Nuclear Defense

Responding To Popular Critiques Of Nuclear Energy

Energy costs are back in the headlines again. This time, it's AI-induced demand that's likely boosting U.S. electricity prices (*see Figure 1*).

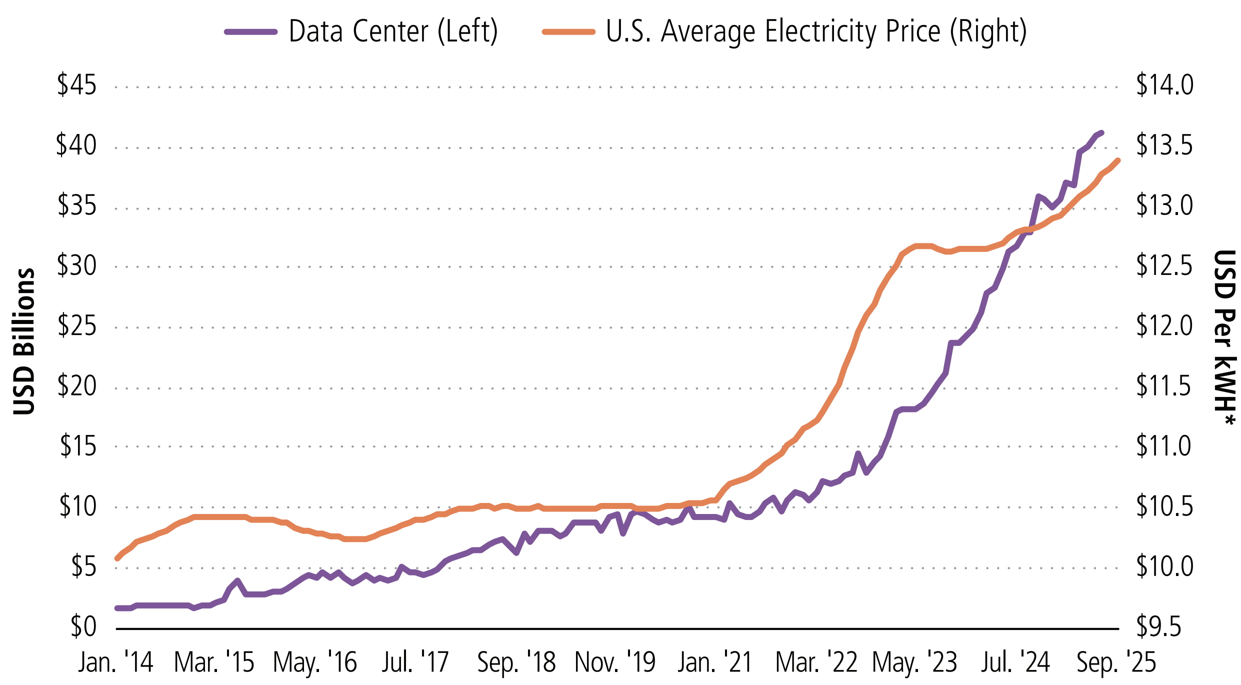
Many readers may respond that we should *save* energy rather than spend it on AI chatbot queries. But, contrary to what you may have heard, we need *more* energy, not less.

«HUMAN PROGRESS IS ABOUT DOING MORE, WHICH HAS ALWAYS REQUIRED MORE ENERGY.»

Indeed, human progress is about doing more, which has *always* required more energy. Without more energy, we'd confine a large segment of the global population to lower living standards and leave the more fortunate rest of us with a static future.

Here's our case for the best path to generating more—not less—energy.

fig 1. WATTS UP WITH AI? DATA CENTER MONTHLY CONSTRUCTION PUT IN PLACE VERSUS AVERAGE ELECTRICITY RETAIL PRICE



Sources: Energy Information Administration, U.S. Census Bureau
*Kilowatt per hour, which measures the amount of electricity used per hour

ENERGY, ENERGY EVERYWHERE

Everything requires energy. Sitting in your cozy chair, reading this article requires energy—even if you do not move a finger.

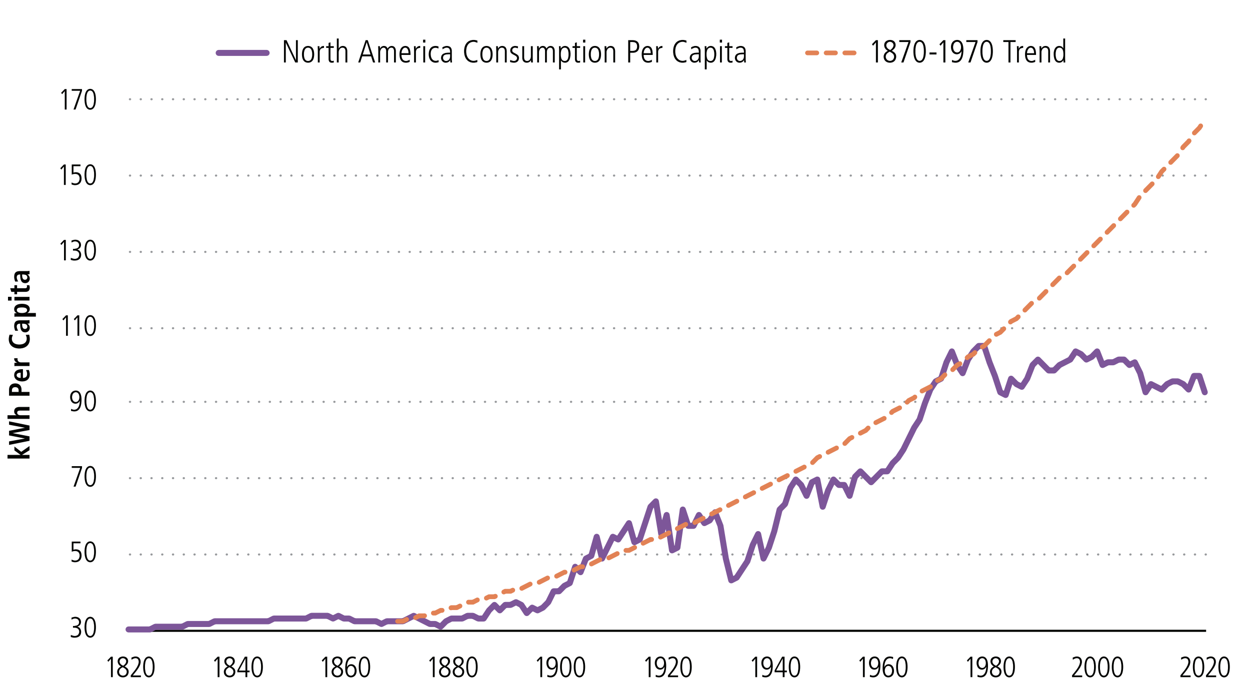
Abject poverty—the original state of humankind—was due mainly to our inability to harness energy resources for human use.

In the words of J. Storrs Hall, "Counting watts… is a better way to measure a people's true standard of living than counting dollars."[1]

«OVER THE LAST TWO CENTURIES, WORLD ENERGY CONSUMPTION PER CAPITA AND GDP PER CAPITA HAVE MOVED IN LOCKSTEP.»

Over the last two centuries, world energy consumption per capita and GDP per capita have moved in lockstep.

fig 2. ENERGY PLATEAU: NORTH AMERICA ENERGY CONSUMPTION PER CAPITA



Source: World Energy Consumption Database

Unfortunately, energy consumption per capita in North America plateaued in the 2000s, and the U.S. economic growth rate also slowed from its previous trend (*see Figure 2*). We've made progress toward more efficient energy use, but stalled energy progress helps explain why many think overall economic progress has stagnated in recent decades.

Thankfully, there is a way forward that benefits everyone—the environment, the poor, the rich, and everyone in between—embracing and unleashing nuclear energy. Below, we address the most common arguments against nuclear power and show why it deserves such a central role in our clean energy future.

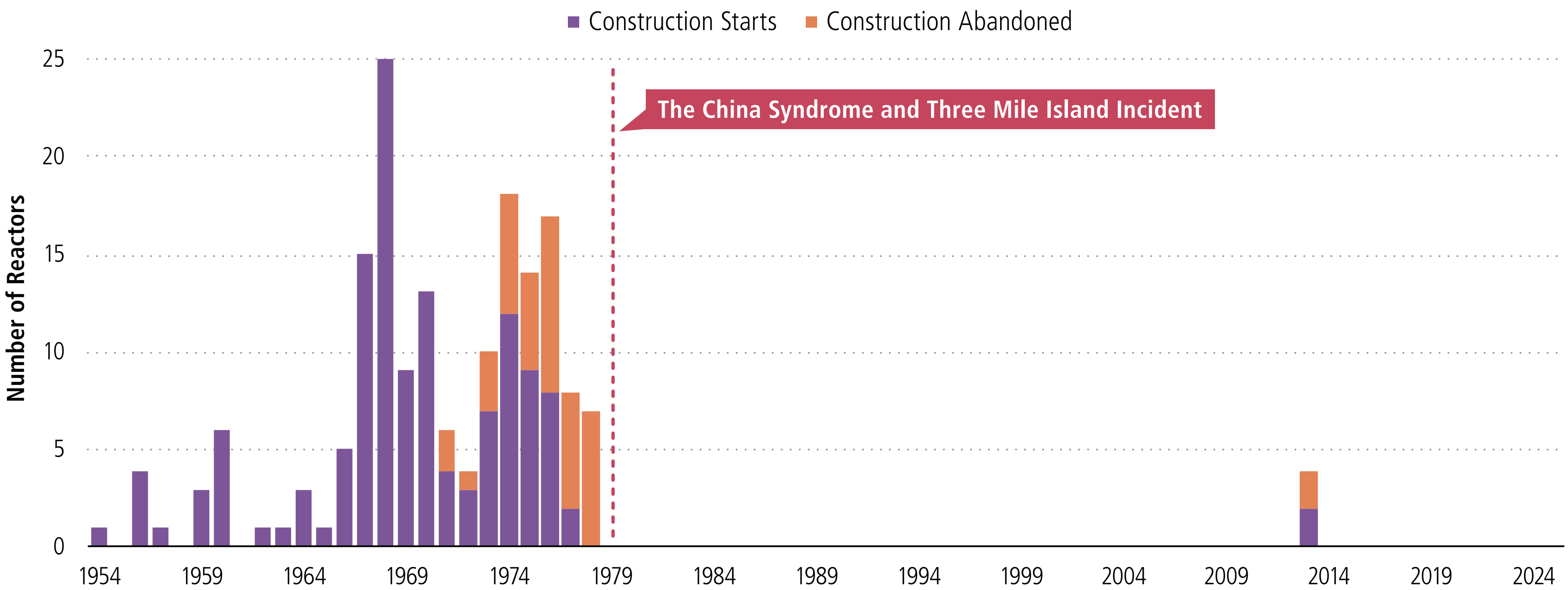
NUCLEAR NAME TARNISHED

The problem with nuclear fission was that its first major application was for *destruction*. Not exactly the right tone to set for a product. As a result, the starting point for any defense of nuclear energy must be the perceived downsides: *disasters*.

Three Mile Island (1979), Chernobyl (1986), and Fukushima (2011) are three notorious accidents that garner the most attention.

However, no one died at Three Mile Island, and the plant released negligible amounts of radiation. Chernobyl was less a nuclear accident and more a catastrophic failure of management whose "safety team" ran an "experiment" by shutting off the safety system to run a mock emergency, which turned into a real one. Even then, the initial

fig 3. PROGRESS PAUSED:
NUCLEAR REACTOR CONSTRUCTION STARTED AND ABANDONED ANNUALLY IN THE U.S.



Sources: World Nuclear Industry Status Report 2025, IAEA-PRIS Database

explosion killed two people, 28 first responders later died from radiation exposure, and another 25 people died from cancer years later—tragic losses, but far fewer than many critics claim, albeit with major ecological impacts in the region and beyond.

The deaths at Fukushima, meanwhile, were due to an earthquake-induced tsunami, not due to the nuclear fallout.

Nonetheless, public opinion has been shaped more by the cinematic than by the scientific fallout. For example, The *China Syndrome* was released a month before the Three Mile Island incident, cementing public fear of nuclear fallout. Public opinion in favor of nuclear power similarly slumped, and U.S. nuclear construction activity halted (*see Figure 3*).

More importantly, nuclear risks must be understood in the context of other forms of energy production (*see Figure 4 on page 3*).

It turns out that nuclear is still one of the safest energy sources—even safer than wind energy! Meanwhile, for every terawatt-hour of electricity

«ROUGHLY 8 MILLION PEOPLE DIE EVERY YEAR FROM AIR POLLUTION FROM COAL-BURNING POWER PLANTS.»

generated by coal, 33 people have died. Given that coal remains one of our main energy sources today, roughly 8 million people die every year from air pollution from coal-burning power plants (*see Figure 4 on page 3 again*).[2]

GREENER ALTERNATIVES?

Readers may say, "Okay, we get it, nuclear didn't kill as many people as we thought. But why not use other renewables that are even *cleaner*?"

Remember, like other "renewables," nuclear power produces no carbon emissions. And nuclear *waste*? All of it could fit on a football field stacked ten yards high.[3] It's also possible that some nuclear reactors could *reuse* fuel![4]

DID YOU KNOW?

FISSION VERSUS FUSION

The nuclear energy we know today relies on a process called fission, in which a neutron (an atom is made of protons, neutrons, and electrons) splits an atom, releasing energy that can be harnessed to heat water and create steam—or, in its earliest applications, an atomic bomb. Fission technology has been used to generate electricity for homes since 1954! Fusion, on the other hand, is when two atoms slam together to form a bigger atom, releasing vast amounts of energy several times greater than that produced by fission. How vast? Well, this is the process that is used by the most significant energy generator we know of—the Sun. Since the Sun has been powering Earth for far longer than just since 1954, and this reaction uses readily available elements like hydrogen, it is often considered a safer and more sustainable form of nuclear energy. In addition, fusion also generates less radioactive material than fission and has an unlimited fuel supply. The problem with fusion is that it can't be easily controlled—yet. In 2022, scientists achieved a net energy gain for the first time—a key research milestone toward discovery.[6]

Contrary to popular belief, solar panels generate various types of toxic waste. Old solar panels often end up in landfills, where heavy metals can leach into groundwater.

Furthermore, the nuclear footprint is *tiny*. "A typical plant requires only about a square mile. In contrast, to produce the same amount of energy, wind requires 260–360 times the amount of land, and solar requires 45–75 times the amount of land."[5] Using fewer resources leaves more land for other purposes, such as building more data centers or establishing recycling facilities.

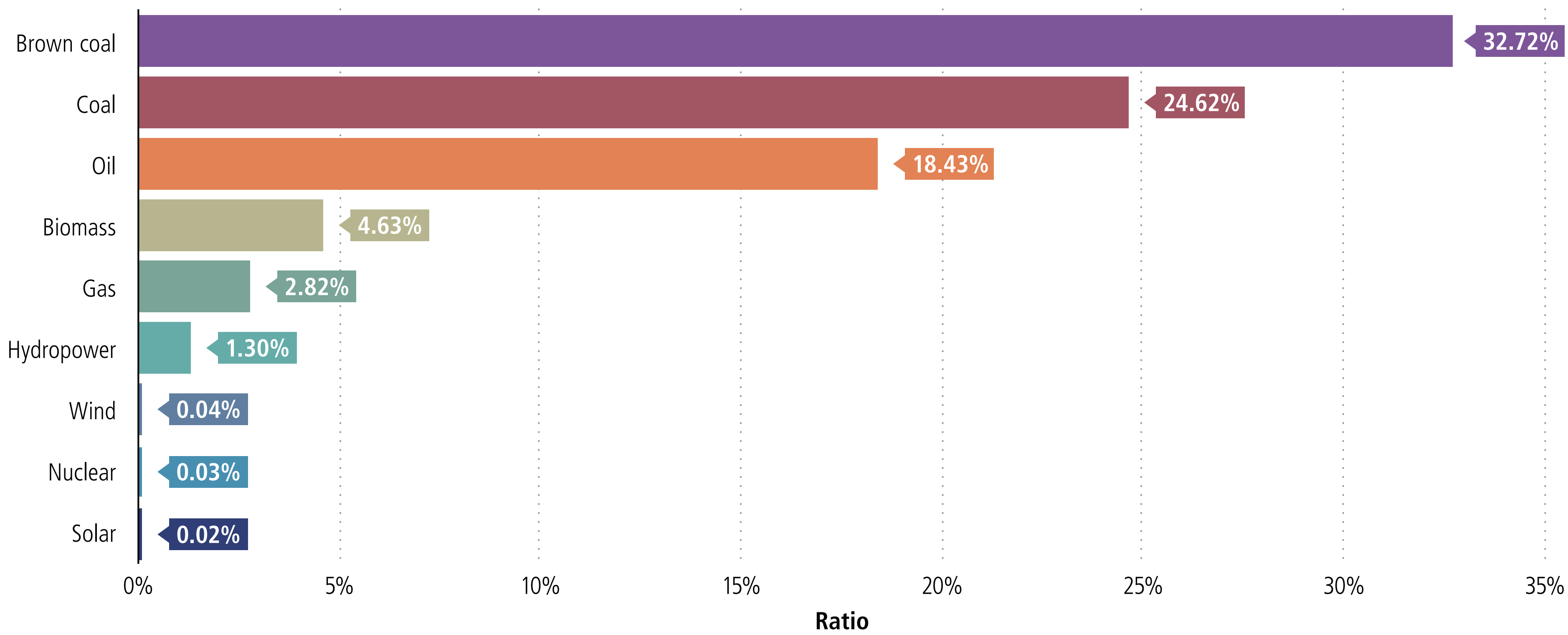
«NUCLEAR PLANTS ACCOUNTED FOR ONLY 8% OF TOTAL U.S. ELECTRICITY CAPACITY IN 2023 BUT SUPPLIED 18% OF TOTAL U.S. ELECTRICITY GENERATION.»

Most importantly, unlike other renewables (or fossil fuels), nuclear energy is by far the most reliable and efficient energy source (*see Figure 5 on page 4*). Nuclear plants accounted for only 8% of total U.S. electricity capacity in 2023 but supplied 18% of total U.S. electricity generation, as they offer the most consistent electricity generation (*see Did You Know? Fission Versus Fusion*)

Other energy sources, on the other hand, are much less reliable, as they are often taken offline for various reasons (*see Figure 5 on page 4 again*). For example, wind and solar energy are much more intermittent because they depend on weather conditions.

In the end, the environmental opposition to nuclear power may have been less about ecological concerns and more about slowing or stopping economic growth. As one environmentalist noted, "More power plants create more industry, which in turn invites greater population density…the state's scenic character will be destroyed."[7]

fig 4. SAFER THAN IT SOUNDS:
NUMBER OF DEATHS PER TERAWATT-HOUR OF ELECTRICITY*



Source: Our World In Data
*Cumulative deaths due to accidents and emissions divided by cumulative amount of electricity generated

PRICEY POWER

Another common criticism of nuclear power is the prohibitively high upfront costs. It's true. Today in the U.S., the levelized cost of nuclear energy is roughly two to five times *more* expensive than that of natural gas power plants, and twice as much for solar and wind energy![8]

«OUT OF THE 135 NUCLEAR REACTOR START-UPS IN THE U.S., ONLY 13 HAVE BEEN ABLE TO OPERATE WITH INITIAL AND SUBSEQUENT LICENSES RENEWED AS OF JULY 2025, WHILE 41 HAVE ALREADY CLOSED.»

Moreover, the construction time for a nuclear power plant is *very* long. According to the 2025 World Nuclear Industry Status Report, the majority of nuclear plant construction takes between five and ten years.[9] Furthermore, the nuclear licensing timeline in the U.S. is time-consuming. As a result, out of the 135 nuclear reactor start-ups in the U.S., only 13 have been able to operate with initial and subsequent licenses renewed as of July 2025, while 41 have already closed due to failed license renewal at both the initial and subsequent stages.[10]

However, we think there's a case for nuclear energy becoming cheaper in the long run.

First, nuclear fuel costs (uranium) per megawatt-hour have already fallen 43.7% from 2012 to 2023.[11] Uranium prices are also much less volatile than oil prices.

Second, regulations have been a huge hindrance to nuclear development. Increased government support can effectively reduce costs. U.S. government funding for nuclear technology declined from 73% of the public energy R&D budget in 1975 to 20% today.[12] Coincidentally, U.S. nuclear plant construction also peaked in the 1970s.

Third, the more we build, the cheaper nuclear power will become. Research has shown that the electricity cost per megawatt for a multiple-unit nuclear power plant can be 30% lower, on average, than for single-unit plants.[13] Building multiple plants in proximity also reduces costs. Emerging technologies, such as small modular reactors, can also reduce upfront costs (*see Did You Know? Nuclear Innovation*).

Fourth, China has already demonstrated that cheaper nuclear energy is attainable. In the last decade, China has built 55 nuclear reactors and nearly tripled its nuclear capacity, driving down construction costs in the process. Today, China's nuclear construction cost per watt is about one-eighth of a similar plant constructed in the U.S.[15]

«TODAY, CHINA'S NUCLEAR CONSTRUCTION COST PER WATT IS ABOUT ONE-EIGHTH OF A SIMILAR PLANT CONSTRUCTED IN THE U.S.»

THE CLOCK IS TICKING

While we've addressed the nuclear critiques above, the current energy regime is far from satisfactory. Today, our energy eggs are all in one not-always-so-friendly basket named "oil," given that "less than fifteen hundred drilling locations account for ninety percent of the world's known oil reserves"![16]

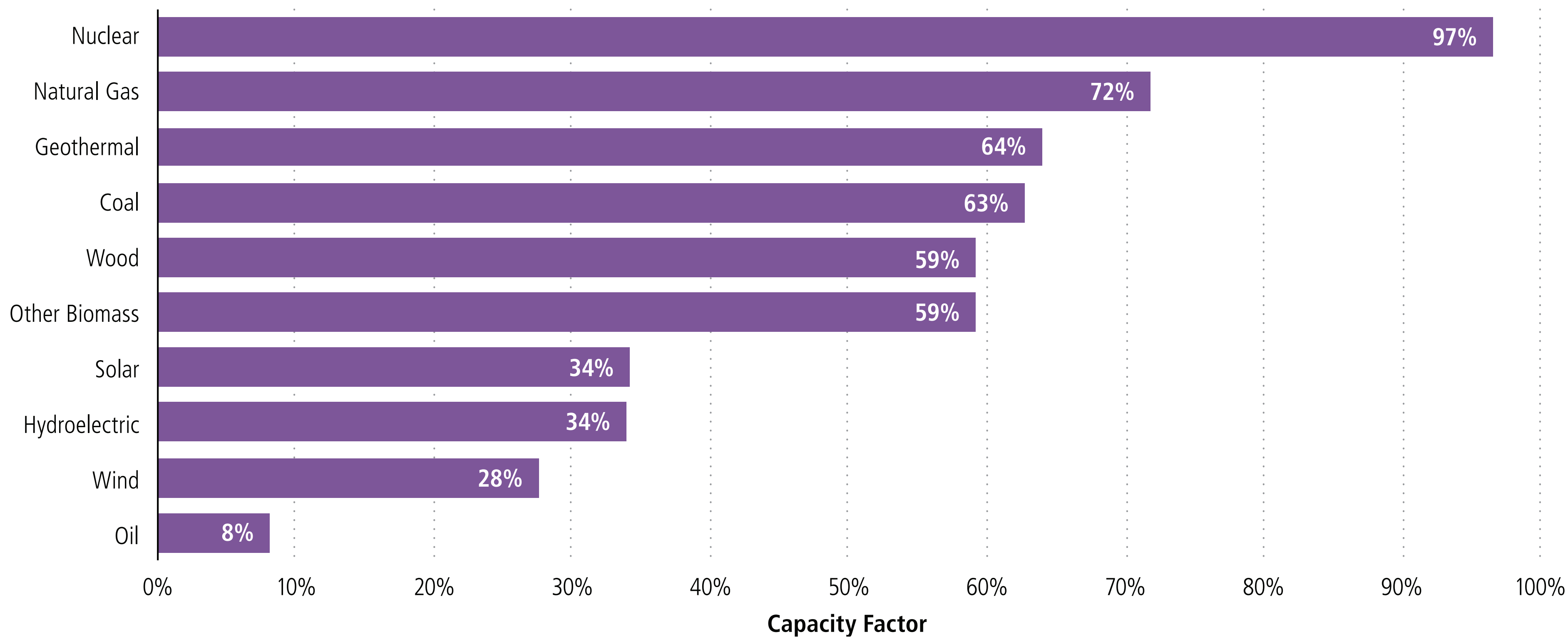
Nuclear power could help trigger a geopolitical reset, enabling countries to reduce their reliance on oil resources that have been a key determinant of geopolitical power in the last century.

DID YOU KNOW?

NUCLEAR INNOVATION

Two publicly traded equities, NuScale and Oklo, have rallied by approximately 127% and about 500%, respectively, this year. Meanwhile, Bill Gates and NVIDIA have raised $650 million for the private company TerraPower. The three companies share a common goal: they are all developing small modular nuclear reactors. Unlike full-sized plants, small modular reactors are designed to be easily sited near data centers. Smaller reactors are also less capital-intensive and require lower upfront investment compared to full-sized plants. NuScale is already approved by U.S. regulators, while Oklo has been approved to build a prototype at the Idaho National Laboratory. Critics claim the technology is untested and too expensive, but that's usually the starting point for any innovation. For now, investors are betting on the future of nuclear technology, and we are rooting for its success as well.[14]

fig 5. 24/7 NUCLEAR SCHEDULE: CAPACITY FACTOR BY ENERGY SOURCE, JULY 2025*



Source: U.S. Department of Energy
*Capacity factor measures a power plant's actual generation compared to the maximum amount it could generate without interruption

And the dream is not as distant as one might suppose. For now, the U.S. remains the country with the highest nuclear capacity, with 94 nuclear reactors, well above the second- and third-place countries, France and China. But the gap is narrowing fast (*see Figure 6*).

However, the U.S. still leads in frontier research on emerging nuclear technologies. Moreover, as capital-intensive as nuclear plants are, the U.S. has the largest and deepest capital market in the world, providing abundant financing opportunities for more nuclear plants, as long as regulations pave the way.

Most importantly, the global race in AI means energy demand in the U.S. and around the world will only accelerate from here—a development that's still underestimated by many, even those who use AI chatbots. Estimates suggest that global

«GLOBAL ENERGY DEMAND MAY INCREASE BY 80% BY 2050, PRIMARILY DUE TO THE ELECTRICITY DEMAND FROM AI, WHICH COULD GENERATE EMISSIONS EQUAL TO DRIVING A FEW ROUND-TRIPS FROM THE EARTH TO THE SUN.»

energy demand may increase by 80% by 2050, primarily due to the electricity demand from AI, which could generate emissions equal to driving a few round-trips from the Earth to the Sun.[17]

And the existing fossil fuel supply may not last us that long (*see Figure 7 on page 5*).[18] Nuclear remains the most abundant energy source in the long run.

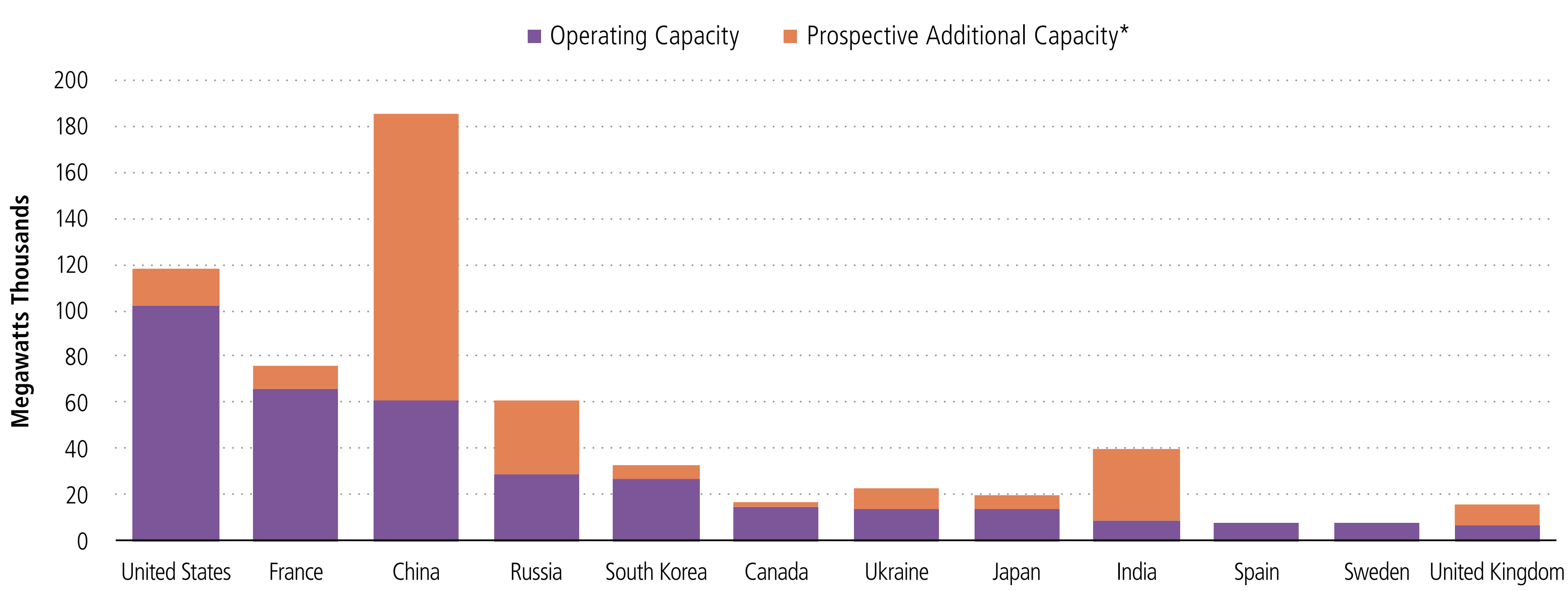
What about solar and wind energy, which are theoretically unlimited? Consider this: *one* standard nuclear plant can generate the same amount of energy as approximately 3.125 million solar panels or 431 utility-scale wind turbines.[19]

The simple math proves the point: nuclear, as the most scalable clean energy source, can not only meet the vast energy demand but also do so with fewer resources and at the lowest environmental cost—truly achieving more with less.

In the end, we suspect the impediments to "going nuclear" are in our heads and hearts, not in reality.

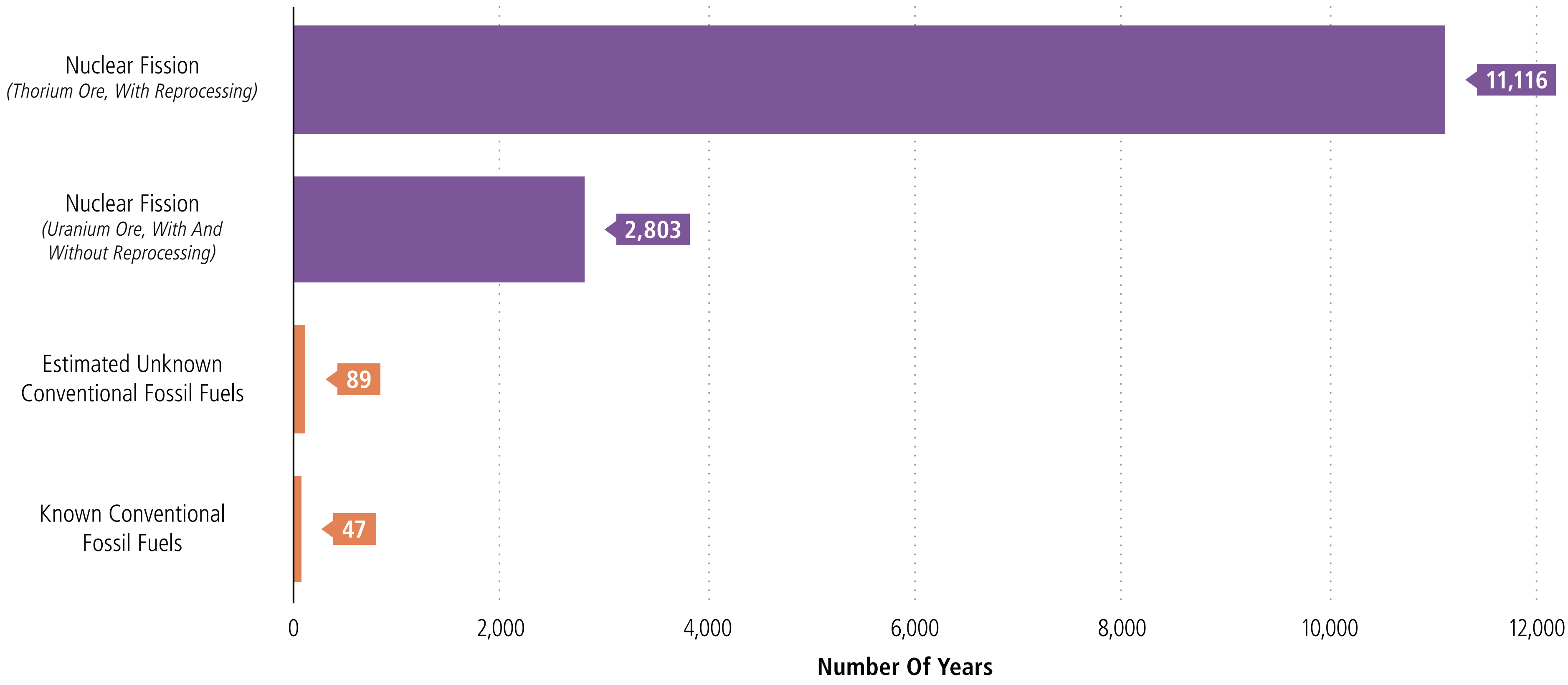
A limitless future awaits.

fig 6. CLOSE COMPETITION: OPERATING AND PROSPECTIVE* NUCLEAR POWER CAPACITY BY COUNTRY



Source: Global Energy Monitor
*Sum of nuclear power under construction, pre-construction, and annouced

fig 7. POWERING THE EARTH:
NUMBER OF YEARS THE EXISTING ENERGY SUPPLY CAN POWER WORLD ENERGY DEMAND*



Sources: Zubrin, R. (2023), Chen, S. (2025)
*Assuming world energy demand increases 80% by 2050 and remains flat thereafter

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