## **Tech Aff --- Fusion, AI**

### **Contention 1 is Fusion**

#### **Nuclear fusion can unlock limitless, safe, clean energy. It’s possible and reaching commercial viability. Unlike current reactors which use fission, fusion reactors are inherently more powerful, safer, and waste free.**

**Davis ’22** [Nicola; December 12; the Guardian's science correspondent and presenter of the Science Weekly podcast. She has a MChem and DPhil in organic chemistry from the University of Oxford; The Guardian, “Breakthrough in nuclear fusion could mean ‘near-limitless energy’” https://www.theguardian.com/environment/2022/dec/12/breakthrough-in-nuclear-fusion-could-mean-near-limitless-energy]

**Researchers** have reportedly made a breakthrough in the quest to unlock a “near-**limitless**, **safe**, **clean**” source of energy: **they** have **got more** energy **out** of a nuclear fusion reaction than they **put in**.

Nuclear fusion involves smashing together light elements such as hydrogen to form heavier elements, releasing a huge burst of energy in the process. The approach, which gives rise to the heat and light of the sun and other stars, has been **hailed** as having **huge potential** as a **sustainable**, **low-carbon** energy source.

However, since nuclear fusion research began in the 1950s, researchers have been unable to a demonstrate a positive energy gain, a condition known as ignition.

That was, it seems, until now.

According to a report in the Financial Times, which has yet to be confirmed by the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory in California that is behind the work, researchers have managed to release 2.5 MJ of energy after using just 2.1 MJ to heat the fuel with lasers.

Dr Robbie Scott, of the Science and Technology Facilities Council’s (STFC) Central Laser Facility (CLF) Plasma Physics Group, who contributed to this research, described the results as a “momentous achievement”.

“Fusion has the potential to provide a near-limitless, safe, clean, source of carbon-free baseload energy,” he said. “This seminal result from the National Ignition Facility is the first laboratory demonstration of fusion ‘energy-gain’ – where more fusion energy is output than input by the laser beams. The scale of the breakthrough for laser fusion research cannot be overstated.

“The experiment **demonstrates unambiguously** that the **physics** of Laser Fusion **works**,” he added. “In order to transform NIF’s result into power production a lot of work remains, but this is a key step along the path.”

Prof Jeremy Chittenden, professor of plasma physics at Imperial College London, agreed. “If what has been reported is true and more energy has been released than was used to produce the plasma, that is a true breakthrough moment which is tremendously exciting,” he said.

“It proves that the long sought-after goal, the ‘**holy grail**’ of fusion, can indeed be **achieved**.”

#### **Investment in development jump starts fusion**

**Merrifield ’23** [Jeffrey S. and Sid Fowler; Former Comissioner of the Nuclear Regulatory Commission, JD in environmental law from Georgetown; Energy Attorney focused on advanced energy and energy transition technologies, former Attorney in the Nuclear Regulatory Commission's (NRC) Honor Law Graduate program; June 16; Journal of Fusion Energy, “Promoting Fusion Development Through Financial Policies: An Examination of How Clean Energy Investment Policies Can Better Incentivize Fusion Investment and Support Development and Deployment of Fusion Technology,” Vol. 42]

Over the past two decades, governments and private sector entities have established a diverse array of policies that have catalyzed massive investments in clean energy technologies. The way in which these policies work is as diverse as the policies themselves, but a common theme is that their effect is to create **financial incentives** that make certain **zero-carbon energy tech**nologies more **attractive** for companies, customers, and investors.Footnote1 These policies have shown **great success** and have encouraged the **significant build-out** of renewables while **helping lower** technology **costs**. Recent efforts by the U.S., Canada, and others to expand these incentives to other clean energy sources, including green hydrogen production and advanced nuclear reactors, is anticipated to **spur** even **greater** clean energy **investment**.

**Fusion** could potentially play a role in helping reach **global net zero** by 2050, and is expected by many to be a source of clean and renewable energy for humanity’s long-term future. The size of this role, though, and the **size of the market** for commercial fusion, have the potential to be **impacted** by **similar policies** to those described above. Energy infrastructure can last for decades, and nations may need to build or restructure their energy grids to accommodate certain energy choices,Footnote2 thus the energy choices made in the coming years could have meaningful long term consequences. All else being equal, **incentivized energy sources** may be better able to **attract capital** or **customers** and be **more widely adopted** than non-incentivized sources. Therefore, clean energy investment policies will likely (and in fact are often intended to) influence what portion of the long-term energy mix is made up of energy technologies favored by such policies and incentives.

Given fusion’s potential as a clean, carbon free energy source, it might be expected that **these policies** would similarly **incentivize investment** in **fusion**. However, clean energy investment policies, as **currently comprised**, are often **not structured** in a manner that provides similar **benefits to fusion**. Some of these policies may require further action to **add fusion** to the list of **specified eligible tech**nologies. Other policies may be technology neutral but have a limited time frame or require that the investment relate to a specific energy-producing facility, making these incentives ill-suited to fusion energy’s current stage of development. While an exhaustive review of clean energy investment policies is beyond the scope of this editorial, several recent prominent examples are described below.

Clean Energy Tax Credits

**Tax credits** are one **frequently deployed** method for **driving investment** in clean energy, and the **U.S**. has **long had** a variety of **tax credits** to **promote adoption** of renewable generation.Footnote3 Recently, these tax credits were expanded and extended by the U.S. Inflation Reduction Act (IRA).Footnote4 The IRA is a major U.S. law that provides approximately $369 billion for energy and climate change investments over a broad network of incentives, much in the form of monetizable tax credits.Footnote5 The U.S. Department of Energy has estimated that the IRA will boost clean energy investment and result in a reduction in U.S. economy-wide greenhouse emissions of 40% below 2005 levels by 2030.Footnote6

The IRA provides four clean energy tax credits of note here: a technology neutral production tax credit (PTC)Footnote7 and investment tax credit (ITC)Footnote8 for new clean energy generating facilities, and a technology specific ITCFootnote9 and PTCFootnote10 for advanced energy manufacturing.

Although fusion could potentially meet the eligibility requirements for the technology neutral clean electricity PTC and ITC, these **programs** are **scheduled to phase out** starting in **2032**. This means that only facilities which start construction during or prior to the **phase-out** date will be **eligible** for **credits**. While some fusion energy developers have suggested their desire to build and operate pilot fusion plants near this date,Footnote11 the **phase out** is likely to **occur too soon** to **meet** the **time horizon** of most commercial-scale fusion energy facilities. Further, both programs **require** that either production or investment relate to a **specific** generating **facility** which enters service, and so would not apply to investment in broader **R&D** or prototype machines.

The **IRA**’s advanced energy manufacturing **ITC** and **PTC** might be **more beneficial** to fusion developers, as such credits could apply to factories for building fusion facility components or to the components themselves. **However**, these credits are **tech**nology **specific** and do **not** currently include **fusion**. The U.S. **Sec**retary of **Treasury** may issue a **determination** allowing other technologies to **qualify** for the **ITC** but has not yet made such a **determination**.Footnote12

#### **No chance of meltdowns.**

**Willis ’21** [Carley and Liou, Joanne; Nuclear engineer with R&D experience in small private industry; “Safety in Fusion”; Published May 2021;<https://www.iaea.org/bulletin/safety-in-fusion>; DOA 04/12/25] manan

The conditions required to start and maintain a **fusion reaction make a fission-type accident or nuclear meltdown based on a chain reaction impossible**. Nuclear fusion power plants will require out-of-this-world conditions — temperatures exceeding 100 million degrees Celsius to achieve high enough particle density for the reaction to take place. **As fusion reactions can only take place under such extreme conditions, a ‘runaway’ chain reaction is impossible**, explained Sehila González de Vicente, Nuclear Fusion Physicist at the IAEA.

Fusion reactions depend on the continuous input of fuel, and the process is highly sensitive to any variation in working conditions. **Given that a fusion reaction could come to a halt within seconds, the process is inherently safe. “Fusion is a self-limiting process: if you cannot control the reaction, the machine switches itself off,” she added.**

Furthermore, **fusion does not produce highly radioactive, long lived nuclear waste. “Fusion produces only low level radioactive waste — more than fission does — but this low level waste does not pose any serious danger**,” said González de Vicente. Contaminated items, such as protective clothing, cleaning supplies and even medical tubes or swabs, are short lived, low level radioactive waste that can be safely handled with basic precautions.

#### **Energy crash causes extinction --- quick fusion solves**

**Freeman 10** (Marsh, Lecturer on Nuclear Physics – New York University, “The True History of The U.S. Fusion Program —And Who Tried To Kill It”, 21st Century Science & Technology, Winter 2009/2010, p. 15-17)

There is no disputing that the world is facing an **energy crisis** of **vast proportions**. But this could have been avoided. For more than five decades, scientists, engineers, energy planners, policy-makers, and, at times, even the public at large, have known what the **ultimate alternative** is to our finite energy resources—nuclear fusion. This energy, which powers the Sun and all of the stars, and can use a **virtually unlimited** supply of isotopes of hydrogen, available from seawater, has been visible on the horizon for years, but seemingly never close at hand. Why?

Legend has it that there are more problems in attaining controlled nuclear fusion than scientists anticipated, and that little progress has been made. “Fusion is still 50 years away, and always has been” has become the common refrain of skeptics. But the reason that we do not have commercially available fusion energy is not what is commonly believed.

In 1976, the Energy Research and Development Administration, or ERDA—the predecessor to the Department of Energy—published a chart showing various policy and funding options for the magnetic fusion energy research program. Each option, called a “Logic,” described how the level of funding for the research would determine when practical fusion power would become available. The most aggressive profile, Logic V, proposed that a budget of approximately $600 million per year would put the fusion program on a path to operate a demonstration reactor by 1990.

At the other end of the scale, Logic 1, set at a level of about $150 million per year, was the option colloquially described as “fusion never,” because the funding never reached the level where the remaining challenges in fusion could be overcome. The U.S. fusion program has been at that fusion- never equivalent level, or below, for the past 30 years. It is a specious argument to claim that there has not been the money available to aggressively pursue fusion research, when one considers the multi-trillion-dollar cost to the U.S. economy of importing oil. In the 1970s, comprehensive studies had already been done, outlining the application of high-density fusion power, not only to produce electricity, but also to create synthetic fuels, such as hydrogen; to create fresh water from the sea, through desalination; to economically create new mineral resources with the fusion torch; to propel spacecraft to Mars and beyond; and myriad other applications. The lack of progress in the U.S. fusion program is **entirely** a result of a lack of political will, a lack of vision, and the promotion of false and destructive economic and energy policies, which have now left us behind the rest of the world in developing practical fusion energy.

One might think that if the **U**nited **S**tates doesn’t push ahead for fusion development, other nations will, leaving the **U**nited **S**tates in the lurch. In reality, the situation is **far worse**. At the **present rate** of **world physical economic collapse**, the ability to sustain the Earth’s 6.7 billion population is **already nearly lost**. A crash program to develop the required physical infrastructure in agriculture, mining, water resource development, housing, health care, and, most of all, power production, must start now. Nuclear power now and fusion power **within a generation** is an **absolute requirement**. Without it, **human civilization** goes the other way—into a **Dark Age**, and the descent has already begun. We must reverse it now.

#### **Decarbonization’s impossible with current energy sources---it’s try-or-die for fusion.**

**Smil ’22** [Vaclav; Distinguished Professor Emeritus at the University of Manitoba, Ph.D. in geography from the College of Earth and Mineral Sciences of Pennsylvania State University, and the author of over forty books on topics including energy, environmental and population change, food production and nutrition, technical innovation, risk assessment, and public policy; How the World Really Works: The Science Behind How We Got Here and Where We're Going, “Understanding Energy: Fuels and Electricity,” Ch. 1]

Notice the key qualifying adjective: the target is not total decarbonization but “**net zero**” or carbon neutrality. This definition allows for continued emissions to be compensated by (as yet **non-existent**!) large-scale **removal** of **CO2** from the atmosphere and its permanent storage underground, or by such temporary measures as the mass-scale planting of trees. [71] By 2020, setting net-zero goals for years ending in five or zero has become a me-too game: more than 100 nations have joined the lineup, ranging from Norway in 2030 and Finland in 2035 to the entire European Union, as well as Canada, Japan, and South Africa, in 2050, and China (the world’s largest consumer of fossil fuels) in 2060.[72] Given the fact that annual CO2 emissions from fossil fuel combustion surpassed 37 billion tons in 2019, the net-zero goal by 2050 will call for an energy transition unprecedented in both pace and scale. A **closer look** at its key components **reveals** the **magnitude** of the **challenges**.

Decarbonization of electricity generation can make the fastest progress, because installation costs per unit of solar or wind capacity can now compete with the least expensive fossil-fueled choices, and some countries have already transformed their generation to a considerable degree. Among large economies, Germany is the most notable example: since the year 2000, it has boosted its wind and solar capacity 10-fold and raised the share of renewables (wind, solar, and hydro) from 11 percent to 40 percent of total generation. Intermittency of wind and solar electricity poses no problems as long as these new renewables supply relatively small shares of the total demand, or as long as any shortfalls can be made up by imports.

As a result, many countries now produce up to 15 percent of all electricity from intermittent sources without any major adjustments, and Denmark shows how a relatively small and well-interconnected market can go far higher. [73] In 2019, 45 percent of its electricity came from wind generation, and this exceptionally high share can be sustained without any massive domestic reserve capacities, because any shortfalls can be readily made up by imports from Sweden (hydro and nuclear electricity) and Germany (electricity coming from many sources). Germany could not do the same: its demand is more than 20 times the Danish total, and the country must maintain a sufficient reserve capacity that could be activated when new renewables are dormant. [74] In 2019, Germany generated 577 terawatt-hours of electricity, less than 5 percent more than in 2000—but its installed generating capacity expanded by about 73 percent (from 121 to about 209 gigawatts). The reason for this discrepancy is obvious.

In 2020, two decades after the beginning of Energiewende, its deliberately accelerated energy transition, Germany still had to keep most of its fossilfired capacity (89 percent of it, actually) in order to meet demand on cloudy and calm days. After all, in gloomy Germany, **photovoltaic generation** works on **average only 11**–12 **percent** of **time**, and the combustion of fossil fuels still produced nearly half (48 percent) of all electricity in 2020. Moreover, as its share of wind generation has increased, its construction of new highvoltage lines to transmit this electricity from the windy north to the southern regions of high demand has fallen behind. And in the US, where much larger transmission projects would be needed to move wind electricity from the Great Plains and solar electricity from the Southwest to high-demand coastal areas, hardly any long-standing plans to build these links have been realized. [75]

As challenging as such **arrangements** are, they rely on **technically mature** (and **still improving**) **solutions**—that is, on **more efficient PV** cells, **large onshore** and **offshore wind turbines**, and **high-voltage** (including **long-distance** direct current) **transmission**. If **costs**, **permitting** processes, and **not**-**in**-my-**backyard sentiments** were no **obstacles**, these techniques could be deployed fairly rapidly and economically. Moreover, the problems of intermittency of solar and wind generation could be resolved by renewed reliance on nuclear electricity generation. A nuclear renaissance would be particularly helpful if we cannot develop better ways of large-scale electricity storage soon.

We need very **large** (multi-gigawatt-hour) **storage** for big cities and megacities, but so far the **only viable** option to serve them is pumped hydro storage (PHS): it uses cheaper nighttime electricity to pump water from a low-lying reservoir to high-lying storage, and its discharge provides instantly available generation. [76] With renewably generated electricity, the pumping could be done whenever surplus solar or wind capacity is available, but obviously **PHS** can **work only** in places with **suitable elevation differences** and the **operation consumes** about a **quarter** of **generated electricity** for the uphill pumping of water. **Other** energy storages, such as **batteries**, **compressed air**, and **supercapacitors**, still have **capacities orders** of **magnitude lower** than needed by large cities, even for a single day’s worth of storage. [77]

In contrast, modern nuclear reactors, if properly built and carefully run, offer safe, long-lasting, and highly reliable ways of electricity generation; as already noted, they are able to operate more than 90 percent of the time, and their lifespan can exceed 40 years. Still, the future of nuclear generation remains uncertain. Only China, India, and South Korea are committed to further expansion of their capacities. In the West, the combination of **high capital costs**, major **construction delays**, and the **availability** of **less expensive choices** (natural gas in the US, wind and solar in Europe) has made new **fission** capacities **unattractive**. Moreover, America’s new **s**mall, **m**odular, and inherently safe **r**eactors (first proposed during the 1980s) have **yet** to be **commercialized**, and Germany, with its decision to abandon all nuclear generation by 2022, is only the most obvious example of Europe’s widely shared, deep anti-nuclear sentiment (for the assessment of real nuclear generation risks, see chapter 5).

But this may not last: even the European Union now recognizes that it could not come close to its extraordinarily ambitious decarbonization target without nuclear reactors. Its 2050 net-zero emissions scenarios set aside the decades-long stagnation and neglect of the nuclear industry, and envisage up to 20 percent of all energy consumption coming from nuclear fission. [78] Notice that this refers to total primary energy consumption, not just to electricity. Electricity is only 18 percent of total final global energy consumption, and the **decarbonization** of more than **80 percent** of **final energy uses**—by industries, households, commerce, and transportation—will be **even more challenging** than the decarbonization of **electricity gen**eration. Expanded electricity generation can be used for space heating and by many industrial processes now relying on fossil fuels, but the course of decarbonizing **modern long-distance** transportation remains **unclear**.

#### **Otherwise, climate unsustainability causes extinction.**

**Sears ’21** [Nathan; April 2021; Ph.D. Candidate in Political Science at the University of Toronto, former Professor of International Relations at the Universidad de Las Americas, Trudeau Fellow in Peace, Conflict, and Justice at the Munk School of Global Affairs; Conference Paper for the International Studies Association, “Great Powers, Polarity, and Existential Threats to Humanity: An Analysis of the Distribution of the Forces of Total Destruction in International Security,” p. 1-38]

Climate Change

Humanity faces **existential** risks from the **large-scale destruction** of Earth’s natural environment making the planet less hospitable for humankind (Wallace-Wells 2019). The decline of some of Earth’s natural systems may already exceed the “planetary boundaries” that represent a “safe operating space for humanity” (Rockstrom et al. 2009). Humanity has become one of the driving forces behind Earth’s climate system (Crutzen 2002). The major anthropogenic drivers of climate change are the burning of fossil fuels (e.g., coal, oil, and gas), combined with the degradation of Earth’s natural systems for absorbing carbon dioxide, such as deforestation for agriculture (e.g., livestock and monocultures) and resource extraction (e.g., mining and oil), and the warming of the oceans (Kump et al. 2003). While humanity has influenced Earth’s climate since at least the Industrial Revolution, the dramatic increase in greenhouse gas emissions since the mid-twentieth century—the “Great Acceleration” (Steffen et al. 2007; 2015; McNeill & Engelke 2016)— is responsible for contemporary climate change, which has reached approximately 1°C above preindustrial levels (IPCC 2018).

Climate change could **be**come an **ex**istential **threat** to humanity if the planet’s climate reaches a “**Hothouse Earth**” state (Ripple et al. 2020). What are the dangers? There are two mechanisms of climate change that threaten humankind. The direct threat is extreme heat. While human societies possesses **some** capacity for **adaptation** and resilience to climate change, the physiological response of humans to heat stress imposes **physical limits**—with a hard limit at roughly 35°C wet-bulb temperature (Sherwood et al. 2010). A rise in global average temperatures by 3–4°C would increase the risk of heat stress, while 7°C could render some regions uninhabitable, and 11–**12**°C would leave much of the planet **too hot** for human **habitation** (Sherwood et al. 2010). The **indirect** effects of climate change could include, inter alia, rising **sea levels** affecting coastal regions (e.g., Miami and Shanghai), or even swallowing entire countries (e.g., Bangladesh and the Maldives); extreme and unpredictable **weather** and **natural disasters** (e.g., hurricanes and forest fires); environmental pressures on **water** and **food scarcity** (e.g., droughts from less-dispersed rainfall, and lower wheat-yields at higher temperatures); the possible inception of new bacteria and **viruses**; and, of course, large-scale **human migration** (World Bank 2012; Wallace-Well 2019; Richards, Lupton & Allywood 2001). While it is difficult to determine the existential implications of extreme environmental conditions, there are historic **precedents** for the **collapse of human societies** under environmental pressures (Diamond 2005). Earth’s “big five” mass extinction events have been **linked to** dramatic shifts in Earth’s **climate** (Ward 2008; Payne & Clapham 2012; Kolbert 2014; Brannen 2017), and a Hothouse Earth climate would represent terra incognita for humanity.

Thus, the assumption here is that a Hothouse Earth climate could pose an existential threat to the habitability of the planet for humanity (Steffen et al. 2018., 5). At what point could climate change cross the threshold of an existential threat to humankind? The complexity of Earth’s natural systems makes it extremely difficult to give a precise figure (Rockstrom et al. 2009; ). However, much of the concern about climate change is over the danger of crossing “**tipping points**,” whereby **positive feedback loops** in Earth’s climate system could lead to potentially **irreversible** and **self-reinforcing** “**runaway**” climate change. For example, the melting of Arctic “permafrost” could produce additional warming, as glacial retreat reduces the refractory effect of the ice and releases huge quantities of methane currently trapped beneath it. A recent study suggests that a “planetary **threshold**” could exist at global average temperature of **2°**C above preindustrial levels (Steffen et al. 2018; also IPCC 2018). Therefore, the analysis here takes the 2°C rise in global average temperatures as representing the lower-boundary of an existential threat to humanity, with higher temperatures increasing the risk of runaway climate change leading to a Hothouse Earth.

The Paris Agreement on Climate Change set the goal of limiting the increase in global average temperatures to “well below” 2°C and to pursue efforts to limit the increase to 1.5°C. If the Paris Agreement goals are **met**, then nations would likely keep climate change **below the threshold** of an **existential** threat to humanity. According to Climate Action Tracker (2020), however, current policies of states are expected to produce global average temperatures of 2.9°C above preindustrial levels by 2100 (range between +2.1 and +3.9°C), while if states succeed in meeting their pledges and targets, global average temperatures are still projected to increase by 2.6°C (range between +2.1 and +3.3°C). Thus, while the Paris Agreements sets a goal that would reduce the existential risk of climate change, the actual policies of states could easily cross the threshold that would constitute an existential threat to humanity (CAT 2020).

### **Contention 2 is AI**

#### **Computing power is central to US’s victory in the AI Race.**

**Kahl ’25** [Colin H; He is co-director of the Center for International Security and Cooperation, the inaugural Steven C. Házy Senior Fellow at the Freeman Spogli Institute for International Studies, and a Professor in the Department of Political Science at Stanford University, and was also a Strategic Consultant to the Penn Biden Center for Diplomacy and Global Engagement; “**America Is Winning the Race for Global AI Primacy—for Now**”; https://www.foreignaffairs.com/united-states/america-winning-race-global-ai-primacy-now; Published 1/17/25; Accessed 2/21/25] mnn

The **Trump administration is well positioned to take advantage of the AI policies put in place by the Biden administration to ensure that the United States and its democratic allies win the global AI competition. But doing so will require more than just doubling down on** the United States’ technological edge. It will also necessitate partnering with the private sector to up the country’s AI offering, both at the frontier and in “good enough” AI, to **outcompete China** around the world. The Trump administration can either choose to lead in shaping the rapidly emerging AI future—or watch as this brave new world is built by Beijing.

TIPPING THE SCALES

**Leading AI labs such as Anthropic, Google DeepMind, and OpenAI partner with U.S. hyperscalers Amazon Web Services (AWS), Google Cloud, and Microsoft Azure to provide the computational resources (or “compute”) needed to train and run frontier AI** models, while Meta and xAI combine proprietary data centers with external cloud services. These data centers rely heavily on advanced semiconductors, particularly graphics processing units, known as GPUs. U.S. companies Nvidia and AMD originally designed and developed GPUs to render video game graphics, but AI labs found that they excel in performing the massive number of simultaneous calculations needed to train deep learning models. Amazon and Google have designed their own specialized chips in an effort to make AI workloads even more efficient.

**Progress in frontier AI has relied heavily on scaling compute and data. U.S. companies are banking on this trend continuing. Last year, Elon Musk’s xAI constructed its Colossus data center**, with 100,000 Nvidia H100 GPUs to train the company’s Grok models, in Memphis, Tennessee, and has raised $5 billion to increase the center’s cluster of GPUs tenfold. Other leading U.S. AI labs and hyperscalers are planning similarly massive data centers.

Emerging frontier models have challenged the maxim, common among AI technologists, that inference—using trained models to respond to queries, make predictions, and generate outputs based on new, unseen data—is less compute-intensive than training. **Frontier AI models have come to rely on “test-time” compute, in which a model dedicates more resources during inference to engage in chain-of-thought “reasoning” and improve performance on complex tasks. The proliferation of models with larger context windows (the amount of text a model holds in its memory) and a rapidly growing user base are further driving escalating demands for compute.**

Because compute is central to frontier AI, Washington has focused on restricting China’s access to advanced AI chips and chipmaking equipment. The Trump administration devised this “denial” strategy in 2018 and 2019, when the United States successfully pressured the Netherlands to block China’s acquisition of extreme ultraviolet lithography equipment, exceedingly complex machines critical in the creation of advanced semiconductors, made by the Dutch company ASML. Starting in October 2022, the Department of Commerce’s Bureau of Industry and Security (BIS) intensified these controls, initially restricting the sale of top GPUs, such as Nvidia’s A100 and H100 chips, along with other AI accelerators, to China. To extend the territorial reach of U.S. controls, the Biden administration also imposed a foreign direct product rule covering foreign-made items derived from U.S. semiconductor technology. A year later, the administration expanded the measures to cover advanced GPUs that had been only slightly modified to satisfy previous restrictions and, in December 2024, it added high-bandwidth memory chips, older immersion deep ultraviolet (DUV) lithography machines, and other critical chipmaking software and tools. Implementing these controls has required significant and sometimes contentious negotiations with U.S. allies, especially the Netherlands; Japan, home to equipment makers Tokyo Electron and Nikon; South Korea, home to semiconductor producers Samsung and SK Hynix; and Taiwan, home to the world-leading chipmaker Taiwan Semiconductor Manufacturing Company (TSMC).

Progress in frontier AI has relied heavily on scaling compute and data.

These restrictions have undeniably slowed China’s access to advanced chips and hindered its ability to produce substitutes. SMIC, China’s most prominent chipmaker, has used existing DUV machines to manufacture some advanced chip nodes for smartphones. It also reportedly produced Huawei’s Ascend 910 AI chips, which Huawei asserts match the performance of Nvidia’s widely used A100s. But domestically manufacturing such chips with older DUV machines is expensive, reduces yield, and undermines reliability. Moreover, Huawei’s supposedly SMIC-produced Ascend 910B chip sets actually contained chips produced by TSMC, which TSMC had unknowingly sold to a Huawei front, casting doubt on SMIC’s true capabilities. In November, BIS directed TSMC to end all sales of its most advanced AI chips to China and has since blacklisted Sophgo, the Huawei cutout.

Meanwhile, U.S. chip designers are pulling further ahead. Nvidia’s leading, TSMC-manufactured H100s and H200s and new Blackwell chips are substantially faster than China’s best. Experts generally assess China to be at least five years behind leading-edge chip producers, with export controls slowing Beijing’s catch-up effort.

**Nevertheless, the computing power gap has not stopped Chinese tech giants such as Alibaba and Tencent, and startups such as 01.AI, DeepSeek, Moonshot AI, and Zhipu AI, from releasing high-performing generative AI** models. Chinese firms have capitalized on data centers equipped with Nvidia chips before the United States’ imposition of export controls, used downgraded chips not covered by U.S. controls, and optimized software to maximize less capable hardware. Crucially, many successful Chinese AI models rely on open-source models already released by U.S. labs or use outputs from U.S. models for training.

Despite these achievements, **U.S. AI labs likely remain one or two years ahead at the frontier, especially since many not-yet-released models are closed-source and therefore harder for Chinese companies to emulate. And as long as scaling state-of-the-art computing power remains** vital for frontier AI progress, U.S. companies will expand their lead. As DeepSeek’s CEO Liang Wenfeng has acknowledged, China’s difficulties competing with U.S. AI firms boil down to Washington’s “bans on shipments of advanced chips.”

#### **Investing in the AI-Nuclear nexus is the only way to stay ahead of China.**

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The **U.S. is lagging behind in the industrial race, losing ground to China** in batteries, EVs, solar, wind, and critical minerals processing. Yet in **a**rtificial **i**ntelligence—perhaps the most transformative technology of our time—**America still ranks number one globally. Maintaining this lead, however, hinges on a critical factor: powering the massive data centers that drive AI development**.

While Europeans have pretty much admitted defeat with respect to innovations, as evidenced by the Draghi report and manifested in a recent industry exodus from the E.U. powerhouse, Germany, there's still a lot of fight left on the other side of the Atlantic. **The alliance between tech entrepreneurs and the energy industry could secure both economic prosperity and environmental sustainability—if executed strategically.**

Maintaining the **U.S. leadership position in AI requires clean firm power. This is where nuclear energy comes to play**. In fact, 2024 marks a monumental shift for nuclear —the start of a long-awaited renaissance. Three developments stand out: the commitment of 14 major banks to finance nuclear projects, the tech sector's initiative to reopen retired nuclear power plants, and the signing of the ADVANCE Act, which modified the Nuclear Regulatory Commission's mission.

This renaissance comes at a critical time, as our electric grid faces unprecedented transformation with a sustained 3% growth through 2035. Beyond load growth, we are also decarbonizing and retiring old generating capacity. While data centers will drive the most dramatic expansion—growing from single digits to 22% of consumption—other sectors will also see significant increases, with transportation accounting for 46% of electricity use, buildings 16%, and industry 15%. Meeting this surging demand—particularly from energy-intensive data centers—requires power sources that can **deliver both scale and reliability.**

**Nuclear power plants and new supercomputers are a perfect match. Operating Nvidia's AI chips may demand as much as 1 GW of power – exactly what a typical AP1000 nuclear reactor provides. While data centers could theoretically run on solar and wind, intermittency poses a fundamental challenge**. Ensuring sufficient renewable electricity would require overbuilding grid infrastructure by at least a factor of 4, perhaps higher, paired with utility-scale battery storage. During electricity shortfalls, residential customers – not data centers – would face potential blackouts. With 80% of global internet traffic flowing through servers in Northern Virginia, even brief disruptions would create billions in economic damage.

The **obvious alternative—natural gas power plants—faces its own insurmountable barrier**. Many tech companies have committed to sustainability goals, promising to match their loads both temporally and geographically – meaning they must use clean power at the exact time it is consumed and from the same region as their data centers. Running datacenters on natural gas long-term is not feasible due to the tech sectors' climate commitments, since carbon capture and storage remains too costly.

**Nuclear power emerges as the only scalable solution to meet these demands. Currently, the United States leads in installed nuclear capacity with 94 working reactors and nearly 100 GW of capacity. This needs to triple by 2050 to meet growing demand – hence the Department of Energy's plan for 200 GW of new nuclear capacity. However, China is positioned to take the lead soon, as the U.S. has largely stopped building new plants**. After 1996, only three new reactors were commissioned: Watts Bar 2 in TN (2015), Units 3 and 4 in Plant Vogtle in GA (2023-2024).

How can the U.S. deliver on its plans to build multiple nuclear plants per year until 2050? The nuclear industry has a saying: France has two kinds of nuclear reactors and a hundred kinds of cheese, while the U.S. has two kinds of cheese but about a hundred kinds of reactors. Building a string of first-of-a-kind nuclear reactors has eroded industrial expertise and inflated costs. While Georgia's Vogtle plant unit 3 faced initial delays and cost overruns, the next reactor proved significantly more economical – demonstrating clear learning-by-doing benefits. But focusing just on construction costs misses the bigger picture. Recent research suggests that current **LCOE calculations may be biasing policy decisions against nuclear power, as they do not account for systems costs**, capacity factors, and reliability benefits. The real economic story becomes clear when examining fully depreciated nuclear plants, which can produce electricity at remarkably competitive rates around $31 per MWh.

#### **Specifically, nuclear is the only solution for growing power demand from data centers.**

**Skidmore ’24** [Zachary; He is a senior Reporter - Energy and Sustainability, DatacenterDynamics; “DOE: Nuclear energy needs to triple by 2050, AI and data centers drive demand”; Published 10/7/24; Accessed 2/22/25; https://www.datacenterdynamics.com/en/news/doe-report-highlights-need-to-triple-nuclear-capacity-by-2050-due-to-ai-and-data-center-load-growth/] mnn

The US needs three times its current nuclear energy capacity to meet AI's growing power needs, a new report has warned.

The US Department of Energy (DOE) has published an updated version of its Pathways to Commercial Liftoff Advanced Nuclear report, warning that AI and data center load growth will require tripling nuclear capacity by 2050; from 100GW to 300GW.

The report highlights a significant **rise in electricity demand over the past year, following decades of stagnation. This surge, primarily driven by AI and data centers, has intensified interest in nuclear energy** due to its ability to provide 24/7 carbon-free power within a compact footprint.

The report highlights the increasing value of clean firm resources by companies with clean energy targets and high-reliability requirements.

For example, **Google’s projections for meeting decarbonization targets for its global data centers found that clean firm technologies (including advanced nuclear) would reduce costs by 40 percent** compared to only wind and solar with lithium-ion storage.

Additionally, the report argues that rather than replacing renewables, nuclear energy can act as a complementary technology with more variable renewable assets, especially in sectors such as the data center sector, where much of the demand is disproportionate for 24/7 electricity. This is made more apparent by the fact that when nuclear capacity has been retired, it has not been fully replaced with wind and solar, it has largely been replaced with natural gas.

**The report emphasizes that securing 5-10 deployments of a single reactor design of at least 1,000MW is crucial for commercial success**. Building multiple reactors of the same design is expected to lower construction costs through repetition and learning. The DOE suggests that value and cost control improve when large reactors are built in "fleet mode."

The **major barrier to nuclear development is cost overrun, and the report highlights several measures to overcome this issue. These include sharing costs across multiple units under construction, public/private partnerships on funding**, and ensuring on-budget delivery through improved cost estimating and implementing best project management practices.

Small Modular Reactors (SMRs) are seen as key players in filling the load gap for certain applications. The report contends that SMRs could be the right fit for certain applications, such as replacing retiring coal plants or smaller-scale data centers. However, to justify investment in manufacturing facilities, microreactor designers may require a committed order book of 30-50 reactors.

The DOE recently said there are 190 coal and ex-nuclear sites that could be powered up for new nuclear capacity, potentially offering up to 269GW.

**Data center operators have increasingly begun to target nuclear power as a means to acquire clean consistent power for their operations.**

#### **It’s the linchpin of conclusively winning the AI race.**

**Kimball ’25** [Spencer; He is an energy reporter for CNBC; “Google says U.S. is facing a power capacity crisis in AI race against China”; Published 2/12/25; Accessed 2/23/25; <https://www.cnbc.com/2025/02/12/google-says-us-faces-power-capacity-crisis-in-ai-race-against-china.html>] mnn

The **U.S. is facing a power capacity crisis as the tech sector invests in data centers to support** artificial intelligence, said Caroline Golin, an energy executive at Alphabet’s Google unit.

Golin said Google turned to nuclear power after realizing utilities were investing in natural gas to back up renewables.

Google announced an agreement last October to purchase power from small nuclear reactors made by Kairos Power.

**The U.S. is facing a power capacity crisis as the tech sector races against China to achieve dominance in artificial intelligence, an executive leading the energy strategy of Alphabet’s Google unit said this week**.

The emergence of China’s DeepSeek artificial intelligence firm sent the shares of major power companies tumbling in late January on speculation that its AI model is cheaper and more efficient. But Caroline Golin, Google’s global head of energy market development, said more power is needed now to keep up with Beijing.

“We are in a capacity crisis in this country right now, and we are in an AI race against China right now,” Golin told a conference hosted by the Nuclear Energy Institute in New York City on Tuesday.

Alphabet’s Google unit embarked four years ago on an ambitious goal to power its operations around the clock with carbon-free renewable energy, but the company faced a major obstacle that forced a turn toward nuclear power.

Google ran into a “very stark reality that we didn’t have enough capacity on the system to power our data centers in the short term and then potentially in the long term,” Golin said.

Google realized the deployment of renewables was potentially causing grid instability, and utilities were investing in carbon-emitting natural gas to back up the system, the executive said. Wind and particularly solar power have grown rapidly in the U.S., but their output depends on weather conditions.

“We learned the importance of the developing clean firm technologies,” Golin said. **“We recognized that nuclear was going to be part of the portfolio.”**

#### **China cares zero about AI risks – if they take the lead on development, it magnifies every single reason AI could be dangerous and they’ll smother any risky developments or accidents which means no checks**

**Drexel and Kelley 23** – \*Associate Fellow at the Center for a New American Security (CNAS), where he researches artificial intelligence, technology competition, and national security, MA at Tsinghua, MA at Cambridge, \*\*Research Assistant at CNAS, where she studies U.S. technology strategy and international technology cooperation, MA in International Policy at the School of Public and International Affairs, University of Georgia [Bill, Hannah, Foreign Affairs, “China Is Flirting With AI Catastrophe,” May 30, 2023, <https://www.foreignaffairs.com/china/china-flirting-ai-catastrophe>]

China, by contrast, ranks as the most optimistic country in the world when it comes to AI, with nearly four out of five Chinese nationals professing faith in its benefits over its risks. Whereas the United States government and Silicon Valley are many years into a backlash against a “move fast and break things” mentality, China’s tech companies and government still pride themselves on embracing that ethos. Chinese technology leaders are enthusiastic about their government’s **willingness to live with AI risks** that, in the words of veteran AI expert and Chinese technology executive Kai-Fu Lee, would “scare away risk-sensitive American politicians.”

DISASTER AMNESIA

The disparity between Chinese and American perceptions of the hazards of AI—and their respective tech sectors’ willingness to take risks—is no accident. It is a result of Chinese policies that systematically suppress citizens’ experience of disasters to protect the government from public criticism.

In the United States, disasters tend to prompt an elevated public consciousness and enhanced safety measures as their heart-rending consequences ripple through the media and society—in machinery-intensive industries such as oil drilling, everyday food and drug production, and the processing of dangerous chemicals. Even now, legislators in Ohio are making progress on new safety regulations in the wake of a fiery train derailment in February that shot a plume of toxic chemicals above the town of East Palestine.

But in China, these types of accidents rarely reverberate through the media as the state maintains a chokehold on information to promote a constant atmosphere of stability. The Chinese Communist Party smothers information when disaster responses are mismanaged and routinely falsifies death tolls. The government sometimes refuses to acknowledge, let alone report on, vast tragedies such as the mass radiation poisoning that resulted from at least 40 nuclear tests conducted between 1964 and 1996, which led to the premature deaths of nearly 200,000 citizens.

The result is a culture of disaster amnesia in which it is often impossible for the public to demand change or for the government to be forced to learn from costly accidents. Little accountability for mistakes means that business owners tend to play fast and loose with safety, as evidenced by China’s grisly history of industrial accidents. Even the rare instances in which mishaps are publicly exposed lack the staying power that might result in serious reform. For example, the public outcry about mass-produced toxic toothpaste in 2007, poisoned infant milk formula in 2008, and the collision of high-speed trains near Wenzhou in 2011 prompted well-publicized displays of scapegoating and loudly proclaimed government reform plans but had limited impacts on public safety. The Chinese government often projects a facade of responsiveness but then buries information about the events, quite literally in the case of the now-underground remains of the Wenzhou train wreckage. Given that China has a far more restrictive media ecosystem under Xi Jinping than it did when these incidents occurred, public exposure is even less likely today.

With the worst run-ins with emerging technologies routinely excised from public consciousness, Chinese society exhibits a seemingly boundless sense of techno-optimism, especially toward new technologies such as AI. Given that China’s historic ascent from poverty went hand in hand with high-speed technological advancement, accelerated scientific research is practically synonymous with national progress in the Chinese zeitgeist—viewed as having few, if any, downsides.

To see this full-steam-ahead approach in action, look no further than He Jiankui, the Chinese scientist who shocked the world in 2018 by genetically modifying human embryos in secret to produce the world's first gene-edited babies. The doctor expected, and initially received, high praise in China for his feat, but the government clumsily pulled an about-face in response to international outrage over his unilateral decision to push humanity into uncharted territory. Unsurprisingly, further examination showed that He irreversibly botched his experiment, in what one geneticist called "a graphic demonstration of attempted gene editing gone awry.” He not only likely failed to make the modified babies (and their potential offspring) HIV-resistant as intended, but also potentially increased their susceptibility to influenza, cancer, and other diseases. After a stint in prison, He was released and continues his research, alongside new Chinese legislation providing loopholes for similar ethically fraught and potentially lucrative genetic experimentation.

UNBRIDLED AMBITION

Not only are experimental technologies seen as largely risk-free in China, but the country has also committed itself to a feverish sprint to become “the world’s premier artificial intelligence innovation center” by 2030.

China’s efforts to overtake the United States in AI have been a priority for the Communist Party since at least 2015, when Xi announced his “Made in China 2025” strategy. This emphasis on AI has since been reiterated in various national documents and speeches. AI has become a linchpin of China’s **military modernization** strategy and is increasingly **integral to** the country’s system of state **surveillance,** **repression**, and **control.** With so much at stake, it is no surprise that China’s government has been investing tens of billions of dollars annually into its AI sector and leveraging its vast espionage network to try to steal foreign corporate technology secrets.

#### **China AI lead causes a laundry list of existential risks.**

**Kroenig ’21** [Matthew; Winter; professor of government and foreign service at Georgetown University and the director of the Scowcroft Strategy Initiative at the Atlantic Council; Strategic Studies Quarterly, “Will Emerging Technology Cause Nuclear War?: Bringing Geopolitics Back In,” Vol. 15, Issue 4] recut manan

How will states use such a newfound advantage? Technology rarely fundamentally changes the nature or objectives of states. More often, states use technology to advance **preexisting geopolitical aims**. Moreover, enhanced power can result in greater ambition. Given the geopolitical landscape described, it is likely the United States and its Allies and partners at the core [end page 66] of the international system will behave differently with new military technologies than will revisionist powers, such as Russia and China.

The spread of new technology to the United States and its Allies and partners would likely serve, on balance, to **reinforce the existing sources of stability** in the prevailing international system. At the end of the Cold War, the United States and its Allies and partners achieved a technological- military advantage over its great power rivals, with the US using its unipolar position to deepen and expand a rules-based system. They also employed their military dominance to counter perceived threats from rogue states and terrorist networks. The United States, its Allies, and partners did not, however, engage in military aggression against great power, nuclear-armed rivals or their allies.

In the future, these status quo powers are apt to use military advantages to reinforce their position in the international system and to deter attacks against Allies and partners in Europe and the Indo-Pacific. These states might also employ military power to deal with threats posed by **terrorist networks** or by regional revisionist powers such as **Iran** and **North Korea**. But it is extremely difficult to imagine scenarios in which Washington or its Allies or partners would use newfound military advantages provided by emerging technology to conduct an armed attack against Russia or China.

Similarly, **Moscow** and **Beijing** would likely use any newfound military strength to advance their preexisting **geopolitical aims**. Given their very different positions in the international system, however, these states are likely to employ new military technologies in ways that are **destabilizing**. These states have made clear their dissatisfaction with the existing international system and their desire to revise it. Both countries have ongoing border disputes with multiple neighboring countries.

If Moscow **developed** new military technologies and operational concepts that shifted the **balance of power** in its favor, it would likely use this advantage to pursue **revisionist aims**. If Moscow acquired a **newfound ability** to more **easily invade** and **occupy territory** in Eastern Europe, for example (or if Putin believed Russia had such a capability), it is more likely Russia would be tempted to engage in **aggression**.

Likewise, if China acquired an **enhanced ability** through new technology to **invade** and **occupy Taiwan** or contested islands in the **E**ast or **S**outh **C**hina **S**eas, Beijing’s leaders might also find this opportunity **tempting**. If new technology enhances either power’s anti-access, area-denial network, then its leaders may be more confident in their ability to achieve a **fait accompli** attack against a **neighbor** and then **block** a **US-led liberation**.

These are **precisely** the types of **shifts in the balance of power that can lead to war**. As mentioned previously, the predominant **scholarly theory** on the causes of war—**the bargaining model**—maintains that imperfect information on the **balance of power** and the **balance of resolve** and credible commitment problems result in **international conflict**.52 New technology can exacerbate these causal mechanisms by increasing **uncertainty** about, or causing rapid **shifts** in, the balance of power. Indeed as noted above, new military technology and the **development** of new **operational concepts** have shifted the balance of power and resulted in **military conflict** throughout history.

Some may argue emerging military technology is more likely to result in a new tech arms race than in conflict. This is possible. But Moscow and Beijing may come to believe (**correctly or not**) that new technology provides them a **usable** military **advantage** over the **U**nited **S**tates and its **Allies** and partners. In so doing, they may underestimate Washington.

If **Moscow** or **Beijing** attacked a vulnerable **US Ally** or **partner** in their near abroad, therefore, there would be a risk of major war with the potential for **nuclear escalation**. The United States has formal treaty commitments with several frontline states as well as an ambiguous defense obligation to Taiwan. If Russia or China were to attack these states, it is likely, or at least possible, that the United States would come to the defense of the victims. While many question the wisdom or credibility of America’s global commitments, it would be difficult for the United States to **simply back down**. Abandoning a treaty ally could cause fears that America’s global commitments would unravel. Any US president, therefore, would feel great pressure to come to an Ally’s defense and expel Russian or Chinese forces.

Once the United States and **Russia** or **China** are at war, there would be a risk of **nuclear escalation**. As noted previously, experts assess the greatest risk of nuclear war today does not come from a bolt-out-of-the-blue strike but from nuclear escalation in a **regional**, **conventional** conflict.53 Russian leaders may believe it is in their interest to use nuclear weapons early in a conflict with the United States and NATO.54 Russia possesses a large and diverse arsenal, including thousands of nonstrategic nuclear weapons, to support this nuclear strategy.

In the 2018 Nuclear Posture Review, Washington indicates it could retaliate against any Russian nuclear “de-escalation” strikes with limited nuclear strikes of its own using low-yield nuclear weapons.55 The purpose of US strategy is to deter Russian strikes. If **deterrence fails**, however, there is a clear pathway to nuclear war between the United States and Russia. As Henry Kissinger pointed out decades ago, there is **no guarantee** that, once begun, a **limited** nuclear war **stays limited**.56

There are similar risks of nuclear escalation in the event of a **US-China conflict**. China has traditionally possessed a relaxed nuclear posture with a small “lean and effective” deterrent and a formal “no first use” policy. But China is relying more on its **strategic forces**. It is projected to double—if not triple or **quadruple**—the size of its **nuclear arsenal** in the coming decade.57

Chinese experts have acknowledged there is a narrow range of contingencies in which China might use nuclear weapons first.58 As in the case of Russia, the US Nuclear Posture Review recognizes the possibility of limited Chinese nuclear attacks and also holds out the potential of a limited US reprisal with low-yield nuclear weapons as a deterrent.59 If the nuclear threshold is breached in a conflict between the United States and China, **the risk of nuclear exchange is real**.

In short, if a coming revolution in military affairs provides a real or perceived battlefield advantage for Russia or China, such a development raises the likelihood of **armed aggression against US regional allies**, **major power war**, and **an increased risk of nuclear escalation**.

Implications

Future scholarship should incorporate geopolitical conditions and the related foreign policy goals of the states in question when theorizing the effects of technology on international politics. Often scholars attempt to conceptualize the effects of weapons systems in isolation from the political context in which they are embedded.

Studies treat technology as disembodied from geopolitics and as exerting independent effects on the international system. But technology does not float freely. Technology is a tool different actors can use in different ways. Bakers and arsonists employ fire in their crafts to strikingly different ends. In the current international environment, Russia and China would tend to employ technology toward advancing revisionist aims. Technological advances in these countries are therefore much more likely to **disrupt the prevailing international order** and **nuclear strategic stability**.

This approach also suggests the potential threat new technology poses to nuclear strategic stability is **more pervasive** than previously understood. To undermine strategic stability, new technology need **not** directly impact strategic capabilities. Rather, **any** technology that promises to shift the local balance of power in Eastern Europe or the Indo-Pacific has the potential to **threaten nuclear strategic stability**.

This understanding of this issue leads to different policy prescriptions. If the technology itself is the problem, then it must be controlled and should not be allowed to spread to any states. In contrast, the framework outlined here suggests a different recommendation: preserve the prevailing balance of power in Europe and Asia. Technological change that, on balance, **reinforces** the prevailing international system should **strengthen** stability.

Leading democracies, therefore, should **increase investments in emerging tech**nology **to maintain a tech**nological **edge** over their adversaries. Export control and nonproliferation measures should be designed to deny emerging military technology to Russia and China. Arms control should be negotiated with the primary objective of sustaining the current international distribution of power. Making progress in these areas will be difficult. But the consequences of failure could be **shifts in the international balance of power**, **conflict among great powers**, and **an increased risk of nuclear war**.