C1: Heg

Cohen 24 (Dr. Ariel Cohen, Ph.D. is a Senior Fellow at the Atlantic Council and the Founding Principal of International Market Analysis, a Washington, D.C.-based global risk advisory boutique. He is also Managing Director of the Energy, Growth, and Security Program (EGS) and a Senior Fellow with the International Tax and Investment Center (ITIC). 7 June 2024, "China And Russia Now Dominate The Global Nuclear Trade" Forbes, https://www.forbes.com/sites/arielcohen/2024/06/07/china-and-russia-now-dominate-the-global-nuclear-trade/, DOA: 3/5/25) LLO

Russia is not alone in surpassing the US. **China is also far ahead of the US in the nuclear energy industry. China's nuclear power industry has retained its domestic focus, with twenty-three power plants under construction in China as of July 2023.** This is due to increasing energy demand, as China continues to develop its economy. The United States is constructing a single nuclear power plant. **While China has refined its nuclear power production process, the last plant built in the US arrived 7 years late and 17 billion dollars over budget, as a testament to America's byzantine permitting and environmental review system. China has built upon this expertise also to begin supplying reactors abroad. The China National Nuclear Corporation and China General Nuclear Power Group have developed a third-generation reactor called Hualong One.** This new reactor began operations in 2021 in Fuqing**. In 2023, China began construction on the Chashma-5 nuclear power plant in Pakistan, which will use Hualong One reactors. Such actions contribute to China's capacity to construct infrastructure abroad and expand its influence.** The American nuclear power industry was once the world's envy, peaking with 112 operational reactors in 1990, with America on a path to carbon neutrality much earlier than current predictions. **34 years later, the United States has lost nearly a third of its operational nuclear reactors, has built almost no new ones, and its average reactor age is decades old. If nothing is done to rectify this, in the next 10-15 years, scores of nuclear reactors will have to be retired as their operational lifecycles end, and as a result, America will have to contend with nearly 20% of its electricity capacity evaporating.**

And China is expanding abroad. Kim 23

Lami Kim, 4-24-2023, "Nuclear Belt and Road and U.S.-South Korea Nuclear Cooperation", No Publication, https://www.csis.org/analysis/nuclear-belt-and-road-and-us-south-korea-nuclear-cooperation

Nuclear exports are an important component of the Belt and Road Initiative, Xi Jinping's signature infrastructure and development project abroad. Chinese nuclear industry officials have said that China could build as many as 30 nuclear reactors abroad worth $145.5 billion by 2030. China has already built four nuclear reactors and is currently building two more in Pakistan. It has also entered the United Kingdom's nuclear market by financing a third of the

French construction of the United Kingdom's new nuclear reactors. China has also recently signed a contract to build a Hualong One nuclear reactor in Argentina, and is currently in negotiations with Saudi Arabia and Kazakhstan, among many others.

Russia is as well.

Cohen 24 (Dr. Ariel Cohen, Ph.D. is a Senior Fellow at the Atlantic Council and the Founding Principal of International Market Analysis, a Washington, D.C.-based global risk advisory boutique. He is also Managing Director of the Energy, Growth, and Security Program (EGS) and a Senior Fellow with the International Tax and Investment Center (ITIC). 7 June 2024, "China And Russia Now Dominate The Global Nuclear Trade" Forbes, https://www.forbes.com/sites/arielcohen/2024/06/07/china-and-russia-now-dominate-the-global-nuclear-trade/, DOA: 3/5/25) LLO

Through Rosatom, Russia remains the global leader in nuclear reactor construction. According to the World Nuclear Strategy Report, **as of July 2023, Russia had twenty-four. Nuclear reactors under construction in seven countries: China, India, Turkey, Egypt, Bangladesh, Iran, and Slovakia. For comparison, the US was constructing zero. Russia dominates the nuclear industry in more areas than just reactors. They also have the largest uranium conversion and enrichment industries in the world, at 38% and 46% of international capacity**, respectively, in 2020. **This makes it a major fuel exporter as well. Russia exported over $1 billion worth of nuclear energy-related products from February 2022-2024. Two of the countries in which Russia is constructing nuclear power plants, Turkey and Slovakia, are NATO members.** They are not alone amongst the collective West in enabling Russia's nuclear dominance while ostensibly being committed to containing the Kremlin. As my colleague Wesley A. Hill wrote, Russian-enabled geopolitical turmoil in Africa, which Russia is using to try to acquire formerly French uranium assets, helped force Europe to double its import of Russian uranium in 2023. The US was no better, remaining dependent on Russian nuclear exports even after the war in Ukraine restarted in 2022. The US imported Russian nuclear fuel until May 14th, 2024, over two years after Russia's invasion of Ukraine began, from the same entities that the White House sanctioned.

And, America is losing influence

Policy Circle 24 (Policy Circle is a digital platform that offers in-depth coverage of public policy issues in governance, environment, and society. It was launched in 2020 by a group of policy experts who share a vision of promoting evidence-based policymaking and constructive policy dialogue. It also organises summits, roundtables, and online discussions to bring together policymakers, researchers, corporate executives, professionals, and other stakeholders to deliberate on policy issues. December 27, 2024 "End of American hegemony: Can the superpower reinvent power for the 21st century" Policy Circle, https://www.policycircle.org/world/end-of-american-hegemony/, DOA: 3/28/25) LLO

In 2010, a historian predicted that the American hegemony might end by 2025 — not with a bang but with a whimper — as domestic divisions deepened and rival powers rose to challenge its authority. Today, that prediction appears prophetic as America faces increasing pressures from within and outside. Even as the US retains

military dominance and an economy capable of immense influence, **the structural underpinnings of its global power are eroding. This decline, though not necessarily terminal, signals a transition away from the so-called American Century. Historically, the US leveraged its unmatched economic strength, technological innovation, and cultural influence to dominate the post-World War II global order. However, the foundations of the American hegemony are crumbling. The US share of global GDP has steadily declined,** falling from 50% in the mid-20th century to approximately 15% today when adjusted for purchasing power parity. **The globalisation, initially championed by the US, has redistributed industrial power, with China emerging as a key beneficiary. China's rise has reoriented global economic networks, particularly in the Global South.** In contrast to America's interventionist foreign policy, **China has cultivated influence through infrastructure investments, soft power campaigns**, and state-sponsored media. The United States, while still a major player, has failed to present an alternative vision that resonates with developing nations, where perceptions of Chinese leadership are increasingly favourable.

Domestic production is critical to hegemony

Price et al 24 (Christel Hiltibran, Director of International Policy, Climate and Energy Program, Rowen Price, Policy Advisor for Nuclear Energy, Ryan Norman, Senior Policy Advisor for Clean Energy Finance, Climate and Energy Program, Alan Ahn, Deputy Director for Nuclear, 31 January 2025, "Trump Has Been a China Hawk on Nuclear Energy. But Congress Could Compromise That During Reconciliation.", Third Way, https://www.thirdway.org/memo/trump-has-been-a-china-hawk-on-nuclear-energy-but-congress-could-compromise-that-during-reconciliation#:~:text=A%20strong%20US%20nuclear%20energy,valuable%20hundred%2Dyear%20geopolitical%20relationships., DOA 3/1/2025) ESR

President **Trump has long considered himself a China hawk,** stoking a trade war with the country, supporting ever-increasing tariffs on its goods, and using aggressive rhetoric to combat its growing global influence. **But his approach has a blind spot, failing to mitigate China's increasing dominance in the energy sector, especially in nuclear energy development and deployment**. Until we confront China's rising role in global energy markets, **the US will continue to cede market share and lose geopolitical influence, threatening national security both in the US and among our allied nations**. The US needs a synchronized foreign policy to counter Chinese attacks on American hegemony. But since the election, **the incoming administration and Congress have signaled misaligned approaches to foreign energy policy**. The Trump Administration's Day 1 executive orders reaffirmed the President's commitment to domestic energy production—now it's up to Congress to ensure legislation is going to support energy goals. Nuclear Energy Must Be a Foreign Policy Priority Beyond bilateral trade barriers, the US must also dominate critical global industries to remain competitive. **There is broad consensus that investments in national defense, space, artificial intelligence, and quantum computing will help make America more secure and more prosperous. The same is true of investments in nuclear energy. A robust domestic nuclear supply chain has corollary benefits, including reliable energy supply, that are foundational to our defense and technology sectors**. Moreover, **the strength of our nuclear industry directly supports our competitiveness abroad, which in turn affects our ability to uphold the highest global norms in nuclear security and nonproliferation. Failure to compete overseas will enable China, Russia, and other rivals to erode our influence on these international standards and cement century-long geostrategic partnerships around the world. Putting the US at the forefront of global civil nuclear markets will make us stronger,**

more secure, and more influential on the global stage. Our adversaries understand the stakes. **China and Russia have state-owned, heavily subsidized nuclear industries that are a key part of their efforts to gain allies and influence throughout the developing world.** China and Russia view nuclear exports as a way to develop century long partnerships **in Africa, Asia, and** Eastern **Europe.** Their interest in advanced nuclear power is less about economics, and more about influence. The competition is well underway and the United States is losing. According to the International Atomic Energy Agency, **85% of all new reactors currently under construction in 2024 are Russian or PRC designs; 0% are US designs.** This year, President Trump and the new Republican Congress have an opportunity to do just that—through budget reconciliation. Trump Could Cede Critical Geopolitical "Energy Dominance" to China in His First 100 Days by Compromising America's Nuclear Industry—But It's Not Too Late Put simply, **if we want to outcompete China, Congress needs to continue to prioritize clean energy.** The incoming Trump administration has made no secret of its hostility to the Inflation Reduction Act (IRA) and its clean energy provisions, especially its investments in wind and solar. But despite recent bipartisan alignment in support of nuclear energy, **Trump's agenda not only targets renewables but may also incidentally deal a significant blow to programs supporting nuclear development and demonstration in the US.** During the 117th Congress, **IRA and the Bipartisan Infrastructure Law (BIL) created tax credits, grants, and loan programs to finance the research, development, demonstration, and even the deployment of emerging clean energy technologies**, including nuclear. In a flurry of signals issued during the lame-duck period, the incoming administration and Republican Congressional leadership have made clear **that many of these programs are on the chopping block in the first 100 days of the second Trump administration**. In competition with state-backed civil nuclear programs such as China**, the US needs to bolster its federal government funding for nuclear, not decrease it. China is churning out large reactors at home, demonstrating** (i.e., building and operating) **advanced reactor technologies, and marketing advanced reactors cheaply along its "Belt and Road."** To stay relevant in this race for international market share, **the US must rapidly finance the demonstration and subsequent commercialization of US nuclear small modular reactors** (SMRs) **and advanced nuclear reactors. The time is now, in the 2025 reconciliation process, to save this critical sector from opening its global market to China.** Why? **The decisions the US government makes this year will dictate whether US nuclear developers have the resources they need to keep pace and ground test these technologies. In the interest of national security and to ensure US competitiveness, Congress must robustly appropriate funding for advanced nuclear demonstrations and maintain federal programs critical to the scale-up of these technologies**. The following programs are all essential to preserve or expand during budget reconciliation.

Affirming enables exports

Bowen et al 20 (Matt Bowen is a research scholar at the Center on Global Energy Policy at Columbia University School of International Public Affairs and a senior fellow at the Atlantic Council Global Energy Center. Jackie (Kempfer) Siebens is a senior policy adviser for the energy and climate program at Third Way and a senior fellow at the Atlantic Council Global Energy Center. Jennifer T. Gordon is the managing editor and senior fellow for nuclear energy at the Atlantic Council Global Energy Center. 10/7/20, "Strengthening cooperation with allies could help the United States lead in exporting carbon-free nuclear energy", The Atlantic Council, https://www.atlanticcouncil.org/blogs/energysource/strengthening-cooperation-with-allies-could-help-the-united-states-lead-in-exporting-carbon-free-nuclear-energy/ //. DOA: 3/3/25)JDE

First, **the federal government should establish a more comprehensive and coordinated interagency system focused on the development and deployment of civilian nuclear technologies**, which would **support**

bringing advanced nuclear power to the global market. This would involve establishing a collaborative network of nuclear-specific staff positions embedded in the collection of government agencies that **play a meaningful role in safely and securely developing**, deploying, and exporting US energy **technologies**. Similar to the "Team USA" whole-of-government approach first initiated under the Obama Administration, a network of nuclear-specific staff positions could be located across different US agencies including: the Department of Energy, Department of State, Nuclear Regulatory Commission (NRC), White House Office of Science and Technology Policy, National Security Council (NSC), Department of Commerce, and any future Climate Office. While the Obama Administration created an NSC role to coordinate interagency nuclear policy, and the DOE report released earlier this year, Restoring America's Competitive Nuclear Advantage, recommended reinstating that role, there is currently no high-level mechanism for interagency coordination on US nuclear exports. And, **since it is difficult to export a product that lacks a domestic market, continued policy support for constructing advanced reactors here in the United States is imperative.**

Exports secure positive global relationships

Graham 19 (Thomas Graham is a retired diplomat who helped negotiate every international arms control and nonproliferation agreement from 1970 to 1977, co-chair of the Nuclear Energy and National Security Coalition, 5/29/19, "National security stakes of US nuclear energy" The Hill, https://thehill.com/opinion/national-security/445550-national-security-stakes-of-us-nuclear-energy/, DOA: 3/4/25) ST

We have dedicated our careers to controlling the destructive potential of nuclear weapons. But since the Atoms for Peace era, **U.S. leadership in supplying peaceful nuclear energy technology, equipment, and fuel to the world has been important for world development and therefore critical for the United States to establish and enforce standards for nuclear safety, security and nonproliferation**. But in recent decades, the U.S. share of international commercial nuclear energy markets has diminished, and so with it has the United States' ability to influence global standards in peaceful nuclear energy. The critical moment for U.S. leadership in nuclear energy is when a country is developing nuclear energy for the first time. **The supplier country and the developing country typically forge a relationship that endures for the 80- to 100-year** life of the nuclear program. Unlike a coal or gas plant**, nuclear reactors need specialized fuel and maintenance. Once established, the bilateral commercial relationship is not easily dislodged by a rival nation, providing the supplier profound and lasting influence on the partner's nuclear policies and practices. Russia and China have identified nuclear energy as a strategic export, to be leveraged for geopolitical influence as well as for economic gain.** According to a recent analysis, **Russia is the supplier of more nuclear technology than the next four largest suppliers combined, and China is quickly emerging as a rival. If the United States fails to compete in commercial markets, it will cede leadership to these countries on nuclear safety, security and nonproliferation, as well as foreign policy influence.** As the competition intensifies to deliver **the next generation of nuclear power technologies**, U.S. nuclear leadership is approaching a watershed opportunity. Simpler, scalable, and less expensive, small and advanced reactors **are commercially attractive to an expanded range of markets** — particularly in Africa, Asia and the Middle East. The United States has the world's best training and development programs, unmatched regulatory experience, and multiple small and advanced reactor designs; we should be the easy choice for the next generation of nuclear technology. But early U.S. engagement in these important geopolitical regions is critical. Without it, **Russia and China will lock up future nuclear markets through MOUs and other bilateral agreements.** And for addressing the national security risks of climate change, nuclear energy is not just an option but a necessity. Developing nations that are planning to meet power and water needs for large and growing populations must have reliable, demonstrated, zero-emission nuclear power in order to meet global climate goals as well. Advanced reactors are integral to these goals. In the United States, nuclear energy is responsible for a fifth of the United States' total electricity and more than 55 percent of our emissions-free energy, but the pace of domestic construction of new

natural gas plants far exceeds the few nuclear plants under development, and the existing fleet is retiring prematurely at an alarming rate. Which brings us back to the domestic nuclear industry**. U.S. global competitiveness and leadership are inextricably linked to a strong domestic nuclear program. Without a healthy domestic fleet of plants, the U.S. supply chain will weaken against international rivals. Russia has brought six new plants online in the past five years and has six more plants currently under construction. In the same period, China has brought 28 new plants online and has 11 others under construction. These domestic projects provide Russia and China with a robust supply chain, an experienced workforce, and economies of scale that make them more competitive in bidding on international projects. Unless we continue to innovate and build new plants, we will cease to be relevant elsewhere.** Even our own domestic energy security is supported by nuclear power. The nuclear plants operating today are the most robust elements of U.S. critical infrastructure, offering a level of protection against natural and adversarial threats that is unmatched by other plants. Because the nation's grid supplies power to 99 percent of U.S. military installations, large scale disruptions affect the nation's ability to defend itself. **We can regain U.S. leadership in nuclear energy. The key steps are to maintain the domestic reactor fleet, with its reservoir of know-how, and to assist American entrepreneurs in developing the next generation of the technology**.

US hegemony deters multiple revisionists

Ignatieff 24 (Michael Ignatieff is Professor of History at Central European University and the author of On Consolation: Finding Solace in Dark Times (Metropolitan Books, 2021)., , "The Threat to American Hegemony is Real," 3-15-2024, https://www.project-syndicate.org/commentary/us-western-hegemony-vulnerable-to-russian-chinese-coordinated-challenge-by-michael-ignatieff-2024-03, // accessed 10-29-2024)ops

The post-1945 world order – written into international law, ratified by the United Nations, and kept in place by the balance of nuclear terror among major powers – **is hanging by a thread**. The United States is divided against itself and stretched to the limits of its capabilities. Europe is waking up to the possibility that, come November, America may no longer fulfill its collective-defense obligations under Article 5 of the NATO treaty. Faced with this new uncertainty, Europe is cranking up its defense production, and European politicians are screwing up the courage to persuade their electorates that they will need to ante up 2% of their GDP to guarantee their own safety. **The Western alliance** doesn't just face the challenge of doubling down on defense while maintaining unity across the Atlantic. It also now **faces an "axis of resistance" that might be tempted to threaten Western hegemony with a simultaneous, coordinated challenge**. The lynchpin of this axis is the Russia-China "no-limits" partnership. While the Chinese supply the Russians with advanced circuitry for their weapons systems, Russian President Vladimir Putin ships them cheap oil. **Together they have imposed autocratic rule over most of Eurasia**. If **Ukraine's exhausted defenders are forced to concede Russian sovereignty over Crimea and the Donbas region, the Eurasian axis of dictators will have succeeded in changing a European land frontier by force**. **Achieving this will threaten every state on the edge of Eurasia: Taiwan, the Baltic countries, and even Poland**. Both **dictatorial regimes will use their vetoes on the UN Security Council to ratify conquest, effectively consigning the UN Charter to history's dustbin**. **This partnership of dictators works in tandem with a cluster of rights-abusing renegades**, led by Iran and North Korea. The **North Koreans provide Putin with artillery shells while plotting to invade the rest of their peninsula.** The Iranians manufacture the drones that terrorize Ukrainians in their trenches. Meanwhile, **Iran's proxies – Hamas, Hezbollah, and the Houthis – are helping Russia and China by tying down America and Israel**. Unless the US can force Israel into a long-term ceasefire, **it**

will find itself struggling to control conflicts on three fronts (Asia, Europe, and the Middle East). Not even a country that outspends its rivals on defense by two to one can maintain a war footing simultaneously across so many theaters. The idea that democracies around the world will join up with America and Europe against the authoritarian threat seems like an illusion. **Instead of joining with the embattled democracies of the Global North, the rising democracies of the Global South – Brazil, India, and South Africa – seem unembarrassed to be aligning with regimes that rely on mass repression**, the cantonment of entire populations (the Uighurs in China), and shameless murder (Navalny being only the most recent example). To be sure, **the authoritarian axis currently is united only by what it opposes: American power**. It is otherwise divided by its ultimate interests. The Chinese, for example, cannot be overjoyed that the Houthis are blocking freight traffic through the Red Sea. The world's second most powerful economy doesn't have all that much in common with an impoverished Muslim resistance army or with theocratic Iran. Moreover, **both Russia and China remain parasitic beneficiaries of a global economy that is sustained by US alliances and deterrence**. That is why they still hesitate to challenge the hegemon too directly. However, like sharks, they smell blood in the water. **They have not only survived US sanctions but continued to prosper, replacing their dependence on embargoed markets with new markets in Latin America, Asia, and India**. Both Russia and China have discovered that American control of the global economy is not what it once was. **This discovery of American weakness might tempt them to risk a joint military challenge**. As matters stand, **US diplomacy and deterrence have successfully kept the axis divided**. CIA Director William Burns and National Security Adviser Jake Sullivan are keeping the channels open to China. Blowback American strikes against Iran have apparently convinced the theocrats to rein in Hezbollah and the militias in Iraq – though not the Houthis, whom nobody seems able to control. It doesn't take strategic genius to see the opportunity China and Russia might be contemplating. **If they decided to mount an overt challenge to the American order** – for example, with a coordinated, **simultaneous offensive against Ukraine and Taiwan – the US would struggle to rush weapons and technology into the breach**. **Nuclear weapons would not** necessarily **deter China and Russia from risking a coordinated attempt to take Taiwan and the rest of Ukraine**. All parties would pay a horrendous price, but **Russia has shown what it is willing to expend in Ukraine, and both China and Russia may believe that there will never be a more opportune moment to overthrow American hegemony. If they were to combine forces, we would face the most serious challenge to the global economic and strategic order since 1945**. Nobody has any idea what the world would be like on the other side of such a confrontation. We cannot even assume, as we have always done, that America would prevail if faced with a simultaneous challenge from two formidable powers. If a pessimist is someone who imagines the worst in order to forestall it, we should all be pessimists. **Keeping the authoritarian axis from becoming a full-fledged alliance should be America's first-order priority**.

Great power war would be detrimental

Clare 21 (Stephen Clare: Research Fellow at the Forethought Foundation for Global Priorities Research Fellow, November 2021, "Great Power Conflict," https://dkqj4hmn5mktp.cloudfront.net/Great_Power_Conflict_report_Founders_Pledge_e4124df2ac.pdf , Founders Pledge .//. DOA: 12/11/24) TZL

This report explores issues at the intersection of international relations, conflict studies, and longtermism.l In it, we draw extensively on the mainstream international relations literature but focus specifically on understanding the potential effects of war on the long-term future. Taking **a lng-term view focuses our attention on the risk a Great Power war poses to humanity's future potential. Extinction, an unrecoverable collapse of civilization, or a permanent end to humanity's growth** and progress **would** all **destroy the long-term potential of our species**. We call events that could lead to one of **these** scenarios **existential risks** .2 Such an event, if it occurred, would be unprecedented in human history. It **would cause unimaginable suffering for everyone alive today and extinguish any possibility for trillions of our would-be descendants to live happy lives**. **Some** of these global catastrophic risks, like an asteroid impact, **are direct**

risks. By contrast, Great Power conflict is a risk factor: it is **connected to multiple other risks**, and **raising or lowering the amount of conflict affects the seriousness of** the **threats** we face **in** these **other areas**. In section 4 of this report we consider several concrete pathways through which **Great Power conflict poses a global catastrophic risk**. We will sort these pathways into three broad categories. First, we consider ways in which Great Power conflict poses a risk **even without a full-blown war breaking out**. For example, **a new Cold War could hasten the development of dangerous technologies or cause a breakdown in cooperation that precludes international agreements to mitigate other existential risks**. Second, **a Great Power war could itself be a global catastrophic risk**. In an all-out war between Great Power nations, **weapons with the potential to kill everyone on earth or irreparably damage civilization could be used**. Or, **in the aftermath** of a major war, **the victorious side could** emerge as a global hegemon that is able to **use advanced technologies to lock in** its **sub-optimal values**. 3 Third, **a Great Power war could weaken humanity and leave us more vulnerable to subsequent disasters**, like a serious pandemic.

C2: AI

China is using nuclear power to get the AI edge. Rio Times 24

Rio Times, 12-17-2024, "Nuclear Power: The Unsung Engine Driving China's Bold A.I. Ambitions", The Rio Times, https://www.riotimesonline.com/nuclear-power-the-unsung-engine-driving-chinas-bold-a-i-ambitions/ // Lunde

Notably, China began operating the world's first fourth-generation nuclear power plant, the 200 MW Shidaowan-1 in Shandong province, in December 2023. It's a strategic move, aligning these powerhouses with emerging tech clusters to ensure AI development never lacks for energy. The United States, once the undisputed leader in both nuclear technology and AI research, now finds itself in a precarious position. It still had 93 reactors at commercial power plants as of August 2023, totaling about 94.7 million kW in 2022, but new large-scale expansions face regulatory hurdles and high costs. This slowdown could jeopardize its AI edge. Chips of Power: The Role of Semiconductors in the Battle for Global Dominance Europe faces its own challenges, with France struggling to modernize aging reactors and Germany's decision to abandon nuclear power potentially undermining its ability to feed large-scale AI systems all together. India and Japan, despite clear technical capabilities, remain constrained by slow expansions and public caution. This isn't just about bragging rights. The ability to train massive AI models, run complex simulations, and power vast data centers could determine which nations lead in fields from healthcare to finance to national security. Without reliable baseload power, future AI giants may find themselves held back.

Data centers are booming but shortages are restricting growth

Patel 25 (Sonal Patel, POWER senior editor, 3-3-2025, "The SMR Gamble: Betting on Nuclear to Fuel the Data Center Boom", POWER Magazine, https://www.powermag.com/the-smr-gamble-betting-on-nuclear-to-fuel-the-data-center-boom/, DOA: 3/7/2024)ET

That has dramatically raised the stakes, igniting a desperate frenzy across both the power industry—which must generate and deliver reliable electricity for a variety of emerging large load consumers—and the data center industry, which is scrambling to procure firm scalable energy to

sustain its explosive growth, now and well into the future. The stakes are fueled by real fear. **In November, research firm Gartner projected that power required for AI data centers could reach 500 TWh per year by 2027, a 2.6x increase from 2023 levels. It warned that power shortages could restrict 40% of AI data centers by 2027 and drive up energy costs.** The upfront cost of power is no longer the deciding factor for data centers, speakers at the Sustainable Data Centers Summit in Dallas, Texas, suggested in early February. “It’s crazy because we look at like the state of Oregon is about 6 GW, and you have these large hyperscalers [asking] ‘Can I get 6 GW too?’ ” said Mohammed Hassan, senior technical program manager for Amazon Web Services (AWS) Sustainability. Hassan suggested the industry has had to rethink how it approaches energy planning and procurement completely to align with incentives, address regulatory hurdles, and secure long-term reliability. “Solar and wind has taken off in the lead. But if you look at the needs of 2045, in trying to meet the Paris Agreement, solar and wind won’t be enough, so you have to look at what’s the next step.” At the conference, speakers pointed to potential alternatives that could perform over the short term: natural gas as a “bridge fuel,” carbon capture as a potential future solution, energy storage solutions for flexibility and to promote grid resilience, and renewable diesel as a cleaner backup power option. But to meet long-term goals, the industry is willing to bet on nuclear power for its many benefits—despite the significant challenges that remain.

The answer to AI power demand is nuclear. Brumfiel 24

Geoff Brumfiel, 12-8-2024, "Artificial Intelligence wants to go nuclear. Will it work?", NPR, https://www.npr.org/2024/12/09/nx-s1-5171063/artificial-intelligence-wants-to-go-nuclear-will-it-work // Lunde

Big tech firms have long promised to grow sustainably, and in recent years they've pledged to slash or even eliminate their greenhouse gas emissions. Initially, they tried to do so with solar, wind and hydroelectric power. "If you went back a decade, they were all focused on being 100% renewable-energy powered," says Ted Nordhaus, executive director of the Breakthrough Institute, a Berkley, Calif.,-based environmental think tank that has studied nuclear power and the tech sector. Large tech companies purchased power from renewable sources, but Nordhaus says they drew criticism, because the purchase agreements often left parts of their demand uncovered. For example, purchasing power from a solar plant does little to reduce emissions during night time operations. Over the years, some companies have moved towards 24/7 matching of their demand with clean energy supply. Nordhaus says that change, together with the anticipated and enormous power requirements of AI, have left nuclear power as one of the few solutions. "I think nuclear is probably the most cost-effective current technology stopgap that we have," Strubell agrees. Wind or solar are just too intermittent and "the size of the battery you would need to build next to a data center in order to support these workloads is enormous and it would be incredibly expensive." Given the looming energy needs, paying to restart a plant like Three Mile Island seems like a bargain for a company like Microsoft. "You're talking about data centers that are very power intensive, 24 hours a day, seven days a week independent of whether the sun is shining or the wind is blowing," says Hanson, who is trained as a nuclear engineer. "It's a perfect match for nuclear energy." Hanson says that Constellation will have the plant, which has been renamed the Crane Clean Energy Center, up and running by 2028.

High capacity is crucial. USDE 21

US Department of Energy, 3-24-2021, "Nuclear Power is the Most Reliable Energy Source and It's Not Even Close", Energy.gov, https://www.energy.gov/ne/articles/nuclear-power-most-reliable-energy-source-and-its-not-even-close // Lunde

As you can see, nuclear energy has by far the highest capacity factor of any other energy source. This basically means nuclear power plants are producing maximum power more than 92% of the time during

the year. That's about nearly 2 times more than natural gas and coal units, and almost 3 times or more reliable than wind and solar plants. Nuclear power plants are typically used more often because they require less maintenance and are designed to operate for longer stretches before refueling (typically every 1.5 or 2 years). Natural gas and coal capacity factors are generally lower due to routine maintenance and/or refueling at these facilities. Renewable plants are considered intermittent or variable sources and are mostly limited by a lack of fuel (i.e. wind, sun, or water). As a result, these plants need a backup power source such as large-scale storage (not currently available at grid-scale)—or they can be paired with a reliable baseload power like nuclear energy. A typical nuclear reactor produces 1 gigawatt (GW) of electricity. That doesn't mean you can simply replace it with a 1 gigawatt coal or renewable plant. Based on the capacity factors above, you would need almost two coal or three to four renewable plants (each of 1 GW size) to generate the same amount of electricity onto the grid.

Nuclear power is scalable quickly, 4 warrants:

1. **AI - Hollingshead 24**

Todd Hollingshead, 7-29-2024, "BYU engineering research finds key to quicker nuclear power: artificial intelligence", BYU News, https://news.byu.edu/intellect/byu-engineering-research-finds-key-to-quicker-nuclear-power-artificial-intelligence

A BYU professor has figured out a way to shave critical years off the complicated design and licensing processes for modern nuclear reactors: artificial intelligence. You heard that right, AI is teaming up with nuclear power. And while that may seem like a worrisome bit straight out of a science fiction movie, chemical engineering professor Matt Memmott says it's not what it sounds like; no one is giving AI the nuclear codes. It's all about speeding up the process to get more nuclear power online. The typical time frame and cost to license a new nuclear reactor design in the United States is roughly **20 years** and $1 billion. To then build that reactor requires an additional five years and between $5 and $30 billion. By using AI in the time-consuming computational design process, Memmott estimates a decade or more could be cut off the overall timeline, saving millions and millions of dollars in the process — which should prove critical given the nation's looming energy needs. "Our **demand for electricity** is going to **skyrocket** in years to come and we need to figure out how to produce additional power quickly," Memmott said. "The only baseload power we can make in the Gigawatt quantities needed that is completely emissions free is nuclear power. **Being able to reduce the time** and cost to produce and license nuclear reactors **will make that power cheaper and a more viable option** for environmentally friendly power **to meet the future demand**." Designing and building a nuclear reactor is so complex and time consuming because it requires multi-scale efforts, according to Memmott. Engineers deal with elements from neutrons on the quantum scale all the way up to coolant flow and heat transfer on the macro scale. He also said there are multiple layers of physics that are "tightly coupled" in that process: the movement of neutrons is tightly coupled to the heat transfer which is tightly coupled to materials which is tightly coupled to the corrosion which is coupled to the coolant flow. "A lot of these reactor design problems are so massive and involve so much data that it takes months of teams of people working together to resolve the issues," he said. "When I was at **Westinghouse** it took the team of neutron guys six months just to run one of their complete-core multi-physics models. And if they made a mistake two months in, then they just wasted two months of the valuable computational time and they would have to start over." Memmott's is finding AI can reduce that heavy time burden and lead to more power production to

not only meet rising demands, but to also keep power costs down for general consumers. In recent years, homeowners and renters nationwide have already felt the sting of rising utility costs. Technically speaking, Memmott's research proves the concept of replacing a portion of the required thermal hydraulic and neutronics simulations with a trained machine learning model to predict temperature profiles based on geometric reactor parameters that are variable, and then optimizing those parameters. The result would create an optimal nuclear reactor design at a fraction of the computational expense required by traditional design methods. For his research, he and BYU colleagues built a dozen machine learning algorithms to examine their ability to process the simulated data needed in designing a reactor. They identified the top three algorithms, then refined the parameters until they found one that worked really well and could handle a preliminary data set as a proof of concept. It worked (and they published a paper on it) so they took the model and (for a second paper) put it to the test on a very difficult nuclear design problem: optimal nuclear shield design. The resulting papers, recently published in academic journal Nuclear Engineering and Design, showed that their refined model can geometrically optimize the design elements much faster than the traditional method. For example, it took Memmott's AI algorithm just two days to come up with an optimal shield design for a nuclear reactor while local molten salt reactor company Alpha Tech Research Corp. took six months to do the same. "When you look at nuclear reactor design, you have this huge design space of possibilities — it's as if you have people combing through this mile-wide area looking for the right reactor design," Memmott said. "Now AI can help those people focus on that little quarter-sized sweet spot of design which will drastically reduce the search time. Of course, humans still ultimately make the final design decisions and carry out all the safety assessments, but it saves a significant amount of time at the front end." Fellow BYU researchers include Andrew Larsen, Ross Lee, Braden Clayton, Edwards Mercado, Ethan Wright, Brent Edgerton, Brian Gonda and chemical engineering professor John Hedengren. Collaborators from Alpha Tech, Caden Wilson and John Benson, also contributed their efforts to the research.

2. Centralization - Mcbride 18

Jameson Mcbride [Senior Research Analyst in the energy program at Breakthrough], 12-17-2018, "The Green New Deal and the Legacy of Public Power", Breakthrough Institute, https://thebreakthrough.org/issues/energy/the-green-new-deal-and-the-legacy-of-public-power?te=1&nl=debatable&emc=edit_db_20210826 // Lunde

Each of the countries with the fastest historical declines in carbon intensity experienced a rapid clean energy transition led by the public sector. Four of the five countries achieved these declines primarily by building large-scale clean energy generating projects — nuclear reactors and hydroelectric dams. (Saudi Arabia transitioned from oil to natural gas.) In this period, South Korea, Canada, and France were all varieties of social democracies, which viewed the nationalized expansion of clean energy as an explicit political goal rooted in commitments to equality, prosperity, and sustainability. It's no coincidence that the fastest **decarbonization rates** occurred in **centralized, state-dominated** energy systems and have prominently featured **nuclear** and hydroelectric power. State-run energy sectors enable speed and scale, as public finance enables long-term **capital-intensive projects** with low financial uncertainty. South Korea rapidly expanded nuclear capacity in the **nine-year** period from 1983 to 1992, in a standardized and centralized fashion that led to nuclear construction getting cheaper over time — a stark contrast to the mostly **privatized and unorganized** nuclear buildout in the US and the resulting escalation in costs. In Canada, a collection of provincial state-owned utilities including Hydro-Québec, BC Hydro, and Ontario Hydro drove a massive expansion in hydroelectric and nuclear generation. The nuclear plants built in Ontario include the largest nuclear power plant in the world, and continue to provide a majority of the province's electricity. Meanwhile, in Brazil, the US-backed dictatorship built a massive series of hydroelectric generators in the 1970s and 1980s, including the largest hydroelectric dam in the world at the time. And, finally, France is a global leader in nuclear power. The French nuclear fleet — construction of which peaked from the 1970s to the 1980s — continues to supply about three-quarters of France's electricity today. Public finance and public power worked together to drive these energy transitions through long-term investment in large-scale nuclear and hydroelectric generation. Past American experience tells a similar story. The federal (i.e. nationalized) power agencies created in the New Deal era, like the Bonneville Power Administration and the Tennessee Valley Authority, substantially expanded emissions-free generation. Today, the BPA operates one of the lowest-carbon grids in the US, thanks to its

large supply of hydro. Meanwhile, the TVA today is 37% nuclear — a plurality among its energy sources — and owns nearly one-tenth of the operating nuclear reactors in the US. Beyond these headline statistics, federal power agencies played a crucial role in the electrification and development of rural America during and after the Great Depression. Public power, when properly managed and deployed, can create benefits that extend far beyond the wires. The environmental movement has traditionally been skeptical of scale and centralization, thanks to its ideological roots in post-material liberalism. But scale and centralization seem conducive — if not necessary — to achieving rapid energy transitions. These issues are especially clear in debates around global development, where small-scale "energy access" projects (like solar lamps) are often favored by Western donors over large-scale projects (like dams and nuclear reactors) that could reduce energy poverty more substantially. In the US, environmentalists like Amory Lovins have long argued for a "soft energy path" that would prioritize efficiency and localism. But **the empirical record is unimpeachable** — all of the countries with the fastest historical decarbonization rates took advantage of centralization, abundance, and scale. Expectations for a Green New Deal must be tempered by current political realities. Getting any sort of climate policy through a divided Congress and an openly hostile administration would be a tremendous achievement, and advocates should not make the perfect the enemy of the good. But the core of the success of the "Medicare for All" campaign has been to remind people what the public sector can do, and the Green New Deal can do the same. This effort may be viable at first on smaller scales — for example, the burgeoning movement to bring Pacific Gas and Electric, the private utility here in Northern California, under public state control. Regardless, the legacy of public power cannot be forgotten. Public investments in clean energy decades ago continue to help the climate, as they will for decades to come.

3. SMRs Columbus 23

Olivia Columbus, 02-xx-2023, "Small Modular Reactors (SMRs): A Beginner's Guide", No Publication, https://www.lastenergy.com/blog/small-modular-reactors-smrs-a-beginners-guide

Unlike the reactors before them, some SMRs, like Last Energy's PWR-20, are truly modular, meaning that all of their systems and components are factory-assembled and easily transported as units to other locations for installation. With an SMR, you're not building a reactor from the ground up: you're simply assembling the existing pieces. Compared to preconstructed reactors and partially modular SMRs, the PWR-20 can be assembled quickly on-site. The speed to delivery is less than 24 months, while traditional, non-modular reactors can take over five years to build – and sometimes, decades. Case in point: in the U.S., construction on the Vogtle nuclear plant began in 2012 with projected startup dates of 2016 and 2017. Yet in 2023, it's still under construction and at least $16 billion over budget.

SMRs are key for stability. Hurtado 25

Jorge Hurtado, "AI goes nuclear: Can small modular reactors meet AI's energy demands?," January 21, 2025 // Arham S.
https://www.prescouter.com/2025/01/can-small-modular-reactors-address-ai-growing-energy-demands/

×–B Jorge Hurtado, xx-xx-xxxx, "AI goes nuclear: Can small modular reactors meet AI's energy demands?", PreScouter, https://www.prescouter.com/2025/01/can-small-modular-reactors-address-ai-growing-energy-demands/ Our Insights & Work How We Help Clients About Us Work On Our Projects How we help clients in All Topics Contact us Article January 2025 AI goes nuclear: Can SMRs meet AI's huge energy demands? By Jorge Hurtado Artificial intelligence drives progress, but its energy demands come at a cost. A single ChatGPT query uses about ten times the energy of a typical Google search, which consumes around 0.3 watt-hours. Training GPT-3 consumed 1,287 MWh and consequently emitted 502 tons of CO_2 – similar to driving a car to the moon and back. AI's reliance on electricity could reach unprecedented levels. **By 2030, AI is** expected **to account for** around **5% of** Europe's **total electricity** use, up from the current 2%. As AI grows resource-intensive and emissions increase, companies must turn to carbon-free energy sources. **Small modular reactors** present a promising pathway to sustainably meet AI's energy demands while addressing regulatory and scalability challenges. Despite their potential, **SMRs are** still **in** the **early stages of development**, currently at technology readiness levels (TRL) 5–6. The **deployment of the first s**mall **m**odular **r**eactors **is expected by 2030** at the earliest. How Investments in Third Wave AI Are Generating 5x Returns What strategies are helping businesses achieve 5x returns on their AI investments? DOWNLOAD REPORT What are small modular reactors? A small modular reactor (SMR) is a nuclear reactor that produces energy through nuclear fission. In this process, the nucleus of a heavy

atom, like uranium, splits into two smaller parts, releasing a large amount of heat. The produced heat is then used to generate electricity. SMRs are smaller and simpler than traditional nuclear plants. They are made from compact, factory-built parts that can be assembled as needed. SMRs can power cities, provide heat for factories, or turn seawater into fresh drinking water. Why are SMRs important? SMR's parts are factory-made, faster, and cheaper to build, reducing labor and construction time to as little as three years, compared to up to 12 years for traditional plants. Compact SMRs, for instance, can be used in different locations (e.g., small markets, isolated areas, and places with limited water). In addition, SMRs can be scaled to match energy needs, replace old plants, and work alongside other zero-emission sources**. SMR projects** can **boost nuclear energy,** potentially creating 7,000 jobs and generating over $1 billion in sales for a 100-megawatt plant. Why does AI consume so much energy? AI's energy demands start with the massive energy needed to train large models. GPT-4 requires processing vast datasets through extensive calculations across thousands of high-performance servers. Training GPT-3 used around 1.3 GWh of electricity, equivalent to fully charging over 100 million smartphones. Data centers engage in intense data processing, which is supported by: Servers performing complex computations Storage systems managing large amounts of data Cooling systems ensuring operational stability by preventing equipment from overheating All of this requires substantial energy. It is estimated that data centers use ~1-1.5% of the world's electricity, with data center energy consumption expected to rise as AI grows. AI applications, such as ChatGPT, must provide instant responses to users, meaning they must continuously consume power, even when idle. As AI models become more complex, their energy needs increase quickly. The **computing power for AI doubles** about **every 100 days**, showing just how fast these **demands are escalating**. State of generative AI: CIO survey Can generative AI transform your business? Discover what top CIOs reveal about the true potential of this technology. DOWNLOAD REPORT How can small modular reactors meet AI's increasing energy demands? **SMRs provide a stable** 24/7 **power source, ideal for** the continuous demands of **AI data** centers. SMRs have capacities ranging from 20 to 300 megawatts, meeting energy needs without large infrastructure, as in the case of traditional nuclear plants. Independent of power grids **S**mall **m**odular nuclear **r**eactors operate independently of centralized power grids, ensuring resilience for AI-critical functions. This **self-sufficiency reduces risks from** outages or **grid instability,** allowing continuous operations. Such features are essential for the uninterrupted processing capabilities of AI technologies. Low carbon footprint SMRs present a low-carbon alternative to fossil fuels, aiding tech companies in achieving sustainability objectives.

4. Repurposing Coal

Abdussami 24 [Muhammad R. Abdussami, M.A. in Nuclear Engineering from Ontario Tech University & PhD from University of Michigan, June 2024, Investigation of potential sites for coal-to-nuclear energy transitions in the United States, Energy Reports, https://www.sciencedirect.com/science/article/pii/S2352484724002993, Willie T.]

1.2. Literature review

The U.S. government has undertaken various initiatives to assess the potential for coal-to-nuclear (C2N) transitions at coal sites across the country. Hansen et al. drafted an extensive report for the U.S. Department of Energy (DOE) that examined key factors influencing viable transitions for a hypothetical coal plant, considered the techno-economic aspects of C2N conversions, and evaluated the potential effects on local communities during this transition (Hansen et al., 2022). Similarly, Griffith et al. investigated different nuclear reactor technologies and provided **valuable insights** into the considerations for siting and replacing coal plants with nuclear alternatives (Griffith, 2021). A few technical studies have also been carried out in the field of C2N transitions. One investigation ("Gone with the Steam How new nuclear, 2021) discovered that repurposing coal plants with advanced reactors could offer economic advantages and benefits for host communities compared to renewable energy generation. A technical report published by NuScale SMR technology highlighted the capability of NuScale SMR technology to **repurpose retired coal plants** while **ensuring the economic stability** of communities and workers ("An Ideal Solution for Repurposing U.S, 2021). Bartela et al. conducted a case study on a 460 MWe supercritical coal-fired plant in Poland, demonstrating the techno-economic benefits

of replacing it with a nuclear reactor incorporating thermal energy storage (Bartela et al., 2022), (Bartela et al., 2021). Furthermore, Lukowicz et al. performed a techno-economic analysis on the same Polish coal plant, proposing the replacement of the plant's steam cycle with a small-scale modular Pressurized Water Reactor (PWR) (Łukowicz et al., 2023). Simonian et al. evaluate the potential of C2N transition at the Limestone coal plant in Texas, comparing small modular, high-temperature gas-cooled, and molten salt nuclear reactor technologies. Each technology's pros and cons are weighed against cost, risk, and C2N integration complexity. The study concludes no one-size-fits-all solution exists for C2N transitions, and specific nuclear designs and transition schemes must be carefully considered for each project based on technical specifications and feasibility (Simonian and Kimber, 2023). Notably, although these studies focused on specific candidate coal plants, comprehensive siting analyses for C2N transitions were not addressed.

The potential for advanced nuclear reactors to replace coal plants has been discussed in ("Coal-to-Nuclear Transitions, 2024), **emphasizing their compatibility** with variable renewable technologies and their capability to provide both electricity and process heat. The document ("Coal-to-Nuclear Transitions, 2024) examines economic impacts, job creation, and revenue benefits in host communities, noting **significant increases in employment and income** following a coal-to-nuclear transition. It discusses workforce requirements, educational needs, and training for transitioning workers, outlining the overlap and distinct roles between coal and nuclear plants. Policy and funding aspects, including **tax incentives** and loans, are also addressed, with a focus on achieving net-zero emissions targets by 2050 and supporting disadvantaged communities. The document emphasizes the critical role of utilities in managing transitions and presents a comprehensive outlook on infrastructure reuse and community engagement strategies for successful coal-to-nuclear conversions. In another paper, the advantages of repurposing existing site infrastructure, including transmission infrastructure, environmental permits, and water usage rights, have been examined. Repowering coal plant sites with nuclear power offers **clean, reliable, and dispatchable energy**, addressing the twin challenges of decommissioning and transitioning to low-carbon energy sources. The paper guides utilities through the key considerations and steps involved in evaluating and repurposing coal plant sites for advanced nuclear generation, focusing on the potential to retain jobs, tax bases, and community support.

In contrast to the technoeconomic analyses described above, the siting of advanced nuclear reactors within operating or retired CPPs has received relatively little attention in the literature. Belles et al. conducted an analysis using the Oak Ridge Siting Analysis for Power Generation Expansion (OR-SAGE) tool to evaluate the suitability of 13 coal power plants in the Tennessee Valley Authority (TVA) service territory for the deployment of advanced nuclear reactors (Belles et al., 2013). A similar approach was adopted in another study (Belles et al., 2021), where OR-SAGE was utilized to assess the retrofitting of advanced nuclear reactors in existing or retired coal plants. Furthermore, Omitaomu et al. employed the OR-SAGE tool to investigate the siting of advanced nuclear reactors across the contiguous United States (Omitaomu et al., 2022). In a separate study, Toth et al. employed the Advanced Nuclear Site Locator (ANSL) tool to evaluate 304 coal sites in the U.S., identifying **79** potentially feasible sites for coal-to-nuclear transitions (Toth et al., 2021). However, they reported that state-level policies could pose challenges to the demonstration of advanced nuclear reactors. Therefore, a comprehensive assessment of all coal plants in the United States, encompassing operational and retired facilities, is necessary to gain an understanding of the most suitable coal sites for transitioning to nuclear power. While the existing literature provides some valuable insights into the siting potential of advanced nuclear reactors in coal plants, the number of studies on this subject remains limited.

1.3. Contribution

This paper aims to assess the feasibility of converting each operational coal site to nuclear power using a tool called Siting Tool for Advanced Nuclear Development (STAND). The studied coal plants are classified into two different groups (Group-01 and Group-02) based on their capacity. Since advanced nuclear reactors are divided into various classes, such as micro-reactors, medium-scale reactors, and Small Modular Reactors (SMRs), it is necessary to categorize coal plants accordingly to match their capacity for a smooth transition to nuclear power. Categorization will also help in presenting the research findings and data clearly, considering the substantial amount of data involved in the analysis. To conduct this analysis, our first step was to gather information on all operational coal sites in the U.S. until January 2023. The operational coal sites are the focus of this study to **take advantage** of the existing Balance of Plant (BOP) equipment, such as transmission lines and power system protection components, which can **reduce construction time and costs**. Analyzing operational coal plants will also guide policymakers, state-level governments, and energy modelers in determining the prioritization of coal plant retirements. Furthermore, we limit our study to operational coal sites in the U.S. as many retired coal sites lack the necessary technical infrastructure for an attractive coal-to-nuclear transition. Next, we classify all operational coal sites into two clusters based on their nameplate capacity. The CPPs located in non-contiguous states (e.g., Alaska and Hawaii) are not considered due to the lack of sufficient data in STAND. Each cluster is then individually simulated in STAND using selected attribute values, as mentioned in Section 2, specifically in Table 1, Table 2, Table 3. Section 3 discusses the clustering of CPPs. Section 4 provides additional information about the STAND tool. Section 5 presents the results of the study, while Section 6 concludes the study with discussion. This paper presents a comprehensive approach for utilizing STAND in evaluating the feasibility of transitioning from coal to nuclear energy across the U.S. The detailed results and investigation will provide a clear idea on which factors one should consider for a particular region/area to C2N transitions.

Without quick action, power shortages will kill the AI race

Li 2025(FENGRONG LI, CFA, CIRA Managing Director Power, Renewables & Energy Transition (PRET) FTI Consulting, 27 February 2025, "The Powerful Duo of Nuclear and Data Centers", FTI, https://www.fticonsulting.com/insights/articles/powerful-duo-nuclear-data-centers, DOA: 3/7/2025)ET

Acute power shortages and mounting resource adequacy challenges have emerged as existential threats to the AI race. Hyperscale and colocation data centers — among the most energy- intensive digital infrastructures — **depend on reliable, 24/7 electricity to sustain AI workloads and cloud computing. However, intermittent, non-dispatchable generation resources dominate the interconnection queues; power constraints stall data center deployment. Nuclear power, with its carbon-free, high-energy output, presents a compelling solution to alleviate the bottleneck.** Large tech players and the nuclear industry have forged strategic alliances to **move new nuclear projects forward. These partnerships represent a crucial down payment on building sustainable energy infrastructures capable of supporting AI growth.** Experts at FTI Consulting have evaluated the collaboration models between these two sectors, including co-location strategies, which have gained momentum despite encountering pushbacks from market participants and regulatory bodies.

Domestic development is necessary for the US to beat China

Allison and Schmidt 20 (Graham Allison is the Douglas Dillon Professor of Government at Harvard University where he has taught for five decades., Eric Schmidt, "Is China Beating the U.S. to AI Supremacy?", Belfer Center, https://www.belfercenter.org/publication/china-beating-us-ai-supremacy, DOA 4/2/23) RK

Combining decades of experience advancing frontier technologies, on the one hand, and analyzing national security decisionmaking, on the other, we have been collaborating over the past year in an effort to understand the national security implications of China's great leap forward in artificial intelligence (AI). Our purpose in this essay is to **sound an alarm over China's rapid progress and the current prospect of it overtaking the United States in applying AI in the decade ahead**; to explain why **AI is for the autocracy led by the Chinese Communist Party** (hereafter, the "Party") **an existential priority**; to identify key unanswered questions about the dangers of an unconstrained AI arms race between the two digital superpowers; and to point to the reasons why we believe that **this is a race the United States can and must win**. We begin with four key points. First, most Americans believe that U.S. leadership in advanced technologies is so entrenched that it is unassailable. Likewise, many in the American national security community insist that in the AI arena China can never be more than a "near-peer competitor." Both are wrong. In fact, **China stands today as a full-spectrum peer competitor of the United States in commercial and national security applications of AI. Beijing is not just trying to master AI—it is succeeding. Because AI will have as transformative an impact on commerce and national security over the next two decades as semiconductors**, computers and the web have had over the past quarter century, **this should be recognized as a matter of grave national concern**.[1,2,3] Second, China's zeal to master AI goes far beyond its recognition that this suite of technologies promises to be the biggest driver of economic advances in the next quarter century. **For the Party, AI is mission critical. The command of 1.4 billion citizens by a Party-controlled authoritarian government is a herculean challenge**. Since the fall of the Soviet Union, Americans have been confident that authoritarian governments are doomed to fail—eventually. But AI offers a realistic possibility of upending this proposition. **AI could give the Party** not just an escape hatch from the "end of history,"[4] but **a claim to advance a model of governance—a national operating system—superior to today's dysfunctional**

democracies. As one former Democratic presidential candidate put it: "**China is using technology to perfect dictatorship**."5 **It's a value proposition that resonates with many leaders around the world**. As former Google ceo Eric Schmidt has argued: "**if the Soviet Union had been able to leverage the kind of sophisticated data observation, collection and analytics employed by the leaders of Amazon today, it might well have won the Cold War**." Third, while we share the general enthusiasm about AI's potential to make huge improvements in human wellbeing, the development of machines with intelligence vastly superior to humans will pose special, perhaps even unique risks. In 1946, Albert Einstein warned, "the unleashed power of the atom has changed everything save our modes of thinking, and thus we drift towards unparalleled catastrophe." We believe the same could be said of AI. Henry Kissinger has identified these risks in what we call "Kissinger's Specter." In his words, **AI threatens an unpredictable revolution in our consciousness and our thinking, and an "inevitable evolution in our understanding of truth and reality**."6 In response to Einstein's insight, the technologists and strategists who had built and used the bomb to end World War II joined forces to find ways to prevent a nuclear World War III. Meeting the challenges posed by AI will require nothing less. Fourth, **China's advantages in size, data collection and national determination have allowed it over the past decade to close the gap with American leaders of this industry. It is currently on a trajectory to overtake the United States in the decade ahead. Nonetheless, if the United States will awake to the challenge and mobilize a national effort**, we believe that **it can develop and execute a winning strategy**. For many readers, AI is just the latest bright, shiny object on the technology horizon. A brief explainer to provide some further context may be helpful. **AI encompasses big data, machine learning and multiple related technologies that allow machines to act in ways humans describe as "intelligent" when we do the same thing**.7 For example, consider gps navigation app Waze locating the best route through heavy traffic; Amazon's eerily relevant product suggestions; or the programmed machines that now regularly defeat world masters in chess. Today's leading information technology companies—including the faangs (Facebook, Amazon, Apple, Netflix and Google) and bats (Baidu, Alibaba and Tencent)—are betting their r&d budgets on the AI revolution. As Amazon's Jeff Bezos said this year, "We're at the beginning of a golden age of AI."8 China's AI Surge Though still in their infancy, **AI technologies will be drivers of future economic growth and national security. From facial recognition and fintech to drones and 5g, China is not just catching up. In many cases, it has already overtaken the United States to become the world's undisputed No. 1.** In some arenas, because of constitutional constraints and different values, the United States willfully forfeits the race. In others, China is simply more determined to win. China's AI surge is so recent that anyone not watching closely has likely missed it. As late as 2015, when assessing its international competition, American industry leaders—Google, Microsoft, Facebook and Amazon—saw Chinese companies in their rearview mirrors alongside German or French firms in the third tier. But this changed four years ago—in 2016—when leading AI application company DeepMind fielded a machine that defeated world champion Lee Sedol in the world's most complex board game, Go.9 Even after several American companies' machines had bested the chess masters of the universe10, most Chinese remained confident that machines could never beat Go champions, since Go is ten thousand times more complex than chess. Thus, DeepMind's decisive victory became for China a "Sputnik moment"11—a jolt as dramatic as the Soviet Union's launch of the first satellite into space that sparked America's whole-of nation surge in math and science, nasa's creation and the original "moon shot." Kai-Fu Lee's book AI Superpowers offers an insightful summary of China's engagement in the field. It began with President Xi Jinping's personal reaction to the defeat of the world's Go champion. Declaring that this was a technology in which China had to lead, he set specific targets for 2020 and 2025 that put China on a path to dominance over AI technology and related applications by 2030.12 Recognizing that this would have to be led by entrepreneurial companies rather than agencies of government, he designated five companies to become China's national champions: Baidu, Alibaba, Tencent, iFlytek and SenseTime.13 Twelve months after Xi's directive, investments in Chinese AI startups had topped investments in American AI startups.14 By 2018, China filed 2.5 times more patents in AI technologies than the United States.15 And this year China is graduating three times as many computer scientists as the United States. In contrast to nuclear weapons—where governments led in discovery, development and deployment—**AI and related technologies have been created and are being advanced by private firms and university researchers. The military establishments in Washington and Beijing are essentially playing catch-up, adopting and adapting private-sector products**. Where do these two competitors stand in the AI race today? Consider leading indicators under six key headings: product market tests, financial market tests, research publications and patents, results in international competitions, talent and national operating environments. Consumers' choices of products in markets speak for themselves. In fintech, China stands alone. Tencent's WeChat Pay has nine hundred million Chinese users,16 while Apple Pay only has 22 million in the United States.17 And when it comes to capability, **WeChat** Pay can do much more than Apple Pay. Chinese consumers use their app to buy coffee at Starbucks and new products from Alibaba, pay bills, transfer money, take out loans, make investments, donate to charity and manage their bank accounts. In doing so, they

generate a treasure trove of granular data about individual consumer behavior that AI systems use to make better assessments of individuals' credit-worthiness, interest in products, capacity to pay for them and other behavior. In mobile payments, Chinese spend $50 for every dollar Americans spend, in total, $19 trillion in 2018.18 U.S. mobile payments have yet to reach $1 trillion. Credit cards are as old-fashioned to Chinese millennials as handwritten checks are to their American counterparts. Mark Zuckerberg has noticed: Facebook's major moves last year into digital payments,19 including the recent introduction of Facebook Pay, are copying Tencent, rather than the other way around.

Losing the AI race emboldens China Kroenig 21

(Dr. Matthew Kroenig is a professor of government and foreign service at Georgetown University and the director of the Scowcroft Strategy Initiative at the Atlantic Council. His most recent book is The Return of Great Power Rivalry: Democracy versus Autocracy from the Ancient World to the US and China (2020), Winter 2021, "Will Emerging Technology Cause Nuclear War?" Strategic Studies Quarterly, https://www.jstor.org/stable/pdf/48638052.pdf DOA: 3/7/23) LLO

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 deof 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 East or South China Seas, 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 United States 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.**

Extinction!

Sarg 15 [Dr. Stoyan Sarg, 10-9-2015, Director of the Physics Research Department at the World Institute for Scientific Exploration, PhD in Physics, "The Unknown Danger of Nuclear Apocalypse," Foreign Policy

Journal, https://www.foreignpolicyjournal.com/2015/10/09/the-unknown-danger-of-nuclear-apocalypse/, accessed: 11-5-2023] // sid

With the new NATO plan for installation of nuclear tactical weapons in Europe, nuclear missiles may reach Moscow in only 6 minutes, and the opposite case is also possible in the same time. The question is: how can we be sure that this will not be triggered by a human error or computer malfunction. An adequate reaction dictated by the dilemma "to be or not to be" and the concept of preventive nuclear strike may **lead to a nuclear consequence** that is difficult to stop. At the present level of distributed controlled systems and military global navigations, this will lead to **unstoppable global nuclear war.** However, there is **something not predicted**, of which the military strategists, politicians and powerful forces are not aware. Probably, it will not be a nuclear winter that they hope to survive in their underground facilities. The most probable consequence will be a partial **loss of the Earth's atmosphere** as a result of one or many powerful simultaneous tornadoes caused by the nuclear explosions. In a tornado, a powerful **antigravitational effect** takes place. The official science does not have an adequate explanation for this feature due to an incorrect concept about space. The antigravitational effect is **not a result of the circling air**. It is a specific physical effect in the aether space that is **dismissed in physics** as it is currently taught. Therefore, the effective height of this effect is **not limited to the height of the atmosphere.** Then in the case of many simultaneous powerful tornadoes, an effect of **suction of the earth atmosphere** into space might take place. Such events are **observed on the Sun** and the present physical science does not have an explanation for them. The antigravitational effect is accompanied by **specific electric and magnetic fields** with a twisted shape. This is observed in tornado events on the Sun. Some effects in the upper Earth atmosphere known as sprites have a similar **combination of electrical and magnetic fields** but in a weaker form. They are also a mystery for contemporary physical science.

At the time of atmospheric nuclear tests, made in the last century, a **number of induced tornadoes are observed** near the nuclear mushroom as shown in Figure 1.

The strongest **antigravitational effect**, however, occurs in the central column of the formed nuclear mushroom. The analysis of underwater nuclear tests also indicates a **strong antigravitational effect**. It causes a rise of a vertical column of water. In the test shown in Figure 2, the vertical column contains millions tons of water. Thermonuclear bombs are **multiple times more powerful**. The largest thermonuclear bomb of the former Soviet Union tested in 1961 is 50 megatons. It is 3,300 times more powerful than the bomb dropped by USA on Hiroshima at the second world war and may kill millions.

It is known that Mars once had liquid water and consequently an atmosphere that has mysteriously disappeared. If the scenario described above takes place, the **Earth will become a dead planet** like Mars. The powerful politicians, military adventurers and their financial supporters must be aware that even the most secured underground facility w**ill not save them** if a global nuclear conflict is triggered. Their disgraced end will be more miserable than the deaths of the **billions of innocent human beings**, including the animal world.

Rebuttal

A2 Stablecoin

1. Aff is popular

Larson 25 [Aaron Larson, Writer @ Power Magazine, 3-3-2025, Trump Energy Policy Changes Signal Major Industry Shifts in 2025 and Beyond, POWER Magazine, https://www.powermag.com/trump-energy-policy-changes-signal-major-industry-shifts-in-2025-and-beyond/, Willie T.]

"We see a potentially bifurcated outcome with respect to IRA repeal, with a greater-than-appreciated probability that the IRA may remain intact," Morgan Stanley Research speculated. The group acknowledged, however, that IRA repeal risk remains a key area of concern for clean energy investors. "Our base case for IRA-related spending remains intact: expect efforts to challenge or delay disbursements through the executive branch, as well as potentially targeted repeal efforts/accelerated phase-outs as Republicans attempt to find offsets for tax-cut extensions, but broader repeal is a lower probability event," the team of analysts, strategists, and researchers said.

Morgan Stanley expects tariffs to continue being used for leverage to reduce the trade deficit and increase the competitiveness of U.S. manufacturing. Meanwhile, the group said there is **significant bipartisan support** for nuclear power, as it is **viewed as** a critical source of **reliable and clean power** needed to support **growing energy demand** in the U.S. stemming from artificial intelligence and the onshoring of manufacturing. "The ADVANCE Act, which passed the Senate by a vote of 88–2, is clear evidence of this bipartisan support. This gives us confidence that if there were to be any changes to the IRA, the nuclear PTC [production tax credit] would likely be untouched," the group said.

Concerning natural gas, Trump lifted the pause on new Department of Energy permits for LNG export facilities, easing the path for new facilities to advance. "Beyond LNG, the Trump administration may target a roll-back of greenhouse gas limits for new and existing power plants, potentially helping gas to take a larger share of electricity demand growth," Morgan Stanley Research said.

Their evidence about clean energy policy breaking GOP unity is unspecific to nuclear. It doesn't mention it once. Insofar as they don't tell you about any disagreement regarding nuclear in Congress, you prefer us hold the line there don't reward them from unspecific evidence.

2. No spillover---lawmakers compartmentalize.

Pergram '18 [Chad; October 13; Congressional reporter; Fox News,"Amid Kavanaugh cacophony, Congress forges bipartisan agreements on key issues," https://www.foxnews.com/politics/amid-kavanaugh-cacophony-congress-forges-bipartisan-agreements-on-key-issues]

Amid the **turmoil**, Congress **approved** the first revamp of national **aviation policy** in **years**. The Senate approved the final version of the legislation 93-6. This came after a staggering six extensions due to **bickering** and disagreement. Then, Congress **approved** a **sweeping**, bipartisan **measure** to combat **opioid abuse**. The House okayed the package 393-8. The Senate adopted the measure 98-1. And, there was no government shutdown. The House and Senate came to terms on two bipartisan bills which funded five of the 12 annual spending bills which operate the government. The sides agreed to latch an additional measure to one of the spending plans to fund the remaining seven areas of federal spending through December 7. President Trump briefly threatened to force a government shutdown if lawmakers didn't include money for his border wall in the plan. But the President ultimately punted that battle until December. Democrats praised Republicans for keeping conservative "**poison pill**" **riders** out of the **appropriations** bills. That decision drew Democratic support for the measures. The Senate **approved** a bipartisan **water** and **infrastructure** package. McConnell hailed the **bipartisanship** which descended upon the Senate – **even as** the **senators fought** over **Kavanaugh**. Nearly in the **same breath**, McConnell derided boisterous, anti-Kavanaugh protesters outside the Capitol as a "mob." McConnell insisted this week he needed the Senate to clear a slate of 15 conservative judges to lower courts before he could cut senators loose for the midterm elections. McConnell and Schumer appeared at loggerheads. McConnell's goal was clear: extract the confirmation of these nominees – or tether to Washington vulnerable Democratic senators from battleground states to keep them off the campaign trail. Schumer knew McConnell would ultimately prevail on the nominees after the midterms. So the New York Democrat accepted McConnell's ransom,

permitting the Senate vote on a slate of nominees on Thursday night. Schumer also extracted a concession from McConnell: send senators home until November 13th. One may wonder how lawmakers can find themselves in an **imbroglio** over a **major issue** like Kavanaugh – **yet** forge **major bipartisan accords** on other. Frankly, that's just politics. Politics always elicits strange bedfellows. Successful lawmakers know they should **compartmentalize** their disputes. The enemy today may be your best ally tomorrow

That means they don't take their disputes on nuclear and disband other areas into GOP. They read no competing evidence in constructive on this fact.

A2 Biod

1. No brightine they cant just send brink cards and not read them

1. Alt countries trigger the impact - China proves. EIA 24

EIA, 5-6-2024, "China continues rapid growth of nuclear power capacity", US Energy Information Adminstration, https://www.eia.gov/todayinenergy/detail.php?id=61927

In the past 10 years, more than 34 gigawatts (GW) of nuclear power capacity were added in China, bringing the country's number of operating nuclear reactors to 55 with a total net capacity of 53.2 GW as of April 2024. An additional 23 reactors are under construction in China.

The United States has the largest nuclear fleet, with 94 reactors, but it took nearly 40 years to add the same nuclear power capacity as China added in 10 years.

They themselves tell us any expansion of nuclear causes biod loss and extinction, China is expanding 23 right now. Brink analysis doesn't apply

2. Entire arguments NU their ev says decline now

2. No impact to biodiversity.

Sagoff 97 Mark, Senior Research Scholar – Institute for Philosophy and Public policy in School of Public Affairs – U. Maryland, William and Mary Law Review, "INSTITUTE OF BILL OF RIGHTS LAW SYMPOSIUM DEFINING TAKINGS: PRIVATE PROPERTY AND THE FUTURE OF GOVERNMENT REGULATION: MUDDLE OR MUDDLE THROUGH? TAKINGS JURISPRUDENCE MEETS THE ENDANGERED SPECIES ACT", 38 Wm and Mary L. Rev. 825, March, L/N

Note – Colin Tudge - Research Fellow at the Centre for Philosophy at the London School of Economics. Frmr Zoological Society of London: Scientific Fellow and tons of other positions. PhD. Read zoology at Cambridge.

Simon Levin = Moffet Professor of Biology, Princeton. 2007 American Institute of Biological Sciences Distinguished Scientist Award 2008 Istituto Veneto di Scienze Lettere ed Arti 2009 Honorary Doctorate of Science, Michigan State University 2010 Eminent Ecologist Award, Ecological Society of America 2010 Margalef Prize in Ecology, etc… PhD

Although one may agree with ecologists such as Ehrlich and Raven that the earth stands on the brink of an episode of massive extinction, it may not follow from this grim fact that human beings will suffer as a result. On the contrary, skeptics such as science writer Colin Tudge have challenged biologists to explain why we need more than a tenth of the 10 to 100 million species that grace the earth. Noting that "cultivated systems often out-produce wild systems by 100-fold or more," Tudge declared that "the argument that humans need the variety of other species is, when you think about it, a theological one." n343 Tudge observed that "the elimination of all but a tiny minority of our fellow creatures does not affect the material well-being of humans one iota." n344 This skeptic challenged ecologists to list more than 10,000 species (other than unthreatened microbes) that are essential to ecosystem productivity or functioning. n345 "The human species could survive just as well if 99.9% of our fellow creatures went extinct, provided only that we retained the appropriate 0.1% that we need." n346 [*906] The monumental Global Biodiversity Assessment ("the Assessment") identified two positions with respect to redundancy of species. "At one extreme is the idea that each species is unique and important, such that its removal or loss will have demonstrable consequences to the functioning of the community or ecosystem." n347 The authors of the Assessment, a panel of eminent ecologists, endorsed this position, saying it is "unlikely that there is much, if any, ecological redundancy in communities over time scales of decades to centuries, the time period over which environmental policy should operate." n348 These eminent ecologists rejected the opposing view, "the notion that species overlap in function to a sufficient degree that removal or loss of a species will be compensated by others, with negligible overall consequences to the community or ecosystem." n349 Other biologists believe, however, that species are so fabulously redundant in the ecological functions they perform that the life-support systems and processes of the planet and ecological processes in general will function perfectly well with fewer of them, certainly fewer than the millions and millions we can expect to remain even if every threatened organism becomes extinct. n350 Even the kind of sparse and miserable world depicted in the movie Blade Runner could provide a "sustainable" context for the human economy as long as people forgot their aesthetic and moral commitment to the glory and beauty of the natural world. n351 The Assessment makes this point. "Although any ecosystem contains hundreds to thousands of species interacting among themselves and their physical environment, the emerging consensus is that the system is driven by a small number of . . . biotic variables on whose interactions the balance of species are, in a sense, carried along." n352 [*907] To make up your mind on the question of the functional redundancy of species, consider an endangered species of bird, plant, or insect and ask how the ecosystem would fare in its absence. The fact that the creature is endangered suggests an answer: it is already in limbo as far as ecosystem processes are concerned. What crucial ecological services does the black-capped vireo, for example, serve? Are any of the species threatened with extinction necessary to the provision of any ecosystem service on which humans depend? If so, which ones are they? Ecosystems and the species that compose them have changed, dramatically, continually, and totally in virtually every part of the United States. There is little ecological similarity, for example, between New England today and the land where the Pilgrims died. n353 In view of the constant reconfiguration of the biota, one may wonder why Americans have not suffered more as a result of ecological catastrophes. The cast of species in nearly every environment changes constantly-local extinction is commonplace in nature-but the crops still grow. Somehow, it seems, property values keep going up on Martha's Vineyard in spite of the tragic disappearance of the heath hen. One might argue that the sheer number and variety of creatures available to any ecosystem buffers that system against stress. Accordingly, we should be concerned if the "library" of creatures ready, willing, and able to colonize ecosystems gets too small. (Advances in genetic engineering may well permit us to write a large number of additions to that "library.") In the United States as in many other parts of the world, however, the number of species has been increasing dramatically not decreasing, as a result of human activity. This is because the hordes of exotic species coming into ecosystems in the United States far exceed the number of species that are becoming extinct. Indeed, introductions may outnumber extinctions by more than ten to one, so that the United States is becoming more and more species-rich all the time largely as a result of human action. n354 [*908] Peter Vitousek and colleagues estimate that over 1000 non-native plants grow in California alone; in Hawaii there are 861; in Florida, 1210. n355 In Florida more than 1000 non-native insects, 23 species of mammals, and about 11 exotic birds have established themselves. n356 Anyone who waters a lawn or hoes a garden knows how many weeds desire to grow there, how many birds and bugs visit the yard, and how many fungi, creepy-crawlies, and other odd life forms show forth when it rains. All belong to nature, from wherever they might hail, but not many homeowners would claim that there are too few of them. Now, not all exotic species provide ecosystem services; indeed, some may be disruptive or have no instrumental value. n357 This also may be true, of course, of native species as well, especially because all exotics are native somewhere. Certain exotic species, however, such as Kentucky blue grass, establish an area's sense of identity and place; others, such as the green crabs showing up around Martha's Vineyard, are nuisances. n358 Consider an analogy [*909] with human migration. Everyone knows that after a generation or two, immigrants to this country are hard to distinguish from everyone else. The vast majority of Americans did not evolve here, as it were, from hominids; most of us "came over" at one time or another. This is true of many of our fellow species as well, and they may fit in here just as well as we do. It is possible to distinguish exotic species from native ones for a period of time, just as we can distinguish immigrants from native-born Americans, but as the centuries roll by, species, like people, fit into the landscape or the society, changing and often enriching it. Shall we have a rule that a species had to come over on the Mayflower, as so many did, to count as "truly" American? Plainly not. When, then, is the cutoff date? Insofar as we are concerned with the absolute numbers of "rivets" holding ecosystems together, extinction seems not to pose a general problem because a far greater number of kinds of mammals, insects, fish, plants, and other creatures thrive on land and in water in America today than in prelapsarian times. n359 The Ecological Society of America has urged managers to maintain biological diversity as a critical component in strengthening ecosystems against disturbance. n360 Yet as Simon Levin observed, "much of the detail about species composition will be irrelevant in terms of influences on ecosystem properties." n361 [*910] He added: "For net primary productivity, as is likely to be the case for any system property, biodiversity matters only up to a point; above a certain level, increasing biodiversity is likely to make little difference." n362

A2 Grid stability

The only relevant empiric in this round - the US - finds nuclear and renewables work together, there has been no tradeoff.

Nuclear **I**nnovation **A**lliance, 10-07-20**20**, "We Need Both Nuclear and Renewables to Protect the Climate", Nuclear Innovation Alliance,

https://www.nuclearinnovationalliance.org/we-need-both-nuclear-and-renewables-protect-climate // Lunde

A review of country-level data further supports the importance of nuclear power in decarbonization. The number one producer of nuclear power in the world is the United States, where existing nuclear power plants still provide more than half of carbon-free clean electricity. Contrary to the study's conclusion that nuclear and renewable crowd each other out, the US is also emerging as a strong leader in **renewable** energy, with solar and wind growing rapidly. Policies that value nuclear and renewable energy can help both sectors grow and reduce US emissions further. China, the largest producer of solar panels, is also aggressively pursuing nuclear power and is on track to the become the second largest producer of nuclear energy. In the European Union, the countries with the lowest power sector emissions are countries that embrace nuclear power.

At the U.S. state level, nuclear and renewable energy are working together to decarbonize electric grids, as seen in the chart below. The top 10 nuclear producing states have an average carbon intensity **~30% lower** than the national average. More broadly, states with some nuclear generation have an emissions intensity 24% lower than states without it.

Prefer the US empirics it's specific to aff investment and finds nuclear and renewable can work together