# Strategies for U.S. Energy Leadership

Energy is the defining variable of civilizational power. Throughout history, the ability to harness increasingly efficient energy sources has been the primary spark for economic growth, technological advancement, and national security. Today, the United States stands at a critical point where the aging infrastructure of the twentieth century is rapidly colliding with the power demands of next-generation technologies, especially artificial intelligence and data centers. Simultaneously, the global transition toward advanced energy systems has ignited geopolitical competition over critical supply chains and resources. To maintain its strategic dominance and drive the next century of domestic prosperity, the U.S. must shift from passive consumption to more aggressive innovation, leveraging targeted capital deployment, regulatory streamlining, and public-private partnerships to secure absolute energy abundance.

For the vast majority of human history, global economic output was strictly constrained by the biological limits of the "organic economy". Pre-industrial societies relied entirely burning biomass like wood or peat, used wind and water energy and had human/animal muscle. Because these energy sources possessed remarkably low energy density and required vast amounts of land to sustain, economic scale was fundamentally capped. Growth was largely a zero-sum game tethered to agricultural acreage; an empire could only expand its economic output by conquering more land to feed more draft animals and laborers. Consequently, human progress and per-capita living standards remained stagnant for millennia. This is exactly why you would see these large empires in our history. It all was to control more energy.

The extraction of coal primarily shattered this biological ceiling, acting as the catalyst for the First Industrial Revolution. By tapping into millions of years of compressed, fossilized solar energy, humanity gained access to an exceptionally dense and portable fuel source. The arrival of the coal-fired steam engine severed the geographical chain that previously forced industries to build along fast-flowing rivers. For the first time, drastic amounts of mechanical power could be generated anywhere at any time. This newfound liberation unlocked the factory system and mass production, allowing nations that controlled the coal reserves (Most notably Great Britain) to compound their economic output at unprecedented rates and project global naval power via steamships.

If coal built the factory, oil built the modern world. The transition to petroleum in the late 19*th* and early 20*th* centuries marked the second Industrial Revolution. Oil offered a significantly higher energy density than coal and, crucially, was a liquid, making it highly transportable and easily refined. This unlocked the internal combustion engine, vitally transforming global logistics, maritime trade, and human mobility. Beyond mechanical transportation, petroleum became the foundational starting material for the modern economy. We still use petroleum today for a multitude of purposes. It enabled the Haber-Bosch process, which revolutionized synthetic fertilizer production and allowed the global population to grow sustainably. You can even see its value in the current Middle East tensions; it is mainly about oil.

As the 20*th* century progressed, the pattern shifted from raw mechanical power to systemic electrification. The development of the modern electrical grid required various energy inputs to maintain stable, continuous power. Natural gas emerged as a critical pillar, offering a cleaner, more thermally efficient alternative to coal for both heating and electricity generation. Mid-century, the successful harnessing of nuclear fission provided an explosive leap in energy density (Millions of times greater than chemical combustion), offering sovereign nations a pathway to massive, zero-emission baseload generation without fossil fuel supply chains.

Together, this integrated system of gas, nuclear, and centralized electrical grids formed the modern infrastructure that dictates modern economic prosperity and national security.

History shows us a simple truth: the countries that control the best fuel usually dictate the rules of the world. Energy is not just about keeping the lights on. It is the ultimate geopolitical wild card. When a nation figures out how to harness a new, powerful energy source, it almost always catapults them into superpower status.

Think of Great Britain in the 1800s. It was a relatively small island, yet it managed to rule a global empire. There is a saying that the sun never sets on the British Empire; it comes from the fact that their territory was so vast that the sun was always shining on some part of it. What was their secret weapon? Mountains of cheap, accessible coal. While the rest of the world was still relying on wind, wood, and horsepower, Britain was building steam-powered factories and an unstoppable iron navy. Coal gave Britain a tremendous, unstoppable head start in the Industrial Revolution. Britain was able to span its empire across almost every continent due to its energy monopoly.

By the late 1800s and early 1900s, the global game shifted from rocks to liquid. When oil gushers started erupting in places like Pennsylvania and Texas, the United States struck the ultimate geological jackpot. Oil was easier to transport than coal and packed far more energy. This homegrown oil boom is what built the American middle class. It fueled our booming factories, put millions of Ford Model Ts on the road, and transformed the U.S. into the undisputed industrial heavyweight of the 20*th* century. This provided millions of jobs for a rapidly growing America. This allowed us to grow into the country we are today.

Fast forward to the Cold War. Some may wonder how the Soviet Union could afford to go toe-to-toe with the booming U.S. economy in a global arms and space race? They sat on an absolute ocean of oil and natural gas. By selling that energy to the rest of the world, the Soviets raked in billions of “petrodollars”. Energy wealth was the financial engine that kept the Soviet Union and its Iron Curtain funded for decades. By selling energy, the societies were able to compete with one of the fastest-growing countries ever. This is no small feat.

But what happens when a powerful country relies on someone else for its fuel? In 1973, America found out the hard way. Angry at U.S. foreign policy in the Middle East, Arab members of OPEC decided to simply turn off the oil tap. The impact on the U.S. was devastating and immediate. Americans faced miles-long lines at gas stations, skyrocketing inflation, and a stalled economy. It was a terrifying wake-up call that truly proved energy wasn’t just a trade good; it could be used as a weapon of mass economic disruption. Today we face a similar issue with all the tension in the Middle East. You constantly hear people complaining about rising gas prices. This is all due to tension on energy; energy runs the modern world. I highly doubt that humans could survive 1 week without energy.

Japan is perhaps the best historical example of an energy vulnerability. Japan is an island nation with a large, desirable economy, but has practically 0 natural energy resources. In the 1930s, to fuel their growing empire, they had to import almost all of their oil. When the United States cut off that oil supply, Japan’s economy faced total collapse, which directly triggered their attack on Pearl Harbor. At its core, the Pacific War was a war for energy. Decades later, to make sure they were never that vulnerable again, a rebuilt Japan poured its resources into nuclear power- a technology that allowed them to generate massive electricity without relying on imported oil ships. This was really eye-opening. I never connected the dots between Pearl Harbor and a war on energy. After doing this research, most, if not all, wars revolve around energy. When someone wants or has more energy than another, it creates tension, then conflict, and finally war.

If coal built American industry, oil built our global strength. The U.S. Navy proved this early on when it switched its ships from coal to oil, making them faster and able to travel much farther. During both World Wars, American energy was our secret weapon. In World War II, the U.S. produced nearly 2/3 of the world's oil. We literally fueled the Allied victory, powering the tanks, planes, and ships of both our troops and allies. Meanwhile, the Axis powers simply ran out of gas and were immediately in trouble. This proves that energy is not only the cause of most wars but also one of the most important factors in them. If you cannot power your war machines, how will you even arrive at the war, let alone fight it? This seems like such common sense, but until this paper, I had never once thought of this. Before you assume countries with a lot of troops and machines are strong, and wars are fought over political disagreements. But now I know that countries with a lot of energy are strong, and wars are mostly fought over energy.

By the early 2000s, the U.S. was heavily reliant on foreign oil, with experts believing domestic production had permanently peaked. That changed around 2005, with the shale revolution. New techniques like fracking and horizontal drilling unlocked huge underground reserves, quickly transforming America from a vulnerable importer into a powerful global energy exporter independent of the Middle East. Places all over Texas started popping up and the U.S. was in another oil tycoon. This also once again provided jobs and really boosted the economy.

Today, the United States stands as the world’s leading producer of both crude oil and natural gas. This abundance not only strengthens the domestic economy but also provides a vital lifeline to European allies as they shift away from Russian energy. Even as the global focus moves toward renewables, America's vast resources strive to achieve its ongoing role as a central energy leader.

The world’s population is still growing, and economies are expanding. More people mean more houses to heat up, more food to grow, and more stuff being made. But the real story is happening in the developing world. Places like India, large parts of Africa, and Southeast Asia are going through immense changes. For decades, millions of people in these areas lived in “energy poverty”. Now, they are racing to industrialize. They are building new cities, putting up factories, and connecting millions of homes to the grid for the first time. People in these regions want the same standard of living that people in the West have enjoyed for decades. They want refrigerators, air conditioners, cars and smartphones. You cannot blame them, but providing all of that requires an unbelievable amount of cheap, reliable energy.

You may be thinking, “Aren't things getting more energy efficient?” Yes, they are. We have LED lightbulbs, better insulation, and appliances that sip power rather than chugging it. But, here is the catch, because things are cheaper and easier to power, we end up just using more of them.

Experts and governments have spent years making charts and projections about how much power the world will need in the future. And almost every single time, they guess too low. They factor in our new, efficient technology and assume our power use will level off. But human behavior doesn’t work like that. As energy gets more accessible, we will find new ways to use it. That is why energy demand projections just keep getting revised upward, year after year.

While the developing world is building factories and cities, the developed world is building something completely different, and it requires just as much power. The new frontier of energy is entirely digital. Think about every time you stream a movie, scroll social media, or back up your photos to the cloud. All of that data doesn’t just float in the sky. It lives in huge warehouses filled with computer servers, known as data centers. For the past decade, these data centers have been growing fast, but lately, their electricity use has gone off the charts.

The biggest reason for this sudden spike is Artificial Intelligence. When you ask a program like ChatGPT a question, it takes a lot of computing power to give an answer. But that’s just the tip of the iceberg. The real power drain happens during the AI’s training. Tech companies have to feed these AI models billions of pieces of information so they can learn. Training an AI model is not like running a normal computer program; it's basically a colossal, industrial-scale project. It requires warehouses packed with specialized chips running at full speed, generating so much heat that they need huge cooling systems just to keep them from melting down. All of that requires energy/electricity.

Because of this AI boom, the projections for the near future are staggering. By 2030, data centers are expected to consume a large and growing share of the electricity produced in the U.S. It is happening so quickly that local power grids are struggling to keep up. Tech companies are literally buying nuclear energy just to make sure their servers don’t go out.

This also brings a major global problem: the competition with China. China’s government sees exactly what is happening. They know that whoever controls AI will control the future of the global economy and military power. Because China has a state-run system, it doesn’t have to deal with the same red tape, zoning laws, or grid delays that we do in the U.S. It's just building with almost no regulations. They are heavily funding both their AI tech and the power plants needed to run it, aligning energy and tech goals. China's main strategic advantage lies in the fact that its government is directly funding its tech ventures. They also have little to 0 regulations. The U.S. does not have either of these liberties, so we must figure out how to work around these roadblocks and remain the most advanced with AI.

For the U.S. and its allies, this is a serious weak spot. We have the smartest tech companies in the world and currently lead the AI field, but if we can't plug our computers into the wall because the grid is maxed out, it just doesn’t matter. Having enough energy is no longer just about keeping gas prices low or keeping the lights on at home. Energy availability is now a hard limit on who wins the AI race. If we don’t figure out how to generate way more power, it becomes a major strategic vulnerability.

While the rise of AI is an influential change in the energy landscape, with companies seeking ways to power their data centers as cost-effectively as possible, there are many other energy shifts taking place in the world. As mentioned earlier in the paper, countries worldwide are working to connect their rural areas to electricity to boost GDP in rural areas. Many countries are also interested in expanding their renewable energy sources and reducing their fossil fuel consumption. As of 2023, the IEA (International Energy Agency) lists oil as the world’s primary energy source, accounting for 30% of the energy supply. It is followed by Coal (27.8%), Natural gas (22.7%), Biofuels and waste (9%), Nuclear (4%), Solar, Wind, and other Renewables (3%), and Hydropower at (2%). There’s a huge gap between fossil fuels and renewable energy sources, and that gap is what countries are trying to address. As the world tries to reduce its carbon footprint, there simply isn't enough infrastructure to rely solely on renewable energy for consumption. In addition to the lack of current infrastructure, new projects to build renewable energy plants take years to be approved and constructed. So, as energy providers wait for renewable energy production to scale, they have turned to Natural gas as a “bridge” energy source from fossil fuels to renewable energy. Natural gas, when extracted correctly, emits significantly less harmful gases than coal and oil. As a result, the share of energy supply that Natural gas accounts for has significantly increased, especially in the United States, as it’s the only fossil fuel used by the U.S. with a larger energy supply in 2024 than in 2000. At the micro-level, individuals have also become more aware of their carbon footprint and are taking measures to reduce their carbon emissions. In the U.S., 6 million homes have a solar unit, which equates to about 9% of homes. EVs (Electric Vehicles) are another avenue through which individual consumers have expressed a desire to reduce their carbon footprint. In 2025, 25% of cars sold worldwide were EVs, totaling 23.4 million EVs.

All these changes in the global energy landscape affect how energy is produced, stored, and processed. To adapt to these changes, countries need innovations and materials they may not have. To address energy or infrastructure shortages, countries must engage in trade, which can contribute to political tensions and leverage between countries. Demand has risen sharply, especially for batteries and other metal parts that can store or generate energy. These parts are composed of rare metals such as Lithium, Uranium, Dysprosium, Indium, Gallium, and others. The catch about rare metals is not that they are rare in existence, but rather that they are rarely concentrated together. As a result, mining and processing these elements requires expensive, time-consuming operations. Most countries don’t mine these rare metals, and even fewer process them. To make matters worse, the Department of Energy projects that the global demand for some of these metals will surpass the mining capacity. This all benefits the one country that dominates both mining and processing, China. China can mine and process these metals at low cost, which benefits them immensely whether they trade the metals or use them. Aside from trade leverage, resources critical to energy infrastructure can be a reason to go to war or a target for attack during conflict. While there were many factors for the Russia-Ukraine conflict, one of the reasons Russia is attempting to conquer Ukraine is that southeastern Ukraine has large deposits of natural resources. Through this attack, Russia received energy-related pushback from the rest of Europe and other allies of Ukraine. Energy infrastructure was not only a reason, but also a target during the Ukraine-Russia conflict. The Nord Stream pipelines are a system of pipes that were used to transport natural gas from Russia to Western Europe. However, in 2022, a series of explosions damaged three of the four pipelines, leaving them inoperable. There is yet to be a conviction, but Germany does have a Ukrainian suspect in custody and facing charges. Additionally, in the Iran, USA, Israel conflict, both sides of the war have targeted energy sources in the conflict. Iran shut down the Strait of Hormuz, where around 20 to 25% of the world's oil is produced. Iran also targeted the critical infrastructure of its Gulf neighbors. It attacked refineries, facilities, and plants that processed gas and natural gas. A combination of shutting down the Strait and attacking  energy infrastructure has caused energy prices to rise significantly worldwide. Alternatively, Israel and the U.S have also attacked key natural gas and oil facilities in Iran, which will have huge military and civilian repercussions for Iran.

A country's energy program plays a vital role in its security in subtle ways, and the effects of an insufficient energy program can be devastating. While trade agreements involving energy can help countries build good relationships with one another and address energy shortcomings, when a country relies too heavily on imported energy, it allows a foreign country to exert influence over its politics. This is not a problem for the U.S currently, since the U.S provides most of the energy it uses. However, this problem can affect its allies and threaten their political stability. The surge in renewable energy also has security implications for countries that derive a substantial share of their GDP from fossil fuel exports. As fewer fossil fuels are exported, economic growth reverses, and the nation’s stability is threatened.

The U.S. government has historically been a leader in energy and has dominated the global energy landscape primarily through its proactivity and investment in research. For example, the U.S. pursued efforts to connect its rural and farming population to its electrical grid in the mid-1900’s due to very low rates of farmhouses having access to electricity. The U.S. passed the Rural Electrification Act of 1936, which provided a framework for powering the farms. 14 years later, 90% of rural homes and farms were connected to electricity. The main goal of rural electrification was increased economic productivity, which is exactly what occurred. Jump to the modern day, and rural America is looking for ways to generate renewable energy on farms, while other countries are still trying to connect their residents to electricity. The U.S’s dominance in natural gas production is another example of its research investments and proactivity paying off. The Shale revolution was driven by a series of breakthroughs in natural gas extraction, funded by the U.S. government, that transformed the U.S. energy landscape. The breakthroughs were horizontal drilling, hydraulic fracturing, and advanced seismic imaging. Horizontal drilling is the concept of drilling horizontally through shale formations to access more natural gas. Hydraulic fracturing, also known as fracking, is the process of injecting fluids into shale formations, allowing the natural gas to pool in a concentrated area. Seismic imaging is the use of electromagnetic waves to map the geological composition under the Earth’s surface. Combined, these 3 allowed the U.S to rapidly increase its natural gas production, reduce its spending on energy imports, and become the largest energy exporter in the world. Building upon the shale revolution, the United States optimized its exportation of natural gas through liquid natural gas (LNG). Liquid natural gas is natural gas cooled and compressed to the point that its volume has 1/600th the volume of its gas form. The U.S is the largest exporter of LNG, which gives it huge leverage globally. The U.S's LNG supply has allowed it to undermine Russia's dominance in the natural gas industry, especially in Europe. Outside of natural gas, the U.S government has conducted or funded research in other facets of energy. The Department of Energy has contributed to modern technological research and development, such as the cathode technology used in EV batteries, computer servers, and efficient renewable energy production. The Department of Defense also has a research-focused program called the Defense Advanced Research Projects Agency (DARPA). Historically, DARPA has played a part in developing the Internet and GPS. Now, DARPA is researching ways to transmit power from a generator to a device miles away, efficient and environmentally conscious ways to utilize machine learning, and additional ways to store energy.

The government has done a lot well, but there are still times when the government has dropped the ball. The main shortcomings the U.S. faces are its aging infrastructure, a tedious permitting process, and its dependence on imports of rare metals. The most impactful bottleneck is the permitting process for new energy projects. Even with all the necessary conditions to begin construction, projects can sit in regulatory review for years before construction begins. According to the American Clean Power Association, the average review timeline for a typical energy project today is around 4.5 years, and transmission projects average 6.5 years, often stretching beyond a decade. Much of this delay traces back to the National Environmental Policy Act (NEPA) and the layered, duplicative reviews required across multiple federal agencies. Environmental review exists for good reason, but a framework that takes longer to approve a clean energy plant than it does to build one is working against itself. In 2023 alone, more than

60,000 MW of clean energy capacity experienced permitting-related delays. As the country tries to scale up renewable energy and meet surging demand from data centers and civilians, the government's own approval process is its biggest obstacle.

The transmission grid magnifies this problem. Much of the U.S. electric grid was built in the 1960s and 1970s and is now approaching the end of its typical lifecycle. It was designed for a different era of energy and is poorly suited to a future built on renewables, which will need to move energy more dynamically. Yet building new interstate transmission lines can take a decade or more to permit, and there is no coordinated national plan governing the grid at all. The U.S. system is fragmented into three largely isolated interconnections and split further into roughly a dozen separate transmission planning regions that mostly plan in isolation from one another. To address this, the Department of Energy estimates the country needs to expand its transmission system by roughly 60% by 2030, yet only 255 miles of new transmission were delivered in 2023. Against the roughly 10,000-mile goal, this was negligible progress. Without a plan and faster permitting, the existing electrical grid exacerbates the bottleneck.

Nuclear energy is another example of progress stalling because of past mistakes. In 1979, a cooling problem at the Three Mile Island reactor in Pennsylvania caused part of the core to melt and released a small amount of radiation. It was the worst nuclear accident in U.S. history, but no one was hurt, and there were no documented health effects. The meltdown occurred due to human error and poor training by the managing company. Still, public trust in nuclear energy collapsed, and new plant construction slowed down in the 1980s and 1990s. Instead of learning from the accident and improving safety, regulations became so strict that they stopped new nuclear projects. This shut down a clean and reliable energy source because of fear and a lack of government support.

The government also let rare earth production slip away. Today, China controls about 90% of the world's rare metal processing, but the U.S. once led this industry. In the 1960s, the Mountain Pass mine in California was the top source of rare earths. Over time, China took over by offering cheaper labor and looser environmental rules. China's control of the rare metals market is so dominant that it has used it as leverage, cutting off exports to Japan in 2010 during a dispute or flooding the market when competitors attempt to make progress in rare metal mining. The U.S. is now trying to rebuild its rare earth industry, but experts say it will take years to catch up. Regaining this lost ground will be much harder and more expensive than keeping it in the first place.

Underlying all of these failures is a more general problem: the politicization of energy policy. Because energy priorities swing sharply between administrations, long-term investment becomes riskier than it should be. ARPA-E, the Advanced Research Projects Agency–Energy, which has funded some of the country's most promising early-stage energy research, offers a telling example. Despite a strong track record, it has repeatedly been targeted for elimination in some budget proposals and rescued by Congress in others. That kind of instability greatly limits what can be accomplished by these programs when they face budget restructures every election cycle. If these are the places where the government has fallen short, the path forward is not simply to spend more or regulate less. It is to be deliberate about what the federal government's next course of action is.

The following principles offer a framework for federal energy leadership that acts as a catalyst rather than a bottleneck. The first principle is to continue to do what it does well: fund basic research generously. The government's greatest advantage is its ability to absorb risk on early-stage research that no private company would rationally pursue on its own, exactly the kind of high-risk, high-reward work that ARPA-E and DARPA operate in. That mandate should be expanded, and its budget increased, not left to the whims of each budget cycle or administration. When these government research agencies produce a significant breakthrough, the private sector can then go on to adapt it and spread it, as has been the case so far. This has proven to be a successful model, and there is no reason to change it.

The second principle is to build a diverse energy portfolio. There are plenty of benefits to utilizing various energy sources. For starters, it allows your energy infrastructure to be stable in all 3 phases of energy distribution: production, storage, and transmission. If a certain energy source is negatively impacted by world events or other unforeseen conditions, a diverse energy portfolio allows you to overcome these issues with minimal consequences. Additionally, abandoning fossil fuels entirely is impractical. Renewable energy is not as convenient as fossil fuels in terms of space it takes, existing infrastructure, and cost for consumers. Furthermore, if the U.S. were to abandon fossil fuel production entirely, it would be ceding the leverage and the profit it gains from supplying the rest of the world with natural gas

The third principle is to fix the permitting crisis directly, since it is the single largest bottleneck that the government controls. This means reforming NEPA and all other relevant regulations so that review timelines for critical energy infrastructure are established. The goal is not to weaken environmental protection but to make the process predictable and time-bound, so that the country can build at the speed the moment demands. The country has aging infrastructure and won’t be able to address it efficiently without changes. Possible solutions are easing environmental guidelines, assigning a single task force to tackle all reviews, or reducing the overlap between different department reviews. These are possible solutions, and the optimal one may not be one that is listed, but either way, the permitting process needs to be addressed so it is no longer a setback.

The fourth principle is to secure critical mineral supply chains, so the United States is never again dependent on political rivals for the materials its energy future depends on. That requires reforming domestic mining permitting to make it possible to responsibly extract these minerals at home, building supply-chain partnerships with trusted allies through frameworks, and maintaining strategic stockpiles of critical materials as a buffer against the kind of export cutoffs China has already demonstrated it is willing to use.

Strong energy leadership is essential for a country's stability. While geographic advantages and resources help, conscious efforts are still required by the U.S. to continue leading the world in energy production and innovation. This kind of leadership comes from steady investment in research, smart policies that remove obstacles, and planning ahead to keep advantages. The examples in this paper all show the same thing: rural electrification happened because the government acted, and the shale revolution came from years of research. Where the country has fallen behind, it is because that same effort was missing. The stakes are extremely high as energy is the base for everything the twenty-first century will depend on. Growing power needs across AI, data centers, advanced manufacturing, and military strength all rely on sufficient, secure, and affordable energy. The country that leads in energy will lead in these areas. The one that does not will be limited by its own power grid. The good news is that the United States still has everything it needs to stay a leader in energy. It has natural resources, strong financial markets, top research institutions, and a large pool of talented scientists and engineers. What is needed now is the determination to act quickly and clearly, and to treat energy as a top priority, not a political issue. Every period of American success has been powered by strong energy leadership. Electrified farms, wartime factories, and the technology that changed the economy all depended on it. The next era will be the same. The real question is whether the United States will choose to lead or let another country take that role.

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