers willing to pay the most. When fears of jet fuel shortages sent prices even higher, refiners adjusted their operations to produce more jet fuel and less gasoline and diesel. In March, for example, European refineries increased jet fuel output by 22 percent year-over-year, according to the IEA, cutting the region's need for overseas imports by more than half.

Whereas state-driven economies such as China's may simply order refineries to operate at lower capacity, in market-driven economies, market forces help direct scarce supplies to where they are most valuable, encourage conservation, and shift production toward the fuels consumers need most. If the Hormuz crisis escalates in its next phase and prices soar, Washington may face greater political pressure to restrict oil exports in the belief that doing so will cushion domestic prices. Giving in to such pressures would be a mistake. An export ban would damage U.S. credibility as an apolitical supplier, harm allies, distort price signals, and weaken incentives to invest in U.S. production and refining capacity, which would ultimately raise costs for Americans.

Expanding the base of domestic production is another pillar of resilience. The Hormuz crisis demonstrated the strategic value of the United States' transformation from a major oil importer into a leading producer and exporter. The lesson for other countries is not simply to produce more oil and gas but to develop a diverse portfolio of reliable domestic energy sources—including oil and gas where appropriate, as well as renewables, nuclear, and other sources—that reduces their exposure to crises and gives governments more options when one occurs.

The benefits of domestic production are already driving some countries to rethink policy. In the United Kingdom, for example, Prime Minister Andy Burnham has begun easing the Labour government's restrictive approach to oil and gas development in the North Sea. Several European countries, including Belgium, Denmark, and Italy, have also begun revisiting their long-standing resistance to nuclear power.

Finally, a system that relies on the most vulnerable to absorb the worst consequences cannot be resilient in the long term. Instead, it leads to political and economic instability. Strengthening lower-income countries' ability to endure energy shocks will require assistance in the clean energy domain—including financial and technical support to accelerate electrification, to improve energy efficiency, and to expand secure, lower-carbon domestic sources of energy. The Hormuz crisis also demonstrates why these countries would benefit from carefully targeted assistance in oil and gas development and infrastructure. Even though multilateral development banks have largely retreated from fossil fuel financing, that system will persist for decades. Selective

support for storage, refining, pipelines, and ports can reduce vulnerabilities and provide a more stable foundation for the decades-long transition to cleaner energy.

KNOWLEDGE IS POWER

The real hazard of the Hormuz crisis is not the shock that the world endured but the overconfidence it may foster. The closure of the world's most important oil chokepoint should have tipped the global economy into recession, and that it did not will tempt many to conclude that energy security risks no longer matter. The opposite is true. The buffers that have minimized the disruption so far will hold for only so long and must be reinforced if the world is to endure future shocks. Moreover, fears around energy security alone will not be enough to push the transition to clean energy forward; doing so will require concerted effort and intention.

The crisis has also exposed a new balance of power in energy politics. A disruption that a generation ago would have humbled Washington instead left the United States more insulated than any major economy, as costs overwhelmed the countries least able to bear them. Whereas energy shocks once disciplined the powerful, they now increasingly punish the vulnerable and spare the strong. A superpower shielded from the consequences of the turmoil it helps create has fewer reasons for restraint, and a country that can steady or shake the market at will—be it the United States or China—has a lever difficult to counter.

The next energy shock will not look exactly like the crisis of Hormuz. But that shock offers important lessons for how to prepare for the next battle. Now that the energy weapon is back, that moment may come sooner than we think.

Looking North: Alaska's Strategic Resources and America's Future

By Dr. Gwen Holdmann

For many Americans, Alaska occupies a curious place in the national imagination. It evokes a land of wilderness – a rugged frontier rich in wildlife, glaciers, and natural resources. It is where many of us dream of taking an Inside Passage cruise, where breathtaking photographs of Denali grace the pages of travel magazines, and where the tales of Jack London and the poetry of Robert Service still evoke a bygone era of adventure, self-reliance, and frontier grit in the far north.

Alaska often can feel distant and inaccessible, both geographically and psychologically – a place apart from everyday American life. After all, most schoolchildren are first introduced to the 49th state as a small inset floating somewhere off the coast of California beside Hawaii – a cartographic convenience that subtly reinforces the idea that Alaska exists somewhere beyond the nation's mainstream.

Yet in many ways, Alaska is not on the periphery at all. It sits at the intersection of some of the most important geopolitical, economic, and strategic forces shaping the twenty-first century. Anchorage consistently ranks among the five busiest cargo airports in the world despite its modest population of fewer than 300,000 residents. That is because, on a globe rather than a flat map, the shortest air routes between many of the Northern Hemisphere's major economic centers pass over the Arctic, making Anchorage a natural crossroads for global commerce, particularly between Asia and North America. That same geography also places Alaska on the front line of North American defense. Ballistic missiles launched toward the United States from adversaries in Asia would naturally follow trajectories over the Arctic, making Alaska a cornerstone of the nation's homeland defense system. Today, that geography is taking on yet another dimension. As Arctic sea ice retreats, vessel traffic through the Bering Strait is increasing, and cruise ships are beginning to arrive from the north after traversing the Northwest Passage. Passengers now stand on deck, cocktail in hand, watching polar bears and sea ice drift by – a striking reminder that the Arctic is no longer a remote frontier but an increasingly accessible and strategically important region.

When Secretary of State William Seward negotiated the purchase of Alaska from Russia in 1867, many Americans derided the acquisition as "Seward's Folly" and "Seward's Icebox." History has rendered a very different verdict. Gold rushes, world-class fisheries, the discovery of oil on the North Slope, the construction of the Trans-Alaska Pipeline, Alaska's role in the Cold War, and today's race for critical minerals have transformed what many dismissed as a frozen wilderness into one of the most consequential land acquisitions in American history. It is worth asking how differently the world might look today if Russia retained ownership of this vast and highly strategic corner of North America.

Alaska's Resource Wealth

If Alaska's geography has made it strategically important to the United States, its geology has endowed it with one of the richest and most diverse natural resource portfolios on Earth. Throughout American history, different Alaskan resources have risen to national prominence. Gold fueled the settlement of the North at the turn of the twentieth century. The discovery of Prudhoe Bay transformed Alaska into one of America's great energy provinces, and the state continues to hold enormous undeveloped oil and natural gas resources. Today, attention has shifted once again as nations seek secure supplies of the critical minerals needed for advanced manufacturing, artificial intelligence, renewable energy, and national defense.

Much recent attention has focused on Greenland's mineral potential. Yet Alaska is at least as well endowed – and arguably more so. Beneath its mountains lie world-class deposits of zinc, gold, copper, graphite, and rare earth elements, along with known occurrences of nearly every critical mineral identified by the U.S. Geological Survey. These minerals are the building blocks of the modern economy. They are used in batteries, electric vehicles, semiconductors, wind turbines, smartphones, aircraft, satellites, and defense systems. Despite this extraordinary endowment, Alaska currently has only seven large operating hard-rock mines, leaving tremendous untapped potential for future development.

This remarkable abundance is the product of Alaska's extraordinary geology. Unlike most of North America, Alaska was not formed as a single piece of continental crust. Instead, over hundreds of millions of years, the Pacific Ocean acted like a giant conveyor belt, carrying volcanic island chains, fragments of ancient continents, underwater mountain ranges, and pieces of oceanic crust relentlessly northward. One by one, these fragments collided with the edge of North America. Some sank beneath the continent, fueling volcanism and mountain building. Others were simply too buoyant to descend. Instead, they crumpled, folded, and became welded onto the continent's edge, like rafts piling up against the bow of a ship. Geologists call these fragments *terranes*. Together they created an intricate and varied geological mosaic unlike anywhere else in the United States.

These repeated collisions did far more than build Alaska's spectacular mountains. They fractured the Earth's crust, generated enormous heat, and drove mineral-rich fluids through networks of faults and fractures deep underground. As those fluids cooled, they left behind veins of precious metals, critical minerals and rare earth elements. Elsewhere, ancient marine basins accumulated the organic material that would eventually become Alaska's vast oil and natural gas resources, while extensive coastal forests and swamps gave rise to its immense coal deposits.

Yet Alaska's natural wealth extends well beyond the resources found beneath its surface.

Cold, nutrient-rich waters of the North Pacific and Bering Sea support one of the world's largest and best-managed commercial fisheries, accounting for roughly 60% of U.S. commercial seafood landings. At a time when global food security is becoming increasingly strategic, Alaska's fisheries represent far more than an economic sector –they are a renewable national asset whose long-term value depends on healthy ecosystems and careful

stewardship. A changing climate makes this stewardship increasingly challenging. The collapse of the Yukon River Chinook salmon run over the past decade, influenced by a combination of environmental changes and other pressures, has had profound cultural, nutritional, and economic consequences for Indigenous communities that have depended on these fish for countless generations. It is a stark reminder that these resources cannot be taken for granted.

Alaska's forests represent another strategic renewable resource. The Tongass National Forest – the largest in the U.S. – provides timber, biomass, carbon storage, wildlife habitat, and immense cultural value. Yet it also exemplifies the difficult tradeoffs that accompany resource development. Once home to a thriving timber industry, Southeast Alaska's large-scale timber harvest has declined dramatically as national priorities have shifted toward conservation, habitat protection, recreation, and carbon storage. The Tongass illustrates that the challenge is not simply whether to use renewable resources, but how to balance competing public values in managing them.

Finally, Alaska is endowed with diverse renewable energy resources. Steep topography and abundant precipitation create enormous, largely untapped hydroelectric potential in parts of the state. Alaska's volcanic regions provide potential for geothermal development, while exceptional wind resources along the state's western coast are already helping power many remote communities. Cook Inlet, with the second-largest tidal range in the Western Hemisphere, also holds tremendous promise for ocean energy.

Yet abundance of natural resources alone does not guarantee prosperity. Every resource carries difficult questions about how it should be developed, who should benefit, and what should be preserved for future generations. In Alaska, those questions are especially challenging because the state's generous resource endowment is matched by equally significant ecological, cultural, and strategic values. Here, resource development is rarely a choice between right and wrong. More often, it is a balancing act between competing local, state, and national priorities, each of which are important in their own right.

Alaska's Great Balancing Act

Alaska sits at the intersection of multiple legitimate national priorities. It is expected to provide the energy and critical minerals needed to strengthen America's economy and national security while simultaneously protecting some of the world's most intact ecosystems, sustaining globally significant fisheries, preserving opportunities for subsistence hunting and fishing, supporting Alaska Native communities, and maintaining military readiness in an increasingly strategic Arctic. None of these objectives is unreasonable. The challenge is that they do not always point in the same direction. Adding another layer of complexity, many Alaskans depend on responsible resource development for jobs, thriving communities, and the long-term viability of the state's economy.

These competing priorities are amplified by Alaska's unique pattern of land ownership. More than 60% of the state is federally owned, meaning roughly one out of every three acres the U.S. government owns is located in Alaska. Decisions made in Washington therefore have an outsized influence on Alaska's economy, communities, and future. While those lands belong to all Americans, many Alaskans believe the people who live closest to them should have a stronger voice in how they are managed. Balancing national interests with local priorities has become one of Alaska's defining policy challenges.

Few recent decisions illustrate this tension more clearly than the Willow Project on Alaska's North Slope, a major new oil development on federal lands within the National Petroleum Reserve. To many Alaskans, Willow represents jobs, state revenue, domestic energy production, and greater American energy security. To many environmental advocates, it represents continued investment in long-lived fossil fuel infrastructure at a time when the world is working to reduce greenhouse gas emissions. The project became the focus of intense national debate not because either side lacked legitimate concerns, but because it sat squarely at the intersection of competing public priorities: climate policy, energy security, economic opportunity, subsistence resources, and responsible stewardship of federal lands.

The Tongass National Forest presents a different version of the same challenge. As the largest national forest in the United States, it provides globally significant wildlife habitat, stores immense quantities of carbon, and supports world-class fisheries and a thriving tourism economy. At the same time, generations of Southeast Alaskans have viewed it as a source of timber, family-wage jobs, and economic opportunity. Debates over roadless protections and timber harvest are therefore not simply environmental disputes. They reflect two legitimate visions of how public lands should serve both the nation and the communities that depend upon them.

Even the University of Alaska illustrates how deeply these tensions are woven into the state's history. Although Alaska is America's largest state, its land-grant university historically received the second-smallest land grant in the nation, larger only than Rhode Island's. Recent efforts to fulfill that longstanding promise have required identifying hundreds of thousands of acres of federal land for transfer – a process that has itself sparked debates over recreation, wildlife habitat, subsistence, conservation, and future economic development. So even strengthening higher education in Alaska ultimately becomes a conversation about competing national priorities.

These debates rarely produce perfect solutions because Alaska is rarely confronted with simple choices between development and conservation. More often, it must reconcile legitimate competing interests for its lands and resources. That balancing act has become one of the defining characteristics of modern Alaska.

Unlocking Alaska's Potential

Natural resources create potential. Infrastructure transforms that potential into prosperity. Throughout Alaska's history, strategic infrastructure investments have repeatedly unlocked new chapters of economic development. The Alaska Railroad accelerated the opening of the *Aspen Institute Congressional Program*

Interior to settlement and mining. The Trans-Alaska Pipeline transformed one of the world's largest oil discoveries into a cornerstone of American energy security. Airports, ports, highways, and telecommunications expanded the range of what was economically possible. Alaska's next chapter will likewise depend not only on the resources it possesses, but on the infrastructure that allows those resources to create value.

Perhaps no infrastructure investment will be more important than affordable electricity. The industries that will define the twenty-first century – critical mineral development, mineral processing, advanced manufacturing, military installations, artificial intelligence, and data centers – all require abundant, reliable, and competitively priced power. Yet despite its extraordinary energy resources, Alaska has some of the highest electricity costs in the nation. That reality threatens not only the competitiveness of existing industries, but also the development of future opportunities. In the decades ahead, access to abundant, reliable, and affordable electricity may prove just as strategically important as access to the resources themselves.

History offers an important lesson. Much of the Pacific Northwest's economic success rests on hydroelectric projects built generations ago that continue to provide reliable, low-cost electricity today. Those investments were not simply about generating power –they created the foundation upon which industries, communities, and regional prosperity were built. Alaska now faces a similar generational opportunity. Through strong state-federal partnerships, investments in long-lived infrastructure – such as the proposed Susitna–Watana hydroelectric project, long envisioned as a source of abundant, low-cost electricity for Southcentral Alaska – could fundamentally reshape the state's economic future.

Transportation infrastructure is equally strategic. As the Arctic becomes increasingly accessible, the planned deepwater port at Nome represents far more than a regional harbor. It is America's first deepwater Arctic port – a national asset that will strengthen military readiness, Coast Guard operations, scientific research, emergency response, commercial shipping, and responsible resource development. Just as the Trans-Alaska Pipeline connected Alaska's North Slope to global energy markets, the Port of Nome has the potential to connect America's Arctic to the transportation network needed for the next era of Arctic commerce and security.

The common thread is that infrastructure creates opportunity. Infrastructure determines whether Alaska's natural resources remain stranded or become engines of prosperity. Roads, ports, electric transmission, broadband, and reliable energy systems shape where industries invest, where communities grow, and how effectively the nation can respond to emerging strategic challenges.

Looking North

For more than 150 years, America's relationship with Alaska has evolved as the nation's needs have changed. Gold helped settle the North. Oil strengthened American energy security during the twentieth century. Today, a new convergence of forces – including geopolitical competition, critical minerals, affordable electricity, Arctic shipping, and climate change – is once again reshaping Alaska's national importance.

That convergence creates extraordinary opportunities, but it also demands difficult choices. Climate change is transforming Alaska's landscapes and communities faster than almost anywhere else in the nation. Permafrost is thawing beneath roads and buildings. Coastal villages face accelerating erosion. Fisheries are changing, wildfire seasons are lengthening, and ecosystems are adapting in ways we are only beginning to understand. For Alaskans, these are not abstract policy debates. They are lived realities.

For generations, Americans have viewed Alaska as the nation's frontier—a distant place on the edge of the map. The twenty-first century demands a different perspective. The choices we make in Alaska today foreshadow many of the choices the nation will face tomorrow: how to balance resource development with environmental stewardship, strengthen national security while supporting local communities, and build the infrastructure needed for long-term prosperity. If we make those choices wisely, Alaska offers a generational opportunity to strengthen America's security, economy, and resilience. Far from being America's last frontier, the decisions we make about Alaska today will help shape – and foreshadow – the future of our nation.

Chokepoints and Energy Security: When Load-Bearing Assumptions Collapse⁸

By Bob McNally

There is a category of assumption in economics and finance so foundational that markets are incapable of pricing for its failure. Examples include the gold-dollar peg and the Federal Reserve's implicit guarantee against systemically important bank failures—toppled in 1971 and 2008, respectively—and the Treasury's still-maintained commitment to honoring its debt obligations. When these load-bearing assumptions give way, the consequences are not merely large—they are reordering. Participants do not simply update a single variable in their models; they must reconstruct their models themselves.

Energy security has its own financial load-bearing assumptions. This category includes the assumption that no hostile power could impose a prolonged closure of the Strait of Hormuz—a nightmare scenario given that the passage is the world's most critical energy chokepoint, carrying roughly 20 percent of petroleum liquids consumption, one-fifth of LNG shipments, and significant volumes of petrochemical feedstocks and fertilizer inputs on which global agriculture and industrial production depend.⁹

Hormuz closure was an obvious risk, but one the market had discounted due to the perception of US military dominance. For roughly four decades—from the Carter Doctrine of 1980 through the spring of 2026—the assumption that the United States would guarantee the free flow of energy from the Arabian Gulf underpinned the pricing, investment, and security architecture of global oil and liquefied natural gas (LNG) markets.

Operation Epic Fury, the United States-led military campaign that began in February 2026 and precipitated Iran's decision to interdict Hormuz shipping for five months as of this writing, collapsed that assumption. Markets, industries, and governments found themselves unprepared. They will not make the same mistake again — not because prices will stay permanently elevated, but because the assumption itself, once broken, cannot be quietly re-assumed.

The architecture of complacency

The Carter Doctrine, issued in January 1980, stated that any attempt by an outside force to gain control of the Persian Gulf region would be repelled by any means necessary, including military force. The Reagan Corollary extended the same guarantee to threats from within the region. These doctrines, and the successive demonstration of rapid American military dominance in the 1991 Gulf War and the 2003 invasion of Iraq, created a durable strategic presumption.

⁸ This article was originally published by the Oxford Emerge Forum in May, 2026:

<https://www.oxfordenergy.org/wpcms/wp-content/uploads/2026/05/OEF-149.pdf>

⁹Fattouh, B., and Economou, A. (2026, April), 'The anatomy of the Strait of Hormuz oil shock', Energy Insight 181, 1 (Introduction), Oxford Institute for Energy Studies, <https://www.oxfordenergy.org/publications/the-anatomy-of-the-strait-of-hormuz-oil-shock/>.

Iran was recognized as a threat to the Gulf, but it was considered manageable. During Operation Praying Mantis in April 1988, the US destroyed several Iranian naval vessels and military facilities in a matter of hours. Thus, markets assumed that in the event of any conflict, the United States military would overmatch any regional rival, pre-empting threats to Gulf allies and preventing prolonged disruption of the Strait of Hormuz. That presumption was, over time, internalized so deeply by energy markets that it effectively ceased to be priced as a risk and became a standing assumption instead.

Security concerns within the Gulf did periodically command attention—the tanker war of the 1980s most prominently. But that episode, which did not produce a single day of closure at Hormuz itself, reinforced rather than challenged the underlying confidence. The Iraqi Exocet strikes and Iranian mine-laying pushed commodity prices but did not break flows at the chokepoint. Market participants saw repeated demonstrations of US capability and the absence of Hormuz closure, and therefore rationally inferred an extremely low probability that it could occur.

The more consequential but less remarked analog came later. The failure of US and coalition forces to militarily suppress the Houthis' maritime campaign in the Red Sea corridor through 2024 and 2025 should have been a warning sign. Specifically, during Operation Rough Rider, conducted between March and mid-May 2025, US and coalition forces mounted a large air and naval campaign to suppress the Houthis' maritime threat to the Bab el-Mandeb, conducting around a thousand strikes over two months. The stated goal was to degrade Houthi military capabilities to the point where they could no longer threaten commercial shipping, but the result was a ceasefire that protected US ships only.¹⁰

While there are important differences between Operations Rough Rider and Epic Fury—including geography, mine warfare, and traffic density—a non-state actor with Iranian backing had demonstrated, for the first time in the modern era, the capacity to impose sustained disruption on a major global shipping lane despite active military countermeasures.

The boy who cried wolf, 2019–2025

Markets did not enter the 2026 conflict naïve to geopolitical risk. They had been educated, and mis-educated, by a sequence of supply disruption events that each resolved faster than feared, with oil price spikes quickly reversing.

The Abqaiq-Khuraib drone and cruise missile attack on Saturday, September 14, 2019, briefly took roughly five per cent of global oil supply offline; prices spiked sharply on the Sunday opening, then retraced the entire move within two weeks as Saudi Arabia restored capacity ahead of schedule.

Russia's full-scale invasion of Ukraine in February 2022 briefly drove Brent crude above US\$125 per barrel; within months, market re-routing and demand softening had absorbed the shock.

¹⁰Johnsen, G. (2025, June), 'Feature commentary: an assessment of Operation Rough Rider', CTC Sentinel, 18, no. 6, <https://ctc.westpoint.edu/feature-commentary-an-assessment-of-operation-rough-rider/>.

The joint American-Israeli strikes on Iranian nuclear and military facilities in June 2025 caused a one-session spike and a rapid reversal as traders concluded—correctly, for that moment—that Iran would absorb the blow without retaliating with its oil card.

Over the last seven years, this sequence systematically trained the market to fade geopolitical spikes. That track record bred the complacency that preceded the largest oil (and LNG) geopolitical disruption in history, which began in February 2026 and continues as of this writing in late July, 2026.

Why Iran played the oil card in 2026

What changed? Iran had conspicuously declined to use the Hormuz card in prior confrontations. The 28 February 2026 strikes constituted an entirely different order of provocation. Iranian air defense and military infrastructure were degraded severely. Senior figures in the Islamic Revolutionary Guard Corps were killed in decapitation strikes. The regime faced what its own internal communications characterized as an existential challenge, compounded by the popular uprising that had been gathering force since late December 2025.

A government fighting for its political survival had different incentives than one seeking tactical advantage. The oil card, always available, had previously been too costly to play; the political calculus shifted when the alternative appeared to be regime collapse.¹¹ The duration of the resulting disruption shocked market participants across the board.¹² Leading banks and investors assumed a quick disruption, with one notable exception.¹³ So did the Trump administration, which reportedly brushed aside warnings from senior military officers about a prolonged closure of the Strait.¹⁴ The administration's public posture was that American military superiority would resolve the situation quickly, which contributed to a market environment in which optimism about a resolution was treated as the responsible default.

What the disruption will and will not change

As of this writing, an end to the conflict is not in sight, but crude oil markets have exhibited surprising optimism that it will end soon. The crude oil market impact of the Hormuz disruption was initially dampened by a large and sudden drop in Chinese imports, though this trend has recently begun to reverse. The largest-ever coordinated strategic stock release by US and other IEA countries also helped cushion the supply loss. However, these buffers are wearing off as commercial inventories continue dropping. If Hormuz does not reopen and supply is not restored soon, crude oil prices are likely headed higher. Refined product markets did not benefit from these buffers and are quite tight, with refinery margins at

¹¹Internal power dynamics were also in play. Decapitation strikes that killed senior IRGC commanders paradoxically hardened the surviving inner circle's resolve rather than producing paralysis.

¹²For a recent analysis of the oil and gas implications of a US–Iran conflict, see McNally, B., Modell, S., and Ferreira, F. (2025), *Battlespace and Barrel Flow: Oil Market Impacts of a US-Iran Conflict*, <https://www.rapidanenergy.com/bab-flow-report>.

¹³Bianco, J. [@biancoresearch] (2026, March 13), X; Brown, P., et al. (2026, March 11), *Iran Conflict and the Strait of Hormuz: Impacts on Oil, Gas, and Other Commodities*, Congressional Research Service Report R45281, <https://www.congress.gov/crs-product/R45281>.

¹⁴Ward, A., Seligman, L., Leary, A., and Bergengruen, V. (2026, March 13), 'Trump knew the risk of Iran blocking the Strait of Hormuz. He still went to war', *The Wall Street Journal*.

record levels.

Regardless of how and when the conflict ends, the consequences of Hormuz's first sustained disruption will be significant, but they require careful distinction between what is likely and what is merely rhetorically compelling.

What the disruption will change, durably and materially, is the premium that markets, insurers, and governments attach to supply and infrastructure located outside the Arabian Gulf chokepoint system. Projects and pipelines that offer deliverability independent of Hormuz—the East-West Pipeline capacity that allows Saudi crude to reach Yanbu on the Red Sea, Omani LNG export terminals facing the Arabian Sea, alternative routing options for Iraqi crude through Turkey—will attract greater commercial and strategic value. Assets priced on an assumption of a permanently open Strait passage will be repriced somewhat lower, while assets in regions deemed geopolitically more secure, especially North and South America, will receive a premium.

The disruption will substantially boost political support for rebuilding and enlarging strategic stock reserves. The coordinated drawdown conducted by the International Energy Agency during the acute disruption phase demonstrated that consumer country reserves remain a meaningful tool for crisis management. Governments that had allowed reserves to erode—including the United States, which had made substantial sales from the Strategic Petroleum Reserve over the past decade for a combination of fiscal and political reasons—will face both political pressure and genuine security logic to rebuild buffer stocks. Minimum stockholding obligations within the European Union mandatory stockholding framework will be revised upward. China's strategy of building and maintaining large commercial and strategic crude inventories appears vindicated, and other Asian importers are likely to follow suit.

Finally, and perhaps most consequentially for military planning, the disruption will embed chokepoint security as a first-order concern in American and allied defense posture, as not seen since the early 1980s. The Houthi precedent demonstrated the vulnerability of maritime chokepoints to non-state actors with anti-ship missile capability. The US deprioritized efforts to prevent Iran from disrupting shipping in the Strait of Hormuz, marking a material miscalculation in operational contingency planning that is unlikely to be repeated. The Iranian interdiction in 2026 showed that a state actor under sufficient pressure will exploit that vulnerability even at extreme cost to itself. Mine countermeasures, anti-ship missile defense, and the capacity to guarantee freedom of navigation through narrow waterways will become budgetary and doctrinal priorities that competition with China and Russia had displaced.

The disruption will not structurally accelerate the energy transition on a Paris Agreement-relevant timescale: while high oil prices boost EV adoption and renew purchase incentives, the underlying constraints of grid infrastructure, critical mineral supply chains, consumer behavior, and legacy fleet economics remain intact, and any incremental transition pull fades when prices normalize. Nor will it prompt importers or investors to abandon the Middle East as an energy province—the Arabian Gulf's unmatched reserves of low-cost conventional crude and gas cannot be relocated by policy or investment decisions, making the central question not whether the Gulf remains essential to global supply, but on what terms that supply is accessed and secured.

LNG and the geopolitics of a single chokepoint

Oil has dominated the Hormuz narrative, but LNG absorbed the more structural blow. Crude has multiple origin points and partial bypass routes—the East-West Pipeline, Fujairah, ADCOP. Gulf LNG does not. Qatar's Ras Laffan complex, the operational hub of the world's largest LNG export facility, has no pipeline alternative and no canal. Every cargo bound for Asia or Europe transits the strait, or it does not move.

That geography now carries a political cost Qatar cannot hedge away. On 7 July, an Iranian strike hit a Qatari LNG tanker, the Nakilat-owned Al Rekayyat, near the Omani coast—the first Qatari LNG carrier struck since the war began, and a strike that landed even with an interim US-Iran peace deal nominally in place since June.¹⁵ QatarEnergy's response was immediate: CEO Saad al-Kaabi halted the push to ramp Ras Laffan back toward pre-war output and held operations at a minimum for safety.¹⁶ This is not an isolated event but the latest turn in a stop-start cycle running back to the war's opening days—force majeure at the outset, a partial restart after the spring ceasefire, renewed curtailment after Iran's late-June closure declaration, and now this pause. Roughly one-fifth of global LNG trade transits Hormuz, with Qatar and the UAE (mostly the former) supplying the majority of that volume.¹⁷

The load-bearing assumption that broke for oil was that American power guaranteed Hormuz's openness. The assumption that LNG breaks are narrower and more damaging: that Qatari supply, contracted under decades-long take-or-pay agreements with utilities across Asia and Europe, is as reliable as a pipeline. It is not. It is a single 21-nautical-mile passage away from an economy stopping cold. That is now permanent knowledge, not a transient crisis input. Qatar's risk premium will not fully retreat even once this war ends, because the underlying vulnerability—no bypass, no alternative export geography—cannot be engineered away. Buyers negotiating supply contracts for delivery into the 2030s and 2040s will price that reality in for the life of the contract.

Two producers do not share this exposure at scale: the United States and Australia. Both load cargoes from terminals with unconstrained ocean access—no narrow strait, no single point of state or non-state coercion. Russia, the world's fourth-largest LNG producer before 2022, remains largely outside the buyer pool for Western-aligned utilities. EU sanctions and self-sanctioning by Japanese, Korean, and European buyers continue to constrain Arctic LNG 2 offtake, notwithstanding Europe's heavy reliance on Yamal LNG ahead of an impending ban on imports from January 2027.¹⁸

There is no credible near-term scenario in which Russian LNG re-enters Western portfolios as a strategic hedge; the sanctions architecture is durable, and the reputational cost of chokepoint dependence has just been relearned the hard way with Gulf gas. That leaves the

¹⁵Al Jazeera (2026, July 7), 'Saudi, Qatari tankers hit as Strait of Hormuz risks worsen'; Insurance Journal / Bloomberg (2026, July 7), 'Update: Qatari LNG Ship Struck in Strait of Hormuz, Testing US Talks.'

¹⁶Bloomberg (2026, July 9), 'Qatar Pauses Push to Ramp Up LNG After Hormuz Tanker Attack.'

¹⁷Congressional Research Service Report R45281 puts LNG transit through the Strait at roughly 20 per cent of global trade; Wikipedia, '2026 Strait of Hormuz crisis', citing Europe's 12–14 per cent Qatari LNG share.

¹⁸Urgewald data reported by The Independent found the EU imported a record £3bn of Yamal LNG between January and April 2026 amid Hormuz disruption concerns.

US and Australia as the only two large-scale, geopolitically secure LNG suppliers capable of absorbing the demand this crisis will redirect.

Australia's capacity to fill that role is real but constrained by the policy of its own making. Canberra's new east coast domestic gas reservation scheme requires exporters to divert 20 percent of uncontracted export volumes to the domestic market from mid-2027, layering a political supply constraint on top of a physical one: Australia's own Gas Statement of Opportunities projects combined, east coast production will fall roughly 12 percent between 2026 and 2030 as the Gippsland and other southern fields deplete.¹⁹ Australia will remain a large exporter—on the order of 80 mtpa nationally—but its incremental growth capacity into the 2030s is limited relative to the US, and an increasing share of existing output is being redirected to domestic obligations rather than freed up for security-conscious Asian buyers.

That leaves the United States as the swing supplier of secure LNG for a market that has just relearned, at enormous cost, why chokepoint-free supply commands a premium.

What does it mean for US LNG and policy?

Demand forecasts have moved in the direction that supports this thesis. The "peak LNG demand by 2030" framing that dominated modeling through 2023–2024—built on European post-Ukraine gas retrenchment, aggressive Asian decarbonization timelines, and an expected supply glut from 2026 onward—is losing credibility as a base case. Data center power demand, industrial reshoring, and a re-priced chokepoint risk premium are pulling the demand curve in the opposite direction from the 2023-era peak-demand consensus.

The US is already positioned to be the primary beneficiary. US peak export capacity has grown from roughly 12.8 Bcf/d in 2024 to more than 18 Bcf/d by mid-2026, with Corpus Christi Stage 3, the first Golden Pass train, and a full year of Plaquemines LNG adding volume, and a new wave of large-scale greenfield LNG developments due in 2027.²⁰ The Department of Energy projects capacity more than doubling by the early 2030s on the back of the 2025 permitting reset, which produced a record 83 bcm/yr of new US final investment decisions—more than 90 percent of the global total that year—with FIDs continuing into 2026.²¹

For the US to benefit from structurally increasing investor interest in LNG, policymakers should implement sound, market-based policies keep “above ground risk” to a minimum.

First, keep permitting predictable rather than merely fast and let the market decide which projects move forward. The 2024 pause and 2025 reversal demonstrated that policy discontinuity, not technical or commercial constraint, is the binding risk to US LNG capacity growth. DOE and FERC should commit to statutory review timelines that survive a change of administration, stripping the political risk premium out of US project economics just as Hormuz has added one to Qatari cargoes.

¹⁹Allens (2026, May), 'Australia's gas reservation scheme'; Australia 2026 Gas Statement of Opportunities, cited in IEEFA and World Pipelines coverage of the east coast reservation mechanism, May 2026.

²⁰EIA, 'U.S. natural gas exports to grow nearly 30% by 2027 as LNG facilities ramp up' (2026, April 16); Natural Gas Intelligence (2026, January 6), 'Clearer Timeline Emerges for Next Wave of U.S. LNG Projects.'

²¹IEA, Global LNG Capacity Tracker, status as of 12 June 2026; U.S. Department of Energy (2026, February 24), 'A Decade of U.S. LNG Leadership.'

Second, resist the temptation to limit or ban LNG exports. Australia's east coast scheme — grandfathering existing contracts but requiring exporters to divert 20 percent of uncontracted volumes from mid-2027 — is a narrower intervention than reservation proposals typically floated in the US, and even at that scale, it has drawn warnings from Australian producers that it will discourage the upstream investment needed to expand supply, the actual solution to domestic price concerns. A blanket US mandate, untethered to existing contracts, would risk the same distortion at a greater scale. US Henry Hub pricing remains a fraction of JKM and TTF; that gap is the commercial case for export growth, not an argument to suppress it.

Third, accelerate pipeline and interconnection buildout ahead of terminal completions. Feed-gas delivery and power-sector interconnection queues, not liquefaction capacity, are increasingly the binding constraints on realized US export growth through 2028–2029. There is a need for new pipelines from the northeast to expand delivery of the lowest-cost Marcellus gas into Louisiana (pipeline investment is already booming in the Gulf region to feed LNG export demand from the Permian and Haynesville).

The reordering

The Strait of Hormuz was always the world's most critical chokepoint; after 2026, it will be priced as one. The 1971 and 2008 comparisons are not decorative — in both cases, the old assumption did not just lose credibility, it became unusable. No serious market participant re-priced gold convertibility back in after 1971, or systemic bank solvency back in after 2008. The same holds here: American deterrence no longer functions as a standing guarantee against Hormuz closure, and Arabian Gulf supply will likely embed a higher structural risk premium as a result, not a transient one that decays as the war recedes from memory.

LNG makes the case more sharply. Oil at least retains bypass routes, storage, and multiple origin points to draw on when Hormuz is threatened. Qatari LNG has none of these — a single strait, a single buyer relationship built on decades-long contracts, and no engineering fix for either. If the reordering is durable for oil, it is close to permanent for gas that has no way around the strait at all.

Electricity Affordability and Load Growth: Diagnosing and Fixing the Problem

By Robin Millican, Dr. Douglas J. Arent, and David Sandalow

- Rising electricity prices reflect a convergence of long-standing system weaknesses, including inefficient infrastructure planning, misaligned utility incentives, slow permitting, supply chain innovation, and reactive climate risk management. Increasing electricity demand, or load growth, including from data centers, is accelerating these pressures.
- Whether load growth raises or lowers prices depends on trail design, cost allocation, and supply availability. Where low-cost supply is available and existing infrastructure is efficiently utilized, additional demand can lower per-unit costs; where supply is constrained or capital needs are high, demand can raise prices.
- Optimization of the existing US power system through grid-enhancing technologies, demand response, and large-load flexibility could quickly unlock supply in the form of underutilized capacity. These efforts could defer costly infrastructure buildout but are under-deployed due to regulatory and incentive barriers that favor capital investment over system optimization.
- Sustained cost control will require structural reforms across three areas: realigning utility incentives with cost efficiency rather than capital investment; ensuring that large new loads bear a fair share of system costs at both the federal and state level; and removing the interconnection and permitting bottlenecks that prevent price signals from translating into deliverable supply.

Concerns about electricity affordability in the United States have been rising along with prices. The problem reflects a convergence of pre-existing structural failures: inefficient infrastructure planning, utility incentive structures misaligned with cost efficiency, chronic undervaluation of flexibility in grid operations, slow permitting timelines that have not improved in decades, and storm damage and wider costs—both worsening with climate change. Higher electricity demand, or load growth, including from data centers, is accelerating all of these pressures, and adding some of its own.

This commentary draws on recent research and discussions on electricity affordability, including a new analysis from Lawrence Berkeley National Laboratory (LBNL) and The Brattle Group and a roundtable series the Center on Global Energy Policy (CGEP) at Columbia University SIPA held in New York, Washington DC, and Austin in late 2025 and early 2026. It examines the structural roots of rising electricity prices and identifies near- and medium-term solutions available to federal and state actors as well as the need for long-term proactive storm-, wild- and cyber-related risk reductions. The central finding is that rising electricity prices are driven by structural features of the power system rather than

demand growth alone, and that affordability outcomes under increasing load will depend on how effectively supply, infrastructure, and cost allocation are managed.

Current and Forecast Prices, and Drivers

A new analysis from LBNL provides important grounding on the drivers of electricity pricing in the United States. From 2019 to 2024—a period during which inflation in the United States reached the highest level in 40 years and became a top-tier political issue—average residential retail electricity prices roughly tracked the rate of inflation. Last year marked a departure from this trend, when the average residential retail price of electricity in the United States rose by 6 percent in nominal terms, more than twice the rate of inflation—and by 2.6 percent in real terms.

Primary year-over-year price drivers in 2025, reported in the LBNL analysis, include increases in fuel and wholesale supply costs (a factor in 21 states), distribution cost growth (16 states), generation capital expenditure (11 states), transmission infrastructure costs (11 states), and storm cost recovery (9 states). Annual investor-owned utility (IOU) generation capital expenditure, for example, increased 22 percent in inflation-adjusted terms in 2025 alone, following 13 percent increases in each of the two prior years.

A particularly underappreciated contributor to electricity price increases mentioned in the LBNL study is equipment cost inflation. Since 2019, producer prices for transformers have risen 89 percent, switchgear 77 percent, and wire and cable 152 percent. These cost increases now directly into utility capital expenditures and, with a regulatory lag, into customer bills over asset lifetimes.

One of the most consequential findings from the LBNL analysis concerns load growth itself: whether load growth raises prices for existing customers is not predetermined. The direction and magnitude of the effect depend on tariff design, cost allocation, and the adequacy of available supply. States with the highest demand growth from 2019 to 2025 generally saw all-sector average, inflation-adjusted prices decline by more than one cent per kilowatt-hour, as fixed infrastructure costs were spread over a larger consumption base. Nebraska, New Mexico, and North Dakota all absorbed large industrial and data center load additions while reducing inflation-adjusted retail prices. Two factors drove this: 1. abundant low-cost wind and solar generation served new loads at belowsystem-average incremental cost, and 2. substantial commercial and industrial growth spread existing fixed infrastructure costs over more demand, reducing per-unit prices for all customers including residential ratepayers.

That said, early 2026 data show prices climbing broadly, with increases particularly concentrated in the PJM Interconnection (13 states in the mid-Atlantic and Midwest, and Washington DC) and the Southeast. LBNL found that IOUs led \$18 billion in rate increase

requests in 2025—the highest level since the mid-1980s. Regulators approved, on average, 64 percent of those requests over the past five years, with 2025 running at 66 percent.

Much of that cost has not yet reached customer bills but will in the coming years. That burden has also fallen unevenly: the Energy Information Administration’s data show that residential customers saw roughly 27 percent higher bills from 2019 to 2024, compared to approximately 19 percent for commercial and industrial customers—a disparity driven in part by utility cost-allocation methods that have historically shielded large commercial users from proportionate cost recovery.

With roughly one-third of American households dedicating more than 5 percent of their income to electricity, according to LBNL, calls for action are certain to grow.

Near-Term Opportunity: Optimizing Existing Infrastructure

The aforementioned CGEP electricity affordability roundtables that included stakeholders from government, industry, finance, academia, and think tanks consistently surfaced this multifactor diagnosis of the drivers of price increases. However, a recurring theme from the roundtables, and one with a strong near-term political and economic case, is that the United States has substantial untapped capacity in its existing transmission infrastructure. New supply and delivery infrastructure will require years of permitting, siting, and construction; in the interim, tools including commercially available grid-enhancing technologies (GETs) and demand response can provide a faster and lower-cost path to meaningful capacity increases.

CGEP recently published a white paper examining the evidence base for GETs. A leading GET example is dynamic line rating (DLR), which uses real-time weather and sensor data to determine actual line capacity rather than relying on conservative static assumptions. DLR reduced congestion by up to 65 percent on monitored lines at PPL Electric in Pennsylvania, delivering over \$50 million in congestion cost savings.

The UK’s National Grid announced deployment of DLR across 275 kilometers of its transmission infrastructure—driven in part by the need to relieve growing congestion on corridors connecting Scottish wind generation to demand centers in London. The company said this deployment has the potential to enable service to approximately 75,000 additional homes and generate an estimated £20 million per year in consumer savings.

Advanced power flow control devices, which reroute electricity from congested lines to underutilized parallel routes, freed 2 gigawatts (GW) of additional capacity on National Grid’s UK system—equivalent to roughly two million homes—saving customers £390 million over seven years.

And advanced conductors, some of which replace steel cores with carbon fiber composites, can nearly double line capacity without new towers or rights-of-way, with deployment timelines measured in months rather than the decade-plus required for new transmission.

All told, the savings realized from GETs could be substantial: analysis in Proceedings of the National Academy of Sciences projects \$180 billion in savings by 2050 from strategic deployment of GETs across the United States.

Grid-enhancing technologies address the supply and delivery side of the equation. On the demand side, large-load flexibility—particularly data center load shaping, or reducing usage during peak periods—offers a complementary lever for managing peak demand without relying on high-cost, low-utilization generation. The DCFlex initiative—a collaboration of 53 utilities, grid operators, and hyperscalers—has completed proof-of-concept pilots in Arizona, North Carolina, and France demonstrating that data centers can curtail or shift computational workloads in response to grid signals during peak hours. The DCFlex Arizona project achieved 10 to 40 percent flexibility in workload during a simulated peak event.

Given the potential benefits to the system, regulators are beginning to evaluate new constructs to drive uptake of GETs, demand response, and flexibility. Near-term actions to mandate consideration of GETs in planning processes—as FERC Order 1920 did in 2024—and to require disclosure of transmission utilization rates would represent meaningful progress toward accountability without requiring fundamental restructuring of the regulatory compact. More broadly, these measures point toward a pragmatic near-term strategy for electricity affordability: maximizing the performance of existing infrastructure while longer-term generation and transmission buildout proceeds.

Medium-Term Agenda: Structural Reform

The transition from slow or very low growth to a new era of accelerated load growth, particularly driven by data centers and advanced computing, has exposed structural limitations in how the US power system is governed, planned, and operated. GETs and demand response and flexibility address near-term capacity constraints, but affordability over time requires tackling the deeper structural misalignments that the LBNL analysis and the CGEP roundtables identified.

Several reform priorities have emerged repeatedly in both the literature and practitioner discussions: realigning utility incentives, modernizing cost allocation for a new era of large and concentrated loads, and removing the institutional barriers that prevent price signals from translating into deliverable supply.

Aligning Utility Incentives with Cost Efficiency

The barriers to broader use of tools like GETs and demand response are not technological but institutional and structural. Under traditional cost-of-service regulation, utilities earn authorized returns on equity of approximately 9 to 10 percent—a return structure that applies to transmission owners as well as distribution utilities. This regulatory structure rewards capital deployment more than system optimization. As long as frameworks remain oriented toward proving “need” for new capital investment rather than systematically evaluating lower-cost alternatives, the pace of deployment will lag.

Performance-based regulation (PBR)—which ties utility returns to measurable outcomes like system cost reduction, interconnection speed, and congestion relief—is a commonly proposed structural remedy, including at CGEP’s roundtables, but data are still being assembled on its effectiveness at cost management. The UK’s experience with PBR under Ofgem’s RIIO framework represents the most developed implementation, with some evidence of cost discipline, though results have been mixed and the institutional context differs substantially from the United States. Domestic experience with PBR is limited. New York’s Reforming the Energy Vision (REV) initiative is the most prominent US report, and its track record is still being assessed.

Allocating Costs Fairly as Demand Patterns Shift

The arrival of data centers and other large, concentrated loads is testing cost allocation frameworks at every level of the system. Whether this new demand raises or lowers prices for existing customers depends not on the scale of the load itself but on how the costs of serving it are structured and distributed, according to the recent LBNL analysis and an earlier paper from the Electric Power Research Institute.

At the federal level, FERC is addressing the transmission side of this question. The Commission’s advance notice of proposed rulemaking on large load interconnection (RM26-4) proposes that large-load customers bear the full cost of network upgrades their projects trigger—shifting those costs to the interconnection customers who cause them rather than socializing them across all ratepayers. This approach would shield existing customers from bearing the infrastructure burden of new large loads, though it raises a legitimate design question: how to credit the original payer when upgrades they trigger deliver broader system benefits over time. FERC expects to act on this rulemaking by June 2026.

Separately, state commissions are grappling with large-load retail tariff design. Emerging approaches such as take-or-pay contract structures (which require a buyer to pay for a minimum amount of a product, regardless of actual usage), upfront financial commitments, exit fees, and load flexibility requirements, can in principle protect residential ratepayers while accommodating new large loads.

Early utility projections are encouraging. Indiana utility NIPSCO projects \$7 to \$9 per month in residential savings by 2032 under its Amazon data center agreements; and Detroit-based DTE estimates a potential 8 percent reduction in residential costs under conditionally approved data center contracts.

But LBNL notes that these are forward-looking projections, not realized outcomes, and that new tariff structures carry a real risk of insufficient cost protection. A 2025 Harvard Law School review of nearly 50 regulatory proceedings on data center rates questioned the ability to isolate data center energy costs from consumer bills and suggested that details of contract structures be transparent and rigorously evaluated. Once established, state commissions will need to actively monitor these structures to verify whether projected savings materialize.

Translating Price Signals into Deliverable Supply

A third area for structural reform is removing supply delivery bottlenecks. In PJM Interconnection, rapid data center growth is colliding with supply and transmission constraints, driving capacity auction prices to historic highs. According to LBNL, capacity payments alone are expected to add roughly 1.5 cents per kilowatt-hour (kWh) to PJM wholesale costs across 2025 and 2026. Nationally, LBNL estimates capacity payments added nearly 1 cent/kWh to average wholesale costs in 2025, with a further 0.6 cents expected in 2026.

While the capacity market is pricing scarcity correctly, the broader system cannot respond at the required speed. Interconnection and new-build transmission timelines that take years sever the link between price signals and supply entry. Higher capacity prices mostly end up paying existing generators more rather than inducing new construction, and those extra costs are passed on to consumers through their electricity bills over time.

Addressing this bottleneck requires reforms on two parallel fronts: improving the speed and discipline of interconnection processes, while reducing the time required to permit and build new infrastructure.

The interconnection queue—the process by which new generation and storage projects are studied and approved for grid connection—can be reformed through such efforts as readiness-based prioritization, standardized study processes, and enforceable timelines to reduce delays and bring viable projects online faster. Cluster-based interconnection studies—where projects in a geographic area are evaluated together and required system upgrade costs are shared across entrants rather than borne entirely by the first mover—are another structural reform option. Cluster studies and other queue prioritization reforms were incorporated in FERC Order 2023, though implementation has been slow and uneven.

The rule is likely to improve queue efficiency over time but will not by itself resolve the gap between demand growth and the pace of deliverable supply.

Texas has moved furthest in the direction of queue reform: ERCOT's SB6 framework passed in 2025 introduced approximately \$50,000 per megawatt in non-refundable interconnection fees, financial security requirements, and a tiered queue process designed to prioritize projects with demonstrated readiness and screen out speculative entries that clog studies without ever reaching construction.

More broadly, permitting timelines for new transmission have not materially improved in decades: the average transmission project takes a decade to complete, new high-voltage line construction has fallen to roughly 20 percent of early-2010s levels, and the federal government's authority to site interstate corridors remains limited and contested.²⁰ Federal and state siting reforms—including streamlined environmental review, categorical exclusions for lower-impact projects, and clearer federal authority for interstate transmission corridors—can help more quickly translate price signals into actual supply additions.

Long-Term Need: Risk Management

Storm cost recovery is emerging as a meaningful retail price driver across multiple states, with LBNL documenting surcharges of 1–3 cents/kWh in places such as Florida in the 2024–2025 period, and multiyear securitization of storm costs. These are not low-probability events—they are recurring, compounding costs that have been and will be embedded in the rate base for decades.

In California, LBNL funds wildfire mitigation and related costs added about 4 cents/kWh from 2019–2024, making them one of the largest contributors to recent rate increases. However, ex-ante resilience investment is demonstrably cheaper than ex-post investment. For example, an analysis from the Energy Institute at UC Berkeley found that the cost of ignitions caused by vegetation striking powerlines would have been 4.5 times greater in 2022 and 2023 absent the California utility PG&E's proactive risk reduction efforts.

Hardening transmission lines in high-risk corridors and accelerating undergrounding in re-prone areas can reduce long-run costs to ratepayers by lowering the frequency and severity of damage and associated recovery costs, even if they increase near-term capital expenditure. Similarly, expanding interregional transmission to enable reserve-sharing requires upfront investment and coordination but can reduce system costs over time by improving resource utilization and avoiding duplicative capacity buildout.

Another structural liability affects some Western states: utilities bear wider liability even absent negligence, creating a material disincentive to build the transmission infrastructure. Federal reinsurance mechanisms or carefully designed liability caps (limited to cases without negligence and conditioned on demonstrated hardening standards) merit serious

consideration—not as regulatory relief for utilities but as a risk-allocation reform that avoids the current dynamic in which ratepayers absorb multidecade recovery costs without any coordination or pooling of risk across jurisdictions.

Cybersecurity presents an additional and growing dimension of system risk and will require ongoing diligence. As the number of interconnected devices (“the internet of energy things”)—advanced sensors, distributed energy resources, cloud-based control architectures, and real-time communications networks—expands, vulnerabilities grow exponentially. Ensuring the resilience of these increasingly networked systems will require sustained investment in cybersecurity provisions and ongoing regulatory attention, particularly as grid modernization accelerates the pace of digital integration.

Conclusion

The central lesson from the LBNL analysis and broader evidence is that electricity price outcomes are not driven by demand growth alone but by how the system responds to it. Prices rise when new demand triggers high-cost infrastructure buildout, rejects inefficient planning, or shifts costs unevenly across customers. They can fall, or grow more slowly, when low-cost supply is available, existing infrastructure is more fully utilized, and cost allocation ensures that new demand contributes to system efficiency.

This framing points to a clear set of policy priorities across time horizons. In the near term, the most immediate opportunity is to optimize the existing system—deploying grid-enhancing technologies, demand response, and large-load flexibility to unlock latent capacity and defer costly new investment. In the medium term, structural reforms are needed: improving trail design and cost allocation, and enabling new supply to be built and connected at lower cost via reforms to interconnection queues, transmission siting, and permitting for energy projects. Over the longer term, risk management becomes central, as costs related to storm damage, wildfire mitigation, and cybersecurity increasingly shape the trajectory of retail prices.

The most adverse price outcomes are not inevitable. They are the result of policy and regulatory choices. Delivering affordable electricity depends on aligning supply, infrastructure, and cost allocation so that rising demand can drive higher utilization and lower costs—taking advantage of load growth as an opportunity, rather than a liability.

US Power Grid Status and Modernization Opportunities

By Rob Gramlich



US Power Grid Status and Modernization Opportunities

Rob Gramlich

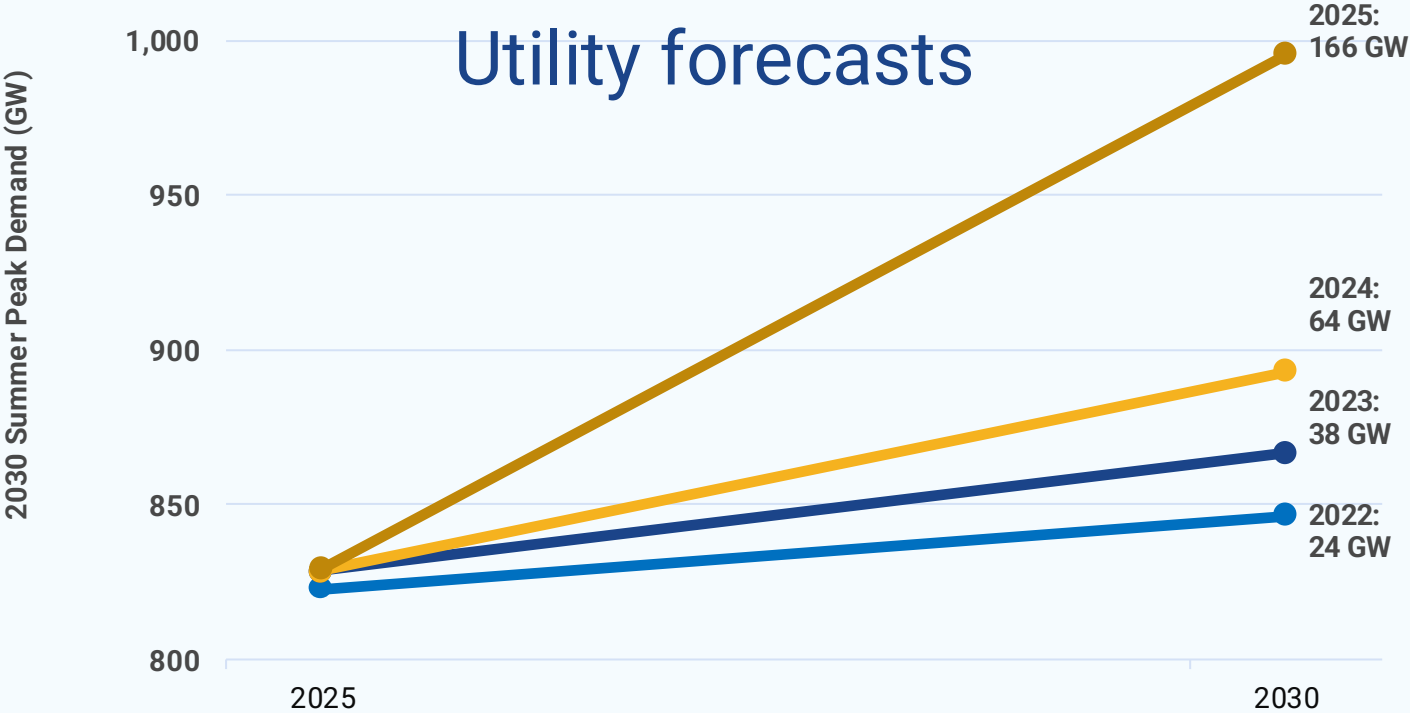
President, Grid Strategies

August 2026

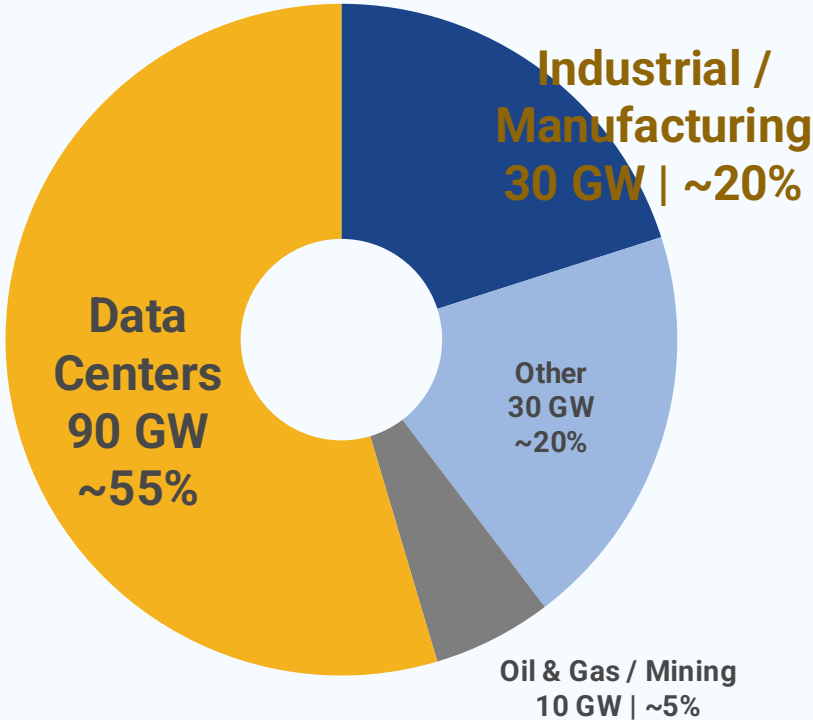
US Power Sector is Hot: Five-Year US Power Demand Growth Up Six-Fold to 166 Gigawatts

New demand = 15x
the peak load of
New York City

5-year Nationwide Summer Peak Growth



Drivers of demand growth

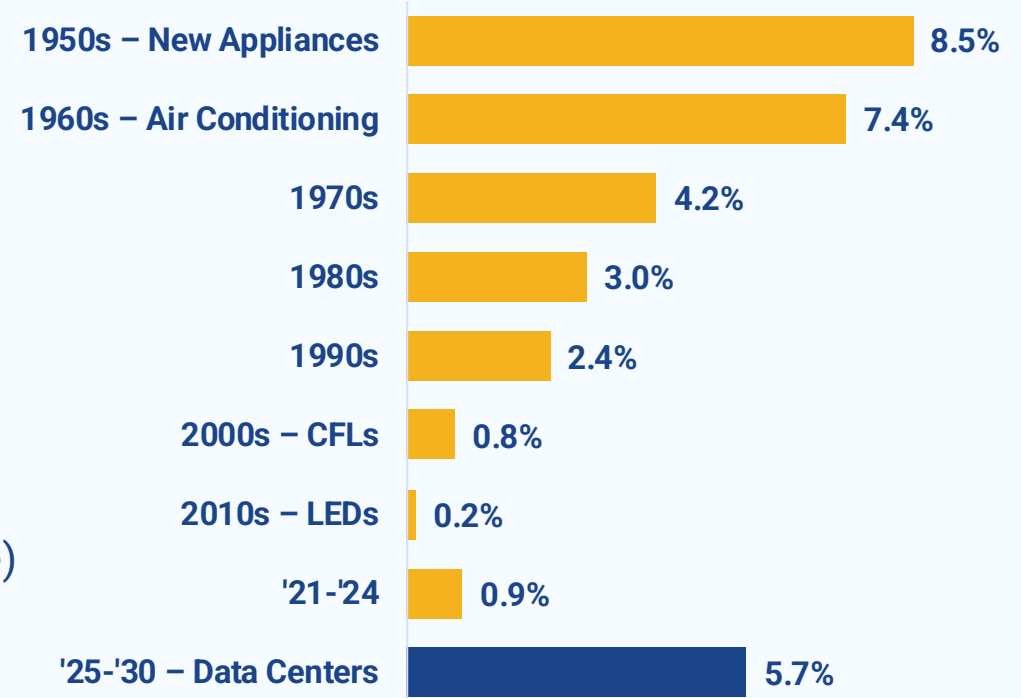


Post FERC 714 Adjustments:
SPP: SPP, [2025 Integrated Transmission Planning Assessment Report](#), Draft v. 0.3 (October 6, 2025).

Historical Inflection Points

- Late 1800s Tesla, Westinghouse, Edison inventions
- Late 1800s Sam Insull created first integrated utilities
- 1930s rural electrification and creation of consumer-owned cooperatives
- ~3000 utilities, with fragmented, balkanized “territories”
- Power pools developed in 1920s-40s
- 1965 blackout, greater connections between utilities, reliability standards
- 1950s-70s Remote hydro and coal connected to load with big lines
- 1980s-2000s partial deregulation (competition in generation, retail service)
- 2000s Regional Transmission Organizations in 2/3 of country
- 2003 Northeast blackout, led to Energy Policy Act of 2005
- 2000s Renewables growth globally and in US
- 2000-2023 Flat power demand
- 2005-15 Shale gas revolution
- 2023-6 Sudden unexpected load growth

Demand growth by decade

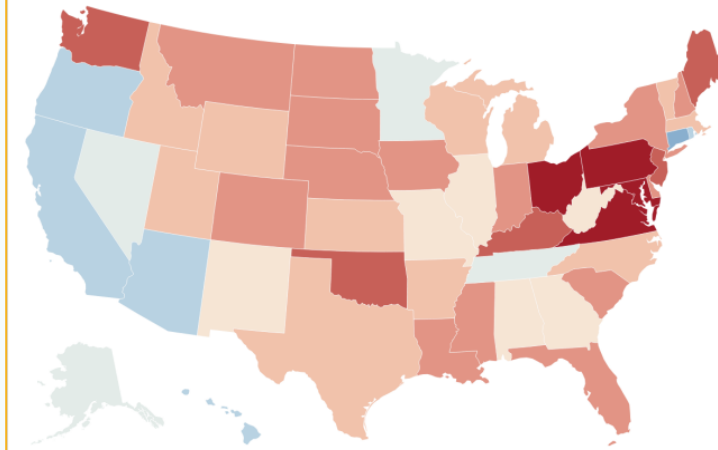
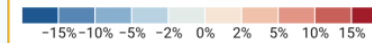


Affordability Challenge: Retail Rates Rising Faster than General Inflation

- Fuel / wholesale supply
- Asset replacement needs
- Higher capacity prices as supply-demand balance tightens
- Storm and fire damage:
- Generation cost overruns
- Expensive equipment

Percentage Change in All-Sector Retail Electricity Prices: January 2025 to January 2026

Percentage change, adjusted for inflation in 2025\$



Source: EIA • Created with Datawrapper

Primary Drivers of Price Changes: 2024 to 2025

Stated reasons for price changes from 2024 to 2025 for those states with price increases or decreases of greater than 2%, after adjusting for inflation

	INCREASE >2%, 30 states	DECREASE > 2%, 4 states
Fuel / wholesale supply	21	4
Distribution cost	16	0
Generation CapEx	11	0
Transmission cost	11	0
Storm cost recovery	9	0
Capacity market prices	7	0
Extreme inflation	6	0
Clean energy policy	5	0
Wildfire cost	2	0
Other	2	2

Source: LBNL • Created with Datawrapper

Complicated industry structure, slow to respond to demand

Economic regulators

FERC

Regulates all transmission and wholesale power markets in RTO areas, and the wholesale transmission and power sales for utilities in non-RTO areas

State PUCs

Build and maintain safe, reliable, and high-quality electric infrastructure. Regulate most aspects of utilities outside of RTOs.

Market operators

ISOs/RTOs

Oversee electricity grid operations, wholesale market functions, and transmission planning across multi-state regions.

Reliability regulator

NERC

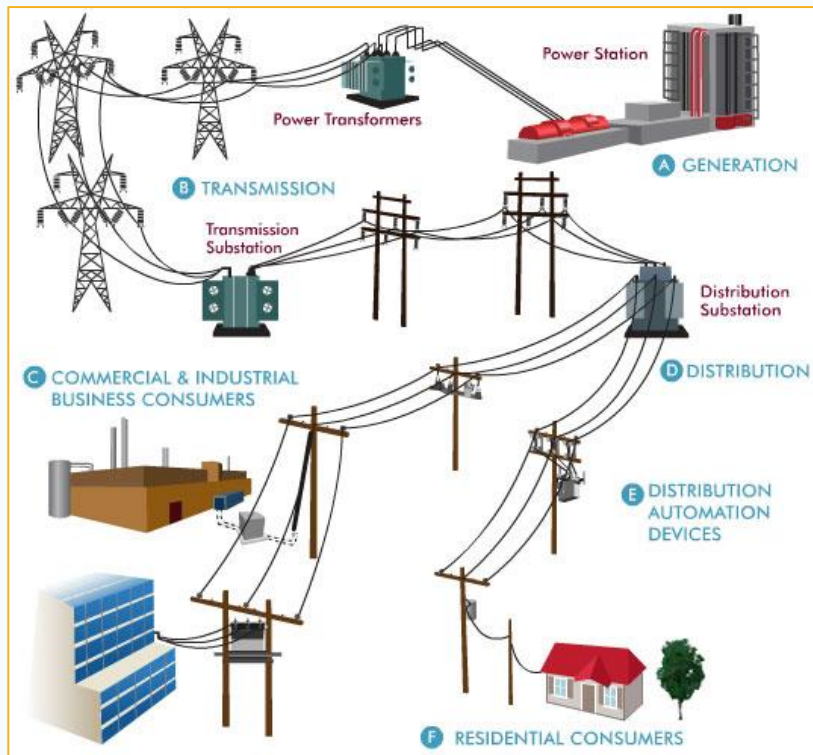
North American Electric Reliability Corporation ensures reliability of bulk power system

Other stakeholders

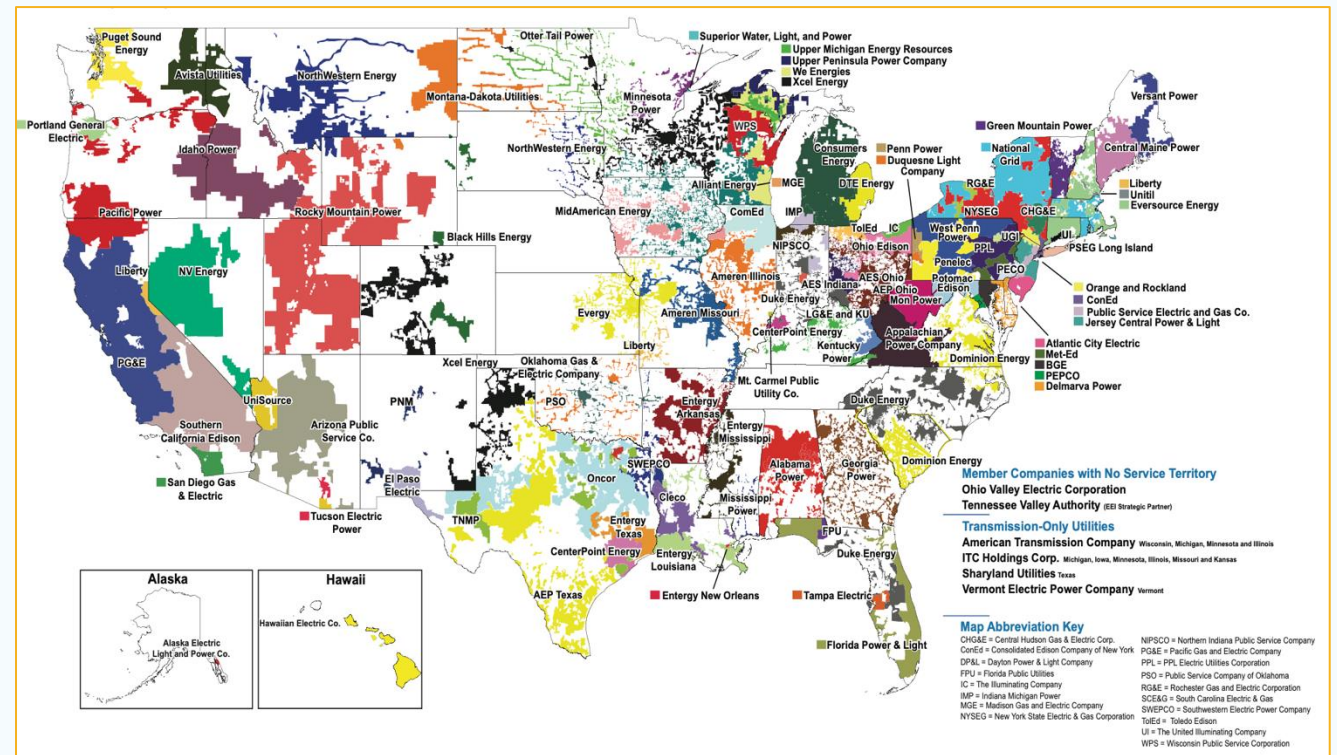
Includes those who develop and build transmission (i.e., utilities, independent developers), consumers (e.g., residential, commercial, industrial), independent power producers, environmental NGOs, and the clean energy industry.

Fragmented US Utility Industry Not Designed to Build Large Regional Networks

Utilities operate individual systems...

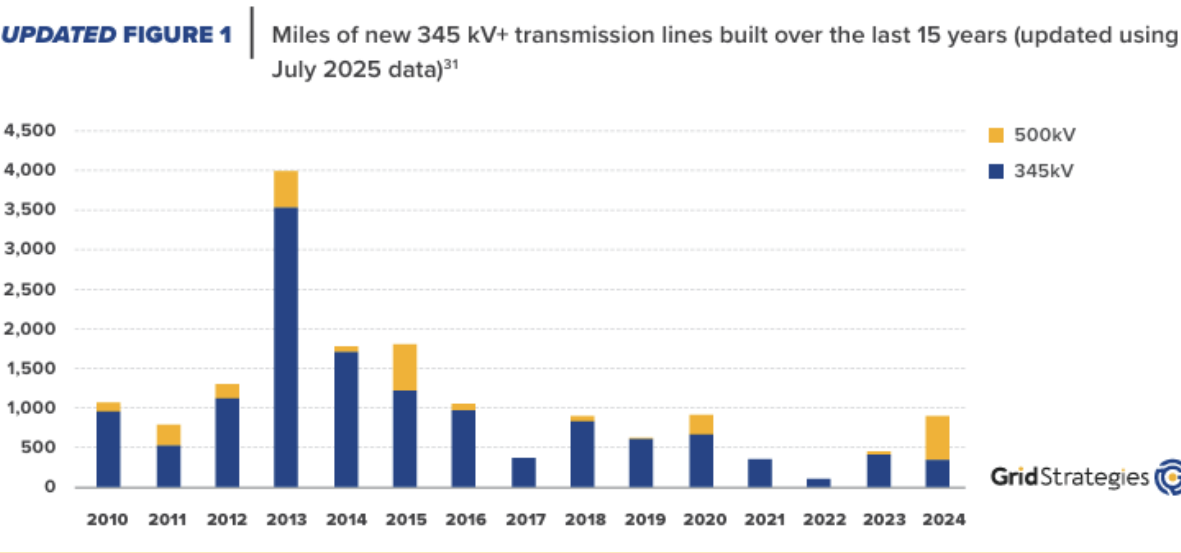


...with around 3000 separate utilities focused on their own small footprint



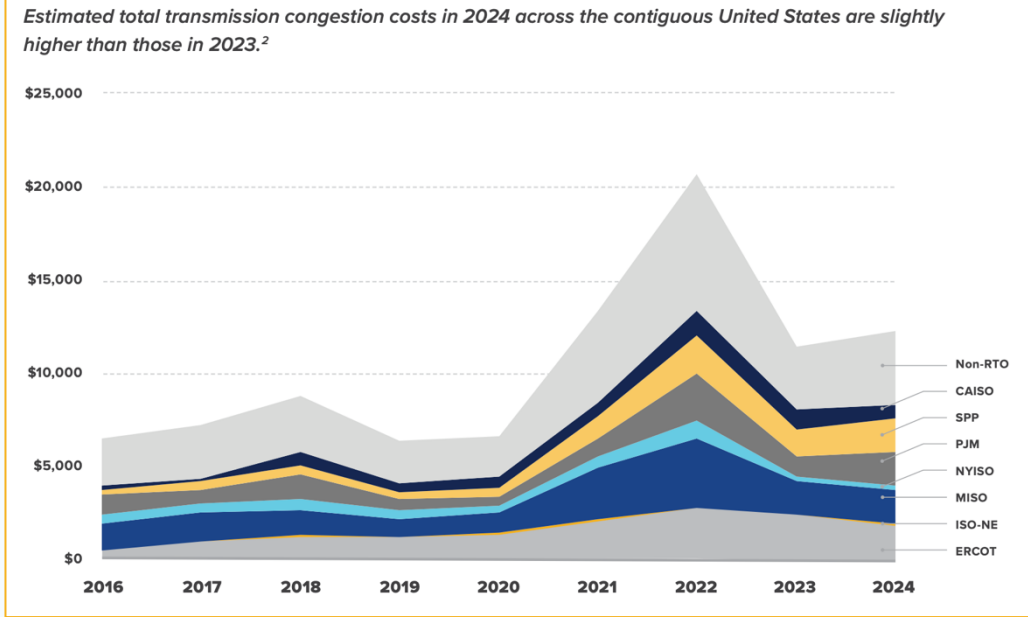
Very little long-distance transmission has been built recently

Many miles of new transmission in 2013, then dropped to a trickle



SOURCE | Grid Strategies LLC, [Fewer New Miles](#) (July 2025)

Congestion costs are rising



Big transmission CAN be built!

Address the 3Ps

Planning

- Proactive to Meet Projected Demand
- Alternative scenarios
- Portfolio of network upgrades
- All technology options

Permitting

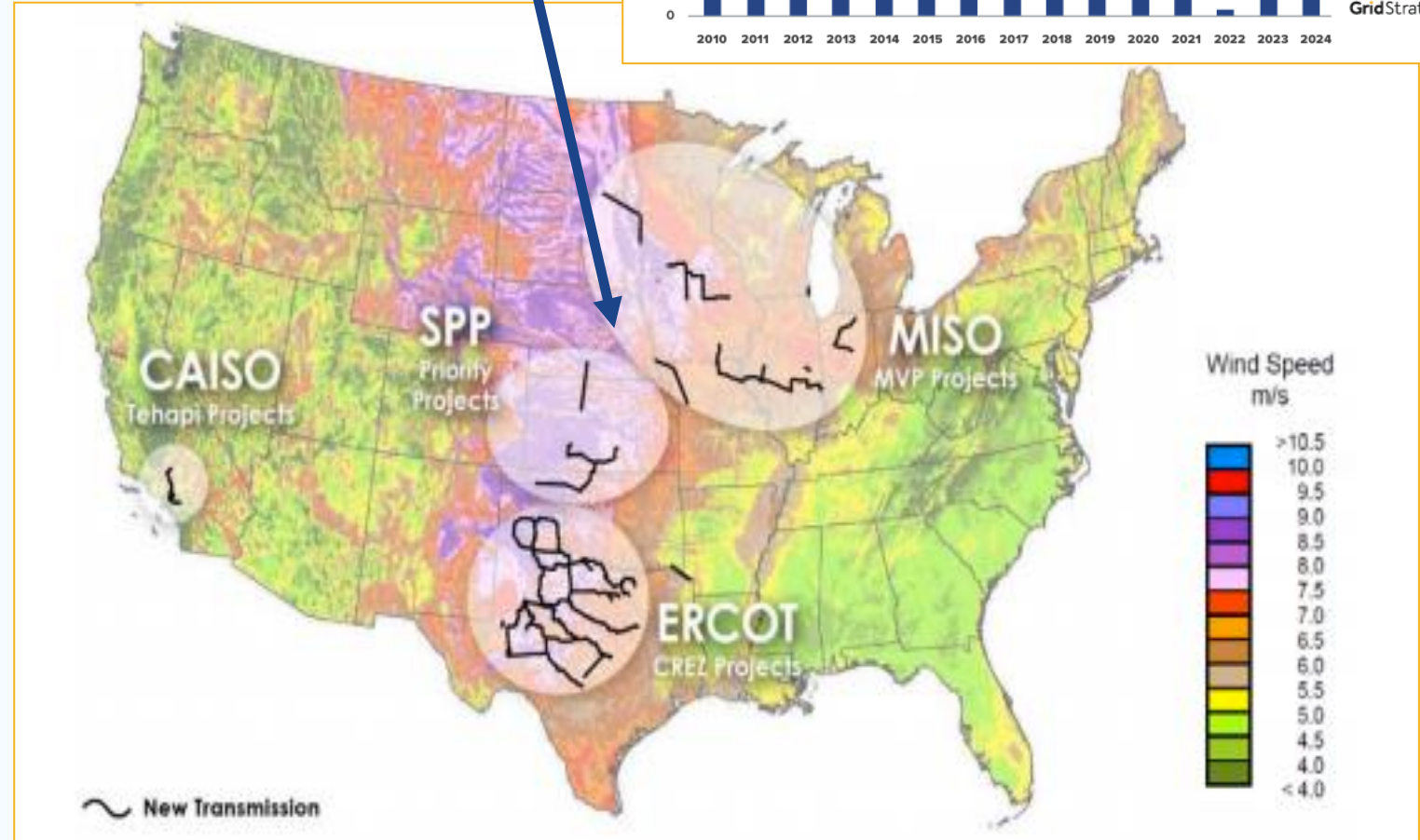
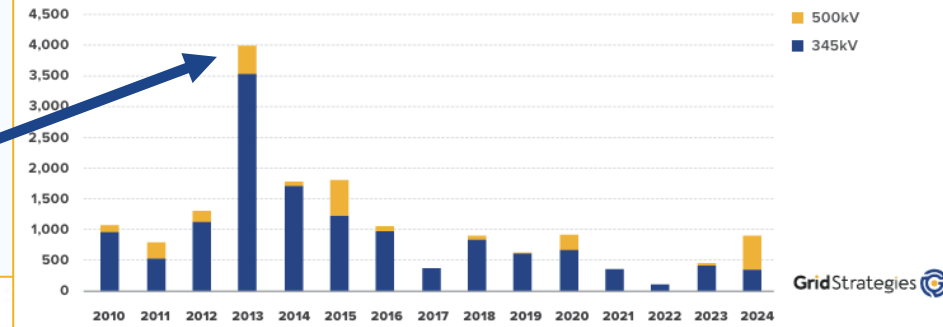
- FERC authority
- NEPA implementation

Paying

- Clarify list of benefits for beneficiary pays-based cost allocation

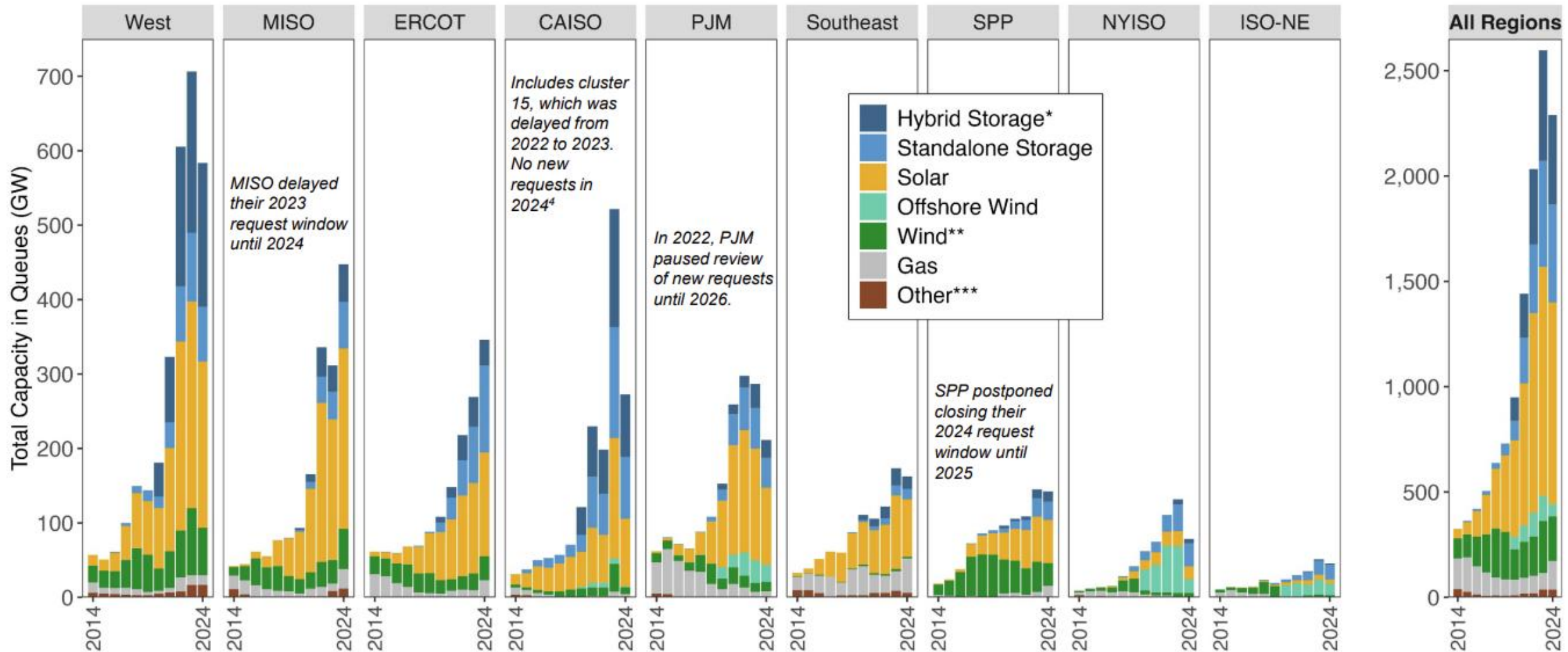
We did it in 2013,
we can do it again

UPDATED FIGURE 1 | Miles of new 345 kV+ transmission lines built over the last 15 years (updated using July 2025 data)³¹



Generator Interconnection Requests Ballooning

Limited transmission capacity slows interconnection

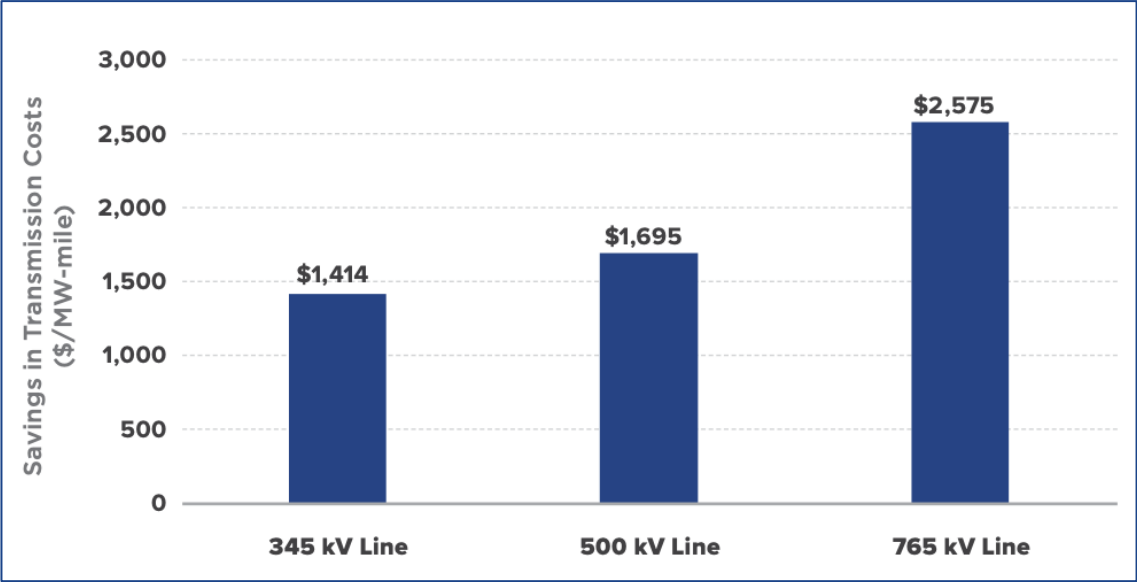


High-voltage transmission delivers power at lower costs

Higher-voltage transmission lines significantly reduce consumer costs by capturing economies of scale. By moving larger volumes of electricity more efficiently across long distances, higher-voltage transmission reduces power losses and minimizes the need for more expensive, piecemeal investments in lower-voltage transmission. Thus, high-capacity transmission reduces the cost per delivered megawatt (MW) of power.

The figures on the right show that high-capacity transmission can deliver the same amount of power for less cost using high-capacity transmission (765 kilovolt, or kV) as compared to lower-capacity transmission (230 kV). Cost comparisons for power delivery on a per-MW-mile basis underscore this advantage for higher-voltage transmission. For instance, using data from MISO summarized in the table to the right, **765 kV lines deliver power at just \$903 per MW-mile, compared to \$3,581 per MW-mile for 230 kV lines, a 75% decrease in cost.** While higher-voltage lines may have a slight upfront premium, these differences highlight the long-term ratepayer savings made possible through investment in higher-capacity infrastructure.

Savings (\$/MW-mi) compared to 230 kV transmission lines



Cost to deliver power (\$/MW-mi) by voltage

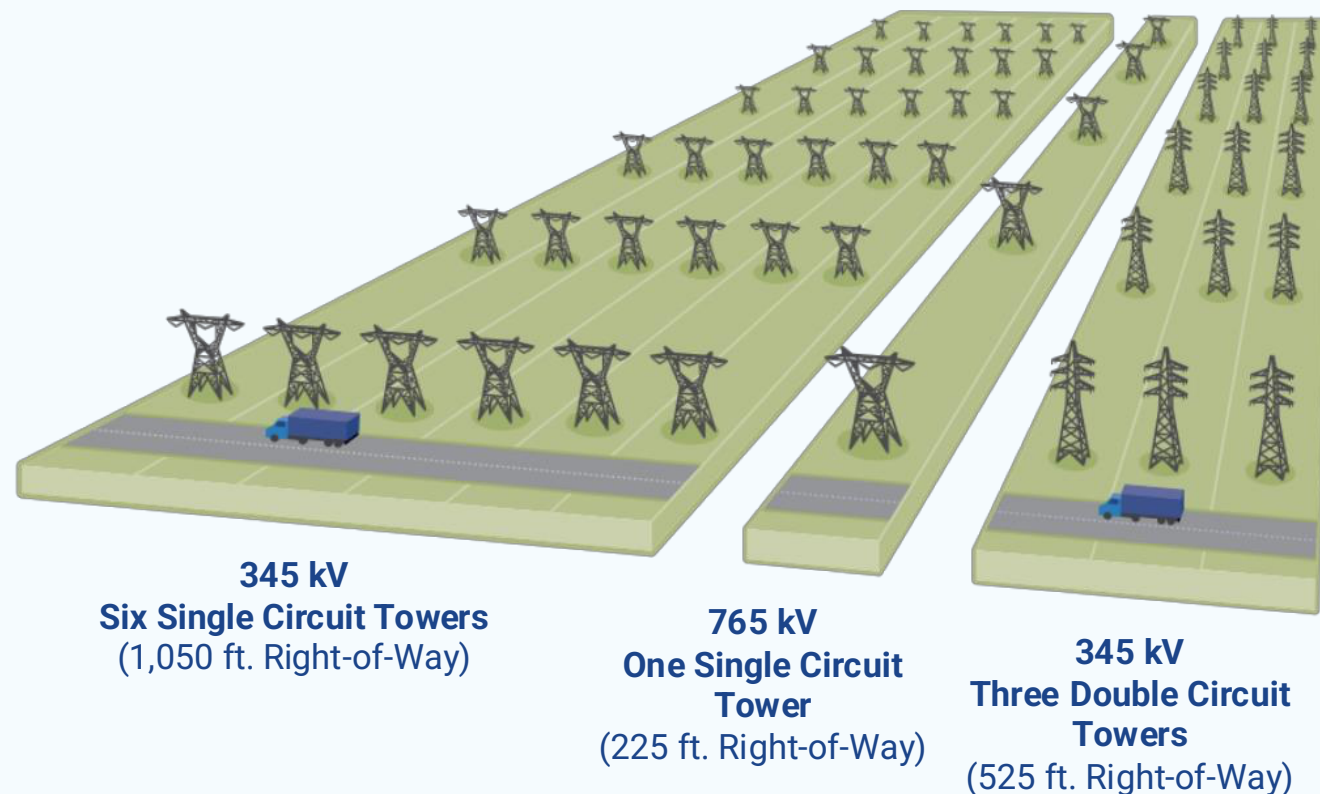
Transmission Voltage (kV)	Cost per Mile (\$ Million / Mile)	Capacity (MW)	Cost per Unit of Capacity (\$/MW-Mile)
230	\$2.353	657	\$3,581
345	\$3.744	1,792	\$2,090
500	\$4.738	2,598	\$1,824
765	\$5.982	6,625	\$903

High-voltage transmission reduces land impacts

As discussed on the previous slide, higher-voltage transmission can move larger volumes of electricity more efficiently across long distances. These power transfer efficiencies mean higher-voltage transmission lines also significantly reduce land impacts. As the figure on the right shows, depending on the configuration, **one 765 kV line compared to 345 kV lines needs 20-40% less land for the right-of-way, while still delivering equivalent amounts of power.** Put another way, one 765 kV line can deliver approximately six times the power of a 345 kV lines while requiring nearly five times less land.

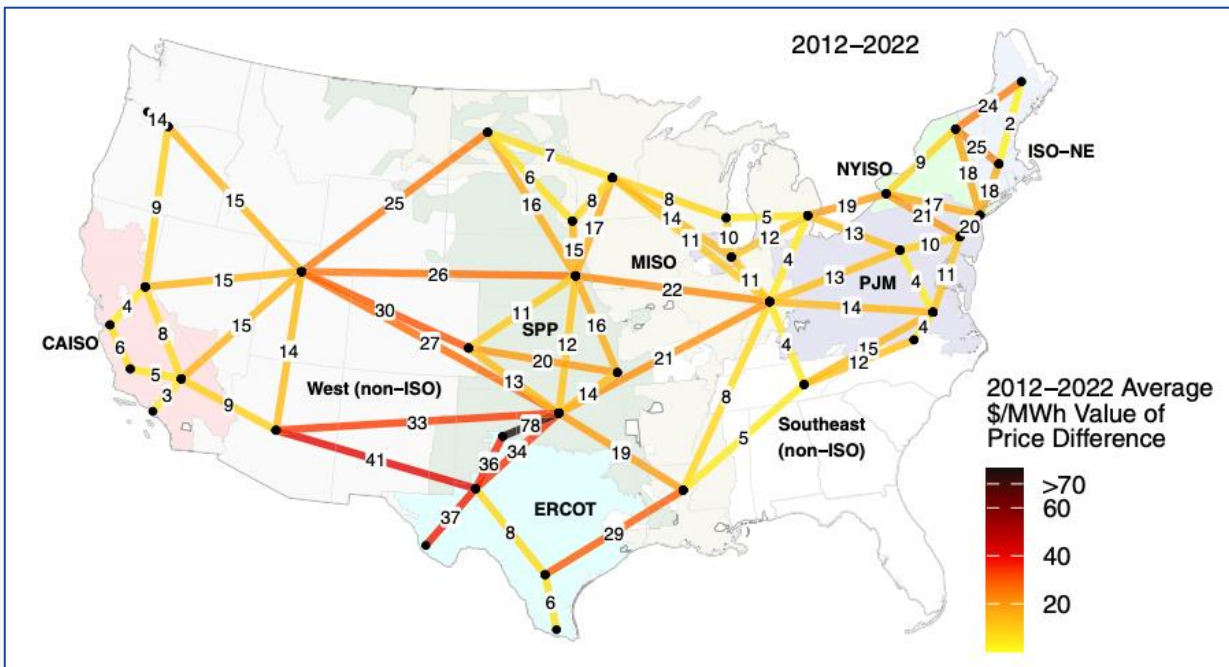
Smaller rights-of-way mean lands impacts are also reduced potentially limiting siting and permitting delays. Avoiding delays in transmission development provides significant additional benefits to consumers. A report from Grid Strategies estimates that **for every \$1 billion invested in transmission that is delayed, it costs consumers between \$150 million to \$370 million in lost net benefits for each year of delay.**

Right-of-way requirements for equivalent power transfers



Interregional transmission provides significant value

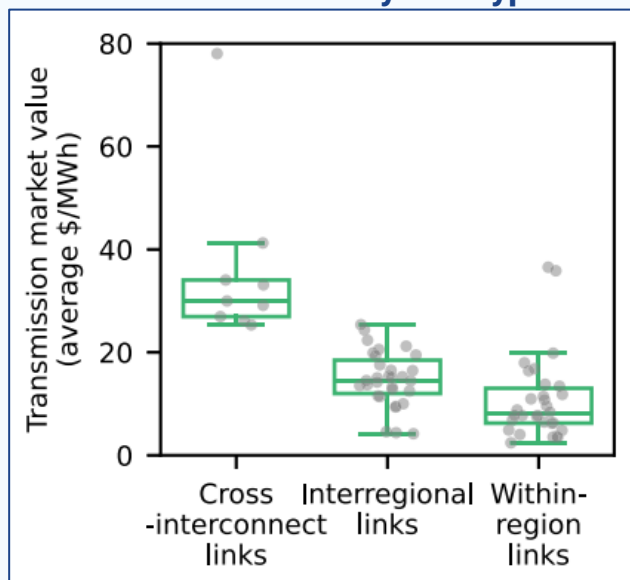
Average value of transmission (\$/MWh) (2012-2022)



Interregional transmission provides increased transfer capacity between planning regions, such as two RTOs/ISOs or increase transfer capacity across interconnections.

The figure at left illustrates the average annual difference in wholesale-market energy prices (\$/MWh) demonstrating one benefit of interregional transmission and cross-interconnect transmission lines, the ability to reduce regionally high energy costs through arbitrage. Value for interregional transmission is highly concentrated in a few number of hours. Lawrence Berkeley National Laboratory (LBNL) found that **from 2012-2022 the top 5% of hours accounted for half of the value of the line demonstrating the “insurance value” provided to**

Distribution of average transmission value by line type



consumers. The figure below, also from LBNL, shows that on average, cross-interconnect and interregional transmission provide the highest marginal value to consumers. In addition, that the value of interregional and cross-interconnect transmission lines are more evenly distributed between both ends of the line compared to transmission lines within a single region.

Large transmission investments consistently provide net-benefits

The benefits discussed on previous slides consistently yields long-term savings that exceed upfront capital investments for well-planned, large scale regional transmission plans and interregional transmission projects. In other words, the benefits generally outweigh the costs, to the advantage of consumers. In previous analyses by Grid Strategies estimate the average benefit-to-cost ratio was between 2.4 to 4.4 for large-scale regional transmission investments. This means that **for every \$1 invested in these transmission plans, consumers receive between \$2.41 to \$4.45 in benefits, indicating an average payback period of approximately 3 to 5 years.**

Many studies have also demonstrated that interregional transmission lines have some of the highest benefit-cost ratios of any type of transmission project. In a follow-on study quantifying the economic benefits of NERC’s recommended prudent interregional transmission capacity increases in their Interregional Transfer Capability Study (ITCS), **Grid Strategies found that each \$1 invested would yield benefits of \$4.30 to \$5.80, with a payback period of less than three years.** The high benefit-cost ratios demonstrate consumers are getting their biggest “bang for their buck” with interregional transmission lines compared to other type of transmission investment.



SOURCES | Grid Strategies, [Delaying transmission increases costs and reduces benefits for consumer](#) (Nov. 2025); Grid Strategies, [Large-scale transmission deployment saves consumers money](#) (Jun 2025);

Benefit to cost ratios for regional transmission plans		
Region	Transmission Portfolio	Benefit to Cost Ratio
SPP	2023 ITP	\$2.29 to \$1
SPP	2024 ITP	\$6.50 to \$1
SPP	2025 ITP	\$5.70 to \$1
ERCOT	CREZ	\$12.20 to \$1
MISO	MVP	\$1.80 to \$1
MISO	L RTP Tranche 1	\$2.60 to \$1
MISO	L RTP Tranche 2.1	\$1.80 to \$1
Nationwide	Average transmission portfolio	\$2.41-\$4.45 to \$1

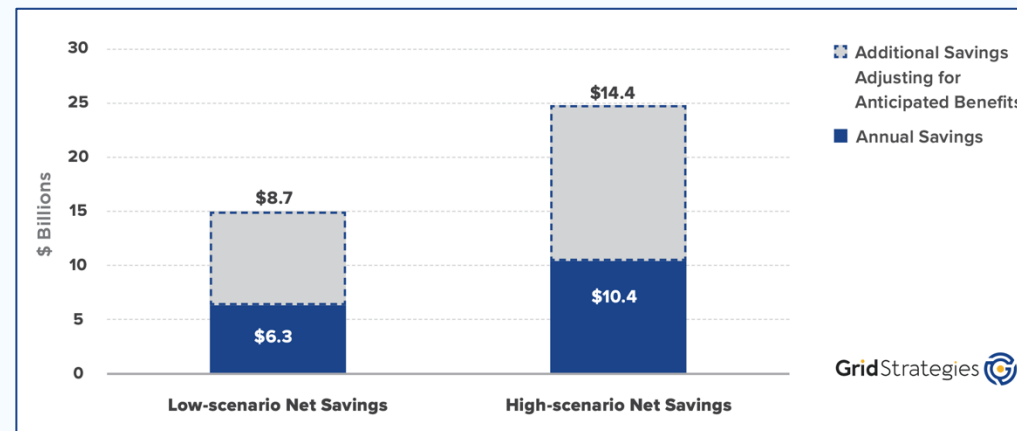
Benefit to cost ratios for interregional transmission projects		
Region	Transmission Project	Benefit to Cost Ratio
MISO, SPP, & the West	North Plains Connector	\$4.86 to \$1
SPP & the West	Three Corners Connector	\$3.32 to \$1
MISO & Texas	Southern Spirit	\$3.64 to \$1
Nationwide	NERC ITCS Prudent Additions	\$4.30-\$5.80 to \$1

Transmission saves consumers money

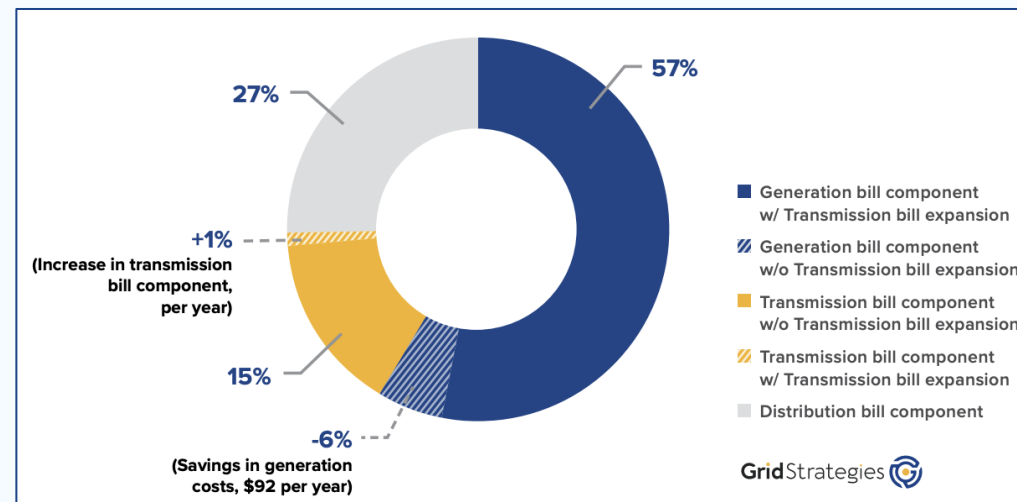
These benefits can translate directly to savings for ratepayers. In previous studies reviewing regional transmission plans and interregional lines, Grid Strategies estimates investment in well-planned, **high-capacity transmission could save residential consumers \$6.3-\$10.4 billion per year** across the United States after accounting for the cost of the transmission. In addition, benefit-cost analyses tend to underestimate transmission benefits in initial planning studies. **Ex-post assessments of consumer savings are often 20%–40% higher than initially projected**, which means potential annual net savings for residential consumers could be as high as \$8.7-\$14.4 billion.

While the upfront cost of transmission may raise concerns about electricity affordability, the alternative is accepting a less reliable and more expensive system. Much of the estimated retail electric bill savings are associated with production cost savings, the term used to describe savings from lowering the cost of the power supply, such as by accessing lower-cost generation. As can be seen from the figure to the right, well-planned, high-capacity transmission investments increase the transmission component of an average residential bill about 1% overall, which is roughly a \$19 increase annually. However, the transmission investments facilitate a 6% overall decrease in generation costs, which is a larger portion of the bill, and translates to \$92 in savings annually for an average household. **For the average U.S. household, expanded investment in the grid, could save between \$2,221-\$3,672 over the life of the transmission projects, after accounting for the full cost of construction.**

National estimated residential electric bill savings from expanding transmission



Components of an electric bill with and without well-planned transmission expansion



Outside of Typical Grid Connection: Four On-site Generation Models to Serve Data Center Load

Option	Speed	Reliability	Industry is pursuing grid-connected models
1 On-site generation (behind the meter), disconnected from the grid	M	L	
2 Behind the meter gas or hybrid generation, but grid connected	M	H	
3 New load on the site of existing generation	H	H	
4 New load on the site of new generation	L	H	

Most data center developers are finding off-grid solutions to be extremely difficult and expensive

Generation Options: What Can Power Large Loads?

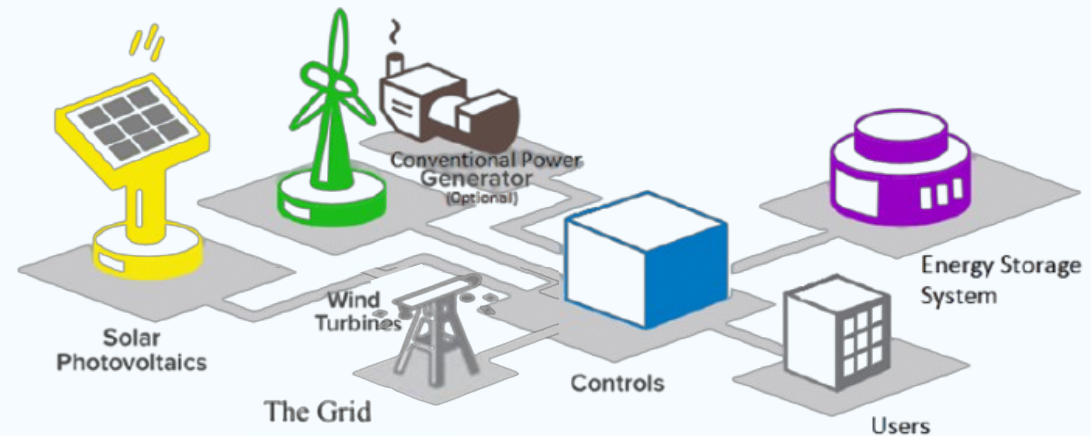
Various generation options exist...

- **Nuclear:** Firm and carbon free, but not ready for at least 8 years.
- **Natural gas:** New turbines available in 2030+
- **Renewables:** Ready now, but limited on site supply, requires regional grid.
- **Coal:** Firm, but no US supply chain, workforce, or vendors, and no investors willing to take 40+ year emission/regulatory risks.



...hybrid, grid-connected solutions provide reliable, scalable, diverse power.

Blended models can use gas, renewables, and storage. No single solution will be enough; all require grid backup because all generators have outages.



SOURCE | Adapted from [Stellae Energy](#) (accessed April 2025).

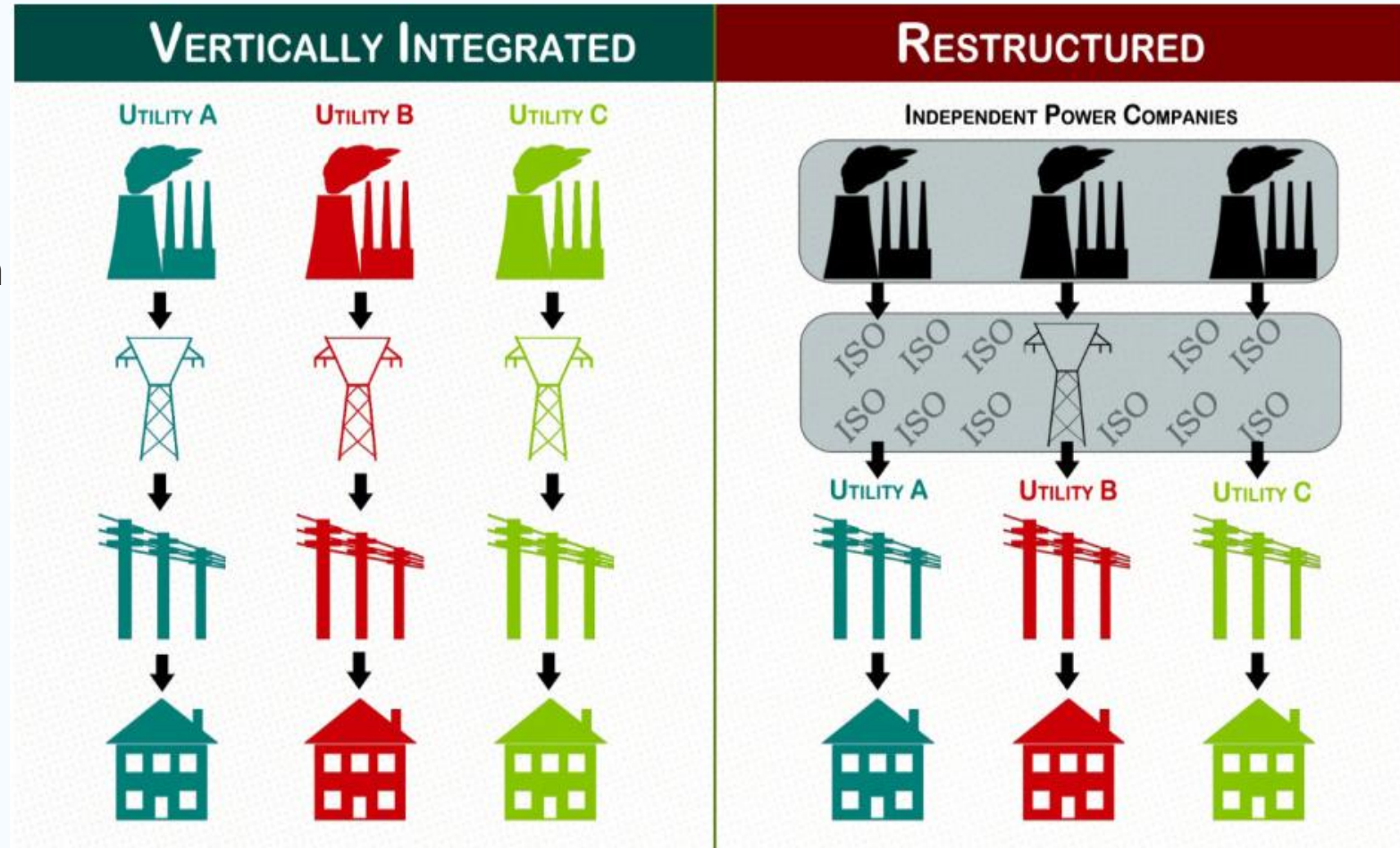
2 main power industry structures

Traditional vertically integrated since the early 20th Century:

- Generation, transmission, distribution in one company
- Non-CA West, Central and Southeast regions

Restructured (circa 1995-2005):

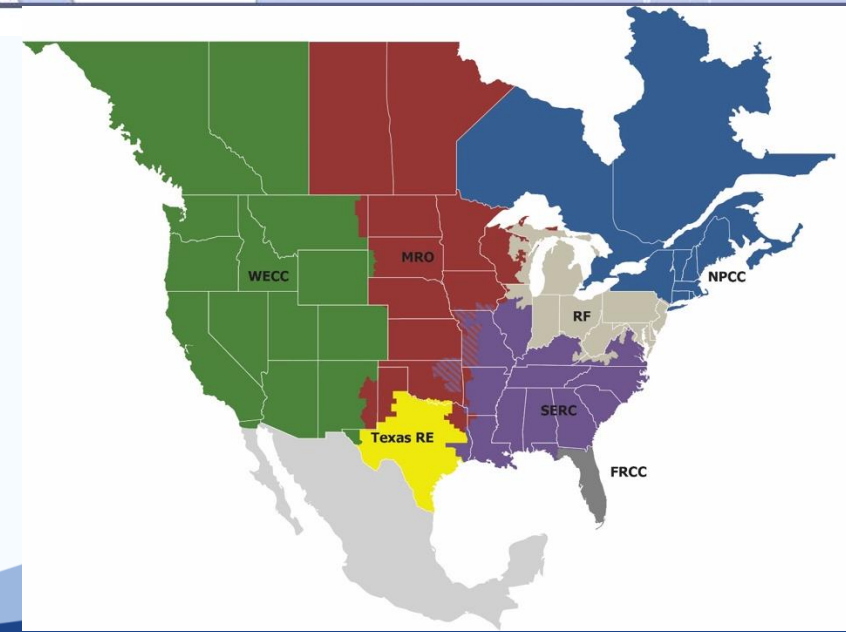
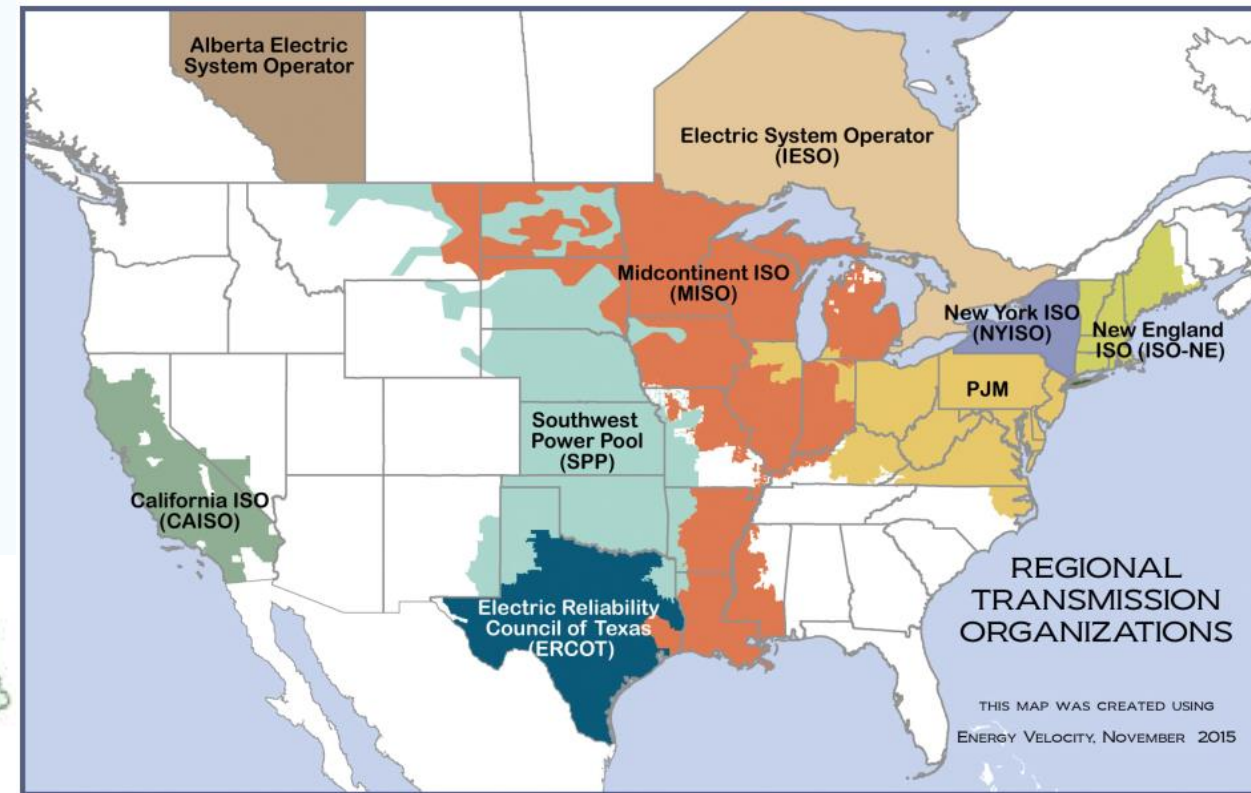
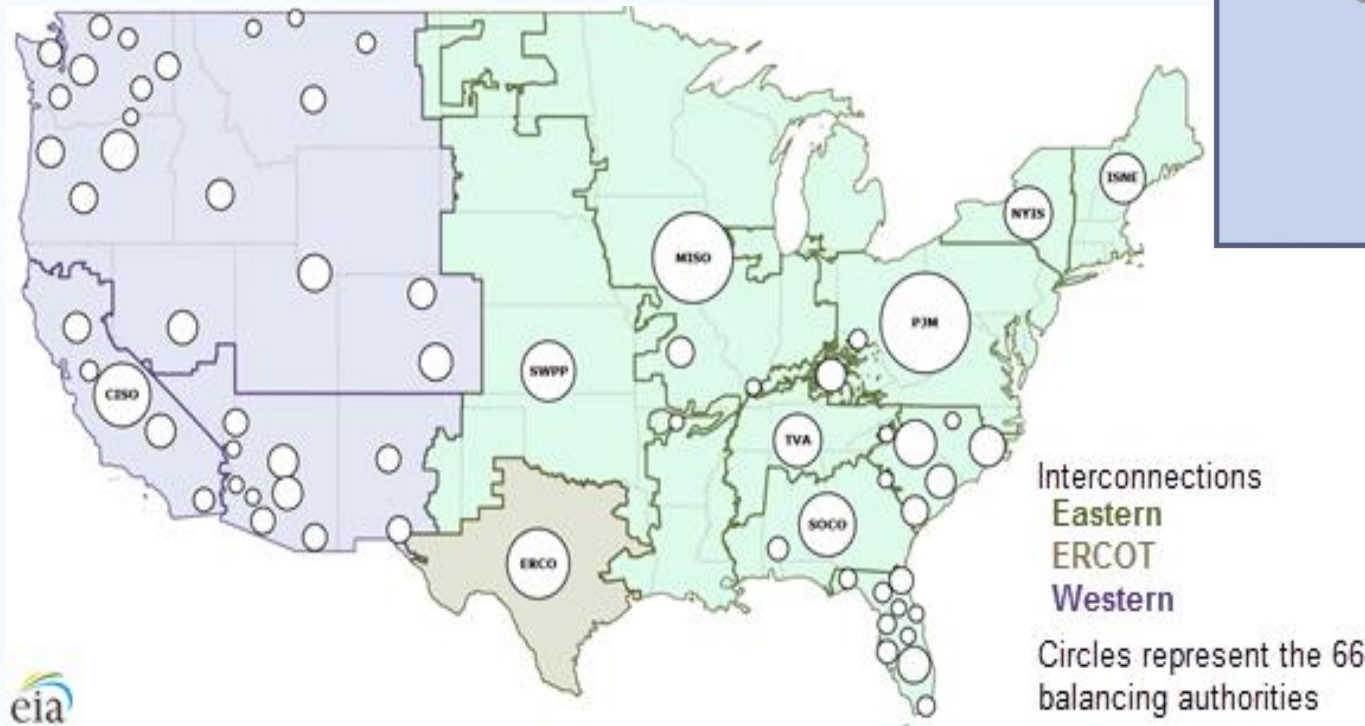
- US Mid-Atlantic, Northeast, Texas, California
- Generation divested into Independent Power Producers (IPPs).
- Independent System Operator/Regional Transmission Organization runs transmission.
- Utility owns T&D



Source: Devin Hartman, R St Institute

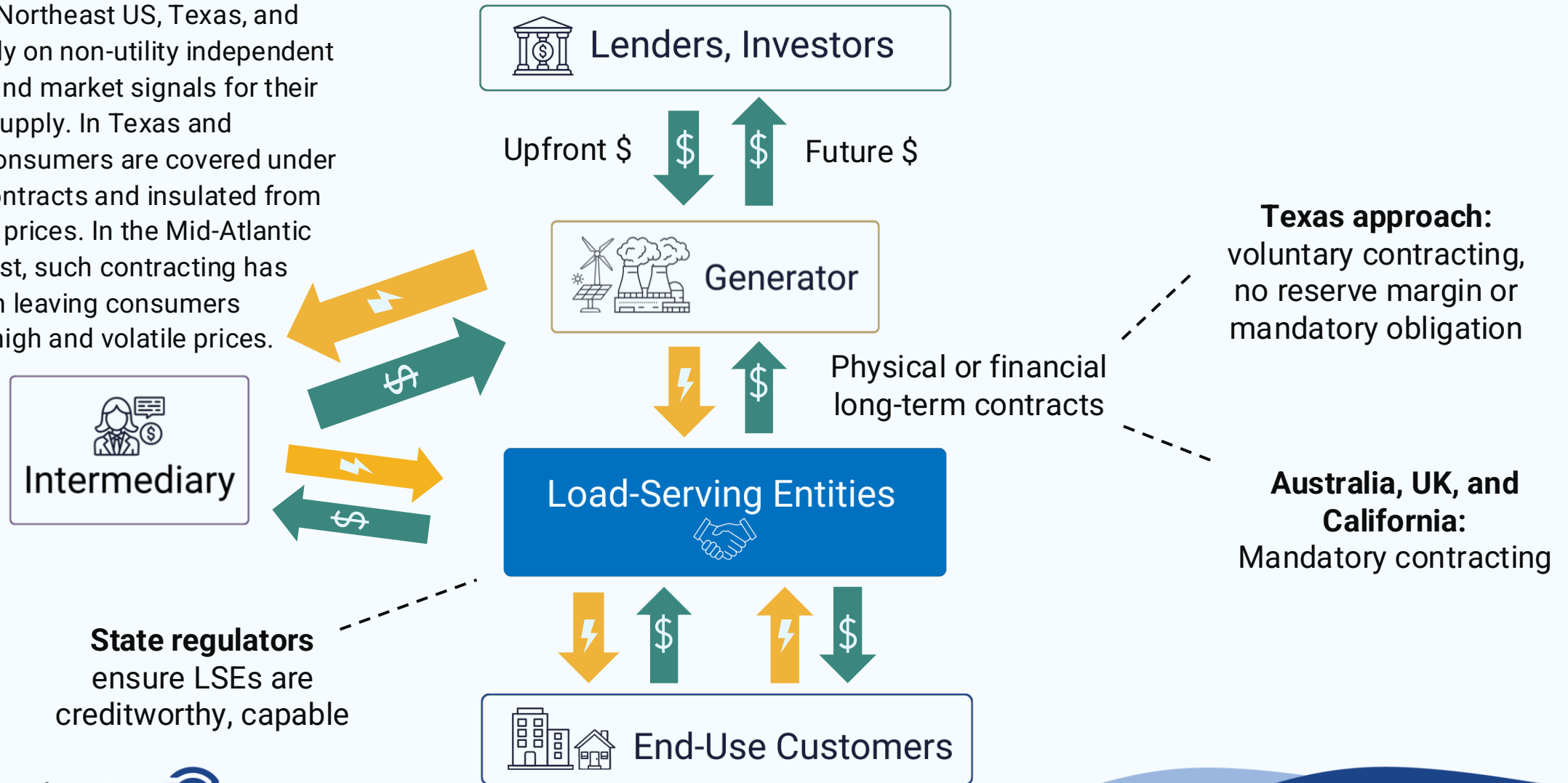
Industry geography

3 Interconnections, 7 RTO/ISOs, 66 Balancing Authorities, 7 reliability coordinators



Markets for generation can work, but restructured states lack a buyer (“off-taker”) for power

Most of the Northeast US, Texas, and California rely on non-utility independent generators and market signals for their generation supply. In Texas and California, consumers are covered under long-term contracts and insulated from volatile spot prices. In the Mid-Atlantic and Northeast, such contracting has broken down leaving consumers exposed to high and volatile prices.



Federal Electricity Policy 2025-2026

- **DOE Section 403 Order to FERC:** Rulemaking for FERC jurisdiction over large loads.
 - FERC orders to each ISO/RTO June 2026 directing changes, but leaving retail rate regulation to states
- **DOE 202c orders** requiring continued coal plant operation.
- **FERC Order 1920:** Regional transmission planning. Now to be implemented in regions with FERC approval.
- **FERC Order 2023** and other interconnection reforms.
- **Capacity markets** price shock and RTO/regional market developments.
- **Permitting legislation:** Active consideration in multiple Congressional committees.
- **Advanced Transmission Technologies:** Incentives and requirements at FERC and in Congress. Grants and loans from DOE

The New Economics of Energy: America has the fuel. Infrastructure increasingly determines cost

By Alex Flint

The United States is entering one of the most significant periods of change in its energy system since the expansion of the interstate electric grid. America possesses abundant supplies of coal, geothermal energy, hydropower, natural gas, oil, solar energy, uranium, and wind. Increasingly, however, the economics of energy are determined less by the availability and cost of fuel than by the ability to build the infrastructure needed to produce, transport, transmit, and consume it.

The United States already operates approximately 1,300 gigawatts of electric generating capacity, roughly 3 million miles of natural gas pipelines, more than 600,000 miles of high-voltage transmission lines, and millions of miles of local distribution lines. Meeting projected demand over the next quarter century may require adding another 500 to 700 gigawatts of generation, together with hundreds of thousands of miles of transmission and distribution upgrades, new pipelines, storage systems, export facilities, and other supporting infrastructure.

The central energy policy question is therefore changing. Success will no longer depend on picking the best fuel. It will depend on whether we build the infrastructure needed to deliver affordable, reliable energy.

Demand is growing—and the economy is becoming more electric

Fossil fuels still supplied approximately 81.5% of global primary energy in 2023 despite record renewable deployment. Because energy infrastructure commonly remains in service for 30 to 80 years, transitions occur gradually. The global population is expected to grow from approximately 8.2 billion today toward 10 billion by the end of the century, while rising incomes increase per-capita energy consumption across much of the developing world. Although forecasts differ, global energy demand is likely to increase by roughly 50% to 100% by 2100.

The United States faces a different challenge. Total energy consumption is projected to remain relatively flat because population growth is slowing and efficiency improvements are expected to offset economic growth. Electricity demand, however, is expected to increase by approximately 25% to 50%. Because much of the new generation is likely to come from intermittent sources, installed generating capacity may need to increase by roughly 50% to 90% by 2050. Electric vehicles and data centers account for much of that growth, with many forecasts projecting that data centers alone could require well over 100 gigawatts of additional electric capacity.

The challenge is no longer producing more energy. It is delivering substantially more electricity.

Climate and electrification increase infrastructure needs

The global climate has warmed approximately 1.5°C since the preindustrial era, while Alaska has warmed roughly twice that amount. Under current policies, MIT's En-ROADS model projects approximately 3.3°C of warming by 2100. Mainstream climate projections anticipate roughly 24 inches of average global sea-level rise by the end of the century, with substantially larger long-term increases possible as major ice sheets continue to respond.

Financial markets increasingly appear to assume that mitigation policies alone will not prevent substantial climate change and are therefore placing greater emphasis on adaptation.

America's institutions increasingly constrain infrastructure

The United States does not operate a single electric system. It operates a patchwork of vertically integrated utilities, public power systems, competitive wholesale markets, municipal utilities, rural electric cooperatives, and diverse state regulatory structures. A policy that works well in one region may be unworkable in another.

This fragmentation increasingly constrains the nation's ability to build infrastructure. More than 2,000 gigawatts of proposed generation and storage projects are waiting in interconnection queues—more capacity than exists on today's grid—and many projects wait five to ten years simply to obtain permission to connect.

Building major transmission is even more difficult. SunZia, an \$11 billion project combining 3,650 megawatts of wind generation with a 550-mile transmission line, required roughly eighteen years from initial development to commercial operation. By comparison, interstate natural gas pipelines generally benefit from a more unified federal permitting framework.

If America were designing its electric system today, it would almost certainly adopt a different institutional structure. Instead, policymakers must modernize institutions largely designed for the electricity system created under the Federal Power Act of 1935.

Infrastructure increasingly determines the economics of every major energy source

The United States produces approximately one-quarter of the world's natural gas and has become the world's largest exporter of liquefied natural gas. S&P Global projects that the United States could supply approximately 30% of global LNG trade within five years. Yet production creates value only when pipelines, processing facilities, compressor stations, and export terminals can be permitted and constructed.

The same principle applies to renewable energy. Between 2020 and 2024, solar and wind accounted for most additions to U.S. utility-scale generating capacity. In 2024 alone, solar supplied 61% of new utility-scale capacity while wind increased the combined total to approximately 72%; including battery storage raises the figure to approximately 93%. Meanwhile, utility-scale solar costs have fallen roughly 90% over the past fifteen years and battery costs approximately 85% over the past decade. Yet many renewable projects spend longer waiting for transmission access than they require for construction.

Advanced nuclear reactors, enhanced geothermal systems, carbon capture, long-duration storage, advanced transmission technologies, and eventually fusion face the same reality. Their commercial success will depend as much on permitting, financing, manufacturing, transmission access, and public acceptance as on technological performance.

Infrastructure Is Energy Policy, and We Have No Uniform Policy

Every credible forecast points toward hundreds of billions—and ultimately trillions—of dollars of investment in American energy infrastructure. The policy question is no longer simply which technologies should be encouraged. It is how infrastructure should be built, financed, regulated, and paid for.

A 2025 Lawrence Berkeley National Laboratory report illustrates the complexity. As a general rule, generators pay to interconnect, while grid operators recover the cost of broader transmission upgrades. Beyond that, however, cost-allocation rules differ substantially across ISOs, RTOs, federal power marketing administrations, and public power systems. FERC Order No. 1000 identifies three broad categories of transmission—reliability, economic, and public-policy driven—but regional implementation varies considerably.

My recommendation to policymakers is that a single federal infrastructure policy is unlikely to work across such a diverse institutional landscape. Instead, federal policymakers should focus on three national challenges.

First, permitting takes too long. Investors increasingly discount projects not because of engineering risk but because political and legal uncertainty can delay—or even overturn—projects that have already received approvals. Permitting reform is therefore essential regardless of which energy technologies ultimately succeed.

Second, America's regional electricity markets create institutional seams. Electricity flows seamlessly across regional boundaries, but planning, tariffs, cost allocation, and governance do not. Those seams reduce market efficiency, complicate long-term planning, and weaken system resilience.

Third, federal policymakers should devote greater attention to developing durable, broadly applicable principles for allocating infrastructure costs. The objective should not be a single national formula, but a framework that promotes investment while allocating costs transparently, predictably, and fairly across customers and regions.

A Tale of Two Cities: Then and Now in Cordova, Alaska

By Clay Koplin

Alaska is a young and developing state. The extraction of rich natural resources has been the primary economic driver for the last two hundred years. The whaling and fur industries in the 19th century and 20th century timber and fisheries harvest, mineral and oil and gas extractions have built the Alaskan communities and infrastructure that we enjoy today. These industries have all been energy and transportation intensive, requiring a scale of production and shipping to compete in distant markets. As a growing and maturing state, Alaska is confronted with the challenge of developing more stable, long-term industries and economies that can contribute and compete in global markets. Access to reliable, affordable energy has been a key enabler of resource development and will continue to be critical for supporting a vertical shift from raw materials to products and services for local and export markets.

At the community level, the rise and fall of these industries has resulted in a series of boom-and-bust cycles which many communities like Cordova have learned to adapt to. The glory days of the Copper River and Northwestern Railway moved over a billion pounds of copper 220 miles from the Kennecott Copper mine to Cordova for steam ship transport to Tacoma, Washington smelters. The copper boom in 1907 was followed by economic collapse in 1938 when the mine closed. Cordova pivoted to a thriving pacific razor clam industry touting Cordova as “The Razor Clam Capitol of the World”. That industry was devastated overnight by eight feet of uplift in the clam beds resulting from the 1964 Great Alaska Earthquake epicentered 50 miles away. As the community struggled to regain a sustainable economic foothold following the quake, it diversified into other fisheries, innovatively developing quality markets and products. Even as Cordova reached a new pinnacle in seafood processing, the 1989 Exxon Valdez oil spill decimated regional fisheries. Herring, for example, only recently recovered sufficiently to only have its first commercial fishery since the spill in 2025. The local electric utility struggled to meet the needs of these boom-and-bust cycles. The transformation of the community energy supply from a third world class grid to a modern leader in class became the anchor from which the community could tether during the fiercest of economic headwinds or nimbly navigate new threats and opportunities as they emerged.

The transformation was precipitated by the emergence of the Cordova Electric Cooperative (CEC) in 1978. The Cordova Power and Light Company, a private utility founded in 1907 and operated through the railroad era, was ceded to Cordova Public Utilities, the City of Cordova’s (City) electric, telephone, water, sewer, and garbage utilities. Limited financial resources through the 1960’s and 1970’s degraded the electric grid to the point of scheduled blackouts to different parts of the community each day. Frustrated citizens assumed low-interest federal loans, purchased the utility from the City, and incorporated Cordova Electric Cooperative (CEC) as a customer owned, not for profit electric cooperative. CEC’s

founding vision was centered around reliability and self-sufficiency and led with two critical initiatives: 1) convert the entire electric grid to underground power lines to reduce exposure to the harsh environment, and 2) develop local sources of energy to reduce dependence on imported fuels.

Over the next 20 years, the execution of this vision was fraught with challenges and missteps. After spending the first decade stabilizing the 100% diesel generated power supply and converting overhead to underground power lines where time, opportunity, and finances permitted, CEC developed its first hydropower plant. The Humpback Creek plant was built over the remnants of the 1907 project built by Cordova Power and Light which had been abandoned for several decades. Poor relationships with The Eyak Corporation - the Alaska Native Village Corporation landowner, and contractors and vendors poorly qualified for remote, logistically challenging Alaskan environment embroiled CEC in expensive and contentious legal disputes. Plagued by a suboptimal design and haphazard construction, the project ultimately reached completion in 1991, 2 years behind schedule and 100% over budget. The project produced enough energy to offset as much as 15% of CEC's annual diesel use. The financing for the project and high operations and maintenance costs resulted in higher-cost energy than the relatively low-cost diesel with fuel prices low and stable at \$0.76/gallon.

The 1990's were rebuilding years as the Cordova seafood industry restructured and recovered from the Exxon Valdez spill. One positive outcome of the spill was community recognition of the environmental benefits of locally sourced hydropower, engendering stronger support for more hydropower. In 1998 CEC broke ground on the Power Creek Hydroelectric Project, a much larger run-of-river hydro project than Humpback Creek. Like Humpback Creek, poor partner relationships, limited internal human resources capacity at CEC, budget constraints and record snow fall winters put the project 2 years behind schedule and 85% over budget. Despite the auspicious start, things started to change during construction. CEC brought a new engineer and a new general manager on board. A partnership with the Eyak Corporation resulted in \$12mm of construction grant through the Indian Energy Act. As the project came into service, providing 60% of the community's energy, the State of Alaska contributed another \$12mm to fully cover the \$24mm project cost. CEC was able to reduce base rates by nearly 20%, eliminate summer diesel use, and offer incentive rates to seafood processors with significant excess hydropower available during summer months. As fuel prices began to rise after 2000, inexpensive, shoreside hydropower became more compelling for floating, offshore seafood processors. The shore-based processors in Cordova added tens of millions of dollars of high-capacity, high-efficiency seafood processing equipment and started processing all their seafood on shore. Pharmaceutical grade and pet grade salmon oil refineries were added. Processors were able to pay fishermen 400%-500% more per pound for their catch catapulting Cordova into a top ten national seafood delivery port by landed value.

A 3% raw fish tax on landed value of fish crossing a dock is a 50%-50% split between the State and City. The additional raw fish taxes fully recovered the State's \$12M investment in the Power Creek project, and grew City revenues for investments in education, public safety, the community hospital, and other community services. A new era of prosperity and security was ushered in.^{22 23} During construction of the Power Creek project, the power plants were all automated with a data historian added to archive all the operating data of the grid in 1-second resolution. CEC staff experience, capacity, and relentless pursuit of high reliability and affordability of the local energy supply focused on internal improvements and optimization of the hydro plants. Just as CEC was reaching a new zenith of reliable and efficient performance, disasters struck again.

In 2005, an unlikely plant fire totaled the Humpback Creek Power Plant. Just as the rebuilt plant was approaching completion in 2006, Cordova experienced two epic flood events of over 36" of rain fall in three days; one in August and one in October with the latter event destroying the intake structure and much of the newly completed work at the power plant. The Power Creek project was damaged but able to maintain operations. A long and complex reconstruction of Humpback Creek ensued, with FEMA insisting on prior design, capacity, and function while FERC insisted on meeting current dam safety criteria. The design, heavily influenced by CEC site knowledge, resulted in a costly but highly functional \$23mm completion in 2012. Of the project costs, FEMA contributed \$5.1mm, a new Renewables Energy Fund (REF) grant program established by the State of Alaska contributed \$8mm, and CEC financed the \$8.7mm balance. With fuel prices highly volatile and ranging from \$2 to \$7 per gallon, CEC's 75% hydro contribution was now the low-cost option for Cordova at a produced cost of only \$0.07/kWh.

In September of 2011, just before completion of the Humpback Creek plant, the last overhead power line in the system was converted to underground. Record snow falls in winter of 2011-12 totaling nearly 30 feet of wet snow resulted in another federal emergency disaster declaration and the mobilization of national guard to move snow from sinking boats and collapsing buildings from the extreme event. There were no power outages over that entire winter. CEC had set a new benchmark in system hardening and reliability.

With relatively new generation and distribution infrastructure and few capital projects on the horizon, CEC turned its focus from infrastructure to optimization of organizational and administrative performance. Leveraging unprecedented, low fed fund rates, CEC was able to negotiate improved financing rates of its nearly \$20mm of accumulated debt, and ride variable interest rates down to a blended rate of less than 2%. By deferring any new borrowing and accelerating the payment of principal, customer equity increased from 35% in 2010 to 55% in 2017. In 2018, CEC's equity position was strong enough to start paying capital credit patronage back to the customers of the cooperative. Through 2025, CEC has

²² Clay Koplin Verbal Transcript for 3.14.17 US Senate ENR Hearing on Energy Infrastructure

²³ Clay Koplin US Senate ENR Questions for the Record Responses 3.30.17

returned almost \$3mm in capital credits representing as much as an 8% refund on customers' annual electric bill.

Through the sales of hydroelectric Renewable Energy Certificates (RECs), CEC was able to sponsor numerous customer-side energy efficiency initiatives from 2007-2012, particularly in home and business lighting. Because lighting is a significant energy use on the long dark Alaska nights during the winter season when CEC is using most of its annual diesel fuel supplementation, lighting efficiency was low hanging fruit. Externally, CEC converted the entire community to LED street lighting, and internally improved lighting efficiency in the hydro and diesel power plants.

CEC started to gain recognition for the transition to renewable energy, keeping rates flat from 2000 – 2020, improving the reliability of the grid to less than an hour of average outage time from all causes, and a nimble, can-do approach to new technologies and opportunities. Dr. Gwen Holdmann of the Alaska Center for Energy and Power (ACEP) partnered with Cordova on a State of Alaska Emerging Energy Technology Grant (EETG) with the Cordova high school on methane gas production. While touring the CEC grid, she observed the innovative work that CEC was accomplishing. She facilitated connections with the US State Department to showcase Alaska microgrid expertise and attracted the attention of the national laboratories and US Department of Energy (DOE). In 2015 ACEP secured a grant for CEC to evaluate energy storage options for balancing the grid with a storage alternative to diesel generation. This culminated in a state-of-the-art Lithium-Ion battery installation that leveraged CEC data sets to model and right-size, right-place a 1MW, 1MWh BESS with grant assistance from the DOE. The advance use case of BESS frequency control and spinning reserve for the entire grid saved an estimated 50,000 gallons of diesel fuel in its first year of operation while improving grid reliability. On the heels of this success, CEC hosted the largest grid modernization project (RADIANCE) with DOE under the Grid Modernization Laboratory Consortium (GMLC) program from 2017-2021 which is still touted as one of the most successful in that program and one of the few completed during the pandemic.

Further refinements to the hydroelectric plants, and replacement of aged and inefficient diesel generators with newer, lower-emissions units brought record reliability of 23 minutes of outage time per customer to CEC in 2024. CEC achieved a new benchmark of 83% hydropower delivery to the community in 2025. Despite 25% rate increases due to recent inflationary pressures, the 10% leap in diesel fuel efficiency has kept electric bills to customers relatively flat during the past few years. The low regulatory overheads, complete CEC ownership of the vertical stack from the customer's meter to the power plants providing the power, and the autonomy of the CEC board and management as a customer-owned cooperative provides an extremely flexible and adaptable governance structure. This facilitates rapid strategic response to change; a critical strength in the

context of global uncertainty. A highly experienced and capable staff can move at lightning speed to adapt and implement these strategies.

Recent successes include dock side delivery of a new diesel unit that was installed, connected, and commissioned by CEC staff in 14 days. A new incentive rate for a struggling seafood processor rate class and citizens struggling with new inflationary cost pressures was conceived, advertised, and published in the CEC tariff in 40 days. A global boiler manufacturer selected CEC as their test partner for a next-generation air-to-hot-water heat pump that will be rolled out in August of 2026 featuring Cordova in their national marketing campaign. The data industry has selected Cordova for first-in-class small scale data center integration at our remote site. The data center will access CEC excess hydropower for that industry and grow energy sales for CEC economy of scale to stabilize rates (aligned with CEC's current strategy of beneficial load growth). The advanced CEC grid can provide unique insights into the data center - grid interface to improve the interaction between large loads and a grid in a real-world application.

The Cordova story is not unique. The City of Seward, with an energetic and aspirational leadership team, has the same City governance structure, external energy supply dependency, and aging infrastructure that CEC confronted nearly three decades ago. Seward is actively considering a cooperative business model for their utility, and recently re-commissioned a hydro plant abandoned 30 years ago in under 12 months to produce a portion of their energy locally. They are considering other hydropower opportunities that could transition Seward to a net exporter of renewable energy within a decade. Utkiagvik was able to access well-head natural gas in their remote, arctic community to secure a local, reliable, and affordable source of electricity and heat.

On the US national grid, there are regulatory, governance, and ownership barriers that make it difficult to achieve the innovative agility that Alaskan communities have been able to appreciate. In Alaska, the public power model has been highly successful in adapting to change and uncertainty, drawing on their willingness and ability to innovate, adapt, and cooperate with internal and external stakeholders. The decision making resides much closer to the problems, where successful solutions can be developed in a responsive, collaborative, and affordable manner. The transparent sharing of failures and successes among the widely distributed microgrids of Alaska, brokered by ACEP, accelerates the iterative adaptation of these grids, and yields insights to advise policies and strategies elsewhere in the US and across the globe.

A Dangerous Game in the Arctic

By Heather A. Conley

Six months ago, the United States provoked a transatlantic crisis over Greenland. The White House announced in early January that “acquiring Greenland is a national security priority of the United States” and that the options U.S. President Donald Trump was considering in pursuit of this goal included “utilizing the U.S. military.” In response, Greenland’s prime minister, Jens-Frederik Nielsen, declared that the island’s future would “be decided by the people of Greenland” and that for now it would retain its status as an autonomous territory of Denmark, a NATO member. Danish Prime Minister Mette Frederiksen added a warning of her own: should the United States attack Greenland, that would be the day that NATO “would stop.” For added assurance, a small number of Danish and other European NATO forces were deployed to Greenland for an impromptu military exercise. Danish forces were given instructions to destroy airport runways and open fire at invading forces in the event of an attack.

A few days later, Trump withdrew his threat to take Greenland by force, defusing the immediate crisis. But the episode—together with Trump’s repeated talk of incorporating Canada as “the 51st state”—has spurred NATO allies in the Arctic region to step up their security activities. Canada pledged \$28 billion in March 2025 to modernize its Arctic radar system and upgrade the U.S.-Canadian air defense system known as NORAD. In March, Ottawa committed another \$29 billion to build three forward operating sites, improve military satellite communications, and modernize Arctic airports. Denmark has allocated more than \$6 billion to field three new Arctic patrol vessels, long-range drones, and air radar surveillance. The non-Arctic NATO members Norway and the United Kingdom signed an agreement in December to strengthen their anti-submarine warfare capabilities in the North Atlantic. The United Kingdom also recently sent an aircraft carrier to patrol Arctic waters as part of NATO’s Arctic Sentry mission, which began earlier this year.

U.S. Arctic policy is undergoing a seismic shift, too. Since the end of the Cold War, American defense planners have treated the Arctic as a low priority, and programs to build icebreakers, deep-water ports, satellites, drones, and military installations have been severely delayed. The problems these delays created were obvious. In 2015, the United States did not have ships that could track Chinese naval vessels in the Bering Sea, off the coast of Alaska, and had to rely on air surveillance instead. In 2024, U.S. forces struggled to quickly reach Alaska’s remote Shemya Island after 15 Russian warships fired missiles as part of a maritime exercise. But now, the region may finally be getting the funding and attention it deserves. The Trump administration’s strategy documents include proposals to integrate the Arctic into a hemisphere-wide homeland defense plan. Already, Congress has funded the construction of up to three heavy icebreakers and 11 medium icebreakers, and it is beginning to appropriate funds to improve military infrastructure along the Alaskan coast.

The U.S. Space Force is modernizing air and missile defenses based in Alaska, Canada, and Greenland, and Congress is urging it to complete its polar missile-warning satellite program, too. As the military and companies further tap into the Arctic's critical mineral and energy resources, the U.S. government's interest in the region will only increase.

But fully securing the United States' northern frontline will also require that Washington cooperate much more closely with its Arctic allies. Russia and China are steadily investing in Arctic capabilities as they seek greater access to and control over the region and its abundant resources. To counter that growing threat, the United States and its fellow Arctic NATO countries—Canada, Denmark, Finland, Iceland, Norway, and Sweden—will need to pool their economic resources, better integrate their defenses, and pursue technological innovation together. Trump's challenges to Canadian, Danish, and Greenlandic sovereignty are largely responsible for the steps NATO allies have taken so far to increase their Arctic security commitments, but distrust and fear could derail the progress that has been made. The U.S. president has recently fanned the flames again by remarking on the margins of the recent NATO summit in Ankara that Greenland "should be controlled by the United States, not by Denmark." If Washington continues to needlessly provoke tensions with its Arctic partners, it could spoil the best opportunity yet to build a unified defense strategy that can protect U.S. and allied interests in the region for years to come.

DANGEROUS WATERS

Adversaries of the United States understand the strategic value of the Arctic, and they have been expanding their military and dual-use economic capabilities in the region accordingly. Russia now routinely menaces North Atlantic subsea cables, and its nuclear submarines, hypersonic missiles, and subsea submersibles and uncrewed systems are all designed to evade U.S. and NATO defenses. In September 2025, French navy commandos boarded a tanker belonging to Moscow's sanctioned shadow fleet off the French Atlantic coast, suspecting that the vessel had been used as a launchpad for a series of drone flights over Denmark. Drones suspected to have come from Russian research and fishing vessels also harassed Norwegian energy platforms in the North and Norwegian Seas in 2022. Moscow repeatedly attempts to erode Norwegian authority over the strategically important Svalbard archipelago by upgrading a military base on a nearby Russian island, fanning tensions over diminishing fish stocks in the area, and placing Russian Orthodox symbols across the island chain, including a more than 20-foot cross erected near an abandoned Soviet mining settlement.

China has been increasingly active in and around the Arctic, too. Several Chinese icebreakers are able to travel to the Central Arctic Ocean, the high-seas area surrounding the North Pole. Beijing divides its fleet of five icebreakers (and growing) between the waters north of Alaska, where the United States and Russia argue over their shared maritime boundary, and the waters between Greenland and the Siberian coast, which is also a site of overlapping outer continental shelf claims. In the latter area, China is mapping the Arctic

seafloor and assessing critical opportunities for mining minerals. The Norwegian authorities recently arrested a Chinese national on charges of espionage near a satellite ground station in northern Norway; the unique geography of the far north allows this station to provide a near-constant relay of satellite data, giving whatever country that controls it superior access to missile launch information, navigational positioning, and the monitoring of military movements and weather. Beijing has also sought a larger role in Arctic governance, providing the scientific data that informs multilateral agreements on high seas biodiversity and Arctic fisheries management in an effort to shape regulations to its advantage. China's growing economic and scientific presence will also enable its military activities; every Chinese surface ship and submarine that traverses Arctic waters provides Beijing knowledge that will help it conduct future operations.

The Arctic, northern Pacific, and northern Atlantic Oceans function as effective buffers for North America, Europe, and allies in the Pacific—but only if the United States and its NATO allies can defend those frontiers. They must be able to protect freedom of navigation in the Arctic's increasingly accessible sea lanes and to monitor, deter, and counter their adversaries' air, land, space, and maritime activities across vast distances. All of that takes teamwork. As Norwegian Prime Minister Jonas Gahr Store has pointed out, it is Norway and other European allies, not the United States, that will likely first detect Russian nuclear-armed submarines when they depart from Arctic bases; should the submarines escape detection as they cross the Barents or Norwegian Seas, they could directly threaten North American cities. The United States' northern missile defense network, meanwhile, stretches from Alaska to Canada and Greenland; without the cooperation of Canada and Denmark, there would be gaps in the shield, leaving the United States less capable of detecting and intercepting missiles aimed at its territory. If Chinese research vessels or icebreakers travel undetected in the Chukchi Sea to the northwest of Alaska, they could conduct illegal operations in U.S. waters, which is why the U.S. Coast Guard works closely with the Canadian Coast Guard to detect those ships. And to improve American cold-weather fighting capabilities, U.S. Special Forces have repeatedly turned to Canada and the Nordic countries for help in improving their training of personnel and testing new Arctic-ready equipment.

The United States and its allies have stepped up lately to fortify the northern frontline against missiles, monitor surface and subsurface maritime activity, and enhance space-based surveillance. Plans to deploy more polar satellites, Arctic patrol vessels, uncrewed systems, and sensors, to upgrade port and airfield infrastructure, and to exercise under extreme cold-weather conditions will further strengthen U.S. and allied Arctic defenses. NATO has a new battle group that began operations in northern Finland and northern Sweden in June. The alliance also just launched a task force dedicated to integrating autonomous systems to better monitor and track potential threats in the North Atlantic and Arctic territory. Most important, senior Danish, Greenlandic, and U.S. officials have been meeting monthly to negotiate a possible reopening of three U.S. military

installations along Greenland's southern and eastern coasts, where increased surveillance and physical presence would reduce detection and response times in the waters between Greenland and the United Kingdom. But the United States and NATO still have much more work to do to counter the rising threats from China and, especially, Russia.

RAISE YOUR SHIELDS

Thankfully, there seems to be an appetite for even more Arctic collaboration, despite the United States' provocation of its allies. In May, the foreign ministers of seven Arctic countries—Canada, Denmark, Finland, Iceland, Norway, Sweden, and the United States—released a joint statement declaring their intention to cooperate more closely on security matters. The United States needs to build on this momentum, working with its partners to ensure that their military capabilities in the region and their air, maritime, and space surveillance systems can be deployed together and seamlessly exchange data—creating, in effect, an allied Arctic shield.

Elements of a nascent shield are already in place. In July 2024, the United States joined Canada and Finland to form the Icebreaker Collaborative Effort, a plan to speed up the United States' icebreaker production by using those countries' maritime design and building expertise to help U.S. shipyards produce icebreakers. This arrangement will deliver a new 11-ship fleet to the United States, with the first vessel expected to arrive in 2028. In a similar collaborative effort, Canada, Denmark, Germany, Norway, and the United Kingdom have joined forces to purchase American-made P-8 reconnaissance aircraft and surveillance drones, which will help them track Russian submarines.

U.S. allies are also making progress on jointly developing undersea capabilities. Norway and the United Kingdom signed an agreement in late December to construct 13 frigates to hunt Russian submarines in the Arctic and the North Atlantic. According to the British Defense Ministry, Russian submarine and surface activity in the United Kingdom's offshore waters increased nearly 30 percent from 2023 to 2025. British-Norwegian patrols have already successfully detected and deterred Russian activity near undersea cables that transfer vast amounts of data between North America and Europe. Indeed, the United States' NATO allies have begun to assume the bulk of the responsibility of monitoring the seas between Greenland, Iceland, and the United Kingdom.

Still, however important icebreakers and antisubmarine warfare capabilities may be, it will take more than that to fully develop an allied Arctic shield. Most progress so far has been in the maritime domain, but allies also need to improve their space and missile defenses and increase their polar orbital satellites and Arctic-based ground stations. They will need better intelligence sharing and data integration; for the seven NATO countries with Arctic territory, an equivalent of the Five Eyes alliance (Australia, Canada, New Zealand, the United Kingdom, and the United States) would help them develop a comprehensive picture of adversarial activities from the sea floor to outer space. On land, as allies upgrade and

create new military installations for training and deterrence missions, they must make sure that these forward locations are interoperable. They must conduct more cold-weather exercises together and collaborate on the development of cutting-edge Arctic-capable equipment. NATO is the organization best placed to integrate these efforts. The seven Arctic countries are all members of the treaty organization, and non-Arctic NATO members have plenty to contribute. The United Kingdom is a natural partner because of its geography, but France, Germany, the Netherlands, and potentially Poland and the Baltic states will have roles to play, too. Arctic security is too critical for the United States to afford to exclude any of its allies.

Setting up an effective allied Arctic defense will require the United States to make a few changes at home. Those will likely include revisions in the U.S. military's command and control arrangements. Right now, no single command has responsibility for the circumpolar Arctic. As of June 2025, Alaska and Greenland are under the jurisdiction of the U.S. Northern Command, while the U.S. European Command has operational responsibilities for northern Europe and the rest of the high north. The U.S. Army's elite Arctic forces based in Alaska fall under the U.S. Indo-Pacific Command, even though that command has no operational responsibilities in the Arctic. The U.S. Coast Guard, which has the most visible presence in the American Arctic, works closely with regional commands but is not integrated into this command structure, as it belongs to the Department of Homeland Security. This fragmentation can lead to intelligence and response gaps. An effort to restructure U.S. combatant commands would face significant political hurdles, but it will be vital to defending a more militarily and economically active Arctic. Ideally, a new Arctic Command would be given primary responsibility for the region under the U.S. Northern Command and would integrate assets and forces that are currently assigned to the Coast Guard and European and Indo-Pacific Commands.

Another key task is engaging the private sector. The Trump administration's Maritime Action Plan, released in February, focuses on securing Arctic waterways by working closely with industrial and commercial partners to build drones and satellites, update communication and navigational systems, develop mineral and energy resources, and improve dual-use infrastructure such as piers, hangars and runways. Because of the region's extreme climate conditions and extreme distances, the U.S. government must ensure that all available assets—military and civilian—are designed to meet national security requirements. And given that the government's monitoring capabilities and physical presence in the Arctic remain patchy and limited, in many cases it will need to rely on private companies and indigenous communities for information about military and intelligence-gathering activities by Russia and China. Washington must invest in these networks the way it invests in relationships with its Arctic allies, giving companies and communities the tools they need to alert authorities about adversarial activity and respond to an incident.

Finally, the United States must strengthen its scientific missions on the Arctic seabed and in the high seas of the Central Arctic and encourage its allies to do the same. Scientific knowledge is the foundation on which Arctic commerce and security are built, as China is already well aware. The United States has also conducted a wealth of scientific research in the Arctic, but it has trouble aligning its scientific and security priorities. If Washington seeks to achieve maritime dominance in the Arctic, for example, it needs to incorporate best-in-class research on how environmental change affects Arctic waterways. It will need to prevent China and Russia from gaining advantages through their own scientific activities, too. A recently proposed bipartisan bill aims to limit both countries' ability to "exploit scientific research as a cover for espionage" in U.S. Arctic waters, but this legislation is only a first step.

IT TAKES A TEAM

Now is the time for the United States and its allies to update their joint security plans for the Arctic. In Washington, the Pentagon is currently working on a new Arctic strategy, the latest since the Biden administration released one in 2024, and the Department of Homeland Security is considering new Arctic policies of its own, too. Each of these departments seeks to use icebreakers and other Arctic assets for defense and law enforcement purposes in the region, and merging their planning efforts would help reduce the friction between them. Congress is also due to advance supplemental Pentagon budget and defense authorization bills. Whenever that happens, legislators should seize the opportunity to fund joint initiatives with Arctic allies to develop new security infrastructure and technologies, such as forward operating locations, polar orbital satellites, and seafloor sensors.

There is a risk that the effort to strengthen the United States' and NATO's northern flank will be derailed before it can be fully realized. With conflicts in the Middle East and Ukraine, maritime tensions in the South China Sea, and military activities in the Caribbean all demanding Washington's attention and resources, it is all too easy to imagine Arctic security falling down the list of spending priorities, and important Arctic infrastructure left unfunded. And if the Trump administration continues to threaten to take control of new territory in the Arctic, Canada and Europe will reorient their security efforts accordingly, as they did in January, building defenses against the United States instead of joining with it.

Washington must avoid those mistakes. It has all the ingredients to assemble a unified strategy with U.S. allies to improve security in a region that is steadily growing more competitive and more dangerous. A failure to bolster Arctic defenses today will only leave the United States vulnerable in the future.

Framing the Arctic: Geographic and Policy Frameworks for the New Arctic

By Ambassador Mike Sfraga (ret), PhD



Navigating the Arctic's 7 Cs

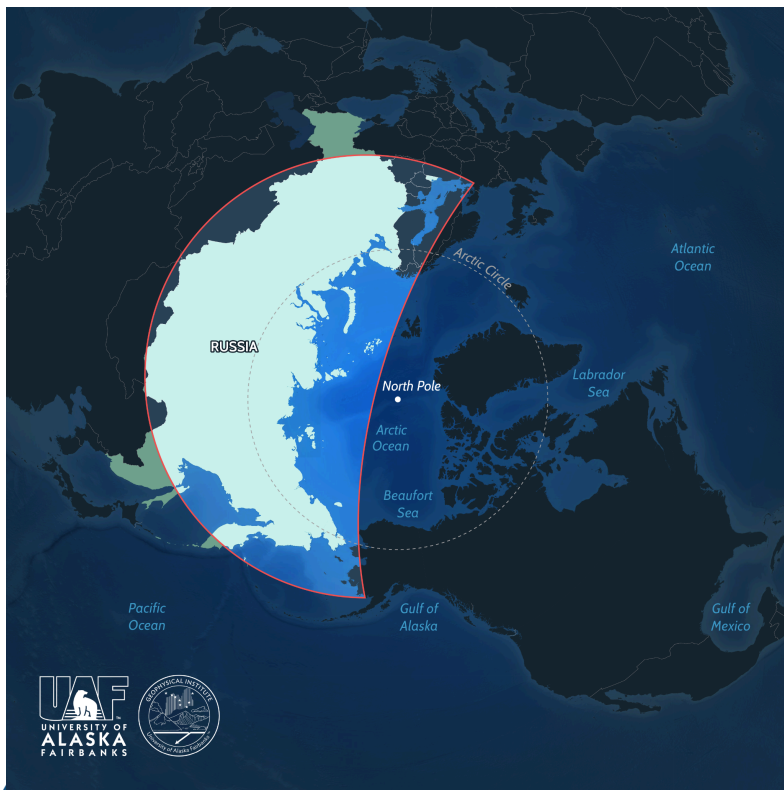


Four Arcs of the Arctic:

North American -Nordic - European Arc:



Russian Federation Arc:



Atlantic Arc:



Pacific Arc:



Powering America

The Five Bs of the Interconnected Arctic:





“Arctic Legos”

Not Just The Port of Nome: A Multi-Use Complex

The “Bering Strait Security, Research, and Economic Corridor”

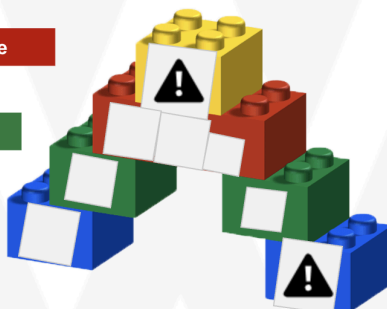
Integrated infrastructure

+

Digital infrastructure

+

Basic infrastructure



ring America

RECOMMENDED READINGS

MONDAY, AUGUST 24:

The Rising Stakes — Demand, Competition, and the New Energy Build-Out:

Appendix 1: Rome G7 Energy Initiative for Energy Security Joint statement of the G7 Rome Energy Ministerial Meeting *The European Commission*

Natural Gas, Oil, LNG, and the Future of the U.S. Energy Security:

Big Oil Balks at Trump’s Invitation to Drill in Alaska’s Arctic Wildlife Refuge *Ari Natter*

Natural Resources in Alaska:

Electricity Affordability and Load Growth: Diagnosing and Fixing the Problem *Robin Millican, Douglas J. Arent & David Sandalow*

TUESDAY, AUGUST 25:

The Decline of Globalization & The Rise of Security in Supply Chains:

AI, Data Centers, and the U.S. Electric Grid: A Watershed Moment *Rachel Mural, Dipesh Pherwani, Chaitanya Gupta, Yiqi Yu, Ai Takahashi, Dongjoo Kim, Subir Majumder, Henry Lee, Minlan Yu, Le Xie*

The Winners and Losers of Oil’s New World Order *Jason Bordoff*

Leapfrogging China’s Critical Minerals Dominance *Heidi E. Crebo-Rediker and Mahnaz Khan*

Appendix 1: Rome G7 Energy Initiative for Energy Security Joint statement of the G7 Rome Energy Ministerial Meeting²⁴

By The European Commission

We, the Energy Ministers of Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, and the EU Commissioner for Energy, following The Hague Declaration of G7 Leaders of March 24th, met in Rome on May 5th and 6th to discuss ways to strengthen collective energy security.

We issue the following joint statement for Leaders' consideration, in view of the G7 Summit to be held in Brussels on June 4-5, 2014.

1. Recent events highlight the need to address energy security challenges. Energy should not be used as a means of political coercion nor as a threat to security. Energy disputes should be solved through dialogue based on reciprocity, transparency and continued cooperation. We are extremely concerned by the energy security implications of developments in Ukraine, as a consequence of Russia's violation of Ukraine's sovereignty and territorial integrity.
2. We are committed to initiate a systematic and enduring step change to improve energy security at national, regional and global levels. And we remain united in our determination to provide various types of assistance that Ukraine needs to strengthen its energy security.
3. We believe that a broader energy security strategy is needed to address the larger dimensions of today's globalized energy markets shared among energy consumers, producers and transit countries. Energy security is a collective responsibility, a core component of our economic and national security that is inherently linked to the energy security of our allies, partners and neighbors. In this respect, we stand ready to pursue discussions and cooperation with European and international partners, in all appropriate fora, including the G20 and in coordination with the European Union.
4. Addressing energy security requires immediate measures and decisions at both the national and regional levels, in order to address short, medium and long term challenges. We believe that the path to energy security is built on a number of core principles:
 - a. Development of flexible, transparent and competitive energy markets, including gas markets.

²⁴ This article was originally published by The European Commission on May 6, 2014:
https://ec.europa.eu/commission/presscorner/detail/en/ip_14_530

- b. Diversification of energy fuels, sources and routes, and encouragement of indigenous sources of energy supply.
 - c. Reducing our greenhouse gas emissions, and accelerating the transition to a low carbon economy, as a key contribution to enduring energy security.
 - d. Enhancing energy efficiency in demand and supply, and demand response management.
 - e. Promoting deployment of clean and sustainable energy technologies and continued investment in research and innovation.
 - f. Improving energy systems resilience by promoting infrastructure modernization and supply and demand policies that help withstand systemic shocks.
 - g. Putting in place emergency response systems, including reserves and fuel substitution for importing countries, in case of major energy disruptions.
5. In the long term, it is vital to ensure diversification of the energy mix. Recognizing that fossil fuels still remain an important element of our energy mix, we believe that reducing emissions from fossil fuels is necessary to tackle climate change and can enhance our energy security. We intend to promote the use of low carbon technologies (renewable energies, nuclear in the countries which opt to use it, and carbon capture and storage) including those which work as a base load energy source.
 6. Energy efficiency needs to be further addressed by proactive policies in industry, in all kinds of power generation, transport, and the building and household sectors, through cooperation to deploy energy efficient technologies and the development of necessary, including financial, capabilities. We support the removal of barriers that limit the diffusion of energy efficient technologies by means of enhanced cooperation with international organizations and international fora.
 7. In the medium term, the diversification of sources and routes for fossil fuels is essential. No country should depend totally on one supplier. We intend to promote a more integrated LNG market, including through new supplies, the development of transport infrastructures, storage capacities, and LNG terminals. We support the opening of new routes to supply energy, in particular the Southern Corridor, as a route for possible other sources of supply for Europe. We will further promote flexible gas markets, including relaxation of destination clauses and producer-consumer dialogue.
 8. Energy security must include timely investment to supply energy in line with economic developments and environmental needs. Some investments in infrastructure, needed to increase security of supply, and that cannot be built according to market rules, could be supported by regulatory frameworks or by means of public funding.
 9. We recall the importance of efforts to protect critical energy infrastructure, including from cyber attacks, of protecting the transit routes and the transport of LNG and oil by ships, of continuing in the joint efforts to ensure the freedom and safety of

navigation on the sea lines of communications including through counter-piracy operations.

10. Consistent with our longer term climate change goals, we will take opportunities to strengthen energy security and economic growth through safe and sustainable development of oil and natural gas resources from conventional and unconventional sources, recognizing that it is for individual countries to choose which sources they wish to develop.
11. We welcome the recent signature in Bratislava of the Memorandum of Understanding and the Interconnection Agreement for reverse flows between Slovakia and Ukraine.
12. We welcome the efforts of the European Commission to identify possible routes for reverse flow from entry points in existing gas infrastructures, to develop emergency plans for winter 2014-2015 at regional level, and to launch a coordinated action to increase the transparency of gas flows through the Ukrainian network.
13. We welcome the efforts of the European Commission to define a list of priority projects among Projects of Common Interest and Projects of Energy Community Interest to enhance the energy security of Ukraine and other Eastern European countries.

We have also agreed to take these immediate actions:

1. G7 members will work to complement the efforts of the European Commission to develop energy emergency plans for winter 2014-2015 at a regional level.
2. Experts from G7 and other invited countries will exchange best practices for assessing energy security vulnerabilities.
3. We ask the International Energy Agency, in close relation with the European Commission, to present within six months options for individual and collective actions of the G7 in the field of gas security.
4. Working with institutions such as the IEA, the International Renewable Energy Agency and international financial institutions, we will supply technical assistance, including leveraging the private sector, and facilitate exchanges with Ukraine and other European countries seeking to develop their indigenous hydrocarbon resources and renewable energies, and improve energy efficiency.

We also agree to sustain our engagement for the medium and long term.

We propose to G7 Leaders to establish a working group to develop comprehensively the Rome G7 Energy Initiative and to report back to Ministers within six months.

Big Oil Balks at Trump's Invitation to Drill in Alaska's Arctic Wildlife Refuge²⁵

Ari Natter

President Donald Trump has long touted the Arctic National Wildlife Refuge as the next great frontier for US oil production.

Yet the industry's biggest companies have balked at three opportunities since 2021 to acquire drilling rights for ANWR. The political realities that drove those decisions don't seem to have changed.

That was evident on Friday, when not a single oil major participated in an Interior Department lease sale for the area. The auction drew just two bidders: Anchorage-based Hex Energy and the Alaska Industrial Development and Export Authority, a state agency.

The fight to prevent drilling in one of North America's largest intact wildernesses has been a touchstone for environmental activists for decades. ANWR's 20 million acres of frozen tundra are home to Porcupine caribou and polar bears that could be affected by the roads, pipelines and other infrastructure needed for oil production.

Big oil companies are leery of a public backlash and mindful that political winds may shift. Any development of the region's estimated 11.8 billion barrels of recoverable crude would take years, in which time Trump and his Republican party could be long gone from the White House.

"Drillers are very hesitant to take oil and gas from ANWR because by the time oil actually gets to production we could have another Democratic administration — and the very first thing they will do is cancel leases," Ellen Wald, a senior fellow with the Atlantic Council Global Energy Center, said in an interview. "It's almost like, what's the point?"

Oil companies' lack of interest in ANWR is in stark contrast to their enthusiasm for the Alaska National Petroleum Reserve, which lies just a few hundred miles to the northwest. That's in part because it was specifically set aside roughly a century ago for energy development and already has infrastructure in place.

A March lease sale there drew a record \$163 million in bids from ConocoPhillips, Exxon Mobil Corp. and others.

²⁵ This article was originally published by Bloomberg on June 9, 2026:
https://www.bloomberg.com/news/newsletters/2026-06-09/big-oil-balks-at-trump-s-invitation-to-drill-in-alaska-s-arctic-wildlife-refuge?cmpid=BBBXT060926_ENERGY&utm_campaign=energy&utm_medium=email&utm_source=newsletter&utm_term=260609&utm_content=5334

Last week's auction doesn't spell the end of efforts to open up ANWR, as it was just the first of four lease sales required under Trump's One Big Beautiful Bill Act between now and 2035.

But it's hard to envisage a sudden burst of enthusiasm from Big Oil.

Chinese aluminum exports surged in May, helping fill a global shortage caused by war in the Middle East. Outbound cargoes climbed 16% from the previous year to 630,000 tons, according to customs data on Tuesday. Smelters in the world's biggest producer have maximized output to capture elevated margins.

Oil declined after Israel and Iran agreed to end attacks against each other, while US President Donald Trump renewed his claims of momentum toward ending the conflict in the Middle East.

China's oil purchases from overseas slumped to the lowest in more than eight years last month as the Iran war crimped supply and Beijing held off scrambling for replacement barrels.

Trafigura Group has told some customers they won't get shipments from a zinc mine in Cuba, as the US ramps up pressure on the country via sanctions and an economic blockade that's choking off fuel supplies.

The world's shipowners have placed orders for a record number of new oil supertankers, surpassing a boom back in 2008 that ultimately led to a glut and a collapse in rates.

Copper advanced along with other industrial metals as tensions eased in the Middle East. Sustained strong demand means copper prices will rise to \$13,000 a ton in 2027, according to Jefferies.

China is shifting its economy to run on electricity far more quickly than the US, leaving its richer geopolitical rival more dependent on oil. Power has already surpassed oil and coal as the main form of energy consumed in China, and that lead will widen sharply by 2050 according to BloombergNEF's New Energy Outlook 2026. In contrast, oil will remain the main fuel in the US until 2047, when electricity catches up.

Electricity Affordability and Load Growth: Diagnosing and Fixing the Problem²⁶

By Robin Millican, Douglas J. Arent & David Sandalow

- Rising electricity prices reflect a convergence of long-standing system weaknesses, including inefficient infrastructure planning, misaligned utility incentives, slow permitting, supply chain inflation, and reactive climate risk management. Increasing electricity demand, or load growth, including from data centers, is accelerating these pressures.
- Whether load growth raises or lowers prices depends on tariff design, cost allocation, and supply availability. Where low-cost supply is available and existing infrastructure is efficiently utilized, additional demand can lower per-unit costs; where supply is constrained or capital needs are high, demand can raise prices.
- Optimization of the existing US power system through grid-enhancing technologies, demand response, and large-load flexibility could quickly unlock supply in the form of underutilized capacity. These efforts could defer costly infrastructure buildout but are under-deployed due to regulatory and incentive barriers that favor capital investment over system optimization.
- Sustained cost control will require structural reforms across three areas: realigning utility incentives with cost efficiency rather than capital investment; ensuring that large new loads bear a fair share of system costs at both the federal and state level; and removing the interconnection and permitting bottlenecks that prevent price signals from translating into deliverable supply.

Concerns about electricity affordability in the United States have been rising along with prices. The problem reflects a convergence of pre-existing structural failures: inefficient infrastructure planning, utility incentive structures misaligned with cost efficiency, chronic undervaluation of flexibility in grid operations, slow permitting timelines that have not improved in decades, and storm damage and wildfire costs—both worsening with climate change. Higher electricity demand, or load growth, including from data centers, is accelerating all of these pressures, and adding some of its own.

This commentary draws on recent research and discussions on electricity affordability, including a new analysis from Lawrence Berkeley National Laboratory (LBNL) and The Brattle Group and a roundtable series the Center on Global Energy Policy (CGEP) at Columbia University SIPA held in New York, Washington DC, and Austin in late 2025 and

²⁶ This article was originally published by Center on Global Energy Policy, Colombia University on June 23, 2026:
<https://www.energypolicy.columbia.edu/publications/electricity-affordability-and-load-growth-diagnosing-and-fixing-the-problem/>
Aspen Institute Congressional Program

early 2026. It examines the structural roots of rising electricity prices and identifies near- and medium-term solutions available to federal and state actors as well as the need for long-term proactive storm-, wildfire- and cyber-related risk reductions.

The central finding is that rising electricity prices are driven by structural features of the power system rather than demand growth alone, and that affordability outcomes under increasing load will depend on how effectively supply, infrastructure, and cost allocation are managed.

Current and Forecast Prices, and Drivers

A new analysis from LBNL provides important grounding on the drivers of electricity pricing in the United States. From 2019 to 2024—a period during which inflation in the United States reached the highest level in 40 years and became a top-tier political issue—average residential retail electricity prices roughly tracked the rate of inflation. Last year marked a departure from this trend, when the average residential retail price of electricity in the United States rose by 6 percent in nominal terms, more than twice the rate of inflation—and by 2.6 percent in real terms.

Primary year-over-year price drivers in 2025, reported in the LBNL analysis, include increases in fuel and wholesale supply costs (a factor in 21 states), distribution cost growth (16 states), generation capital expenditure (11 states), transmission infrastructure costs (11 states), and storm cost recovery (9 states). Annual investor-owned utility (IOU) generation capital expenditure, for example, increased 22 percent in inflation-adjusted terms in 2025 alone, following 13 percent increases in each of the two prior years.

A particularly underappreciated contributor to electricity price increases mentioned in the LBNL study is equipment cost inflation. Since 2019, producer prices for transformers have risen 89 percent, switchgear 77 percent, and wire and cable 152 percent. These cost increases flow directly into utility capital expenditures and, with a regulatory lag, into customer bills over asset lifetimes.

One of the most consequential findings from the LBNL analysis concerns load growth itself: whether load growth raises prices for existing customers is not predetermined. The direction and magnitude of the effect depend on tariff design, cost allocation, and the adequacy of available supply. States with the highest demand growth from 2019 to 2025 generally saw all-sector average, inflation-adjusted prices decline by more than one cent per kilowatt-hour, as fixed infrastructure costs were spread over a larger consumption base. Nebraska, New Mexico, and North Dakota all absorbed large industrial and data center load additions while reducing inflation-adjusted retail prices. Two factors drove this: 1. abundant low-cost wind and solar generation served new load at below-system-average incremental cost, and 2. substantial commercial and industrial growth spread existing fixed infrastructure costs over more demand, reducing per-unit prices for all customers including residential ratepayers.

That said, early 2026 data show prices climbing broadly, with increases particularly concentrated in the PJM Interconnection (13 states in the mid-Atlantic and Midwest, and Washington DC) and the Southeast. LBNL found that IOUs filed \$18 billion in rate increase requests in 2025—the highest level since the mid-1980s. Regulators approved, on average, 64 percent of those requests over the past five years, with 2025 running at 66 percent.

Much of that cost has not yet reached customer bills but will in the coming years. That burden has also fallen unevenly: the Energy Information Administration’s data show that residential customers saw roughly 27 percent higher bills from 2019 to 2024, compared to approximately 19 percent for commercial and industrial customers—a disparity driven in part by utility cost-allocation methods that have historically shielded large commercial users from proportionate cost recovery.

With roughly one-third of American households dedicating more than 5 percent of their income to electricity, according to LBNL, calls for action are certain to grow.

Near-Term Opportunity: Optimizing Existing Infrastructure

The aforementioned CGEP electricity affordability roundtables that included stakeholders from government, industry, finance, academia, and think tanks consistently surfaced this multifactor diagnosis of the drivers of price increases. However, a recurring theme from the roundtables, and one with a strong near-term political and economic case, is that the United States has substantial untapped capacity in its existing transmission infrastructure. New supply and delivery infrastructure will require years of permitting, siting, and construction; in the interim, tools including commercially available grid-enhancing technologies (GETs) and demand response can provide a faster and lower-cost path to meaningful capacity increases.

CGEP recently published a white paper examining the evidence base for GETs. A leading GET example is dynamic line rating (DLR), which uses real-time weather and sensor data to determine actual line capacity rather than relying on conservative static assumptions. DLR reduced congestion by up to 65 percent on monitored lines at PPL Electric in Pennsylvania, delivering over \$50 million in congestion cost savings.

The UK’s National Grid announced deployment of DLR across 275 kilometers of its transmission infrastructure—driven in part by the need to relieve growing congestion on corridors connecting Scottish wind generation to demand centers in London. The company said this deployment has the potential to enable service to approximately 75,000 additional homes and generate an estimated £20 million per year in consumer savings.

Advanced power flow control devices, which reroute electricity from congested lines to underutilized parallel routes, freed 2 gigawatts (GW) of additional capacity on National Grid’s UK system—equivalent to roughly two million homes—saving customers £390 million over seven years.

And advanced conductors, some of which replace steel cores with carbon fiber composites, can nearly double line capacity without new towers or rights-of-way, with deployment timelines measured in months rather than the decade-plus required for new transmission.

All told, the savings realized from GETs could be substantial: analysis in Proceedings of the National Academy of Sciences projects \$180 billion in savings by 2050 from strategic deployment of GETs across the United States.

Grid-enhancing technologies address the supply and delivery side of the equation. On the demand side, large-load flexibility—particularly data center load shaping, or reducing usage during peak periods—offers a complementary lever for managing peak demand without relying on high-cost, low-utilization generation. The DCFlex initiative—a collaboration of 53 utilities, grid operators, and hyperscalers—has completed proof-of-concept pilots in Arizona, North Carolina, and France demonstrating that data centers can curtail or shift computational workloads in response to grid signals during peak hours. The DCFlex Arizona project achieved 10 to 40 percent flexibility in workload during a simulated peak event.

Given the potential benefits to the system, regulators are beginning to evaluate new constructs to drive uptake of GETs, demand response, and flexibility. Near-term actions to mandate consideration of GETs in planning processes—as FERC Order 1920 did in 2024—and to require disclosure of transmission utilization rates would represent meaningful progress toward accountability without requiring fundamental restructuring of the regulatory compact. More broadly, these measures point toward a pragmatic near-term strategy for electricity affordability: maximizing the performance of existing infrastructure while longer-term generation and transmission buildout proceeds.

Medium-Term Agenda: Structural Reform

The transition from slow or very low growth to a new era of accelerated load growth, particularly driven by data centers and advanced computing, has exposed structural limitations in how the US power system is governed, planned, and operated. GETs and demand response and flexibility address near-term capacity constraints, but affordability over time requires tackling the deeper structural misalignments that the LBNL analysis and the CGEP roundtables identified.

Several reform priorities have emerged repeatedly in both the literature and practitioner discussions: realigning utility incentives, modernizing cost allocation for a new era of large and concentrated loads, and removing the institutional barriers that prevent price signals from translating into deliverable supply.

Aligning Utility Incentives with Cost Efficiency

The barriers to broader use of tools like GETs and demand response are not technological but institutional and structural. Under traditional cost-of-service regulation, utilities earn

authorized returns on equity of approximately 9 to 10 percent—a return structure that applies to transmission owners as well as distribution utilities. This regulatory structure rewards capital deployment more than system optimization. As long as frameworks remain oriented toward proving “need” for new capital investment rather than systematically evaluating lower-cost alternatives, the pace of deployment will lag.

Performance-based regulation (PBR)—which ties utility returns to measurable outcomes like system cost reduction, interconnection speed, and congestion relief—is a commonly proposed structural remedy, including at CGEP’s roundtables, but data are still being assembled on its effectiveness at cost management. The UK’s experience with PBR under Ofgem’s RIIO framework represents the most developed implementation, with some evidence of cost discipline, though results have been mixed and the institutional context differs substantially from the United States. Domestic experience with PBR is limited. New York’s Reforming the Energy Vision (REV) initiative is the most prominent US effort, and its track record is still being assessed.

Allocating Costs Fairly as Demand Patterns Shift

The arrival of data centers and other large, concentrated loads is testing cost allocation frameworks at every level of the system. Whether this new demand raises or lowers prices for existing customers depends not on the scale of the load itself but on how the costs of serving it are structured and distributed, according to the recent LBNL analysis and an earlier paper from the Electric Power Research Institute.

At the federal level, FERC is addressing the transmission side of this question. The Commission’s advance notice of proposed rulemaking on large load interconnection (RM26-4) proposes that large-load customers bear the full cost of network upgrades their projects trigger—shifting those costs to the interconnection customers who cause them rather than socializing them across all ratepayers. This approach would shield existing customers from bearing the infrastructure burden of new large loads, though it raises a legitimate design question: how to credit the original payer when upgrades they trigger deliver broader system benefits over time. FERC expects to act on this rulemaking by June 2026.

Separately, state commissions are grappling with large-load retail tariff design. Emerging approaches such as take-or-pay contract structures (which require a buyer to pay for a minimum amount of a product, regardless of actual usage), upfront financial commitments, exit fees, and load flexibility requirements, can in principle protect residential ratepayers while accommodating new large loads.

Early utility projections are encouraging. Indiana utility NIPSCO projects \$7 to \$9 per month in residential savings by 2032 under its Amazon data center agreements; and Detroit-based DTE estimates a potential 8 percent reduction in residential costs under conditionally approved data center contracts.

But LBNL notes that these are forward-looking projections, not realized outcomes, and that new tariff structures carry a real risk of insufficient cost protection. A 2025 Harvard Law School review of nearly 50 regulatory proceedings on data center rates questioned the ability to isolate data center energy costs from consumer bills and suggested that details of contract structures be transparent and rigorously evaluated. Once established, state commissions will need to actively monitor these structures to verify whether projected savings materialize.

Translating Price Signals into Deliverable Supply

A third area for structural reform is removing supply delivery bottlenecks. In PJM Interconnection, rapid data center growth is colliding with supply and transmission constraints, driving capacity auction prices to historic highs. According to LBNL, capacity payments alone are expected to add roughly 1.5 cents per kilowatt-hour (kWh) to PJM wholesale costs across 2025 and 2026. Nationally, LBNL estimates capacity payments added nearly 1 cent/kWh to average wholesale costs in 2025, with a further 0.6 cents expected in 2026.

While the capacity market is pricing scarcity correctly, the broader system cannot respond at the required speed. Interconnection and new-build transmission timelines that take years sever the link between price signals and supply entry. Higher capacity prices mostly end up paying existing generators more rather than inducing new construction, and those extra costs are passed on to consumers through their electricity bills over time.

Addressing this bottleneck requires reforms on two parallel fronts: improving the speed and discipline of interconnection processes, while reducing the time required to permit and build new infrastructure.

The interconnection queue—the process by which new generation and storage projects are studied and approved for grid connection—can be reformed through such efforts as readiness-based prioritization, standardized study processes, and enforceable timelines to reduce delays and bring viable projects online faster. Cluster-based interconnection studies—where projects in a geographic area are evaluated together and required system upgrade costs are shared across entrants rather than borne entirely by the first mover—are another structural reform option. Cluster studies and other queue prioritization reforms were incorporated in FERC Order 2023, though implementation has been slow and uneven. The rule is likely to improve queue efficiency over time but will not by itself resolve the gap between demand growth and the pace of deliverable supply.

Texas has moved furthest in the direction of queue reform: ERCOT's SB6 framework passed in 2025 introduced approximately \$50,000 per megawatt in non-refundable interconnection fees, financial security requirements, and a tiered queue process designed to prioritize projects with demonstrated readiness and screen out speculative entries that clog studies without ever reaching construction.

More broadly, permitting timelines for new transmission have not materially improved in decades: the average transmission project takes a decade to complete, new high-voltage line construction has fallen to roughly 20 percent of early-2010s levels, and the federal government’s authority to site interstate corridors remains limited and contested. Federal and state siting reforms—including streamlined environmental review, categorical exclusions for lower-impact projects, and clearer federal authority for interstate transmission corridors—can help more quickly translate price signals into actual supply additions.

Long-Term Need: Risk Management

Storm cost recovery is emerging as a meaningful retail price driver across multiple states, with LBNL documenting surcharges of 1–3 cents/kWh in places such as Florida in the 2024–2025 period, and multiyear securitization of storm costs. These are not low-probability events—they are recurring, compounding costs that have been and will be embedded in the rate base for decades.

In California, LBNL finds wildfire mitigation and related costs added about 4 cents/kWh from 2019–2024, making them one of the largest contributors to recent rate increases. However, ex-ante resilience investment is demonstrably cheaper than ex-post investment. For example, an analysis from the Energy Institute at UC Berkeley found that the cost of ignitions caused by vegetation striking powerlines would have been 4.5 times greater in 2022 and 2023 absent the California utility PG&E’s proactive risk reduction efforts.

Hardening transmission lines in high-risk corridors and accelerating undergrounding in fire-prone areas can reduce long-run costs to ratepayers by lowering the frequency and severity of damage and associated recovery costs, even if they increase near-term capital expenditure. Similarly, expanding interregional transmission to enable reserve-sharing requires upfront investment and coordination but can reduce system costs over time by improving resource utilization and avoiding duplicative capacity buildout.

Another structural liability affects some Western states: utilities bear wildfire liability even absent negligence, creating a material disincentive to build the transmission infrastructure. Federal reinsurance mechanisms or carefully designed liability caps (limited to cases without negligence and conditioned on demonstrated hardening standards) merit serious consideration—not as regulatory relief for utilities but as a risk-allocation reform that avoids the current dynamic in which ratepayers absorb multidecade recovery costs without any coordination or pooling of risk across jurisdictions.

Cybersecurity presents an additional and growing dimension of system risk and will require ongoing diligence. As the number of interconnected devices (“the internet of energy things”)—advanced sensors, distributed energy resources, cloud-based control architectures, and real-time communications networks—expands, vulnerabilities grow exponentially. Ensuring the resilience of these increasingly networked systems will require

sustained investment in cybersecurity provisions and ongoing regulatory attention, particularly as grid modernization accelerates the pace of digital integration.

Conclusion

The central lesson from the LBNL analysis and broader evidence is that electricity price outcomes are not driven by demand growth alone but by how the system responds to it. Prices rise when new demand triggers high-cost infrastructure buildout, reflects inefficient planning, or shifts costs unevenly across customers. They can fall, or grow more slowly, when low-cost supply is available, existing infrastructure is more fully utilized, and cost allocation ensures that new demand contributes to system efficiency.

This framing points to a clear set of policy priorities across time horizons. In the near term, the most immediate opportunity is to optimize the existing system—deploying grid-enhancing technologies, demand response, and large-load flexibility to unlock latent capacity and defer costly new investment. In the medium term, structural reforms are needed: improving tariff design and cost allocation, and enabling new supply to be built and connected at lower cost via reforms to interconnection queues, transmission siting, and permitting for energy projects. Over the longer term, risk management becomes central, as costs related to storm damage, wildfire mitigation, and cybersecurity increasingly shape the trajectory of retail prices.

The most adverse price outcomes are not inevitable. They are the result of policy and regulatory choices. Delivering affordable electricity depends on aligning supply, infrastructure, and cost allocation so that rising demand can drive higher utilization and lower costs—taking advantage of load growth as an opportunity, rather than a liability.

AI, Data Centers, and the U.S. Electric Grid: A Watershed Moment²⁷

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1. Introduction

Electricity consumption growth rates are increasing across the United States, driven, in part, by a boom in hyperscale data center development. Although the long-term market outlook remains uncertain, the Lawrence Berkeley National Laboratory predicts that data center demand will grow from 176 terawatt hours (TWh) in 2023 (or, about 4.4% of total U.S. electricity consumption) to between 325-580 TWh (6.7-12.0%) by 2028. In some parts of the country, AI-driven energy demand is outpacing available capacity, driving companies to delay projects, contract power directly from private producers, and/or install multiple, inefficient reciprocating generators using natural gas.

Data centers may impact grid reliability in some regions. In July 2024, a voltage fluctuation in northern Virginia triggered the simultaneous disconnection of 60 data centers, prompting a 1,500-megawatt (MW) power surplus, which forced emergency adjustments to prevent cascading outages. Investors claim that massive investments in energy generation and grid infrastructure are needed to power data center development while mitigating outage risks. However, if the anticipated demand does not materialize, utilities (and their consumers) could face stranded costs.

Data centers have enjoyed discounted energy tariffs and tax incentives, as state and local governments compete to attract business. Although these early incentives have driven substantial data center investments, emerging regulatory debates are impacting market development across the country. Policy shifts in major data center markets, such as the passage of Texas Senate Bill 6, signal the probability of future market intervention by both regulators and policy makers to address local-level concerns over reliability and affordability.

As data center infrastructure continues to expand, developing effective regulatory policies becomes critical. The future of data centers and their energy needs, as well as the policy decisions made in this realm, will impact U.S. technological competitiveness for decades to come. While overregulation could hinder AI development, insufficient regulation risks grid instability, rising consumer costs, reliance on high-emission energy sources, public backlash, and setbacks to state and corporate climate goals.

This policy brief outlines the current state (and potential consequences) of U.S. data center electricity usage and corresponding grid expansion. The paper provides an overview of the

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current data center and grid landscape followed by a discussion of potential engineering and policy approaches to address ensuing challenges. The foundations laid herein will inform our future research under the Project on Grid Integration at the Harvard Kennedy School (HKS) and the Harvard School of Engineering and Applied Sciences (SEAS). This Initiative aims to advance 1) the development of new regulatory tools to incentivize increased grid flexibility and 2) the creation of more equitable cost-sharing mechanisms in the wake of expanding data center development. The brief concludes by outlining several critical questions which will guide the Project’s research over the next year.

2. The U.S. Data Center Landscape: An Overview

According to the National Telecommunications and Information Administration (NTIA), there were over 5,000 data centers in the United States in 2024, with demand for data center services expected to grow through 2030. Accordingly, capital spending on hyperscale data center infrastructure has risen to unprecedented levels over the past five years. Amazon CEO Andy Jassy noted that AWS’s AI-related revenue is already a multibillion-dollar business “growing at a triple-digit, year-over-year percentage.” In 2024, Amazon, Microsoft, Google, and Meta collectively spent over \$200 billion on capital expenditures (CapEx), representing a 62% year-over-year increase from 2023. Each firm’s spending reached an all-time high: Amazon’s CapEx was \$85.8 billion (up 78% year-over-year), Microsoft’s was \$44.5 billion (up 58%), Google’s was \$52.5 billion (up 63%), and Meta’s was \$39.2 billion (up 40%). Looking ahead, Amazon’s total CapEx in 2025 is projected to surpass \$100 billion, while Microsoft’s and Google’s are each expected to exceed \$80 billion. The data center buildout race reflects both strategic and financial drivers, as companies race to secure long-term returns and future competitive advantages. By investing ahead of demand, these companies are ensuring infrastructure is available when customers need it. From the industry’s perspective, failure to build ahead of demand places companies at a competitive disadvantage.

While data center financing stems primarily from parent-company balance sheets, corporate bonds, and public incentives, project finance is occasionally used, with green bonds emerging as a supplementary tool. Financing the electricity infrastructure upgrades needed to power data centers, however, is a much more challenging endeavor, as utilities operate under tight financial and regulatory constraints that complicate the acquisition of the large-scale capital deployment needed to fund expansive upgrades.

As data centers continue to seek rapid power interconnection, alternative financing mechanisms for power procurement—through both utilities and third-party providers—are gaining prominence. For example, firms are increasingly relying on third-party power contracts, which include collateral commitments, long-term power purchase agreements (PPAs), availability payments, and upfront capital payments. Additionally, companies are weighing the costs and benefits of co-locating data centers and power generation, despite

challenges surrounding siting rules, asset ownership, and regulatory oversight. Overall, this unprecedented capital outlay exposes both firms and utilities to a range of risks, from increased stranded assets to rising financing costs; therefore, the sustainability of the data center build out depends on both resilient financing structures and continued demand realization.

Future data center market expansion, and its consequent energy usage, remains highly uncertain. Past data center energy studies display numerous flaws. In a review of 258 data center energy consumption estimations, Mytton & Ashtine (2022) found systematic defects within study methodologies, particularly with regards to data availability and transparency. The opacity of data center operations, site planning, and energy efficiency complicate energy estimations and projections. Subsequently, institutional projections of data center electricity demand range from about 200 TWh to over 1,000 TWh by 2030, according to the World Resources Institute. This range complicates medium-to-long term grid planning, as utilities struggle to determine both the true magnitude of the industry's future energy needs and its relationship to economywide electrification.

The 2024 United States Data Center Energy Usage Report attempted to clarify the extent of current and future data center energy consumption. After a period of stagnation from 2014 to 2016, center energy demand grew in 2017 due, in part, to expanded efforts to digitalize data across economic sectors. From 2018 to 2023, data center energy use increased from roughly 76 TWh (comprising 1.9% of the nation's total annual electricity consumption) to 176 TWh (4.4%); future data center energy usage could range from 325 to 580 TWh by 2028, or 6.7-12.0% of 2028 national electricity consumption. However, this range remains uncertain, due to the continued opacity of data center and utility planning as well as uncertain data center market trajectories.

Project risks are assumed by external stakeholders, not just data center companies. For example, utilities face stranded-asset risks with regards to generation and transmission buildout; if infrastructure is built to serve projected data center demand and said demand does not materialize, these assets could be underutilized. Furthermore, increased contract-based financing has shifted projects away from guaranteed "rate-base" recoveries, instead favoring special tariffs and PPA contracts, arrangements which lack transparency and may shift power costs onto other consumers.

These threats raise urgent questions about who should shoulder data center buildout costs and whether returns (and cost recovery) to the utility will remain predictable. Who should pay for grid improvements spurred, at least in part, by data center development? Who are the beneficiaries of these improvements? How should costs be allocated across consumers? How can local communities be protected from rising energy costs and natural resource depletion as data centers expand to new markets across the United States? Rigorous policy, economic, and engineering research—in conjunction with increased transparency from data

center operators and utilities serving them—is crucial for future grid planning as well as for mitigating unwanted environmental, social, and economic impacts.

3. Virginia and Texas – Two Sides of the Regulatory Coin

As data center markets continue to expand, regional differences in electricity market design and energy needs are shaping regulatory and market reforms. Simultaneously, local-level impacts are introducing additional variables for policy consideration. This section surveys two of the largest U.S. data center markets, Virginia and Texas, to demonstrate how locales facing similar challenges differ in the pace and substance of their responses.

3.1. Virginia

Virginia is the epicenter of the global data center industry, with over 4,900 MW of operating capacity (and another 1,000 MW under construction) in Northern Virginia alone. By some estimates, about 70% of global internet traffic passes through the region daily. The area's dense fiber network, linkages with federal facilities, and systemic incentives enabled its market dominance. First, Northern Virginia was an early node in the U.S. government's ARPANET and still hosts major internet exchange points. Second, the state's low power costs, strong electric reliability, economic incentives, and mild climate reduce data center operation costs, while some Northern Virginia counties provided early permit acceleration for large campuses.

Data center growth in Virginia will add thousands of megawatts of nearly constant demand over the next few years, thereby compressing planning timelines and raising new questions around who should bear the costs of system improvements. Dominion's 024 resource plan projects nearly 27 GW of new generation by 2039, including 21 GW of renewable energy (i.e., solar, wind, and nuclear small modular reactors [SMRs]) and 5.9 GW of gas. Simultaneously, Virginia's energy rates are increasing. In February 2025, Dominion proposed its first base-rate increase since 1992, adding about \$8.51 per month in 2026 and \$2.00 per month in 2027 for a typical household.

Furthermore, rapid demand growth has led PJM, Virginia's regional transmission organization, to review how it both defines firm service and manages reliability obligations. The region's wholesale design depends on a balance between competitive generation, long-term capacity procurement, and regulated local service. This dynamic is strained by data center expansion, as a single, fast-growing class of customers with unique load profiles present system needs that differ from those around which PJM was built. Data centers use large, steady electricity loads with limited ability to reduce (or ramp down) their power usage; simultaneously, their energy demand can fluctuate according to equipment usage and job complexity. This pattern differs from the more gradual, weather-sensitive load

patterns. Overall, Virginia is under pressure to embrace new rates, financing, and reliability tools to allocate risks to the drivers of this new demand: data centers.

As the data center industry continues to expand, the Virginia grid must adapt. Cost allocation rules and policy incentives will evolve as the state considers how to sustain reliability investments while stabilizing rates for other customers. Several policy reforms have been proposed. For example, lawmakers have debated scaling back Virginia's data center tax exemptions for both performance and sales. However, proposals to repeal these incentives stalled in the budget process. Furthermore, several 2025 bills sought 1) to link eligibility to tax incentives to improved energy efficiency or clean energy performance, 2) to pause new projects in Northern Virginia, and/or 3) to set uniform development standards, but none of these advanced. A separate bill establishing statewide standards, including land use reviews, reached the governor's desk but was vetoed. That said, local governments are considering enhancing land use and environmental regulations, in order to slow the data center build out process. As of the time of writing, the state tax exemptions remain in place through 2035, signaling Virginia's intent to support competitive market development, but serious concerns around land use and affordability are looming on the horizon.

3.2. Texas

Texas, with its lightly regulated, "energy-only" electricity market structure, offers a contrasting example of how U.S. electricity systems are responding to rapid data center development. The state demonstrates how a market that historically favored low-friction interconnection processes is adjusting its regulatory framework in response to unprecedented new load growth.

Over the past several years, Texas data center investments have been attracted by the state's competitive electricity prices, business-friendly policies (including state sales and use tax exemptions on servers, cooling equipment, backup energy, and other hardware), and rapid interconnection speeds. As a result, the Dallas-Fort Worth area has emerged as one of the largest data center markets in the United States and is continuing to witness massive build out. The Electric Reliability Council of Texas (ERCOT) projects that peak summer power demand could approach 145 GW by 2031, up from 85 GW in 2024; this represents a significant acceleration relative to the gradual 1-2% annual growth in demand experienced over the past two decades. Over half of this new demand (about 32 GW) is projected to come from data centers (including cryptocurrency miners). Unlike past gradual and dispersed growth, the current demand surge is rapid, lumpy, and increasingly clustered around specific localities, leading to increased concerns around demand-supply mismatch, insufficient energy reserve margins, and transmission congestion.

By mid-2024, state lawmakers grew increasingly alarmed by emerging energy risks, particularly with regards to: (1) fairness in cost recovery, with concerns that data center's speculative or duplicative interconnection requests could shift upgrade costs onto smaller

customers; (2) behind-the-meter (BTM) co-location that might pull existing grid-facing generation behind a private fence, reducing available capacity in the system under tight conditions; and (3) managing resource adequacy and emergency operations if large loads remained uncurtailed during an emergency.^[66]

In June 2025, the Texas State Senate enacted Senate Bill 6 (SB6), a package of planning, interconnection, cost-sharing, transparency, and emergency operations reforms aimed at strengthening and protecting the state’s energy grid. The law formalizes ERCOT’s Large Load Interconnection Study (LLIS) process; directs the Public Utility Commission of Texas (PUCT) to determine a “reasonable share” of upgrade costs for new large loads; and requires improved disclosure to reduce speculative filings. Overall, SB6 signals the growing potential for expanded regulation across regional markets in response to increased energy affordability and cost-sharing concerns.

In conclusion, Virginia and Texas face similar energy challenges in the wake of rapid data center development, but their approaches demonstrate different regulatory philosophies. The actions (or lack thereof) taken in these states will serve as models for regulators elsewhere across the country.

4. Technological Opportunities for Data Center Energy Mitigation

Future policy and regulatory solutions for data center energy usage will only work if they are technically feasible, economically sound, and politically acceptable. Data center interconnection is often framed as a choice between grid reliability and economic growth. However, past policies have not been anchored in how large loads behave in the real world. Effective policy solutions must account not only for local-level impacts and cost sharing concerns, but also for computational realities. A modeling-first approach can elucidate policy opportunities by first screening for system reliability, then evaluating system-wide price and congestion effects under certain operational criteria that reflect real flexibility. This exercise will require close collaboration between policymakers, engineers, and business leaders across both the energy grid and corporate sectors.

Ongoing research at the John A. Paulson School of Engineering and Applied Sciences (SEAS) aims to address this gap. By linking security-constrained operations (i.e., reliability screening, congestion and ramping limits) with market outcomes (i.e., price volatility, renewable curtailment risks, and uplift payments), the SEAS team is developing realistic engineering solutions to be integrated into real-world policy tools. This analysis will extend across operational levels, considering everything from hosting capacity to transformer loading to thermal equipment aging. Together, these views link system-wide constraints to local reliability and power-quality considerations to develop standardized, transparent workflows that can align planner decisions, regulatory approvals, and developer obligations on predictable timelines.

Rigorous modeling of data centers' reliability and economic impacts across transmission and distribution enables evidence-driven policymaking. For example, planners could maintain a public shortlist of locations where the grid can reliably host new large loads, aligning private proposals with places with sufficient grid capacity. A similar structure could apply to transmission and distribution by clarifying non-negotiable conditions (such as contingency margins and equipment limits) and possible trade-offs (such as construction timelines). This transparency would enable faster construction, fairer decisions, and clearer expectations among all stakeholders.

At the same time, AI data center power consumption still lacks a standard electricity load profile. Such a baseline would help grid operators, planners, renewable energy developers, and policymakers compare scenarios, estimate future energy costs, gauge resource adequacy, design demand-side flexibility incentives, and set accurate emissions policies. Job submission scheduling provides opportunities to enhance data center demand-side flexibility. Using a bottom-up, minute-by-minute model informed by real job data (i.e., job-arrival traces, per-job resource demands, GPU power profiles, and standard cluster resource allocation mechanisms), SEAS researchers have demonstrated that queuing dynamics (or, how jobs arrive, wait, and are scheduled under finite resources) shape electricity demand. This detailed modeling provides a more granular understanding of power profile dynamics across multiple time scales, ranging from seconds to hours, thereby clarifying the impact of job dynamics on the energy system. This work will provide the basis for regulatory tools designed to mitigate excess power usage and fluctuations stemming from job-level dynamics.

5. Conclusion and Looking Ahead

While the outlook for data centers and their energy needs remains uncertain, future solutions must leverage robust policy instruments to spur technological and/or operational changes. For example, data centers may be able to improve grid reliability by reducing their power usage during peak periods; however, it is unclear which incentives would best encourage these practices. Theoretical solutions must be translated into effective, real-world policy initiatives that consider economic, political, and social realities as well as technological feasibility. Rigorous policy, economic, and engineering research—in conjunction with increased transparency from data center operators and utilities serving them—will facilitate successful reforms.

The **Project on Grid Integration (PGI)** is well-positioned to address these challenges. A joint project of the Harvard Kennedy School of Government (HKS) and the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS), the Project aims to develop new policy, technical, and operational tools that leverage the data center boom in order to strengthen and modernize the U.S. electric grid; at the same time, the project works to

minimize the economic, social, and environmental repercussions of rapid data center expansion.

Moving forward, the Project will examine the following questions:

- **Cost Sharing:** Who should pay for grid improvements spurred, at least in part, by data center development? Who are the beneficiaries of these improvements? How should costs (and associated risks) be allocated across consumers? What cost allocation mechanisms would be fair, methodologically feasible, and politically possible?
- **Behind-the-Meter Energy:** To what extent will data centers rely on third-party energy systems to power their operations? How might behind-the-meter energy buildouts be regulated at the state and federal levels?
- **Grid-Level Impacts:** How might data center operational reforms be used to increase grid capacity, enhance system reliability, and improve operational stability? How might data centers be incentivized to limit their load during peak hours in order to preserve whole-of-system reliability? What impact is high frequency oscillation in large-scale AI training jobs having on energy generation systems and the electric grid at large? How might these impacts be mitigated?
- **Utility Buildouts:** Will utilities be able to access sufficient capital to build necessary infrastructure improvements? How can the cost of such improvements be balanced with electric affordability?
- **Alternative Energy and Externalities:** How can renewable energy and battery storage solutions be better integrated into data center energy needs? How can local communities be protected from rising energy costs and natural resource depletion as data centers expand to new markets across the United States?
- **Data Center Site Selection:** How might data-driven analyses of the electric grid inform future data center site selection processes? How can tariff designs and public policy incentivize data center developers to choose grid-optimal sites?

The Winners and Losers of Oil's New World Order²⁸

Jason Bordoff

The war in Iran has triggered the largest oil-supply disruption in modern history.

The crisis in the Strait of Hormuz is forcing governments to redefine energy security for an age of geopolitical fragmentation—one in which resilience depends not only on how much oil the world produces, but where it flows, who can get it and which countries are able to absorb the shock when it is interrupted.

Nearly 15% of global oil supply has been removed from the market. Crude prices remain elevated above \$100 a barrel after initially spiking higher. They will very likely move sharply higher as inventories run dry.

But while the oil market is global and rising costs are felt everywhere, the consequences are not evenly distributed.

Asia has been hit first and hardest. Last year, the region relied on the Middle East for roughly 60% of its imported oil. The disruption has been particularly severe not just for crude but for refined products like diesel and jet fuel, which have doubled in price since January.

In wealthier countries, pricier oil generally shows up first as inflation and weaker growth.

In lower-income importing countries, it manifests as shortages: Bangladesh has limited air conditioning to a balmy 77 degrees. Laos has shortened the school week from five days to three. Sri Lanka made Wednesday a public holiday. In Pakistan, cricket teams are playing to empty stadiums as fans are urged to watch from home rather than travel.

Shale production, which sharply curbed U.S. oil imports from the Middle East since its boom starting in the 2000s, has so far shielded the U.S. to a degree. But gasoline prices have already risen to more than \$4.50 a gallon from under \$3 before the war, costing the average household more than \$150 a month.

The most consequential effects of the crisis, however, may not be the immediate price spikes around the world but the strategic policy shifts they prompt.

²⁸ This article was originally published by The Wall Street Journal on May 15, 2026:
https://www.wsj.com/business/energy-oil/the-winners-and-losers-of-oils-new-world-order-3841f80f?st=dJVAzd&reflink=article_copyURL_share
Aspen Institute Congressional Program

Just as nations dramatically rethought energy policy after the oil crises of the 1970s, a disruption of this scale will force governments around the world to rethink energy strategy. Here's how:

The United States: Insulated But Not Immune

Impact

Two decades ago, the U.S. imported around 60% of the oil it consumed. Today it's the world's largest oil producer and a major net exporter. Oil use as a share of the economy has also steadily fallen in recent decades. The surge in supply means that physical shortages will take longer to reach American shores. Consumers are paying more at the pump, but the broader macroeconomic damage is smaller because increased consumer spending at the pump now flows to domestic producers rather than abroad. Plus, natural-gas prices surged in Europe and Asia but barely rose in the U.S., a price divergence that has saved U.S. consumers trillions since the onset of the shale revolution.

Long View

In a global market, American consumers still pay higher prices at the pump when a supply disruption occurs overseas, and there are relatively few tools to mitigate disruptions of this scale. As prices rise, politicians may be tempted to embrace more extreme—and economically and geopolitically harmful—options, such as banning oil exports. Longer term, today's crisis holds at least the promise of forging more common ground, as it is both true that America's position has been strengthened by producing more oil and gas, and that the U.S. would still be less vulnerable to supply shocks if we used less oil through tighter fuel-economy standards, more electric vehicles, and better mass transit and rail.

Canada and Mexico: A Need for Diversification

As a major oil and gas exporter, Canada is better positioned than most other countries. According to Goldman Sachs, Canada is among the economies that stand to see the largest GDP gains from higher oil prices. Mexico is in a tougher spot. It produces crude, but declining output and limited refining capacity leave it dependent on imported gasoline and diesel, much of it from the United States. That makes Mexico vulnerable not just to global crude prices but to refined-product shortages, Gulf Coast price spikes and the risk that U.S. domestic politics revives calls for restricting fuel exports.

Long View

The crisis may strengthen the case in both countries for long-delayed efforts to reach markets beyond the U.S., such as a pipeline to the West coast to export Canadian crude. Security concerns will reinforce the shift in Mexico's politics in support of developing its own shale gas, while its broader response has been to double down on "energy sovereignty"

through refining and investment in the state-owned oil company Pemex—a costly strategy that will take time.

South and Central America: Tapping Domestic Supply

Impact

South America depends heavily on imported refined products, and higher fuel prices are creating fiscal and political pressures. However, the region has significant domestic oil and gas production, large renewable and hydropower resources and several major sources of future oil and gas supply that lie outside the Gulf and are thus free from Hormuz risks. That makes the region more strategically valuable if Middle East supplies carry a higher risk premium.

Long View

The interest in investing in countries such as Brazil, Guyana and Argentina, which were already expected to drive much of the growth in non-OPEC supply over the next several years, will extend to other potential producers such as Suriname. Venezuela is the wild card. As its new leadership seeks to attract foreign investment, exports approached 1 million barrels a day in March, the highest level since 2019, although significant risks remain.

China: Beijing's Strategy Validated

Impact

The repercussions for China have been mixed. China is a large net importer, and as oil prices rise and it loses access to discounted Iranian barrels, the cost to import barrels has risen sharply. China's April bill for crude oil imports was up 13% from a year earlier. Still, China holds large petroleum stockpiles. As it curbs imports through the use of inventories and reduced refinery runs, China is also reselling crude it was contracted to buy to other countries, often at a profit.

Long View

The crisis will reinforce, not upend, Beijing's energy strategy. China spent years curbing the growth of oil use. Compared with the U.S. or Europe, petroleum makes up a smaller share of its primary energy mix, and it has electrified more of its automobiles and energy system overall. China's 15th Five-Year Plan, released just after the war started, called for becoming an "energy powerhouse" through "strategic resilience" and "technological sovereignty" with non-fossil sources. The disruption of oil and gas supplies will only strengthen those ambitions.

India: Stability Amid Regional Fragility

Impact

India is more vulnerable than China. It imports nearly 90% of the crude it consumes, and before the war roughly half of those barrels moved through Hormuz. The shock has forced New Delhi to lean harder on Russia—but not on the bargain terms it enjoyed after the Ukraine invasion.

Long View

India has more fiscal capacity, larger inventories and more diversified suppliers than its poorer neighbors such as Pakistan, Bangladesh and Sri Lanka, so it is unlikely to face the same shortages. But expensive crude worsens inflation, strains budgets and raises the cost of shielding consumers. The country's longer-term response may require diversifying supply while accelerating oil displacement through solar, batteries, electric vehicles and rail.

Japan: Drained Reserves, Strained Coffers

Impact

Japan is highly exposed to oil and gas disruptions: imports meet more than 85% of its energy consumption, and in 2025, nearly all of Japanese crude oil imports transited through Hormuz. Japan has been the second-largest contributor to the International Energy Agency's emergency stock release after the U.S., making available the equivalent of roughly 70 days of Japanese consumption—an enormous drawdown by historical standards. The conflict is raising overall import costs and electricity prices at a time when Japanese consumers and businesses continue to struggle with inflation.

Long View

As a resource-poor island that is heavily dependent on maritime trade for essential goods like food and energy, energy security has long been a serious policy concern in Japan. The crisis will reinforce these concerns and strengthen the case for restarting more nuclear reactors, accelerating offshore wind and solar and improving grid flexibility and storage. But Japan's basic import vulnerability will remain, leading it to further prioritize energy efficiency, electrification of more of the economy, and maintaining larger buffers against disruption.

Russia: Putin's Windfall

Impact

Few actors have benefited as visibly, at least in the short term, as Vladimir Putin. Before the war, Russia's oil-export revenue had fallen to its lowest level since the start of the Ukraine invasion in 2022. Its economy appeared on the brink of recession. The Iran war has been a gift for Putin. The U.S. decision to ease sanctions on Russian oil helped Moscow monetize already-loaded barrels at higher prices, and Russia doubled its main source of oil tax revenue in April. (The fiscal benefit has so far been smaller than the oil-price surge suggests,

as part of the increase was offset by payments to oil companies to keep domestic fuel prices down.)

Long View

In the long run, Putin's windfall may prove short-lived. Ukrainian attacks and constraints on investment and technology have accelerated the long-term decline of Russia's oil industry, hampering its ability to structurally increase oil production capacity for the long-term in response to today's higher prices. And Ukrainian attacks are intensifying, with at least 21 strikes on Russian assets and infrastructure in April. Russia's refinery runs last month were the lowest since 2009.

The Gulf Arab States: Bypassing the Chokepoint

Impact

Most of Iran's neighbors are suffering major losses but to different degrees. Saudi Arabia and the U.A.E. are better positioned because they invested in pipelines to the Red Sea and Gulf of Oman, allowing each to bypass Hormuz for roughly half its prewar exports. Oman, located outside the strait, has seen oil revenues rise 80% weekly compared with last year. Saudi revenues are up 10%, despite reduced export volumes. By contrast, Iraq's exports have fallen sharply. Kuwait has exported little oil or refined products for 10 weeks. Qatar's liquefied natural gas exports are offline, and damage to some of the country's export facilities during the conflict could take considerable time to repair.

Long View

As storage reaches capacity, Middle East producers have been forced to stop production of roughly 13 million barrels a day of output. Once the strait reopens, it could take months to restore that supply, especially in Iraq and Kuwait where large mature fields and aging infrastructure make stoppages harder to reverse. For many producers, a priority will be reducing exposure to chokepoints through new pipelines and export routes that bypass Hormuz, and reaffirming they are a trustworthy supplier.

Iran: Leveraging Hormuz

Impact

Iran's position is complicated. It's losing substantial export revenue as the U.S. blockade hinders crude shipment, but in the early phase of the crisis may have benefited from higher prices and temporary sanction relief, with some of its barrels sold far above the discounts the country had accepted on the black market. Because its oil fields and export infrastructure on Kharg Island appear to have suffered relatively little damage, Iran may restore exports relatively quickly if and when the strait reopens.

Long View

Tehran may emerge with new leverage. It has floated the idea of charging a toll to keep the strait open. Even if the war ends without such an arrangement, Iran has demonstrated that its ability to block Hormuz may be as powerful as the threat of a nuclear weapon.

Europe: Accelerated Transitions

Impact

Europe imports far less crude through Hormuz than Asia does, but it faces higher costs as competition intensifies for available barrels. When it comes to oil products such as jet fuel, Europe is particularly vulnerable, owing to its dependence on Middle East imports. The head of the International Energy Agency warned in mid-April that Europe had “maybe 6 weeks of jet fuel left,” after which consumers will see even higher fares and more canceled flights. By contrast, electricity prices, which soared during the 2022 crisis, are not significantly higher, as the initial natural-gas price spike has eased and alternative sources of power have picked up some of the slack.

Long View

European governments have begun discussing voluntary conservation measures. Much like the 2022 energy crisis following Russia’s invasion of Ukraine, this one will reinforce Europe’s imperative to electrify more of the economy with domestic power sources, including by reconsidering opposition to nuclear energy in some countries. But this strategy creates another vulnerability: a dependence on China for solar panels, batteries, electric vehicles and critical-mineral processing, which a recent report from a former U.K. national security official and leading China scholar suggests could create its own risks.

Africa: A Tale of Two Continents

Impact

Oil and gas exporters in north, west and central Africa—including Algeria, Libya, Nigeria, and Angola—may benefit from higher prices and new investments in production capacity. Much harder hit are oil importers closer to the Gulf, including Egypt, Ethiopia, Kenya and Zambia. Many countries, even some producers, import much of the refined fuel they consume. Higher crude prices raise the cost of diesel, gasoline, cooking fuel, transport and food, while governments have limited fiscal room to cushion the blow.

Long View

The crisis will strengthen the case for both refineries and renewables. There are already plans to build a massive new refinery in East Africa, and countries such as Ghana, Angola, Uganda may quickly follow suit. For Africa’s poorest importers, every mini-grid, solar farm, battery and electric bus that displaces fuel imports reduces exposure to the next oil shock, though high borrowing costs, currency risk and weak grids remain major constraints. This

situation will likely expand China's existing investments in these industries in Africa and increase demand for Chinese products such as solar panels, inverters and batteries.

Energy Diversity and Security

The longer the Iran war continues, the more divided the energy world will become across existing geopolitical and geographic fault lines.

China will cast the conflict as proof that American hegemony has become a source of global instability rather than order, while heightened anxiety over oil and gas risk pushes more countries toward the clean-energy technologies Beijing controls.

Wealthy countries will respond by diversifying supply, strengthening buffers and accelerating alternatives, while poorer ones will often be forced to choose what is cheapest rather than most secure.

Importers will pay a premium for diversified supply, while exporters will pay for routes to markets that are less vulnerable to disruption.

Here in the U.S., perhaps the biggest lesson is that even the world's largest producers cannot insulate themselves from shocks in a global market.

Leapfrogging China's Critical Minerals Dominance²⁹

Heidi E. Crebo-Rediker and Mahnaz Khan

Executive Summary

The Trump administration is pursuing ambitious policies to counter China's dominance in and weaponization of critical minerals—essential inputs for advanced technologies, energy infrastructure, and defense systems. Current executive actions focus largely on expanding traditional mining and processing capacity. That is a necessary approach, but one that takes years, often decades, and is insufficient to address potential escalation of tensions with China in the present. Beyond the timing challenge, expanding traditional mining and processing is unlikely to overcome the scale of China's dominance, which spans the entire critical minerals ecosystem.

The United States should therefore pursue a complementary approach that plays to its main strength: innovation. Rather than attempting to out-mine, out-process, and outspend China, the United States should seek to leapfrog China's dominance by scaling disruptive innovation, recovery, and recycling, which is cheaper, cleaner, and faster to deploy today and could help insulate the United States from future supply shocks.

This report provides a comprehensive overview of promising technologies and practical policy recommendations for the U.S. government and its allies to develop, scale, and deploy these technologies together, all in an effort to secure critical mineral independence from China. Key recommendations include:

- Make innovation a centerpiece of U.S. critical minerals strategy. Adopt a whole-of-government approach that, alongside traditional mining, prioritizes innovation across materials science, new extraction and processing technologies, recycling, and waste recovery to reduce strategic dependence on China.
- Use materials engineering to bypass, not replicate, China's choke points. Accelerate the development and deployment of substitute materials—such as rare-earth-free and reduced-content magnets—to eliminate exposure to the most geopolitically vulnerable inputs.
- Scale waste-based recovery as a strategic supply source. Rapidly scale technologies that extract critical minerals from mine tailings, industrial waste, and end-of-life products, transforming environmental liabilities into faster-to-market, lower-cost, and more resilient supply chains while curbing the export of strategically valuable waste.
- Close the scale-up financing gap for frontier mineral technologies. Deploy targeted risk-sharing and investment tools—including streamlined funding pipelines,

²⁹This article was originally published by the Council on Foreign Relations on February, 2026: <https://www.cfr.org/reports/leapfrogging-chinas-critical-minerals-dominance>

early-to-growth stage public venture capital investments, and purchase commitments—to move proven technologies from pilot to commercial scale, catalyzing private capital investment when possible.

- Embed innovation-led mineral security into allied frameworks. Coordinate with allies to co-develop, finance, and deploy emerging mineral technologies—through shared research and development (R&D), pilot infrastructure, and aligned procurement—to build competitive supply chains independent of China that can scale faster than any one country acting alone.

These actions, together with others detailed in the report, form the basis of an innovation-centered strategy for mineral resilience, positioning the United States well for a fast-changing future.

Introduction

Critical minerals are vital resources that serve as inputs for everything from electric vehicle batteries and solar panels to semiconductors and advanced weaponry. Long a quiet fault line in global power, they moved to the center of geopolitics in 2025. China's near-total control over many critical minerals—and willingness to weaponize that dominance—put the world on notice. In October, Beijing significantly expanded its export control regime, demonstrating its ability to restrict global access to rare-earth elements (REEs)—a set of seventeen heavy metals—along with related products, processing technologies, and know-how, nearly bringing vast swaths of the global economy to a standstill. The United States has now reached a dangerous inflection point: Can it overcome its overwhelming dependence on China for critical minerals and rare-earth elements and sufficiently protect its modern industrial base from a Chinese choke hold? Absent a comprehensive strategy, the U.S. industries dependent on critical minerals, including defense, aerospace, autos, and electronics, will remain at risk of Chinese coercion.

China's mineral dominance should come as no surprise. It was a well-publicized goal of the 2015 “Made in China 2025” plan and pursued over a decade of sustained, strategic investments across the entire critical minerals ecosystem. Beijing paired global supply-side expansion with powerful domestic industrial demand, investing in fast-growing industries such as clean energy vehicles, wind power, semiconductors, aerospace, and defense systems.

China's willingness to weaponize its market dominance was also not a surprise; weaponization has long been—and will continue to be—a core feature of Chinese foreign policy. Meanwhile, U.S. companies chronically underinvested in mining, processing, recovery, recycling, and related technologies. Those decisions were partly due to complacency and partly due to concerns about cost, environmental harm, long permitting timelines, and commercial viability. As a result, China was able to consolidate near-total dominance over the critical minerals market.

Catching up to China is a daunting challenge. Even at warp speed and with significant government support, it will take the United States and its allies years to compensate for past neglect. It is hard to out-mine, out-process, or out-fund China. Rather, the United States should seek to leapfrog China's dominance by unlocking and scaling disruptive innovation, recovery, and recycling.

Despite China's formidable position, reasons for optimism exist. Through farsighted U.S. government grant programs—most notably the Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) and the Pentagon's Defense Advanced Research Projects Agency (DARPA)—Washington funded research in breakthrough materials science and in bioengineered and other precision mining, as well as in novel processing technologies. Those early public bets, made in response to China's restricted exports of rare-earth elements to Japan in 2010 over a territorial dispute, seeded emerging technologies that can challenge China's choke hold. Moreover, AI-enabled materials research is now accelerating discovery, mapping, modeling, and engineering across the critical minerals supply chain.

Breakthroughs in two adjacent areas are also promising. The first is mine waste recovery, using novel mining and processing technologies to extract and process critical minerals and rare-earth elements from mine tailings, coal ash, and industrial byproducts, including oil and gas fracking wastewater. These abundant secondary resources offer a far faster path to reducing U.S. dependence on China than permitting and developing new mines. In many cases, waste-based recovery is cleaner, easier to permit, and increasingly cost-competitive with Chinese production. New technologies that unlock critical minerals and REEs from waste streams are often modular, scalable, and compatible with existing infrastructure, allowing them to reach commercial scale far more quickly than traditional extraction projects. As a result, mine waste recovery represents one of the most immediate opportunities for the United States to achieve material gains in supply chain security.

The second set of breakthroughs involves recycling old electronics, or e-waste. Despite the potential that e-waste holds for mineral recovery, especially for securing the REEs necessary to produce magnets used in advanced defense and civilian industries, this area receives far less policy attention than mine waste recovery. Worse, the United States exports e-waste, which could cycle critical minerals and rare-earth elements back into Chinese supply chains. To close this gap, the United States should expand efforts to make, use, and recycle its e-waste, creating a circular supply chain.

For the United States, the current moment holds both promise and peril. Many breakthrough technologies have successfully advanced through demonstration and testing. Many have commercialized, and several innovative technologies are even scaling fast. They represent the building blocks of a future where critical materials are sustainably produced, recycled, and substituted, domestically and among U.S. allies. Yet government programs, decision-making timelines, and regulations often do not align with the needs of

early-to-growth stage companies. Some scientific discoveries remain sidelined—not for lack of strategic value but for lack of patient venture investment at the right stage, connection to the right entrepreneurs or business expertise, commercial traction to scale, or clear demand signals from government or industry. Companies should also collaborate more to break their dangerous overdependence on Chinese-controlled supply chains.

A U.S. innovation strategy should complement, rather than replace, investment in traditional mining and processing projects. The U.S. government should adopt a whole-of-government approach with measures to scale new technologies across the value chain. This strategy should be complemented by policies that build a viable financing ecosystem to support innovative companies from early development through commercialization. These efforts should be pursued in close coordination with U.S. allies, several of which already possess the technological capabilities, financing, and policy tools needed to reduce China’s critical minerals choke points.

The United States has used this playbook before. On the eve of World War II, the United States confronted a similar supply-chain vulnerability when Japan closed Southeast Asian shipping routes, cutting off more than 90 percent of natural rubber supplies, a material indispensable to the U.S. war effort. The response was a surge in government-led innovation: synthetic rubber, scaled at unprecedented speed through public-private partnerships, became as decisive to allied victory as the atomic bomb.² At the same time, the U.S. government launched “Salvage for Victory,” a complementary rubber recycling effort, asking all households, farms, and businesses to contribute old tires, inner tubes, garden hoses, floor mats, and even raincoats.

Like the U.S. government’s solution to the rubber shortage, its response to China’s control of critical mineral supply chains should marry innovation with rapid scaling—mobilizing federal support alongside private capital. This strategy gives the United States the best shot of at last breaking China’s critical minerals choke hold.

Launching a National Critical Minerals Innovation Strategy

Advancing critical minerals innovation at national scale will require a clear strategy and mechanisms to coordinate public-private action across the federal government. It cannot be achieved through fragmented programs or agency-by-agency initiatives; it requires centralized direction, aligned incentives, and sustained bipartisan political backing. This strategy could be launched through a single comprehensive executive order, modeled on the approach President Donald Trump took during the first one hundred days of his second administration, when multiple executive actions elevated critical minerals as a strategic national priority (see Appendix I). Those early executive orders demonstrated important principles: speed matters, and executive authority can be used to overcome institutional

inertia. Congress should also play a critical role, funding and guiding executive-branch strategy through a new Mineral Innovation Bill to enable executive action.

Trump’s ambitious second-term initiatives are building on previous government actions. Granular assessments of U.S. supply chain vulnerabilities led to catalytic government investment in the critical minerals supply chain during the Biden administration, mainly using the Department of Energy grant and loan programs, tax credits, and the Department of Defense’s use of the 1950 Defense Production Act (DPA). DPA authorities provided U.S., Canadian, and, more recently, Australian companies grants, loans, loan guarantees, and purchase commitments to reopen old mines or develop new ones, to build new refining and recycling facilities, and to produce batteries. Those Biden initiatives, in turn, were built on executive orders from Trump’s first term that promoted resilience across the minerals value chain, which, among other things, called for “A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals.”

Building on those precedents, the Trump administration is ramping up interagency cooperation to address the critical minerals challenge, starting with the newly established National Energy Dominance Council (NEDC). But the United States needs a new phase of coordinated executive and legislative action—focused squarely on innovation, recycling, and recovery—to leapfrog China’s dominance. Without a coherent national strategy to elevate those domains alongside traditional mining and processing, and without targeted funding from Congress, the United States risks a continuation of piecemeal initiatives that prevent industry and allies from investing and scaling together.

Recommendations

Launch a national critical minerals innovation strategy. The National Energy Dominance Council, established at the beginning of Trump’s second term to coordinate federal policy in pursuit of global energy dominance, is the logical platform to launch a formal strategy for critical minerals innovation. A strategy led by the White House and championed by the president is essential to ensuring sustained coordination, credibility, and execution across the federal government. This strategy should draw from expertise across federal agencies and labs alongside input from industry. It should also cover engineering and scaling breakthrough materials, capitalizing on mineral waste through breakthrough recovery and processing technologies, funding mineral technology valleys of death, and promoting allied innovation cooperation.

Appoint a senior director of mineral innovation within the National Energy Dominance Council. The president should appoint the senior director, who would ensure implementation of the critical minerals innovation strategy across U.S. agencies. Although clear national security justifications exist to fast-track larger company projects, the director could encourage the deployment of new technologies by those companies. The director

would help early-to-growth stage mining technology companies navigate relevant programs and opportunities. Given the complex, siloed nature of the federal government and the tangled web of programs involved, emerging technology companies often struggle to access federal agencies and funding pathways for their ventures, especially compared to larger, more established mining and processing companies.

Fund and guide a national critical minerals innovation strategy. Congress should work with the Trump administration to support a U.S. critical minerals innovation strategy and provide sufficient funding, guidance, and oversight. A bipartisan mineral innovation act could outline and meet the multifaceted requirements of the Trump administration’s goals to support innovation on critical minerals and could ensure the success and longevity of the strategy beyond the current administration.

Engineering and Scaling Breakthrough Materials

A major leapfrogging strategy for the United States and its allies is to treat materials engineering as a tool of economic statecraft—prioritizing the design of new chemistries, processes, and devices that reduce, replace, or eliminate reliance on the scarcest and most politically exposed inputs. Nowhere is this approach more urgent than in rare-earth magnets that are “permanent,” meaning they produce their own magnetic field without needing an external power source. While the United States primarily produces and processes light rare-earth elements, China controls heavy rare earths essential for high-performance permanent magnets, giving it one of the most strategically consequential choke points in critical minerals. These permanent magnets are integral to high-performance systems—including precision weapons, turbines, drones, and advanced medical equipment—as well as to familiar consumer products like cars, hard drives, and earbuds. There are two types of permanent REE magnets: neodymium-based magnets (often known as NdPr), which are the strongest permanent magnets in the world and rely on heavy REEs such as dysprosium and terbium for thermal stability; and samarium-cobalt magnets, which are critical for high-temperature, high-reliability defense and aerospace uses.

Global heavy-rare-earth supply is highly concentrated and tightly controlled, with mine production dominated by China and neighboring Myanmar. China conducts the overwhelming majority of global heavy-rare-earth processing and permanent magnet manufacturing, and it has further reinforced this position over the course of more than thirty years by effectively locking up global upstream supply. As a result, the United States faces near-total dependence on China for the heavy-rare-earth elements required for permanent magnets. Even under optimistic assumptions, demand for permanent magnets is projected to outpace heavy-rare-earth supply.

China’s weaponization of critical minerals began under President Joe Biden and continued in President Trump’s second term, driven by retaliatory tariffs and export controls on both

sides. Starting in 2023, China imposed export controls on key semiconductor inputs such as gallium and germanium, escalating to export bans the following year. This pattern expanded to other critical minerals as U.S. controls on advanced semiconductor chips and inputs tightened. In April 2025, Beijing imposed export controls on seven heavy-rare-earth elements: dysprosium, gadolinium, lutetium, samarium, scandium, terbium, and yttrium. In October 2025, China expanded its export control regime by adding five rare earths critical to magnets and defense applications: erbium, europium, holmium, thulium, and ytterbium (see Figure 1). China also broadened controls to cover related products, technologies, and, in some cases, downstream or foreign-produced items that incorporate rare earths of Chinese origin.