C1 is Energy

Quantum computing requires an insane amount of energy, Tran 25'

Bao Tran, Patent Attorney, 3-18-2025, "Quantum Computing Energy Consumption: How Sustainable Is It? (Latest Data)," PatentPC, https://patentpc.com/blog/quantum-computing-energy-consumption-how-sustainable-is-it-latest-data, accessed 3-26-2025 //RR

Quantum computing is often seen as the future of computing, promising breakthroughs in everything from drug discovery to artificial intelligence. But there's a big question that few people ask: how much energy does quantum computing use? And more importantly, how sustainable is it? What's next for AVs? Get 2030 market predictions on growth, expansion & key industry trends. 1. Quantum computers **require cryogenic cooling, consuming up to 25 kW per dilution refrigerator**. **Superconducting quantum computers, the most common type today, require extremely low temperatures—colder than outer space—to function. This is achieved using dilution refrigerators, which are complex machines that cool quantum processors to near absolute zero**. A single dilution refrigerator can consume up to 25 kW of power, which is a significant amount when considering energy efficiency. To put that into perspective, this is equivalent to running 25 high-powered air conditioners continuously. Actionable Insight: **For quantum computing to be sustainable, cooling technology must become more energy-efficient**. Researchers are working on new refrigeration techniques, such as cryogen-free cooling and alternative materials that require less extreme temperatures. Companies looking to use quantum computing should factor in the long-term energy costs of cooling. 2. A superconducting quantum processor operates at around 15 millikelvin, requiring substantial cooling energy. **The core of a superconducting quantum computer needs to be at about 15 millikelvin—a temperature so low that even the tiniest vibrations can generate heat and disrupt the system. Maintaining this extreme cold requires constant refrigeration**. This cooling process uses a cascade system, where several cooling stages progressively lower the temperature. Each of these steps demands energy, and inefficiencies at any stage result in higher power usage. Actionable Insight: More sustainable cooling methods could include new materials that remain superconducting at higher temperatures. Research into alternative qubit architectures, such as photonic or topological qubits, could eliminate the need for extreme cooling altogether. 3**. A single dilution refrigerator can consume as much power as 10 average U.S. households. The average U.S. household uses about 2-3 kW of power at any given time. That means one dilution refrigerator consumes as much power as 10 homes running continuously**. This raises concerns about the environmental impact of quantum computing. **If quantum computers scale up significantly, their energy consumption could become a serious challenge.** Actionable Insight: **Businesses investing in quantum technology should factor in energy costs**. Data centers using quantum computers must integrate renewable energy sources to minimize environmental impact. 4. Quantum processors themselves consume negligible power—on the order of milliwatts. Despite the high energy cost of cooling, quantum processors themselves consume almost no power. A single qubit operates on just milliwatts of energy, far less than traditional transistors in a classical computer. This suggests that if cooling efficiency improves, quantum computing could eventually be more energy-efficient than classical computing for complex problems. Actionable Insight: Optimization should focus on reducing supporting energy demands. Companies developing quantum computers should explore hybrid cooling solutions that minimize the power needed while maintaining qubit stability. 5. **Control electronics for quantum computers use kilowatts of energy per system**. While qubits require very little power, the electronics that control them do not. These include microwave signal generators, error correction processors, and readout systems. Together, they consume several kilowatts per quantum computing system. For large-scale quantum computers, this control infrastructure becomes a major bottleneck in energy efficiency. Actionable Insight: Is this article too long? Click Here To Download It For Free! Plus, get a checklist on how to execute the tips in this article, step by step Bao PatentPC Making Intellectual Property Easier Developing low-power control electronics is critical. Researchers are exploring cryogenic electronics that work at low temperatures, reducing the need for high-powered classical controllers. 6. IBM's 127-qubit Eagle processor requires around 10 kW just for control and readout electronics. IBM's 127-qubit Eagle processor is one of the most advanced quantum chips, but its support infrastructure requires 10 kW of power—just for control and readout. This highlights a key issue: as quantum processors grow, the power required to manage them increases, potentially outweighing the efficiency gains of quantum computation. Actionable Insight: Efforts should focus on optimizing qubit connectivity and reducing error correction overhead. Smarter architectures that require fewer classical control components will lower energy demands. 7. Google's Sycamore 53-qubit processor used around 26 kW for supporting infrastructure. When Google achieved "quantum supremacy" with its 53-qubit Sycamore processor, the total energy consumption—including cooling and control systems—was approximately 26 kW. This level of energy consumption is a concern because it suggests that even relatively small quantum computers consume as much power as multiple high-performance classical systems. Actionable Insight: Future quantum computing centers must integrate energy-efficient designs from the ground up. This includes better thermal management, optimized control electronics, and renewable energy integration. 8. **Quantum computers require thousands of classical processors for error correction, adding to power usage**. Quantum computers are incredibly error-prone, meaning they rely on thousands of classical processors to perform error correction. These classical processors significantly increase the total power demand of a quantum system. Error correction remains one of the biggest hurdles to scalable quantum computing. Actionable Insight: Research is moving toward more efficient error correction codes that require fewer classical resources. Advancements in quantum error correction could drastically reduce the energy footprint. Research is moving toward more efficient error correction codes that require fewer classical resources. Advancements in quantum error correction could drastically reduce the energy footprint. 9. Classical supercomputers used to simulate quantum circuits can consume several megawatts of power. Simulating a quantum computer using a classical system is extremely energy-intensive. Some supercomputers consume over 5 MW just to run quantum simulations. This highlights why quantum computers could be more energy-efficient for certain calculations—if their overhead energy costs can be reduced. Actionable Insight: Investment should prioritize applications where quantum computing is significantly more efficient than classical alternatives, reducing overall energy use. 10. The Frontier supercomputer, used for quantum simulations, consumes around 21 MW. Frontier, one of the world's fastest supercomputers, consumes a staggering 21 MW of power. It is often used to model quantum systems. If quantum computers can achieve practical error correction, they could surpass supercomputers while using far less energy. Actionable Insight: The transition to practical quantum computing should prioritize replacing energy-hungry classical simulations with quantum alternatives where appropriate.

Data centers don't have enough power - need nuclear energy, Hapler 24'

Evan Halper [a business reporter for The Washington Post, covering the energy transition. His work focuses on the tensions between energy demands and decarbonizing the economy. He came to The Post from the Los Angeles Times, where he spent two decades, most recently covering domestic policy and presidential politics from its Washington bureau], 2024-03-07, "Amid explosive demand, America is running out of power," Washington Post, https://www.washingtonpost.com/business/2024/03/07/ai-data-centers-power/, Date Accessed: 2025-03-21T17:03:46.088Z //RX

Vast swaths of the United States are at risk of running short of power as electricity-hungry data centers and clean-technology factories proliferate around the country, leaving utilities and regulators grasping for credible plans to expand the nation's creaking power grid. In Georgia, demand for industrial power is surging to record highs, with the **projection of new electricity use for the next decade now 17 times what it was** only **recently**. Arizona Public Service, the largest utility in that state, is also struggling to keep up, projecting it will be out of transmission capacity before the end of the decade absent major upgrades. **Northern Virginia needs the equivalent of several large nuclear power plants to serve all the new data centers planned and under construction.** Texas, where electricity shortages are already routine on hot summer days, faces the same dilemma. Advertisement The soaring demand is touching off a scramble to try to squeeze more juice out of an aging power grid while pushing commercial customers to go to extraordinary lengths to lock down energy sources, such as building their own power plants. "When you look at the numbers, it is staggering," said Jason Shaw, chairman of the Georgia Public Service Commission, which regulates electricity. "It makes you scratch your head and wonder how we ended up in this situation. How were the projections that far off? This has created a challenge like we have never seen before." A major factor behind the skyrocketing demand is the **rapid innovation in artificial intelligence, which is driving the construction of large warehouses of computing infrastructure that require exponentially more power than traditional data centers**. AI is also part of a huge scale-up of cloud computing. Tech firms like Amazon, Apple, Google, Meta and Microsoft are scouring the nation for sites for new data centers, and many lesser-known firms are also on the hunt. **The proliferation of crypto-mining, in which currencies like bitcoin are transacted and minted, is also driving data center growth.** It is all putting new pressures on an overtaxed grid — the network of transmission lines and power stations that move electricity around the country. Bottlenecks are mounting, leaving both new generators of energy, particularly clean energy, and large consumers facing growing wait times for hookups. The situation is sparking battles across the nation over who will pay for new power supplies, with regulators worrying that residential ratepayers could be stuck with the bill for costly upgrades. It also threatens to stifle the transition to cleaner energy, as utility executives lobby to delay the retirement of fossil fuel plants and bring more online. **The power crunch imperils their ability to supply the energy that will be needed to charge the millions of electric cars** and household appliances required to meet state and federal climate goals. The nation's 2,700 data centers sapped more than 4 percent of the country's total electricity in 2022, according to the International Energy Agency. Its projections show that by 2026, they will consume 6 percent. Industry forecasts show the centers eating up a larger share of U.S. electricity in the years that follow, as demand from residential and smaller commercial facilities stays relatively flat thanks to steadily increasing efficiencies in appliances and heating and cooling systems. Skip to end of carousel Power Grab The artificial intelligence industry is driving a nationwide data center building boom. These sprawling warehouses of computing infrastructure are creating explosive demand for power, water and other resources. Power Grab investigates the impacts on America and the risks AI infrastructure creates for the environment and the energy transition. End of carousel Data center operators are clamoring to hook up to regional electricity grids at the same time the Biden administration's industrial policy is luring companies to build factories in the United States at a pace not seen in decades. That includes manufacturers of "clean tech," such as solar panels and electric car batteries, which are being enticed by lucrative federal incentives. Companies announced plans to build or expand more than 155 factories in this country during the first half of the Biden administration, according to the Electric Power Research Institute, a research and development organization. Not since the early 1990s has factory-building accounted for such a large share of U.S. construction spending, according to the group. Utility projections for the amount of power they will need over the next five years have nearly doubled and are expected to grow, according to a review of regulatory filings by the research firm Grid Strategies. Chasing power In the past, companies tried to site their data centers in areas with major internet infrastructure, a large pool of tech talent, and attractive government incentives. But these locations are getting tapped out. Communities that had little connection to the computing industry now find themselves in the middle of a land rush, with data center developers flooding their markets with requests for grid hookups. Officials in Columbus, Ohio; Altoona, Iowa; and Fort Wayne, Ind. are being aggressively courted by data center developers. **But power supply in some of these second-choice markets is already running low**, pushing developers ever farther out, in some cases into cornfields, according to JLL, a commercial real estate firm that serves the tech industry. Grid Strategies warns in its report that "there are real risks some regions may miss out on economic development opportunities because the grid can't keep up." "Across the board, we are seeing power companies say, 'We don't know if we can handle this; we have to audit our system; we've never dealt with this kind of influx before,'" said Andy Cvengros, managing director of data center markets at JLL. "Everyone is now chasing power. They are willing to look everywhere for it." "We saw a quadrupling of land values in some parts of Columbus, and a tripling in areas of Chicago," he said. "It's not about the land. It is about access to power." Some developers, he said, have had to sell the property they bought at inflated prices at a loss, after utilities became overwhelmed by the rush for grid hookups. Rethinking incentives It is all happening at the same time the energy transition is steering large numbers of Americans to rely on the power grid to fuel vehicles, heat pumps, induction stoves and all manner of other household appliances that previously ran on fossil fuels. A huge amount of clean energy is also needed to create the green hydrogen championed by the White House, as developers rush to build plants that can produce the powerful zero-emissions fuel, lured by generous federal subsidies. **Planners are increasingly concerned that the grid won't be green enough or powerful enough to meet these demands.** Already, soaring power consumption is delaying coal plant closures in Kansas, Nebraska, Wisconsin and South Carolina. In Georgia, the state's major power company, Georgia Power, stunned regulators when it revealed recently how wildly off its projections were, pointing to data centers as the main culprit. The demand has Georgia officials rethinking the state's policy of offering incentives to lure **computing operations**, which generate few jobs but can **boost community budgets through the hefty property**

taxes they pay. The top leaders of Georgia’s House and Senate, both Republicans, are championing a pause in data center incentives. Georgia regulators, meanwhile, are exploring how to protect ratepayers while ensuring there is enough power to meet the needs of the state’s most-prized new tenants: clean-technology companies. Factories supplying the electric vehicle and green-energy markets have been rushing to locate in Georgia in large part on promises of cheap, reliable electricity. When the data center industry began looking for new hubs, “Atlanta was like, ‘Bring it on,’” said Pat Lynch, who leads the Data Center Solutions team at real estate giant CBRE. “**Now Georgia Power is warning of limitations. ... Utility shortages in the face of these data center demands are happening in almost every market.” A similar dynamic is playing out in a very different region: the Pacific Northwest. In Oregon, Portland General Electric recently doubled its forecast for new electricity demand over the next five years, citing data centers and “rapid industrial growth” as the driver**s. That power crunch threw a wrench into the plans of Michael Halaburda and Arman Khalili, longtime data center developers whose latest project involves converting a mothballed tile factory in the Portland area. The two were under the impression only a couple of months ago that they would have no problem getting the electricity they needed to run the place. Then the power company alerted them that it would need to do a “line and load study” to assess whether it could supply the facility with 60 megawatts of electricity — roughly the amount needed to power 45,000 homes.

Nuke power will solve the energy shortage, Kramer 24’

Anna Kramer, a human, 8-27-2024, "Nuclear Power Could Solve a U.S. Energy Crisis, If States Can Figure Out How to Pay for It," NOTUS, https://www.notus.org/policy/nuclear-power-energy-crisis-cost, accessed 3-27-2025 //RR

There’s an obvious solution to the compounding energy problems in the United States, but even overwhelming bipartisan excitement can’t overcome one critical obstacle: States say it’s just too expensive. Nuclear power is a source of nearly unlimited, carbon-free, dependable energy that could significantly alleviate the stress on the United States’ electrical grid and any subsequent spikes in electricity prices. This year, Congress passed nuclear reform with near unanimity, with only two senators and 13 House members in opposition. Yet state public utility commissioners are warning that without even more significant federal investment, **new nuclear plants are simply out of reach — or run the risk of seriously increasing consumers’ costs**. “I’m urging commissioner colleagues from around the country to use great caution when considering nuclear,” Tim Echols, one of Georgia’s public service commissioners, said. Echols is an unlikely naysayer; he’s a fan of nuclear power who helped ensure that the first new plant in the country in more than 20 years made it over the finish line in Georgia in 2023. Plant Vogtle will bring stable, dependable, nearly unlimited power to the state. **Still, Georgians will have to pay significantly more for electricity because the project went billions of dollars over budget**. “They are all somewhat aware of Vogtle’s issues here in Georgia, and I want them to be successful in their efforts,” Echols said. Echols and fellow state commissioner Nick Myers in Arizona have been arguing in private meetings and in editorials for the energy community that the Department of Energy and Congress should embrace the idea of a federal backstop to cover the cost overruns for future new nuclear plants. **Echols wants the government to allocate $50 billion of IRA funding for five reactors instead of passing the prices along in the electricity bills of the communities served by the nuclear plant. “Regulators don’t want to pass the costs on to the ratepayers,” Myers said**.

Independently, NPPs are more reliable, ONE 22’

Office for Nuclear Energy, United States Office on Energy, an organisation, x-xx-2022, "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, accessed 3-27-2025 //RR

Nuclear energy has the highest capacity factor of any energy source, and it's not even close. Nuclear energy is America’s work horse. It’s been rolling up its sleeves for six decades now to provide constant, reliable, carbon-free power to millions of Americans. Just how reliable has nuclear energy been? It has roughly supplied a fifth of America’s power each year since 1990. To better understand what makes nuclear so reliable, take a look at the graph below. Nuclear Has The Highest Capacity Factor 2020 U.S. Capacity Factor by Source 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 as natural gas and coal units**, and almost 3 times or more reliable than wind and solar plants. Why Are Nuclear Power Plants More Reliable? 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. Why Does This Matter? **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**.

Tech race coming, Buchaniec 22'

Catherine Buchaniec, reporter at C4ISRNET in ai, 9-13-2022, "US approaching 'critical time' in tech race with China, report says," C4ISRNet, https://www.c4isrnet.com/artificial-intelligence/2022/09/13/us-approaching-critical-time-in-tech-race-with-china-report-says/, accessed 3-26-2025 //RR

The nearly 200-page assessment, called the "Mid-Decade Challenges to National Competitiveness," is the first published by the Special Competitive Studies Project, a private group led by Eric Schmidt, former Google CEO and co-chairman of the U.S government's National Security Commission on Artificial Intelligence, and Work, who serves on the group's board of advisors. The organization seeks to build on the work completed by the congressionally mandated AI commission, which identified technology as the central element of the rivalry between the U.S. and China. The commission wrapped up its work last October. According to the report, **the years 2025 to 2030 will prove critical in deciding whether the U.S. keeps pace or falls behind in the technology battle. Losing the competition could comprise Americans' daily lives**, the report said. Not only could China use its techno-economic advantage for political leverage, but Chinese domination could threaten free access to the internet and create a dependence on the country for most core digital technologies, making nations vulnerable to cyber attacks. "**Up to this point, because of the 20 years we spent in the Middle East, it kind of took our eyes off the ball**," Work said. "As this technological rivalry and competition was really growing in strength, we didn't really respond as we normally have done in the past." **Three technology battlegrounds — microelectronics, fifth-generation wireless technology (5G), and AI — tell the story of the U.S. and its allies coming perilously close to ceding the strategic technology landscape**, the report said. Those technologies represent the critical hardware, network infrastructure and software underpinning everyday life in the U.S. as well as the country's national security apparatus.

Quantum Computing k2 tech advantage, Harper 24'

Jon Harper, Chief Strategy Officer at Strangeworks, a quantum computing and AI software company, co-founded the Quantum Alliance Initiative, 10-1-2024, "The international AI race needs quantum computing," DefenseScoop, https://defensescoop.com/2025/02/19/international-ai-race-needs-quantum-computing/, accessed 3-26-2025 //RR

Quantum computing is the solution to these challenges. Quantum computers will generate higher volumes of data and higher quality data than classical synthetic data. "The future of generative AI training lies in combining real-world data with both classical and quantum synthetic data," says Dr. Graham Enos, vice president of quantum solutions at Strangeworks and a former DOD mathematician. "As quantum computing advances, quantum synthetic data will increasingly dominate the synthetic data used to train AI. What's exciting is that synthetic data generation is one of the most immediate and practical applications of quantum computers." The seemingly otherworldly properties of quantum computers make them ideal for the machine learning and simulation tasks that generate synthetic data. Unlike classical computers, which rely on bits that are either 0 or 1, quantum computers use qubits that can exist in a superposition of both states simultaneously, providing exponentially greater computing power. Entanglement is another critical property of quantum computing that allows qubits to represent more complex data distributions, enabling more complicated calculations than classical computers. By leveraging both superposition and entanglement, quantum computers can double their compute power simply by adding one qubit — in contrast, classical systems require doubling the number of transistors to double compute power. Five years ago, the largest quantum computer was Google's 53-qubit Sycamore chip that demonstrated "beyond classical" performance on a computational benchmark. The largest machines built today, from IBM and Atom Computing, boast upwards of 1,000 qubits. While quantum computers are not yet outperforming classical computers for practical applications, including generating meaningful quantum synthetic data for commercial AI training, they are quickly approaching that moment. **The impacts of quantum computing go beyond improving AI models. Additional defense-related applications include cybersecurity threat detection, adversarial intent prediction, cryptanalysis, electromagnetic spectrum operations, and many more.**

Tech race cause war Kroenig 21

Matthew **Kroenig**, Winter **2021**, "Will Emerging Technology Cause Nuclear War?", Strategic Studies Quarterly, Vol 15 , No 4, page 59-73, https://www.jstor.org/stable/pdf/48638052.pdf?refreqid=excelsior%3A9a8d10d8455b3a3cc9a8b5a98f9f26b0&ab_segments=&origin=, Date Accessed 4-10-2022 // NDF-JM

In contrast, **China** and Russia **are revisionist powers intent on disrupting or displacing the US-led system**, **and they would** likely **employ new tech**nological **advantages to pursue revisionist aims**. The greatest **danger** from emerging technology for nuclear stability, therefore, **may result from the possibility that new tech**nology **provides** Russia or **China an enhanced military advantage over vulnerable US Allies** and partners, **leading to a regional conflict with a significant risk of nuclear escalation**. This article contributes to the growing literature on new technology and nuclear stability by emphasizing politics take precedence over technology.8 Technology rarely transforms states. More commonly, states employ technologies to achieve preexisting ends. It is not simply the technologies themselves that are destabilizing **but the geopolitical ambitions of the states that possess them.** In emphasizing the divergent positions of the United States of America and its nuclear-armed rivals in the international system, this article also contributes to a growing body of literature that takes seriously hierarchy in international relations theory.9 The United States, the international system's leader for the past several decades, is likely to use new technology to reinforce its advantageous position within the existing international order. **China** and Russia **will** most likely **employ new tech**nology **in bids to erode America's privileged position**. Analyses not grounded in an understanding of these states' different positions in the prevailing international order risk overlooking this important source of variation in conflict behavior and nuclear-escalation dynamics.

Great power war goes nuclear, Talmadge 18

Caitlin Talmadge 18, Associate Professor of Security Studies at the Edmund A. Walsh School of Foreign Service at Georgetown University, "Beijing's Nuclear Option: Why a U.S.-Chinese War Could Spiral Out of Control", https://www.foreignaffairs.com/articles/china/2018-10-15/beijings-nuclear-option, //RR

As China's power has grown in recent years,so, too, has the **risk of war** with the United States. Under President Xi Jinping, u has increased its political and economic pressure on Taiwan and built military installations on coral reefs in the South China Sea, **fueling Washington's fears** that Chinese expansionism will threaten U.S. allies and influence in the region. U.S. destroyers have transited the Taiwan Strait, to loud protests from Beijing. American policymakers have wondered aloud whether they should send an aircraft carrier through the strait as well. Chinese fighter jets have **intercepted** U.S. aircraft in the skies above the South China Sea. Meanwhile, U.S. President Donald Trump has brought long-simmering economic disputes to a rolling boil. A war between the two countries remains unlikely, but the prospect of a military confrontation—resulting, for example, from a Chinese campaign against Taiwan—**no longer** seems as implausible as it once did. And the **odds of such a confrontation going nuclear are higher than most policymakers and analysts think.** Members of China's strategic community tend to dismiss such concerns. Likewise, **U.S. studies of a potential war with China often** exclude **nuclear weapons from the analysis entirely, treating them as basically irrelevant to the course of a conflict**. Asked about the issue in 2015, Dennis Blair, the former commander of U.S. forces in the Indo-Pacific, estimated the likelihood of a U.S.-Chinese nuclear crisis as "somewhere between nil and zero." This **assurance is misguided**. If deployed against China,the Pentagon's preferred style of conventional warfare would be a potential recipe for **nuclear escalation**. Since the end of the Cold War, the United States' signature approach to war has been simple: punch deep into enemy territory in order to rapidly knock out the opponent's key military assets at minimal cost. But the Pentagon developed this formula in wars against Afghanistan, Iraq, Libya, and Serbia, none of which was a nuclear power. If deployed against China, the Pentagon's preferred style of conventional warfare would be a potential recipe for nuclear escalation. **China, by contrast, not only has nuclear weapons; it has also intermingled them with its conventional military forces**, **making it difficult to attack one without attacking the other**. This means that a **major U.S. military campaign targeting China's conventional forces would likely also threaten its nuclear arsenal**. **Faced with such a threat, Chinese leaders could decide to use their nuclear weapons while they were still able to**. As U.S. and Chinese leaders navigate a relationship fraught with mutual suspicion, they must come to grips with the fact that a conventional war could skid into a nuclear confrontation. Although this risk is not high in absolute terms, its consequences for the region and the world would be **devastating**. As long as the United States and China continue to pursue their current grand strategies, the risk is likely to endure. This means that leaders on both sides should dispense with the illusion that they can easily fight a limited war. They should focus instead on managing or resolving the political, economic, and military tensions that might lead to a conflict in the first place. There are some reasons for optimism. For one, China has long stood out for its nonaggressive nuclear doctrine. After its first nuclear test, in 1964, China largely avoided the Cold War arms race, building a much smaller and simpler nuclear arsenal than its resources would have allowed. Chinese leaders have consistently characterized nuclear weapons as useful only for deterring nuclear aggression and coercion. Historically, this narrow purpose required only a handful of nuclear weapons that could ensure Chinese retaliation in the event of an attack. To this day, China maintains a "no first use" pledge, promising that it will never be the first to use nuclear weapons. The prospect of a nuclear conflict can also seem like a relic of the Cold War. Back then, the United States and its allies lived in fear of a Warsaw Pact offensive rapidly overrunning Europe. NATO stood ready to use nuclear weapons first to stalemate such an attack. Both Washington and Moscow also consistently worried that their nuclear forces could be taken out in a bolt-from-the-blue nuclear strike by the other side. This mutual fear increased the risk that one superpower might rush to launch in the erroneous belief that it was already under attack. Initially, the danger of unauthorized strikes also loomed large. In the 1950s, lax safety procedures for U.S. nuclear weapons stationed on NATO soil, as well as minimal civilian oversight of U.S. military commanders, raised a serious risk that nuclear escalation could have occurred without explicit orders from the U.S. president. The good news is that these Cold War worries have little bearing on U.S.-Chinese relations today. Neither country could rapidly overrun the other's territory in a conventional war. Neither seems worried about a nuclear bolt from the blue. And civilian political control of nuclear weapons is relatively strong in both countries. What remains, in theory, is the comforting logic of mutual deterrence: in a war between two nuclear powers, neither side will launch a nuclear strike for fear that its enemy will respond in kind. The bad news is that one other trigger remains: a conventional war that **threatens** China's nuclear arsenal. Conventional forces can threaten **nuclear forces**in ways that **generate pressures to escalate**—especially when ever more **capable** U.S. conventional forces face adversaries with relatively small and fragile nuclear arsenals, such as China. If U.S. operations endangered or damaged China's nuclear forces, Chinese leaders might come to think that Washington had aims beyond winning the conventional war—that it might be seeking to disable or destroy China's nuclear arsenal outright, perhaps as a prelude to regime change. In the **fog of war**, Beijing might reluctantly conclude that limited nuclear escalation—an initial strike small enough that it could avoid full-scale U.S. retaliation—was a viable option to defend itself.

The draw-in causes extinction.

Clare 23 [Stephen Clare, former research fellow @ the Forethought Foundation, 6-xx-2023, Great power war, 80,000 Hours, https://80000hours.org/problem-profilesgreat-power-conflict/] //RR

A modern great power war could see nuclear weapons, bioweapons, autonomous weapons, and other destructive new technologies deployed on an unprecedented scale. It would probably be the most destructive event in history, shattering our world. It could even threaten us with extinction. We've come perilously close to just this kind of catastrophe before.¶ On October 27, 1962 — near the peak of the Cuban Missile Crisis — an American U-2 reconnaissance plane set out on a routine mission to the Arctic to collect data on Soviet nuclear tests. But, while flying near the North Pole, with the stars obscured by the northern lights, the pilot made a navigation error and strayed into Soviet airspace.1¶ Soviet commanders sent fighter jets to intercept the American plane. The jets were picked up by American radar operators and nuclear-armed F-102 fighters took off to protect the U-2.¶ Fortunately, the reconnaissance pilot realised his error with enough time to correct course before the Soviet and American fighters met. But the intrusion enraged Soviet Premier Nikita Khrushchev, who was already on high alert amidst the crisis in Cuba.¶ "What is this, a provocation?" Khrushchev wrote to US President John F. Kennedy. "One of your planes violates our frontier during this anxious time when everything has been put into combat readiness."¶ If the U-2's path had strayed further west, or the Soviet fighters had been fast enough to intercept it, this incident could have played out quite differently. Both the United States and the USSR had thousands of nuclear missiles ready to fire. Instead of a nearly-forgotten anecdote, the U-2 incident could have been a trigger for war, like the assassination of Franz Ferdinand.¶ Competition among the world's most powerful countries shapes our world today. And whether it's through future incidents like the lost U-2, or something else entirely, it's plausible that it could escalate and lead to a major, devastating war.¶ Is there anything you can do to help avoid such a terrible outcome? It is, of course, difficult to imagine how any one individual can hope to influence such world-historical events. Even the most powerful world leaders often fail to predict the global consequences of their decisions.¶ But I think the likelihood and severity of great power war makes this among the most pressing problems of our time — and that some solutions could be impactful enough that working on them may be one of the highest-impact things to do with your career.¶ By taking action, I think we can create a future where the threat of great power war is a distant memory rather than an ever-present danger.¶ Summary¶ Economic growth and technological progress have bolstered the arsenals of the world's most powerful countries. That means the next war between them could be far worse than World War II, the deadliest conflict humanity has yet experienced.¶ Could such a war actually occur? We can't rule out the possibility. Technical **accidents or diplomatic misunderstandings** could spark a conflict that quickly **escalates**. Or international **tension could cause leaders to decide they're better off fighting than negotiating.** It seems hard to make progress on this problem. It's also less neglected than some of the problems that we think are most pressing. There are certain issues, like making nuclear weapons or military artificial intelligence systems safer, which seem promising — although it may be more impactful to work on reducing risks from AI, bioweapons or nuclear weapons directly. You might also be able to reduce the chances of misunderstandings and miscalculations by developing expertise in one of the most important bilateral relationships (such as that between the United States and China).¶ Finally, by making conflict less likely, reducing competitive pressures on the development of dangerous technology, and improving international cooperation, you might be helping to reduce other risks, like the chance of future pandemics.¶ Our overall view¶ Recommended¶ Working on this issue seems to be among the best ways of improving the long-term future we know of, but all else equal, we think it's less pressing than our highest priority areas (primarily because it seems less neglected and harder to solve).¶ Scale There's a significant chance that a new great power war occurs this century.¶ Although the world's most powerful countries haven't fought directly since World War II, war has been a constant throughout human history. There have been numerous close calls, and several issues could cause diplomatic disputes in the years to come.¶ These considerations, along with forecasts and statistical models, lead me to think there's about a one-in-three chance that a new great power war breaks out in roughly the next 30 years.¶ Few wars cause more than a million casualties and the next great power war would probably be smaller than that. However, there's some chance it could escalate massively. Today the great powers have much larger economies, more powerful weapons, and bigger military budgets than they did in the past. An all-out war could kill far more people than even World War II, the worst war we've yet experienced.¶ Could it become an existentially threatening war — one that could cause human extinction or significantly damage the prospects of the long-term future? It's very difficult to say. But my best current guess is that the chance of an existential catastrophe due to war in the next century is somewhere between 0.05% and 2%.¶ Neglectedness War is a lot less neglected than some of our other top problems. There are thousands of people in governments, think tanks, and universities already working on this problem. But some solutions or approaches remain neglected. One particularly promising approach is to develop expertise at the intersection of international conflict and another of our top problems. Experts who understand both geopolitical dynamics and risks from advanced artificial intelligence, for example, are sorely needed.¶ Solvability Reducing the risk of great power war seems very difficult. But there are specific technical problems that can be solved to make weapons systems safer or less likely to trigger catastrophic outcomes. And in the best case, working on this problem can have a leverage effect, making the development of several dangerous technologies safer by improving international cooperation and making them less likely to be deployed in war.¶ At the end of this profile, I suggest five issues which I'd be particularly excited to see people work on. These are:¶ Developing expertise in the riskiest bilateral relationships¶ Learning how to manage international crises quickly and effectively and ensuring the systems to do so are properly maintained¶ Doing research to improve particularly important foreign policies, like strategies for sanctions and deterrence¶ Improving how nuclear weapons and other weapons of mass destruction are governed at the international level¶ Improving how such weapons are controlled at the national level¶ Why might preventing great power war be an especially pressing problem?¶ A modern great power war — an all-out conflict between the world's most powerful countries — could be the worst thing to ever happen to humanity.¶ Historically, such wars have been exceptionally destructive. Sixty-six million people died in World War II, likely the deadliest catastrophe humanity has experienced so far.¶ Since World War II, the global population and world economy have continued to grow, nuclear weapons have proliferated, and military technology has continued to advance. This means the next world war could be even worse, just as World War II was much deadlier than World War I.¶ It's not guaranteed that such a war will break out. And if it does, it may not escalate to such a terrible extent. But the chance can't be ignored. In fact, there are reasons to think that the odds of World War III breaking out this century are worryingly high.¶ A modern great power war would be devastating for people alive today. But its effects could also persist long into the future. That's because there is a substantial chance that this century proves to be particularly important. Technologies with the potential to cause a global catastrophe or radically reshape society are likely to be invented. How we choose to develop and deploy them could impact huge numbers of our descendants. And these choices would be affected by the outcomes of a major war.¶ To be more specific, there are three main ways great power conflict could affect the long-term future:¶ High international tension could increase other risks. Great power tensions could make the world more dangerous even if they don't lead to war. During the Cold War, for example, the United States and the USSR never came into direct conflict but invested in bioweapons research and built up nuclear arsenals. This dynamic could return, with tension between great powers fueling races to develop and build new weapons, raising the risk of a disaster even before shots are fired.¶ War could cause an existential catastrophe. If war does break out, it could escalate dramatically, with modern weapons (nuclear weapons, bioweapons, autonomous weapons, or other future technologies) deployed at unprecedented scale. The resulting destruction could irreparably damage humanity's prospects.¶ War could reshape international institutions and power balances. While such a catastrophic war is possible, it seems extremely unlikely. But even a less deadly war, such as another conflict on the scale of World War II, could have very long-lasting effects. For example, it could reshape international institutions and the global balance of power. In a pivotal century, different institutional arrangements and geopolitical balances could cause humanity to follow different long-term trajectories.¶ The rest of this profile explores exactly how pressing a problem great power conflict is. In summary:¶ Great power relations have become more tense. (More.)¶ Partly as a result, a war is more likely than you might think. It's reasonable to put the probability of such a conflict in the coming decades somewhere between 10% and 50%. (More.)¶ If war breaks out, it would probably be hard to control escalation. The chance that it would become large enough to be an existential risk cannot be dismissed. (More.)¶ This makes great power war one of the biggest threats our species currently faces. (More.)¶ It seems hard to make progress on solving such a difficult problem (more) — but there are many things you can try if you want to help (more).¶ International tension has risen and makes other problems worse¶ Imagine we had a thermometer-like device which, instead of measuring temperature, measured the level of international tension.2 This 'tension metre' would max out during periods of all-out global war, like World War II. And it would be relatively low when the great powers3 were peaceful and cooperative. For much of the post-Napoleonic 1800s, for example, the powerful European nations instituted the Concert of Europe and mostly upheld a continental peace. The years following the fall of the USSR also seem like a time of relative calm, when the tension metre would have been quite low.4¶ How much more worried would you be about the coming decades if you knew the tension metre would be very high than if you knew it would be low? Probably quite a lot. In the worst case, of course, the great powers could come into direct conflict. But even if it doesn't lead to war, a high level of tension between great powers could accelerate the development of new strategic technologies, make it harder to solve global problems like climate change, and undermine international institutions.¶ During the Cold War, for instance, the United States and USSR avoided coming into direct conflict. But the tension metre would still have been pretty high. This led to some dangerous events:¶ A nuclear arms race. The number of nuclear warheads in the world grew from just 300 in 1950 to over 64,000 in 1986.¶ The development of new bioweapons. Despite signing the Biological Weapons Convention in 1972, the search for military advantages motivated Soviet decision makers to continue investing in bioweapon development for decades. Although never used in combat, biological agents were accidentally released from research facilities, resulting in dozens of deaths and threatening to cause a pandemic.5¶ Nuclear close calls. Military accidents and false alarms happened regularly, and top decision makers were more likely to interpret these events hostilely when tensions were high. On several occasions it seems the decision about whether or not to start a nuclear war came down to individuals acting under stress and with limited time.¶ This makes international tension an existential risk factor. It's connected to a number of other problems, which means reducing the level of international tension would lower the total amount of existential risk we face.¶ The level of tension today¶ Recently, international tension seems to have once again been rising. To highlight some of the most salient examples:¶ China-United States relations have deteriorated, leading to harsh diplomatic rhetoric and protectionist trade policies that aim to reduce the countries' economic interdependence.¶ Russia's invasion of Ukraine has killed about a hundred thousand people so far, raised the risk of nuclear war, and sent United States-Russia relations to their lowest point since the Cold War.¶ Chinese and Indian soldiers fought deadly skirmishes along their countries' disputed border in 2020–21.¶ These dynamics raise an important question: how much more dangerous is the world given this higher tension than it would be in a world of low tension?¶ I think the answer is quite a bit more dangerous — for several reasons. First, international tension seems likely to make technological progress more dangerous. There's a good chance that, in the coming decades, humanity will make some major technological breakthroughs. We've discussed, for example, why one might worry about the effects of advanced artificial intelligence systems or biotechnology. The level of tension could strongly affect how these technologies are developed and governed. Tense relations could, for example, cause countries to neglect safety concerns in order to develop technology faster.6¶ Second, great power relations will strongly influence how nations do, or do not, cooperate to solve other global collective action problems. For example, in 2022, China withdrew from bilateral negotiations with the United States over climate action in protest of what it perceived as American diplomatic aggression in Taiwan. That same year, efforts to strengthen the Biological Weapons Convention were reportedly hampered by the Russian delegation after their country's invasion of Ukraine raised tensions with the United States and other western countries.¶ And third, if relations deteriorate severely, the great powers could fight a war.¶ How likely is a war?¶ Wars are destructive and risky for all countries involved. Modern weapons, especially nuclear warheads, make starting a great power war today seem like a suicidal undertaking.¶ But factors like the prevalence of war throughout history, the chance that leaders make mistakes, conflicting ideologies, and commitment problems, make me think that conflict could break out anyway.¶ On balance, I think such an event is somewhat unlikely but hardly unthinkable. To quantify this: I put the chance we experience some kind of war between great powers before 2050 at about one-in-three.7¶ War has occurred regularly in the past¶ One reason to think a war is quite likely is that such conflicts have been so common in the past. Over the past 500 years, about two great power wars have occurred per century.8¶ Naively, this would mean that every year there's a 2% chance such a war occurs, implying the chance of experiencing at least one great power war over the next 80 years — roughly until the end of the century — is about 80%.9¶ This is a very simple model. In reality, the risk is not constant over time and independent across years. But it shows that if past trends simply continue, the outcome is likely to be very bad.¶ Has great power war become less likely?¶ One of the most important criticisms of this model is that it assumes the risk is constant over time. Some researchers have argued instead that, especially since the end of World War II, major conflicts have become much less likely due to:¶ Nuclear deterrence: Nuclear weapons are so powerful and destructive that it's just too costly for nuclear-armed countries to start wars against each other.10¶ Democratisation: Democracies have almost never gone to war against each other, perhaps because democracies are more interconnected and their leaders are under more public pressure to peacefully resolve disputes with each other.11 The proportion of countries that are democratic has increased from under 10% in 1945 to about 50% today.¶ Strong economic growth and global trade: Global economic growth accelerated following World War II and the value of global exports grew by a factor of almost 30 between 1950 and 2014. Since war disrupts economies and international trade, strong growth raises the costs of fighting.12¶ The spread of international institutions: Multilateral bodies like the United Nations General Assembly and Security Council promote diplomatic dialogue and facilitate coordination to punish transgressors.13¶ It is true that we are living through an unusually long period of great power peace. It's been about 80 years since World War II. We just saw that a simple model using the historical frequency of great power wars suggests there was only a 20% chance of going that long without at least one more war breaking out. This is some evidence in favour of the idea that wars have become significantly less common.¶ At the same time, we shouldn't feel too optimistic.¶ The numerous close calls during the Cold War suggest we were somewhat lucky to avoid a major war in that time. And a 20% chance of observing 80 years of peace is not that low.14 Structural changes might have dramatically reduced the likelihood of war. Or perhaps we've just been lucky. It could even be that technological advances have made war less likely to break out, but more deadly when it occurs, leaving the overall effect on the level of risk ambiguous. It just hasn't been long enough to support a decisive view.15¶ So while the recent historical trend is somewhat encouraging, we don't have nearly enough data to be confident that great power war is a thing of the past. To better predict the likelihood of future conflict, we should also consider distinctive features of our modern world.16¶ One might think that a modern great power war would simply be so destructive that no state leader would ever choose to start one. And some researchers do think that the destruction such a war would wreak globally makes it less likely to occur. But it would be hard to find anyone who claims this dynamic has driven the risk to zero.¶ First, a war could be started by accident.¶ Second, sometimes even prudent leaders may struggle to avoid a slide towards war.¶ We could blunder into war¶ An accidental war can occur if one side mistakes some event as an aggressive action by an adversary.¶ This happened several times during the Cold War. The earlier example of the wayward American reconnaissance plane shows how routine military exercises carry some escalation risk. Similarly, throughout history, nervous pilots and captains have caused serious incidents by attacking civilian planes and ships.17 Nuclear weapons allow for massive retaliatory strikes to be launched quickly — potentially too quickly to allow for such situations to be explained and de-escalated.¶ It is perhaps more likely, though, that an accidental war could be triggered by a technological malfunction. Faulty computers and satellites have previously triggered nuclear close calls. As monitoring systems have become more reliable, the rate at which such accidents have occurred has been going down. But it would be overconfident to think that technological malfunctions have become impossible.¶ Future technological changes will likely raise new challenges for nuclear weapon control. There may be pressure to integrate artificial intelligence systems into nuclear command and control to allow for faster data processing and decision making. And AI systems are known to behave unexpectedly when deployed in new environments.18¶ New technologies will also create new accident risks of their own, even if they're not connected to nuclear weapon systems. Although these risks are hard to predict, they seem significant. I'll say more about how such technologies — including AI, nuclear, biological, and autonomous weapons — are likely to increase war risks later.¶ Leaders could choose war¶ All that said, most wars have not started by accident. If another great power war does break out in the coming decades, it is more likely to be an intentional decision made by a national leader.¶ Explaining why someone might make such a costly, destructive, unpredictable, and risky decision has been called "the central puzzle about war." It has motivated researchers to search for "rationalist" explanations for war. In his 2022 book Why We Fight, for example, economist Chris Blattman proposes five basic explanations: unchecked interests, intangible incentives, uncertainty, commitment problems, and misperceptions.19¶ This section discusses how great power tensions may escalate to war in the next few decades. It focuses on three potential conflicts in particular: war between the US and China, between the US and Russia, and between China and India. These are discussed because each of these countries are among the world's largest economies and military spenders, and seem particularly likely to fight. At the end, I briefly touch on other potential large conflicts.¶ United States-China¶ The most worrying possibility is war between the United States and China. They are easily the world's largest economies. They spend by far the most on their militaries. Their diplomatic relations are tense and have recently worsened. And their relationship has several of the characteristics that Blattman identifies as causes of war.¶ At the core of the United States-China relationship is a commitment problem.¶ China's economy is growing faster than the United States'. By some metrics, it is already larger.20 If its differential growth continues, the gap will continue to widen between it and the United States. While economic power is not the sole determinant of military power, it is a key factor.21¶ The United States and China may be able to strike a fair deal today. But as China continues to grow faster, that deal may come to seem unbalanced. Historically, such commitment problems seem to have made these kinds of transition periods particularly dangerous.22¶ In practice, the United States and China may find it hard to agree on rules to guide their interactions, such as how to run international institutions or govern areas of the world where their interests overlap.¶ The most obvious issue which could tip the United States-China relationship from tension into war is a conflict over Taiwan. Taiwan's location and technology industries are valuable for both great powers.¶ This issue is further complicated by intangible incentives.¶ For the United States, it is also a conflict over democratic ideals and the United States' reputation for defending its allies.¶ For China, it is also a conflict about territorial integrity and addressing what are seen as past injustices.¶ Still, forecasts suggest that while a conflict is certainly possible, it is far from inevitable. As of 8 June 2023, one aggregated forecast23 gives a 17% chance of a United States-China war breaking out before 2035.24¶ A related aggregated forecast of the chance that at least 100 deaths occur in conflict between China and Taiwan by 2050 gives it, as of 8 June 2023, a much higher 68% chance of occurring.25¶ United States-Russia¶ Russia is the United States' other major geopolitical rival.¶ Unlike China, Russia is not a rival in economic terms: even after adjusting for purchasing power, its economy is only about one-fifth the size of the United States'.¶ However, Russia devotes a substantial fraction of its economy to its military. Crucially, it has the world's largest nuclear arsenal. And Russian leadership has shown a willingness to project power beyond their country's borders.¶ Top five countries by estimated military spending, 2021. Source: SIPRI¶ Russia's 2022 invasion of Ukraine demonstrated the dangers of renewed rivalry between Russia and the United States-led West. The war has already been hugely destructive: the largest war in Europe since World War II, with hundreds of thousands of casualties already and no end to the conflict in sight. And it could get much worse. Most notably, Russian officials have repeatedly refused to rule out the use of nuclear weapons.¶ Unchecked interests and intangible incentives are again at play here. Vladimir Putin leads a highly-centralised government. He has spoken about how his desire to rebuild Russia's reputation played in his decision to invade Ukraine.¶ Given their ideological differences and history of rivalry, it is reasonable to expect that the United States and Russia will continue to experience dangerous disagreements in the future. As of 8 June 2023, an aggregated forecast gives a 20% chance that the United States and Russia will fight a war involving at least 1,000 battle deaths before 2050.¶ China-India¶ India is already the world's third-largest economy. If national growth rates remain roughly constant, the size of the Indian economy will surpass that of the United States' sometime this century. India also has nuclear weapons and is already the world's third-largest military spender (albeit at a much lower level than China or the United States).¶ One reason to worry that China and India could fight a war is that they already dispute territory along their border. Countries that share a border, especially when it is disputed, are more likely to go to war than countries that do not. By one count, 88% of the wars that occurred between 1816 and 1980 began as wars between neighbours.26¶ In fact, China and India already fought a brief but violent border war in 1962. Deadly skirmishes have continued since, resulting in deaths as recently as 2020.¶ Forecasters agree that a China-India conflict seems relatively (though not absolutely) likely. An aggregated forecast gives a 19% chance of war before 2035.¶ Other dangerous conflicts¶ These three conflicts — United States-China, United States-Russia, and China-India — are not the only possible great power wars that could occur. Other potential conflicts could also pose existential risk, either because they drive dangerous arms races or see widespread deployment of dangerous weapons.¶ We should keep in mind India-Pakistan as a particularly likely conflict between nuclear-armed states and China-Russia as a potential, though unlikely, conflict between great powers with a disputed border and history of war. Plus, new great powers may emerge or current great powers may fade in the years to come.¶ While I think we should prioritise the three potential conflicts I've highlighted above, the future is highly uncertain. We should monitor geopolitical changes and be open to changing our priorities in the future.¶ Overall predictions¶ Below is a table listing relevant predictions from the forecasting platform Metaculus, including the number of predictions made, as of 10 March 2023. Note the different timescales and resolution criteria for each question; they may not be intuitively comparable.¶ I have previously independently estimated the likelihood of seeing a World War III-like conflict this century. My calculation first adjusts historical base rates to allow for the possibility that major wars have become somewhat less likely, and uses the adjusted base rate to calculate the probability of seeing a war between now and 2100.¶ This method gives a 45% chance of seeing a major great power war in the next 77 years. If the probability is constant over time then the cumulative probability between now and 2050 would be 22%. This is aligned with the Metaculus predictions above.¶ We can also ask experts what they think. Unfortunately, there are surprisingly few expert predictions about the likelihood of major conflict. One survey was conducted by the Project for the Study of the 21st Century. The numbers were relatively aligned with the Metaculus forecasts, though slightly more pessimistic. However, it seems a mistake to put too much stock in this survey (see footnote).27¶ We now have at least a rough sense of a great power war's probability. But how bad could it get if it occurred?¶ A new great power war could be devastating¶ At the time, the mechanised slaughter of World War I was a shocking step-change in the potential severity of warfare. But its severity was surpassed just 20 years later by the outbreak of World War II, which killed more than twice as many people.¶ A modern great power war could be even worse.¶ How bad have wars been in the past?¶ The graph below shows how common wars of various sizes are, according to the Correlates of War's Interstate War dataset.28¶ The x-axis here represents war size in terms of the logarithm of the number of battle deaths. The y-axis represents the logarithm of the proportion of wars in the dataset that are at least that large.¶ Using logarithms means that each step to the right in the graph represents a war not one unit larger, but 10 times larger. And each step up represents a war that is not one unit more likely, but 10 times more likely.¶ What the graph shows is that wars have a heavy tail. Most wars remain relatively small. But a few escalate greatly and become much worse than average.¶ Of the 95 wars in the latest version of the database, the median battle death count is 8,000. But the heavy tail means the average is 334,000 battle deaths. And the worst war, World War II, had almost 17 million battle deaths.30¶ The number of battle deaths is only one way to measure the badness of wars. We could also consider the proportion of the population of the countries involved who were killed in battle. By this measure, the worst war since 1816 was not World War II. Instead, it's the Paraguayan War of 1864–70. In that war, 30 soldiers died for every 1,000 citizens of the countries involved. It's even worse if we also consider civilian deaths; while estimates are very uncertain, it's plausible that about half of the men in Paraguay, or around a quarter of the entire population, was killed.31¶ What if instead we compared wars by the proportion of the global population killed? World War II is again the worst conflict since 1816 on this measure, having killed about 3% of the global population. Going further back in time, though, we can find worse wars. Ghengis Khan's conquests likely killed about 9.5% of people in the world at the time.¶ The heavy tail means that some wars will be shockingly large.32 The scale of World War I and World War II took people by surprise, including the leaders who initiated it.¶ It's also hard to know exactly how big wars could get. We haven't seen many really large wars. So while we know there's a heavy tail of potential outcomes, we don't know what that tail looks like.¶ That said, there are a few reasons to think that wars much worse than World War II are possible:¶ We're statistically unlikely to have brushed up against the end of the tail, even if the tail has an upper bound.¶ Other wars have been deadlier on a per-capita basis. So unless wars involving countries with larger populations are systematically less intense, we should expect to see more intense wars involving as many people as World War II.¶ Economic growth and technological progress are continually increasing humanity's war-making capacity. This means that, once a war has started, we're at greater risk of extremely bad outcomes than we were in the past.¶ So how bad could it get?

How bad could a modern great power war be?

Over time, two related factors have greatly increased humanity's capacity to make war. 33 First, scientific progress has led to the invention of more powerful weapons and improved military efficiency. Second, economic growth has allowed states to build larger armies and arsenals. Since World War II, the world economy has grown by a factor of more than 10 in real terms; the number of nuclear weapons in the world has grown from basically none to more than 9,000, and we've invented drones, missiles, satellites, and advanced planes, ships, and submarines. Ghengis Khan's conquests killed about 10% of the world, but this took place over the course of two decades. Today that proportion may be killed in a matter of hours. First, **nuclear weapons could be used.** Today there are around 10,000 nuclear warheads globally.34 At the peak of nuclear competition between the United States and the USSR, though, there were 64,000. If arms control agreements break down and competition resurges among two or even three great powers, nuclear arsenals could expand. In fact, China's arsenal is very likely to grow — though by how much remains uncertain. Many of the nuclear weapons in the arsenals of the great powers today are at least 10 times more powerful than the atomic bombs used in World War II.35 Should these weapons be used, th**e consequences would be catastrophic. By any measure, such a war would be by far the most destructive, dangerous event in human history, with the potential to cause billions of deaths. The probability that it would, on its own, lead to humanity's extinction or unrecoverable collapse, is contested. But there seems to be some possibility — whether through a famine caused by nuclear winter, or by reducing humanity's resilience enough that something else, like a catastrophic pandemic, would be far more likely to reach extinction-levels (read more in our problem profile on nuclear war). Nuclear weapons are complemented and amplified by a variety of other modern military technologies, including improved missiles, planes, submarines, and satellites. They are also not the only military technology with the potential to cause a global catastrophe — bioweapons**, too, have the potential to cause massive harm through accidents or unexpected effects. What's more, humanity's war-making capacity seems poised to further increase in the coming years due to technological advances and economic growth. Technological progress could make it cheaper and easier for more states to develop weapons of mass destruction. In some cases, political and economic barriers will remain significant. Nuclear weapons are very expensive to develop and there exists a strong international taboo against their proliferation. In other cases, though, the hurdles to developing extremely powerful weapons may prove lower. Improvements in biotechnology will probably make it cheaper to develop bioweapons. Such weapons may provide the deterrent effect of nuclear weapons at a much lower price. They also seem harder to monitor from abroad, making it more difficult to limit their proliferation. And **they could spark a** global biological catastrophe, like a major — possibly **existentially catastrophic — pandemic**. Artificial intelligence systems are also likely to become cheaper as well as more powerful. It is not hard to imagine important military implications of this technology. For example, AI systems could control large groups of lethal autonomous weapons (though the timeline on which such applications will be developed is unclear). They may increase the pace at which war is waged, enabling rapid escalation outside human control. And AI systems could speed up the development of other dangerous new technologies. Finally, we may have to deal with the invention of other weapons which we can't currently predict. The feasibility and danger of nuclear weapons was unclear to many military strategists and scientists until they were first tested. We could similarly experience the invention of destabilising new weapons in our lifetime. What these technologies have in common is the potential to quickly kill huge numbers of people: A nuclear war could kill tens of millions within hours, and many more in the following days and months. A runaway bioweapon could prove very difficult to stop. Future autonomous systems could act with lightning speed, even taking humans out of the decision-making loop entirely. Faster wars leave less time for humans to intervene, negotiate, and find a resolution that limits the damage. How likely is war to damage the long-run future? When a war begins, leaders often promise a quick, limited conflict. But escalation proves hard to predict ahead of time (perhaps because people are scope-insensitive, or because escalation depends on idiosyncratic decisions). This raises the possibility of enormous wars that threaten all of humanity.

C2 is SMRs

SMR development is being hampered by lack of investment. Waleed '25

Hammad Waleed (Research Associate at Strategic Vision Institute), 03-13-2025, "Nuclear's Next Chapter: Can Small Modular Reactors Succeed?," SVI - Strategic Vision Institute - Strategic Vision Institute, https://thesvi.org/nuclears-next-chapter-can-small-modular-reactors-succeed/, accessed 3-31-2025 //RP

In the vast chessboard of global energy, a new player is making its move—a promise wrapped in steel and uranium, heralded as the saviour of both the climate crisis and the nuclear industry itself. **Small Modular Reactors (SMRs) are being hailed as the future of clean energy, a technology that could redefine power generation as we know it**. **Compact, factory-built, and supposedly safer, faster, and cheaper,** SMRs have been cast as the solution to nuclear energy's greatest pitfalls. SMRs are marketed as a nuclear breakthrough—smaller, safer, and scalable—but their **high costs and lack of investment slow progress**. Yet, for all the fanfare, the revolution has yet to arrive. Over 80 different SMR projects have been proposed in recent decades, yet **only two have been designed and put into commercial operation .** The Western world, despite its enthusiasm, is struggling to make SMRs a reality. **Meanwhile, the East—led by Russia and China—is racing ahead, proving that when it comes to nuclear energy, state-backed ambition often trumps free-market hesitation**. Not too long ago , nuclear energy was the great hope of modern civilization. It was the power of the future, promising limitless energy without the environmental scars of coal and oil. But then came Chernobyl. Three Mile Island. Fukushima. One disaster after another shattered public confidence, turning nuclear into a relic of a more naive era. Now, as the world plummets toward climate catastrophe, **nuclear power is finding its way back into the mainstream energy discourse .** The International Energy Agency (IEA) has stated, unequivocally, that **nuclear capacity must double by 2050 if we are to meet global net-zero targets.** But here's the problem—**traditional nuclear plants are too expensive, too slow to build, and too politically fraught** (something that politicians dependant upon five year election cycles would consider too costly and politically less rewarding) **Enter SMRs, the golden compromise. They're small. They're scalable. They can be mass-produced in factories like airplanes instead of being built from scratch on-site. They take up a fraction of the space required by wind and solar farms**. In theory, they're a silver bullet. In practice? Not so much. **China and Russia lead the SMR race, using state-backed funding, streamlined regulation, and full-service nuclear deals to outpace the West**. The logic behind **SMRs is simple: make them smaller, make them safer, and make them modular. Instead of sprawling mega-facilities that take decades to construct, SMRs could be produced assembly-line style and shipped to wherever they're needed**. They could power remote towns, support industrial manufacturing, and even serve as a replacement for decommissioned coal plants. More importantly, **they are designed with passive safety features—instead of relying on external power and human intervention, many SMRs cool themselves naturally. No pumps, no backup generators—just physics doing its job**. The nuclear industry argues that this makes them inherently safer than their predecessors, ensuring that a **Fukushima-style meltdown would be nearly impossible.**

There is sufficient interest in SMRs Camacho '25

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David Wright, the new chair of the Nuclear Regulatory Commission, inherits a pivotal moment for the nuclear industry, which is navigating an era of advanced reactor development and grappling with long-standing challenges like waste management. **A member of the NRC since 2018 and a former South Carolina utility regulator, Wright has long been vocal about the potential for a nuclear resurgence**. That appears more likely as **small modular reactors gain recognition in Washington and among big U.S. tech companies as essential for providing reliable, 24-7 power to support cloud service data centers driving artificial intelligence.** "A lot of people thought … the renaissance was coming a few years back and didn't quite materialize," he said at a 2023 meeting of the National Association of Regulatory Utility Commissioners. "But I believe this one's going to be real." Advertisement **Wright will face pressure to bolster industry growth without compromising safety. "This wave of interest and different developers is really different, and I think that's something he will pay attention to**," said Stephen Burns, a former NRC chair under then-President Barack Obama and a fellow at the Third Way think tank. **President Donald Trump has pointed to overregulation as a factor holding back nuclear power, and his ally Vivek Ramaswamy has called the NRC an example of "too much bureaucracy" resulting in "less innovation and higher costs."** In July, **Congress passed the bipartisan ADVANCE Act, which directs the NRC to streamline the permitting process for advanced reactors, reduce regulatory fees for companies looking to license advanced reactors and update outdated rules that limit international investment.** Wright's optimism partly stems from the recent completion of the long-delayed Vogtle units in Georgia, the first new reactors in the U.S. in over 30 years, and advancements in small modular reactor technology. SMRs are a fraction of the size of large traditional reactors and are designed to be factory-assembled and transported to a location for installation. **In October, Trump appeared to suggest that SMRs were preferable to large conventional reactors because of their smaller size and potential for mass production.** The NRC chair acts as both the agency's chief executive and public spokesperson, overseeing day-to-day operations, setting the agenda, and representing the agency in domestic and international forums. **While Wright's chairmanship begins with the promise of innovation, regulatory challenges loom large. In addition to the agency reorganizing to meet requirements under the ADVANCE Act, the NRC has debated whether reactor licenses could be extended to 80 years**. In 2022, the NRC ruled that licenses for three plants seeking the extension required updated environmental studies. Wright, dissenting from the commission's decision, criticized the move for undermining transparency and consistency in regulation. "For the NRC to function as an effective and credible regulator, our stakeholders must be able to rely on our statements and positions," he said. This stance reflects Wright's broader commitment to balancing regulatory integrity with practical industry needs, said Burns. **"He will take a very measured view towards some of the policy initiatives that are up for it now," Burns said. Burns, who worked with Wright for two years at the NRC, added that the new chair is likely to temper the ambitions of agency staff more than most.** Burns noted Wright's work narrowing the proposal for the "Part 53" rule, designed to provide a new regulatory framework for advanced reactors like SMRs. The initial proposal was over 1,200 pages long, but **Wright guided staff to streamline the rule by revising risk metrics, delegating specifics to guidance documents, simplifying the rule's structure and exploring the use of applicant safety cases. In Wright's own words, the NRC must be prepared to "get [reactors] through the licensing part so that they can get to market."** Wright's history with nuclear waste policy could also shape his tenure. In 2018, he faced calls to recuse himself from Yucca Mountain deliberations, given his prior support for the controversial project. While Wright maintained he was impartial, Nevada's resistance highlights the contentious politics of waste storage, a persistent challenge as advanced reactors promise to add to the waste burden.

Federal backing is key. Waleed '25

Hammad Waleed (Research Associate at Strategic Vision Institute), 03-13-2025, "Nuclear's Next Chapter: Can Small Modular Reactors Succeed?," SVI - Strategic Vision Institute - Strategic Vision Institute, https://thesvi.org/nuclears-next-chapter-can-small-modular-reactors-succeed/, accessed 3-31-2025 //RP

In the vast chessboard of global energy, a new player is making its move—a promise wrapped in steel and uranium, heralded as the saviour of both the climate crisis and the nuclear industry itself. **Small Modular Reactors (SMRs) are being hailed as the future of clean energy, a technology that could redefine power generation as we know it. Compact, factory-built, and supposedly safer, faster, and cheaper, SMRs have been cast as the solution to nuclear energy's greatest pitfalls.** SMRs are marketed as a nuclear breakthrough—smaller, safer, and scalable—but their high costs and lack of investment slow progress. Yet, for all the fanfare, t**he revolution has yet to arrive. Over 80 different SMR projects have been proposed in recent decades, yet only two have been designed and put into commercial operation . The Western world, despite its enthusiasm, is struggling to make SMRs a reality**. Meanwhile, the East—led by **Russia and China—is racing ahead, proving that when it comes to nuclear energy, state-backed ambition often trumps free-market hesitation**. Not too long ago , nuclear energy was the great hope of modern civilization. It was the power of the future, promising limitless energy without the environmental scars of coal and oil. But then came Chernobyl. Three Mile Island. Fukushima. One disaster after another shattered public confidence, turning nuclear into a relic of a more naive era. Now, as the world plummets toward climate catastrophe, nuclear power is finding its way back into the mainstream energy discourse . **The International Energy Agency (IEA) has stated, unequivocally, that nuclear capacity must double by 2050 if we are to meet global net-zero targets. But here's the problem—traditional nuclear plants are too expensive, too slow to build, and too politically fraught** (something that politicians dependant upon five year election cycles would consider too costly and politically less rewarding) **Enter SMRs, the golden compromise. They're small. They're scalable. They can be mass-produced in factories like airplanes instead of being built from scratch on-site. They take up a fraction of the space required by wind and solar farms**. In theory, they're a silver bullet. In practice? Not so much. **China and Russia lead the SMR race, using state-backed funding, streamlined regulation, and full-service nuclear deals to outpace the West.** The logic behind SMRs is simple: make them smaller, make them safer, and make them modular. Instead of sprawling mega-facilities that take decades to construct, **SMRs could be produced assembly-line style and shipped to wherever they're needed. They could power remote towns, support industrial manufacturing, and even serve as a replacement for decommissioned coal plants.** More importantly, they are **designed with passive safety features—instead of relying on external power and human intervention, many SMRs cool themselves naturally. No pumps, no backup generators—just physics doing its job.** The nuclear industry argues that this makes them inherently safer than their predecessors, ensuring that a Fukushima-style meltdown would be nearly impossible. But while the technology looks good on paper, the economics tell a different story. SMRs lose the economies of scale that make large reactors cost-effective. Smaller reactors generate less electricity, meaning their revenue streams are inherently weaker. **The brutal economic reality is that SMRs, as they stand, are often too expensive to justify their small output. In the free-market-driven economies of the U.S. and Europe, nuclear power must prove itself to investors. And so far, it has failed. But in state-controlled energy systems like Russia and China, SMRs are treated as a strategic national investment, not just a business venture.** Russia's Rosatom and China's CNNC have **sidestepped the financial constraints that have shackled their Western competitors.** They don't have to convince Wall Street or private investors. **They simply build, fund, and operate their reactors with state backing**. China's Linglong One, a 125 MW SMR on Hainan Island, is scheduled to be the first commercial land-based SMR in the world by 2026. Meanwhile, Russia's floating nuclear plants, powered by SMRs, are already in operation, supplying energy to remote Arctic regions where renewables simply aren't feasible. **The Western model relies on private investment, making nuclear expansion slow and expensive compared to state-driven programs in China and Russia.** But it's not just about technology—it's about the entire package. **When China or Russia sells an SMR to another country, it doesn't just deliver a reactor. It provides: financing, through state-backed loans, fuel supply and waste management, technical training and operational support By comparison, Western companies force nations to piece together their nuclear infrastructure from dozens of private firms, making the process more expensive and bureaucratic. Who, then, is a developing country more likely to sign a**

deal with? For all their promise, SMRs are not a magic bullet. The biggest challenge in decarbonizing the planet isn't space—it's money and scale. China, the fastest-growing nuclear nation, has made a bold choice: while it experiments with SMRs, it's doubling down on massive, full-scale reactors. The logic? If you're going to invest in nuclear, bigger is still better. The world's energy needs are skyrocketing, and there is an open question as to whether thousands of smaller reactors make more sense than hundreds of large ones. **For SMRs to truly change the game, they need government backing, regulatory streamlining, and better economic models**. The dream of factory-built, plug-and-play nuclear power stations isn't dead—but it's far from realized. **If the West continues to rely solely on private investment to drive nuclear expansion, it will fall further behind**. Meanwhile, **Russia and China are proving that nuclear success requires state commitment, not just market enthusiasm. SMRs have the potential to reshape the global energy landscape—but they won't do so unless governments decide to make them happen. The question now is not whether the world needs nuclear—it does—but who will lead the way?**

New investment is key. It helps attract investors. Grossi '24

Rafael Mariano Grossi (Director General, International Atomic Energy Agency (IAEA)), 11-8-2024, "Climate goals require a step change in nuclear investment," World Economic Forum, https://www.weforum.org/stories/2024/11/meeting-global-climate-goals-requires-a-step-change-in-nuclear-investment/, accessed 3-31-2025 //RP

Nuclear power is now officially recognized as crucial for global decarbonization, complementing renewables such as wind and solar. **Tripling nuclear capacity by 2050 requires annual investments to grow from $50 billion to $150 billion, driven by public-private partnerships and new financial mechanisms**. **rc**g nuclear power plants – party to the UN Framework Convention on Climate Change agreed that nuclear acceleration was needed to achieve deep global decarbonization. The first stocktake under the Paris Agreement said wind, solar and other low-carbon sources should be accelerated too but the overwhelming consensus was that renewables needed nuclear power. And time is of the essence. Climate change-driven events such as heat waves, floods and powerful storms have affected every part of our planet. Last year was the hottest in the 174 years we have data and this year threatens to break that record. **Acknowledging nuclear energy's crucial role in accelerating the energy transition reflects how much global attitudes have shifted in the past few years.** Have you read? Explainer: Advanced nuclear technologies and their role in the energy transition World's biggest banks back nuclear power, and other top energy stories 5 reasons we must embrace nuclear energy in the fight against climate change Global push to triple nuclear capacity In addition to the agreement reached at COP28, 25 countries (and the nuclear industry) pledged to work towards tripling nuclear power capacity by 2050. The urgency of mitigating carbon emissions was joined by a renewed push for energy security. It shows that fact-based analysis and science have finally overcome misunderstanding and ideology regarding nuclear, which is evident in the data too. **The International Atomic Energy Agency's (IAEA) recently released nuclear capacity projections show that the high-case scenario sees nuclear capacity in 2050 as two and half times greater than today.** This expansion will require extending the operational years of existing nuclear power plants, many built in response to the 1970s oil shocks and an ambitious effort to build 640 gigawatts of new reactor capacity. **We will need to build a greater number of large reactors than the 415 that operate today and introduce a significant number of small modular reactors. Small modular reactors are not yet available on the market but will need to account for a quarter of the increased capacity in 2050 if climate targets are to be met**. **Massive investment needed to scale nuclear To fulfil this demand will necessitate a step-change in financing**. Between 2017-2023 the world spent an average of about $50 billion on nuclear energy every year. That must increase to $125 billion from 2030 onwards. Tripling nuclear capacity by 2050 would require yearly investments of about $150 billion. To put that into perspective, it is just a tenth of what is needed every year to triple renewable capacity by 2030. Nuclear energy is sometimes pitted against wind and solar energy, with some opponents arguing that a dollar of investment in nuclear energy is a dollar less invested in wind and solar energy. That's not true. **Because nuclear is available 24-7, investing in it actually facilitates investment in intermittent renewables such as wind and solar. Having nuclear power in the grid lowers overall costs because it**

negates the need for expensive battery storage and investment in overcapacity. A nuclear power plant built today will pay off by providing low-carbon energy at affordable rates for about a century. No other scalable, proven, low-carbon energy source can do that, making investing in nuclear highly attractive to those who can take a long-term view. **In other words, financing nuclear power plants, particularly the upfront costs, requires government participation.** " At COP29 in Baku, the world must discuss concrete steps to get nuclear from consensus to construction. —Rafael Mariano Grossi, Director General, International Atomic Energy Agency " — Rafael Mariano Grossi, Director General, International Atomic Energy Agency **Public-private partnerships key to nuclear expansion In economies similar to Russia, which holds the largest share of the overall nuclear market and China, which is building about as many new nuclear power plants as the rest of the world combined, the effect of government involvement is evident. But even in market-driven economies, such as the United States,** which operates more nuclear power reactors than any other country and France, where nuclear power plants generate more than two-thirds of the electricity, **a combination of public and private involvement can clearly build sizeable nuclear power programmes. As the need for nuclear has risen, so has the appetite of private investors.** In September, on the margins of the New York Climate Week, 14 major global banks and financial institutions expressed their support for financing the tripling of nuclear capacity by 2050. **New approaches are being implemented in the nuclear sector that are attracting financing. Financial mechanisms such as green bonds, loans and guarantees facilitate broader investor participation. Including nuclear power in sustainable taxonomies, as has been the case in the European Union, can further catalyze commercial bank involvement.**

SMRs are key to decentralized power generation. Noah '24

No Author (No Quals), 6-27-2024, "Small Modular Reactors Global Power Generation," Noah Chemicals https://www.noahchemicals.com/blog/small-modular-reactors-global-power-generation/, accessed 3-31-2025 //RP

In the quest for cleaner, more sustainable energy sources**, Small Modular Reactors (SMRs) are emerging as a promising solution**. These compact nuclear reactors, typically generating less than 300 megawatts (MW) of electricity, **offer several advantages over traditional large nuclear reactors.** As the world grapples with the urgent need to reduce carbon emissions and ensure energy security, **SMRs could play a pivotal role in transforming the global energy landscape.** Advantages of Small Modular Reactors **The appeal of SMRs lies in their innovative design and operational advantages. Unlike their larger counterparts, SMRs offer a combination of safety, economic, and environmental benefits that make them particularly well-suited for the diverse energy needs of the future**. By addressing some of the critical limitations of traditional nuclear reactors, **SMRs provide a more adaptable and sustainable approach to nuclear power generation.** Enhanced Safety Features Safety has always been a paramount concern in the nuclear industry, and **SMRs are at the forefront of integrating advanced safety features. These reactors are designed with passive safety systems that operate without the need for external power or human intervention**. For instance, **SMRs can utilize natural convection to circulate coolant and remove heat from the reactor core**. This **reduces the likelihood of overheating and potential meltdowns. Furthermore, their smaller size means a smaller amount of radioactive material is present, which inherently reduces the potential impact of any incident**. Many **SMRs are also designed to be installed underground, providing an additional layer of security against both natural disasters and potential security threats**. Cost-Effectiveness The high upfront cost of constructing large nuclear reactors has been a significant barrier to the expansion of nuclear energy. **SMRs offer a more economically viable solution. Their modular nature means that they can be manufactured in a factory setting, ensuring higher quality control and reducing construction times. These prefabricated modules can then be transported to the installation site, where they are**

assembled, significantly lowering on-site construction costs. Additionally, the smaller initial capital investment required for SMRs allows for more flexible financing options and reduces financial risk for investors and utilities. Flexibility and Scalability **SMRs provide a versatile solution that can be tailored to various energy needs. Their small size makes them ideal for remote locations, industrial sites, and areas with limited grid infrastructure. For example, remote communities and islands can benefit from a reliable power source without the need for extensive and expensive grid connections**. Furthermore, the modular design of SMRs allows for incremental capacity additions. **Utilities can start with a smaller initial investment and add additional modules as demand grows, providing a scalable and adaptable energy solution that can evolve with changing energy needs.** Reduced Environmental Impact Compared to fossil fuel-based power plants, SMRs produce significantly lower greenhouse gas emissions, contributing to global efforts to combat climate change. **The compact footprint of SMRs means they require less land and cooling water, minimizing their environmental impact. Additionally, the shorter construction times and reduced material requirements compared to large reactors further lower their overall environmental footprint.** SMRs also offer the potential for **co-generation, providing both electricity and heat, which can be used for district heating, desalination, or industrial processes, enhancing their overall efficiency and sustainability.** Proliferation Resistanc**e SMRs are designed with features that enhance proliferation resistance, reducing the risk of nuclear material diversion for weapons production. Innovative fuel designs, longer refueling intervals, and robust security measures make SMRs a safer option in terms of global security**. For instance, some SMR designs incorporate **integrated fuel cycles that reduce the frequency of refueling and the handling of nuclear material, thereby minimizing the opportunities for diversion**. Additionally, the compact and **self-contained design of many SMRs makes them more difficult to tamper with, further enhancing their security profile.** Impact on the Global Energy Landscape The deployment of SMRs could revolutionize the way we generate and distribute electricity. SMRs can contribute to energy independence and resilience by providing a reliable and sustainable energy source. Countries with limited access to large-scale power plants can benefit from localized energy production, reducing their dependence on imported fuels and enhancing energy security. Furthermore, **SMRs can support the integration of renewable energy sources by providing stable baseload power that complements the intermittent nature of solar and wind energy. This hybrid approach can create a more robust and reliable energy grid, facilitating the transition to a low-carbon economy.** Decentralization and Energy Security **One of the most significant impacts of SMRs is the potential to decentralize electricity generation. Traditional large nuclear power plants require substantial infrastructure and centralized grid systems, which can be vulnerable to disruptions. In contrast, SMRs can be deployed in smaller, more distributed networks. This decentralization enhances energy security by reducing the risk of widespread power outages due to natural disasters, technical failures, or targeted attacks on critical infrastructure. For instance, remote communities and island nations, which often rely on costly and polluting diesel generators, can greatly benefit from SMRs. These reactors can provide a consistent and clean energy supply, reducing reliance on imported fuels and associated supply chain vulnerabilities.** Economic Development and Job Creation **The modular nature of SMRs supports economic development and job creation in various sectors. The manufacturing, transportation, and installation of SMR modules require skilled labor, contributing to local economies. Moreover, the construction and operation of SMRs can stimulate job growth in engineering, construction, and maintenance fields.** A study by the U.S. Department of Energy suggests that the **widespread adoption of SMRs could generate thousands of high-paying jobs and stimulate economic activity, particularly in regions transitioning from fossil fuel-based industries.** Enhancing Renewable Energy Integration **SMRs are not just standalone power sources; they**

can play a crucial role in enhancing the integration of renewable energy into the grid. The intermittent nature of solar and wind energy poses challenges for grid stability and reliability. SMRs can provide the necessary baseload power to complement these renewable sources, ensuring a steady and reliable electricity supply. In regions with abundant renewable resources but limited grid infrastructure**, SMRs can serve as anchor points for hybrid energy systems. These systems can efficiently balance the variability of renewable generation, reduce curtailment, and optimize the overall energy mix.** This integration not only supports a cleaner energy grid but also enhances the economic viability of renewable projects by providing a consistent power output. **International Collaboration and Innovation The development and deployment of SMRs also present opportunities for international collaboration and innovation**. Countries with advanced nuclear technology and manufacturing capabilities can partner with nations looking to diversify their energy portfolios. This collaboration can accelerate the global adoption of SMRs, foster technological innovation, and drive down costs through economies of scale. **For example, the United States, United Kingdom, and Canada are actively investing in SMR research and development, creating frameworks for international cooperation on regulatory standards, safety protocols, and technological advancements. Such collaborative efforts can help address common challenges, streamline deployment processes, and ensure the safe and efficient operation of SMRs worldwide.** Environmental Benefits and Climate Goals By significantly reducing greenhouse gas emissions compared to fossil fuel-based power plants, SMRs can play a vital role in achieving global climate goals. **Their ability to provide reliable, low-carbon energy makes them an essential component of strategies aimed at limiting global temperature rise and mitigating the impacts of climate change.** Moreover, the reduced environmental footprint of SMRs—requiring less land and water compared to large reactors—makes them suitable for a wider range of sites, including environmentally sensitive areas. This flexibility in siting, combined with the potential for co-generation of heat and electricity, enhances the overall sustainability of energy systems). Noah Chemicals and the Future of SMRs **The deployment of SMRs holds the promise of a transformative impact on the global energy landscape. By offering enhanced safety, economic viability, flexibility, and environmental benefits, SMRs can address many of the challenges associated with traditional nuclear power and fossil fuel-based generation. As countries seek to secure their energy futures and meet climate targets, SMRs stand out as a pivotal technology in the transition to a sustainable and resilient energy system.** As a leading provider of high-purity chemicals and advanced materials, Noah Chemicals is thrilled to witness the development of SMRs and their potential to reshape the energy sector. We recognize the importance of innovative technologies in addressing global energy challenges and are committed to supporting the advancement of SMRs through the supply of essential materials and expertise. Noah Chemicals is poised to play a crucial role in the SMR revolution, contributing to the development of safer, more efficient, and environmentally friendly nuclear reactors. We'd love to hear your thoughts on the future of Small Modular Reactors (SMRs) and their potential impact on the global energy landscape. How do you see SMRs shaping our energy future? Do you believe they can effectively complement renewable energy sources? Share your insights and join the conversation by leaving a comment below!

The centralized grid leaves us vulnerable to cyber attacks. Kearney 22'

Laila Kearney (U.S. energy reporter for Reuters. Previously covered state and local government finance, national affairs and California. Knight-Bagehot Fellow in economics and business journalism at Columbia University.), 1-26-2022, "US electric grid growing more vulnerable to cyberattacks, regulator says," Reuters, https://www.reuters.com/technology/cybersecurity/us-electric-grid-growing-more-vulnerable-cyberattacks-regulator-says-2024-04-04/, accessed 3-31-2025 //RP

NEW YORK, April 4 (Reuters) - **U.S. power grids are increasingly vulnerable to cyberattacks, with the number of susceptible points in electrical networks increasing by about 60 per day**, the North American Electric Reliability Corporation (NERC) said in a webcast on Thursday. **The grids' virtual and physical weak spots, or points in software or hardware that are susceptible to cyber criminals, grew to a range of 23,000 to 24,000 last year from**

21,000 to 22,000 by the end of 2022, executives with the energy regulator said. The Reuters Daily Briefing newsletter provides all the news you need to start your day. Sign up here. Advertisement · Scroll to continue Report This Ad "It's very hard to keep pace with addressing all those vulnerabilities," said Manny Cancel, senior vice president of NERC. **Geopolitical conflict, including Russia's invasion of Ukraine and the war in Gaza, have dramatically increased the number of cyber threats to North American power grids, NERC said. Threats also commonly come from China, and the regulators said they expect the upcoming U.S. presidential election to increase the probability of attacks on the grid**. "We're going to be very vigilant during this current election cycle," Cancel said. Advertisement · Scroll to continue Report This Ad **Physical assaults on the grid have remained high since rising in 2022, with about 2,800 reports of gunfire, vandalism and other strikes on electrical networks last year, NERC said. Some 3% of those attacks led to outages or other operational problems.**

Straub '19 terminalizes:

Jeremy Straub, 8-16-2019, "A cyberattack could wreak destruction comparable to a nuclear weapon," World from PRX, https://www.pri.org/stories/2019-08-16/cyberattack-could-wreak-destruction-comparable-nuclear-weapon

As someone who studies cybersecurity and information warfare, I'm concerned that **a cyberattack** with widespread impact, an intrusion in one area that spreads to others or a combination of lots of smaller attacks, **could cause** significant damage, including mass injury and death rivaling **the death toll of a nuclear weapon.** Unlike a nuclear weapon, which would vaporize people within 100 feet and kill almost everyone within a half-mile, the death toll from most cyberattacks would be slower. **People might die from a lack of food, power or gas for heat or from car crashes resulting from a corrupted traffic light system. This could happen over a wide area, resulting in mass injury and even deaths.**

A successful cyber-attack causes a great power war. Miller '17,

[James N. Miller and Richard Fontaine, 9-19-2017, A New Era in U.S.-Russian Strategic Stability, Center for a New American Security, https://s3.us-east-1.amazonaws.com/files.cnas.org/hero/documents/CNASReport-ProjectPathways-Finalb.pdf] //

As was the case in the Cold War, the most plausible scenario for U.S. and Russian military forces to engage in large-scale combat is in Europe. It is worth considering first how even a very limited attack or incident could set both sides on a slippery slope to rapid escalation. If armed conflict looks at all likely, both sides would have overwhelming incentives to go early with offensive cyber and counter-space capabilities to negate the other side's military capabilities or advantages. If these early cyber and space attacks succeed, it could result in huge military and coercive advantage for the attacker – with few or even no direct casualties. It may appear very unlikely that the attacked side would retaliate strongly in response to some damaged computers and some malfunctioning satellites in outer space. Moreover, if the attacks fail to have the desired effect, the other side may not even notice. Large-scale **cyber** and space **attacks** – preferably before a kinetic conflict even starts – therefore may**appear** a **low-risk**, high-payoff move for both sides. LIMITED CYBER AND SPACE ATTACKS WITH CASCADING EFFECTS ON CIVIL SOCIETY**With each side having emplaced cyberimplants to disrupt or destroy the other side's military systems and critical infrastructure –** including war-supporting infrastructure as well as purely civilian infrastructure,**a small spark in cyberspace could rapidly escalate**. The spark could come **from**an intentional cyber attack that had**unintended cascading effects, or from proxies or false flag attacks**. Thus, cyber and space attacks intended to be highly discriminative against military targets may cascade to affect critical infrastructure essential to the broader society and economy. If this occurred,**an attack intended to be precise**and limited to military targets instead **could result in the widespread loss of** **electrical power, water**, or other**essential services, with resulting economic disruption and potential loss of life.** The attacked side could feel compelled to respond at least in kind. Alternatively,**a tit-for-tat cycle may occur**, as**one side** may **believe it could gaincoercive advantage** by intentionally demonstrating its ability to hold at risk the other side's critical infrastructure through cyber, counter-space, and perhaps sabotage attacks. There is debate within the expert community as to whether cyber attacks alone could have devastating effects, but it does appear likely that combined cyber and precision attacks on critical infrastructure could devastate an economy and society. Whether such **attacks escalated through a gradual tit-for-tat or more rapid counterpunching, such**

counter-value strikes could lead to major conflict andpotentially**nuclear war**.

Cross x clare 23 on c1 for nuclear war causing extinction

C3 is blue water deterrence

American nuclear deterrence will fail by 2027.

Gabriel **Honrada** [Research Fellow with PhD in International Relations], 20**25**-03-25, "Sinking ship: US undersea nuclear deterrent's plunging credibility," Asia Times, https://asiatimes.com/2025/03/sinking-ship-us-undersea-nuclear-deterrents-plunging-credibility/#, Date Accessed: 2025-03-28T19:31:50.584Z //RX

Delays and cost overruns **in** the **US** Columbia-class **SSBN program threaten the credibility of its undersea nuclear deterrent and ability to match China**'s naval expansion."

The US Navy's plan to replace its aging undersea **nuclear deterrent faces** costly delays, raising **concerns about** the **credibility** of its posture and future ability to keep pace with China's naval expansion.
<<CONDENSED TEXT BEGINS>>
This month, the US Congressional Research Service (CRS) released a report mentioning that the US Navy faces an estimated 12 to 16-month delay in the delivery of its first Columbia-class ballistic missile submarine (SSBN), threatening the timely replacement of aging Ohio-class SSBNs. The delay, attributed to shipyard workforce shortages, supply chain disruptions and component delivery setbacks—particularly Northrop Grumman's late turbine generators and Huntington Ingalls Industries' bow section—raises concerns about the impact on subsequent submarines. The US Navy is considering extending the service life of up to five Ohio-class boats to mitigate risks, but this strategy involves additional costs and logistical hurdles. Meanwhile, the simultaneous construction of Columbia-class SSBNs and Virginia-class attack submarines (SSNs) presents industrial-base challenges as shipyards and suppliers struggle to scale production. The US Navy and industry aim to increase Virginia-class production to two boats annually by 2028, yet the current output remains at 1.1-1.2 submarines per year. Rising costs compound the issue, with the Columbia-class program's procurement budget growing 12.1% in the past year alone. Further overruns could siphon funding from other US Navy shipbuilding programs, placing additional strain on the US Department of Defense's (DOD) long-term naval strategy. Amid ballooning costs and delays, the US may need to ramp up submarine production more urgently than ever. In an article this month for We Are The Mighty, Logan Nye mentions that, at present, China relies on anti-ship ballistic missiles (ASBM) such as the DF-21D and DF-26B to keep US carrier battlegroups at bay from Taiwan. Latest stories Tariffs have a Laffer curve, too Tariffs have a Laffer curve, too USAID closure deepens pain of quake-hit Myanmar USAID closure deepens pain of quake-hit Myanmar What to expect from Modi-Putin tete-e-tete What to expect from Modi-Putin tete-e-tete Nye points out those ASBMs are useless against SSNs that can evade them by diving. He also emphasizes that SSNs are self-sufficient for months, which may be critical if US supply chains in the Pacific are threatened.
<<PARAGRAPH BREAKS RESUME>>

Further, in a 2024 American Affairs article, Jerry Hendrix suggests that SSNs may be considered the "first response force" during a Taiwan conflict due to those advantages. However, Hendrix points out that the post-Cold War peace dividend eroded the US submarine industrial base, resulting in the US not having enough submarines when most needed.

The situation is not much better for the US SSBN fleet, as it too suffers from a weak US submarine industrial base. **The Nuclear Threat Initiative (NTI) says that** as of August 2024, 14 Ohio-class SSBNs form the foundation of the US sea-based nuclear deterrent.

According to NTI, each Ohio-class SSBN has 20 missile launch tubes armed with the Trident II D5 submarine-launched ballistic missile (SLBM). The report also says the US Navy is replacing these older missiles with the Trident II D5LE, which has an upgraded guidance system for improved accuracy.

The report mentions that assuming the US Navy has 12 operational Ohio-class SSBNs with 20 launch tubes each and four warheads per missile, they have 960 warheads. However, it mentions that only 8-10 Ohio-class SSBNs are typically deployed at one time due to regular minor repairs, so the number of active warheads in the field may be closer to 720.

The US Navy's **plan to retire Ohio-class SSBNs** at approximately one per year starting **in 2027 raises concerns about the credibility and survivability of** the US undersea nuclear deterrent since they carry 54% of the **US** deployed **nuclear arsenal.**

Emphasizing the importance of the US SSBN fleet, Geoff Wilson and other writers mention in a February 2025 Stimson Center article that SSBNs are the cornerstone of the US “finite deterrence” doctrine, with **SSBN stealth and survivability disincentivizing a first strike that would eliminate all other nuclear forces, creating strategic stability at lower cost.**
Wilson and others argue that the US SSBN fleet can maintain deterrence against multiple targets at a lower cost than intercontinental ballistic missiles (ICBM), which are less critical for deterrence than other delivery options such as bombers.
However, a smaller US SSBN fleet could undermine the credibility of the US undersea nuclear arsenal. In a June 2020 article for The Strategist, Thomas Mahnken and Bryan Clark argue that while **the US sea-based nuclear arsenal is the** most **survivable leg of its nuclear triad**, it is also the most brittle.
Mahnken and Clark argue that if an SSBN can’t launch its missiles, communicate with commanders or is destroyed, all its missiles will be lost. They also highlight that losing only one SSBN on patrol could eliminate an entire leg of the nuclear triad.
Further, they point out that the lethality of the US undersea nuclear deterrent has prompted near-peer adversaries like China and Russia to enhance their anti-submarine warfare (ASW) capabilities to target US SSBNs.
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Emphasizing the potential fragility of the US undersea nuclear arsenal, they project that during the 2030s, it is probable that only one Columbia-class SSBN will be operational at any given time in the Pacific and Atlantic Oceans, supported by one or two vessels at sea as backup. Despite those fragility concerns, Owen Cote Jr mentions in a January 2019 article in the peer-reviewed Bulletin of Atomic Scientists journal that SSBNs remain the most credible deterrent for the US due to their unmatched survivability and stealth. Hong Kong Sign up for one of our free newsletters The Daily Report Start your day right with Asia Times' top stories AT Weekly Report A weekly roundup of Asia Times' most-read stories Email Address Sign up Cote Jr. highlights the historical effectiveness of US SSBNs, particularly during the Cold War, when they proved resilient against Soviet ASW capabilities. He also addresses concerns about emerging technologies, such as AI and quantum computing, which could make oceans transparent. Regarding those concerns, Cote Jr says these fears are largely unfounded, emphasizing the US’s advanced acoustic surveillance systems, such as SOSUS and the Fixed Distributed System (FDS), that can detect Chinese or Russian submarines alongside its favorable maritime geography encompassing vast swathes of the Atlantic and Pacific, make it exceedingly difficult for near-peer adversaries to detect its SSBNs. Further, Stephen Biddle and Eric Labs mention in a Foreign Policy article this month that while China’s shipbuilding capacity dwarfs the US’s by a factor of 230, US warships are typically larger and have superior sensors, electronics and weapons. Contextualizing submarine capabilities, Biddle and Labs mention that China’s submarine force consists of mostly conventionally powered submarines, while the US operates an all-nuclear fleet of 49 SSNs, 14 SSBNs and four nuclear cruise missile submarines (SSGN). They emphasize that, unlike their Chinese counterparts, US crews have battle experience and superior training. However, Biddle and Labs say that China is building aircraft carriers and nuclear submarines in half the time it takes the US to make the same vessels. They caution that the US places itself at serious risk by assuming future wars will be short and that debates over the US-China naval balance should be tempered by considering the dynamics of competitive production for naval wars of attrition.

Domestically produced submarines are nuclear-powered

Nuclear **T**hreat **I**nitiative [nonprofit global security organization focused on reducing nuclear, biological, and emerging technology threats imperiling humanity], 20**24**-08-12, "United States Submarine Capabilities," https://www.nti.org/analysis/articles/united-states-submarine-capabilities/, Date Accessed: 2025-03-31T03:44:59.855Z //RX

Capabilities at a Glance
The United States submarine force consists of four operational **classes** – Ohio, Los Angeles, Seawolf, and Virginia – all of which **are nuclear-powered**.1 The Ohio-class consists of 14 SSBNs that serve as the sea-based leg of the U.S. nuclear triad.2 An additional four Ohio-class submarines are configured as SSGNs that possess both strike and Special Forces insertion capabilities. The other three operational classes — Virginia, Seawolf, and Los Angeles – are composed of SSN attack submarines tasked with engaging and destroying enemy vessels; supporting onshore operations and carrier groups; and carrying out surveillance.
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Total Submarines in Fleet: 713 Ballistic Missile Submarines (SSBNs): 14 Nuclear-Powered attack submarines (SSNs): 53 Guided Missile Submarines (SSGN): 4 Diesel-electric attack submarines (SSKs): 0 Air-independent propulsion submarines (AIPs): 0 Modernization and Current Capabilities In its current modernization drive, the U.S. Navy hopes to add two to three Virginia-class attack submarines annually to its fleet until the year 2043. However, achieving the current goal of 48 Virginia-class submarines will likely depend on budgetary accommodations from

Congress. The U.S. has procured 40 total Virginia-class vessels through FY2024.4 5 Vice Admiral Michael Connor, former commander of US submarines forces from 2012 to 2015, wrote to the House Armed Services Committee in 2018 that he believes the U.S. needs 66 attack submarines to keep up with the increasing military demand for their underwater capabilities.6 The U.S. Navy is phasing out Ohio-class SSBNs in favor of the newly designed Columbia-class. In June 2018, a Congressional report noted that 12 Columbia-class submarines will replace the 14 Ohio-class vessels currently in service as the new underwater component of the U.S. nuclear triad.7 The first Ohio-class submarine is expected to retire in 2027.8 Each nuclear-powered Columbia-class submarine will carry up to 16 Trident II D-5 submarine-launched ballistic missiles (SLBMs). The same Congressional report noted that, based on the projected procurement schedule, the first Columbia-class submarine will be delivered in October 2027 and become operational by 2031, at a total cost of $8.6 billion (excluding testing costs). The second submarine in the class will be delivered for testing in October 2030, with the following ten entering the fleet at a rate of one per year from 2032 to 2042, at a total remaining procurement cost of $112.7 billion.9 The Columbia-class submarines will be equipped with an electric-drive propulsion system rather than mechanical, increasing stealth and resilience.10 Ship Biographies Ohio-class 14 Ohio-class SSBNs form the sea-based leg of the U.S. strategic deterrent triad. The vessels carry Trident II D5 SLBMs, though since 2017, the Navy has been replacing these with Trident II D5LE, a life-extended version equipped with a new guidance system for improved accuracy. Ohio-class submarines previously contained 24 launch tubes each, but the number was reduced to 20 to meet limits under New START. Assuming an average of twelve operational submarines with 20 launch tubes each and four warheads per missile, these boats carry roughly 960 warheads. However, given that normally only eight to ten of the Ohio-class submarines are deployed at one time due to regular minor repairs, the actual number of warheads in the field is closer to 720. The Columbia-class SSBN program will begin to replace the Ohio-class SSBNs starting in the early 2030s. 11 Los Angeles-class The nuclear-powered Los Angeles-class SSN carries Tomahawk land-attack cruise missiles (LACMs) and MK-48 torpedoes. The boat was primarily developed for anti-submarine warfare, but is also capable of inserting Special Forces and laying mines. The Los Angeles-class is considered the backbone of the US submarine fleet with 34 now in commission.12 As a result of technical improvements over time, there are three variants of the Los Angeles-class. Beginning with the USS Providence in 1977, the vessels were equipped with 12 vertical launch tubes for Tomahawk missiles to complement the original Los Angeles-class's four torpedo tubes. The USS San Juan, commissioned in 1988, was the first of the "improved" quieter Los Angeles-class submarines, fitted with an advanced BSY-1 sonar system, and capable of operating under ice.13 27 of the Los Angeles-class submarines will be retired by the mid-2030s, and five will be refueled to extend their lifespan.14 Seawolf-class The U.S. Navy also possesses three Seawolf-class vessels, based at Bangor Trident Base in Washington state. Originally developed to hunt Soviet SSBNs, this class of attack submarine runs significantly faster and quieter than the Los Angeles-class.15 The boat's stealthy capabilities also make it well suited for the insertion of Special Forces. Although it does not possess a vertical launch capability, it can fire Tomahawk missiles through its torpedo tubes.16 While the original plan was to produce as many as 29 submarines, construction costs proved too high and the end of the Cold War meant that their primary function was no longer applicable. As a result, Congress decided to terminate the program at three boats in 1995.17 Virginia-class The Virginia-class, designed by the Electric Boat Corporation of Connecticut, represents the next generation of U.S. nuclear attack submarines and a more cost-effective alternative to the Seawolf-class. With 22 vessels already commissioned, the Virginia-class will take over the Los Angeles-class's operation role. The Virginia-class's ability to operate effectively in littoral waters, primarily due to its "fly-by-wire" control system, gives it an advantage over the Los Angeles-class, while its unmanned undersea vehicles (UUV) and special force delivery vehicles make it suitable for intelligence gathering and special operation forces missions.18 Furthermore, unlike the Seawolf-class, the Virginia-class possesses vertical launch tubes for firing its land-attack Tomahawk missiles.19 Virginia-class submarines are currently being built at an approximate rate of one per year, but their introduction rate will likely depend in part on the retirement rates of the older Los Angeles-class vessels.20 Most Virginia-class submarines procured in FY2019 and thereafter will be built with the Virginia Payload Module (VPM), a mid-body section equipped with vertical launch tubes. General Dynamics Mission Systems Progeny Systems announced in July 2024 that it was awarded an $11,996,038 contract to provide engineering and technical support for modernizing Virginia Class Block I/II submarines with the Common Weapon Launcher (CWL) system, as well as to pursue other ongoing modernization projects.21

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Import and Export Behavior

Imports

The United States does not import submarines.

Exports

The United **S**tates **does not** export nuclear-powered submarines and no longer **operate**s, produces, or exports **diesel-powered submarines. The U.S. Navy has long opposed the export of diesel-electric submarines due to concerns about the impact of submarine technology proliferation on the ability of its forces to operate securely in coastal waters around the world.**

Between 1945 and 1980, the United States provided roughly 25% of exported diesel-powered submarines globally. Apart from one sale of two submarines to Egypt in 1992 over objections from the U.S. Navy, the United States has not manufactured or exported any diesel-powered submarines since the Cold War.22 Congress did approved contracts for the sale of diesel-electric submarines to Egypt and Taiwan in 2001, but neither came to fruition.23

On 15 September 2021, the United States, United Kingdom, and Australia announced a trilateral partnership called "AUKUS" to assist Australia in acquiring nuclear-powered submarines, among other topics of security cooperation.24 In 2023, a statement from the White House proposed the sale of three U.S. Virgina Class Submarines, as authorized by Congress for the early 2030s.25

Aff solves for the dearth of deterrence

Roger **Wicker** [US Senator & Air Force Veteran], 20**23**-07-16, "The U.S. Navy Needs More Attack Submarines," https://www.wicker.senate.gov/2023/7/the-u-s-navy-needs-more-attack-submarines, Date Accessed: 2025-03-31T03:26:10.816Z //RX

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The United States, Australia and the United Kingdom formed a pact in 2021 to boost the three nations' collective deterrence in the Indo-Pacific. That Aukus agreement is vital but there is more work to do: The U.S. should double its submarine production. Under the first pillar of the Aukus agreement, the U.S. would sell our attack submarines to Australia. In exchange, Australia would expand basing for U.S. submarines. In the second pillar, all three nations would share advanced technology. Attack submarines are among our most effective weapons and the crown jewels of U.S. military power. Undersea warfare is one of the few areas in which we retain a competitive advantage over the Chinese military. Aukus has bipartisan support because of its potential to improve the national security of all three nations. Implementing this deal will require a historic amount of cooperation and trust among the three countries and, here at home, between the executive and legislative branches. As it stands, the Aukus plan would transfer U.S. Virginia-class submarines to a partner nation even before we have met our own Navy's requirements. The U.S. Navy's military requirement is 66 nuclear attack submarines. Today, there are only 49 in the fleet. And the Navy projects its inventory will decline to 46 by 2030 as older nuclear submarines retire faster than they are replaced.
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Worse still, demands on our submarine maintenance capabilities have also stretched our military's readiness. Nearly 40% of U.S. attack submarines cannot be deployed because of maintenance delays. For example, the USS Connecticut had an accident in the South China Sea in 2021 and likely won't be operational until 2026.

The U.S. submarine industrial base is producing an average of 1.2 Virginia-class attack submarines a year, **short of the** two our **Navy needs**. There are many reasons for this underperformance. For years, the U.S. government purchased only one submarine annually—hardly enough to maintain a strong industrial base.

By comparison, during the 1980s we bought four times as many. The effort to ramp up production to a rate of two attack submarines a year has been plagued with workforce and supply-chain challenges.

To keep the commitment made under Aukus, and not reduce our own fleet, **the U.S.** would have to produce between 2.3 and 2.5 attack submarines a year.

Improvements in submarine maintenance and more forward basing of submarines will help increase deployment of the submarine fleet, making the deterrence effect of these weapons even stronger. Australian investment in U.S. shipyards will also help. But we can't afford to shrink the overworked U.S. submarine fleet at a dangerous moment.

China's President Xi Jinping has instructed the People's Liberation Army to be ready for a Taiwan invasion by 2027. Time is of the essence.

Fortunately, there is a solution. President Biden **should immediately send Congress a request for supplemental appropriations** and authorities—including a detailed implementation plan—**that increases U.S. submarine production** to 2.5 Virginia-class attack submarines a year. It is time to make generational investments in U.S. submarine production capacity that include supplier and workforce development initiatives.

There is precedent for such a bold investment. Men, women and industries answered the call at the outset of World War II to produce weapons and materiel. During the Cold War, the U.S. rapidly built a nuclear Navy that was second to none. To fulfill the promise and benefit of the Aukus agreement, we need such clarity of purpose once again.

The impact is a Taiwan Invasion

Spencer 2000 indicates

Jack Spencer, 2000 (Jack, Research Fellow at Thomas A. Roe Institute for Economic Policy Studies, “The Facts About Military Readiness”, Heritage Foundation, September 15th, http://www.heritage.org/Research/Reports/2000/09/BG1394-The-Facts-About-Military-Readiness) //NMM (DOA 03-15-2021)

America's national security requirements dictate that the armed forces must be prepared to defeat groups of adversaries in a given war. America, as the sole remaining superpower, has many enemies. Because attacking America or its interests alone would surely end in defeat for a single nation, these enemies are likely to form alliances. Therefore, basing readiness on American military superiority over any single nation has little saliency. The evidence indicates that the U.S. armed forces are not ready to support America's national security requirements. Moreover, regarding the broader capability to defeat groups of enemies, military readiness has been declining. The National Security Strategy, the U.S. official statement of national security objectives,[3] concludes that the United States "must have the capability to deter and, if deterrence fails, defeat large-scale, cross-border aggression in two distant theaters in overlapping time frames."[4]According to some of the military's highest-ranking officials, however, the United States cannot achieve this goal. Commandant of the Marine Corps General James Jones, former Chief of Naval Operations Admiral Jay Johnson, and Air Force Chief of Staff General Michael Ryan have all expressed serious concerns about their respective services' ability to carry out a two major theater war strategy.[5] Recently retired Generals Anthony Zinni of the U.S. Marine Corps and George Joulwan of the U.S. Army have even questioned America's ability to conduct one major theater war the size of the 1991 Gulf War.[6] Military readiness is vital because **declines in America's military readiness signal to the rest of the world that the United States is not prepared to defend its interests. Therefore, potentially hostile nations will be more likely to lash out against American allies and interests, inevitably leading to U.S. involvement in combat. A high state of military readiness is more likely to deter potentially hostile nations from acting aggressively in regions of vital national interest, thereby preserving peace.**

China pounces on weakness; escalation spirals

John A. **Tirpak** [Editorial Director of Air & Space Forces Magazine, with more than 25 years at the publication and more than 34 years in defense journalism. He has written for Aviation Week & Space Technology, Aerospace Daily, and Jane’s, reporting from all 50 U.S. states and 25 countries. He has been recognized with awards for journalistic excellence from the Society of Professional Journalists, the Aviation and Space Writer’s Association, the Association of Business Publications International, and was the recipient of the 2018 Gill Robb Wilson Award in Arts and Letters from the Air & Space Forces Association. He has lectured at the National War College and did postgraduate research at the Smithsonian’s National Air & Space Museum], 20**24**-11-01, "S&P: Is China Prepared to Uncork the Nuclear Option?," Air & Space Forces Magazine, https://www.airandspaceforces.com/article/sp-is-china-prepared-to-uncork-the-nuclear-option/, Date Accessed: 2025-03-29T21:02:53.871Z //RX

China could be more **ready to launch a nuclear first-strike** than the U.S. realizes, raising the specter of a “limited nuclear exchange” in the Pacific, experts warn, and increasing the risks should conflict breakout and escalate in the future.

The U.S. faces the “increased likelihood of a limited **nuclear exchange in a future Indo-Pacific crisis scenario,”** notes a new report from the Atlantic Council. Based on a wargame plus analysis of China’s public statements and internal machinations, the September report asserts that **China would drop its “no-first-use”** policy **should an** attempted **invasion of Taiwan begin** to fail.

U.S. “institutional **assumptions” about how and when China might resort to nuclear weapons are “flawed,”** the authors said. The U.S. National Security and National Defense strategies need to consider China’s burgeoning nuclear inventory and the chance that it could follow an unconventional nuclear strategy, unleashing theater nuclear weapons against U.S. forces in Guam should an attempted invasion begin to falter.

John Culver, a senior fellow with the Atlantic Council's Global China Hub and a longtime CIA analyst specializing in East Asian Affairs, said a**ssumptions that nuclear powers will hold their fire rather than use nuclear weapons are unproven. China is "prepared to 'go there,'"** he said during a webinar releasing the study.

Culver, David O. Shullman, Kitsch Liao and Samantha Wong co-wrote the Atlantic report, titled "Adapting U.S. Strategy to Account for China's Transformation into a Peer Nuclear Power."

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The report is based on a wargame set in 2032, in which China invades Taiwan but secures only a tenuous lodgment. When follow-on forces are destroyed by the U.S. and tougher-than-expected resistance by Taiwanese forces, China finds itself with "no credible off-ramp to claim victory." Faced with that challenge, Chinese President Xi Jinping must weigh the consequences of going nuclear or accepting defeat. "The need to prevent such failure would likely justify the use of any and all measures, including nuclear employment, once the invasion is underway," the authors concluded. In the wargame, the "Blue" U.S. force was surprised when the "Red" force "attacked Guam with two very large devices," Culver said. One struck the air base and the other attacked the naval base there, effectively taking Guam "off the board" as a launch pad for long-range strikes against China and as a logistical hub for sustaining allied forces in the Western Pacific. The Red team had previously signaled the potential use of nuclear weapons, he said, firing long-range conventional weapons from ballistic missile submarines at U.S. forces and West Coast bases; at least one overflew Guam. The missiles were intercepted, but the clear message was that these could just as well be nuclear weapons. The Red force also engaged in counterspace and cyberattacks, while the Blue force pressed the conventional fight. Meanwhile, a "Green" team—representing regional allies—took significant hits and insisted that "nuclear security guarantees to them required that the U.S. respond proportionally." To preserve the credibility of its nuclear deterrence guarantees, the Blue force did so. According to Culver, Xi believes the world is in the midst of a "tectonic shift," a reset akin to what followed the end of World War I, when major empires collapsed and a New World Order took shape. Russia's invasion of Ukraine and other events have demonstrated to Xi, he said, that "major power war and even nuclear war are back on the table, after being off the table since the end of the Cold War." In recent years, Xi elevated missile and nuclear forces to a full military service, seeing those as of increasing importance, Culver said. "It no longer suited China's interest to have a minimal deterrence capability now that a new, more dangerous world was emerging and the potential for war was rising, especially great power war," he said. Having submitted to what it considers "nuclear blackmail … at least three times in the past," Culver said, China has decided it will not do so again.

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The U.S. government, meanwhile, has not awakened to the challenge posed by China's evolving strategy. U.S. strategists view China's nuclear program as building strategic forces to "sustain a minimal retaliatory posture," the report states, while "China now has a higher likelihood of using its newfound nuclear power to more actively deter or compel its opponents and safeguard its core interests."

Beijing is willing to use its power, however, to counter "perceived external threats that could negatively impact domestic political interests." Meanwhile, the authors write, "structural issues within the U.S. government decision-making process" work against nuclear escalation. These include "fragmentation" and decision-making silos that could lead, in the face of crisis, to "disjointed and … flawed recommendations."

The authors argue that "The misreading of China's core interests contained in these disjointed COAs [courses of action] leads to tension between the United States winning a conventional war and maintaining nuclear deterrence, and also creating uncertain trade-offs in scarce military resources."

In the end, **American failure "to recognize that as China rapidly expands its nuclear arsenal and delivery capabilities, it will behave in a way consistent with the status of a nuclear peer power," poses the gravest risk: This "could translate into a false U.S. assumption that China would not contemplate" a first use of nuclear weapons, which could, in turn, lock the United States and China into an inadvertent escalation spiral that could ultimately trigger a nuclear war.**

Allies and Signals

In a hot war with China**, Japan and South Korea** are likely to pressure the U.S. "to ramp up nuclear signaling" and "**escalate in the nuclear realm**," the authors said—especially if those countries have already lost forces in the conflict and feel vulnerable to continuing attack.

Also complicating the strategy is China's relationship with **Russia**, which the authors said could "shape China's decision-making calculus on nuclear first use." Russia could seek to "**exploit** any **crisis**" in the Indo-Pacific for its own purposes elsewhere, they added, "exercising nuclear coercion to achieve its own ends."

U.S. nuclear theory is “informed by historical memory from the Cold War,” the authors write, but dealing with China as a nuclear power requires a different playbook.

“While Russia’s signaling has been aggressive, escalatory, and clearly communicated, China’s signaling methods tend to be more subtle and ambiguous,” they write. “China has intentionally created these ambiguous redlines, partially to exploit what they perceived as the risk-averse nature of the U.S. and allied decision-making process.”

Beijing is tight-lipped about its nuclear forces, which the U.S. estimates will include more than 1,000 deliverable warheads by the end of the decade. Yet as China’s nuclear inventory is still well below U.S. or Russian stockpiles, Beijing has ignored all invitations to participate in strategic arms talks.

“China’s lack of nuclear transparency may … be attributable to its historically inferior nuclear force,” the report says. As China builds toward nuclear parity with the U.S. and Russia, however, it may yet “be persuaded to become more transparent about its nuclear capabilities and intentions.”

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The authors argue that for Beijing to “safely wield its newfound nuclear peer status to achieve national goals, it must increase transparency of its nuclear intentions and capability both before and during a crisis. More clarity is needed to close this gap between China’s stated nuclear doctrine and its actual motivations, behavior, and intent.” Bonny Lin, director of the China Power Project and senior fellow at the Center for Strategic and International Studies, said on the webinar that the wargame underplayed the amount of coordination that would likely take place between China and Russia. “China is not going to ask Russia for permission,” she said. “China is not going to be telling Russia every single move. [But] I would expect support from Russia early on, even maybe before the invasion has started.” Lin said the exercise demonstrated a serious “lack of crisis communications” between China and the U.S., a concern U.S. leaders have raised with Beijing. Eric Chan, senior nonresident fellow at the Global Taiwan Institute, who participated in the wargame, said he did not think a nuclear strike by China would “get either the U.S. or Taiwan to back off.” Rather, he said, it would prompt them to accelerate the conventional campaign, and “really change the game” for Taiwan “in terms of how they resist the PRC.” The wargame suggests that Taiwan is right to stockpile weapons and enhance its readiness to fight a protracted war. “Ukraine’s readiness and resilience against [Vladimir] Putin’s nuclear threats is one of the two reasons why Putin hasn’t employed nuclear weapons against Ukraine,” he said. President Joe Biden “has quietly threatened Putin that if they were to use tactical nuclear weapons in Ukraine, then the U.S. would use conventional airpower to wipe out these forces in Ukraine.” Also important is that “Ukraine hasn’t shown any signs of being wobbly against Putin’s nuclear use, and that decreases the threat from the nuclear use.” Culver noted in the webinar that most of the arms control treaties between the U.S. and Russia have been “swept away” in recent years except for the SALT II agreement, which comes up for renewal next year. Russia has indicated it may not renew. Under SALT, Russia and the U.S. kept their deliverable warheads to 1,550, many of them “outmoded … air-drop bombs,” according to Culver. China’s rapid expansion of nuclear ICBM capacity changes the entire equation, and makes nuclear war now seem more possible than it has in decades. “The whole panoply of things that allowed us to no longer ‘think about the unthinkable,’ … is wearing thin,” Culver said. China “owes an explanation” to its neighbors and opponents “about what it’s doing.”

Cross x talmage 18 and clare 23 for c2 for nuclear wepaons being used and great power war causing exticntion

2AC

AT: AGI

No impact to AI --- not existential and they won’t attack humans

---at: bostrom

Michael **Shermer 17**. Publisher of Skeptic magazine, a monthly columnist for Scientific American, and a Presidential Fellow at Chapman University. 04/2017. “Why Artificial Intelligence Is Not an Existential Threat.” Skeptic, vol. 22, no. 2, pp. 29–35.

Why AI is not an Existential Threat First, most AI doomsday prophecies are grounded in the **false analogy** between **human nature** and **computer nature**, or natural intelligence and artificial intelligence. We are thinking machines, but natural selection also designed into us **emotions** to **shortcut** the **thinking** process because natural intelligences are limited in speed and capacity by the number of neurons that can be crammed into a skull that has to pass through a pelvic opening at birth, whereas artificial intelligence need not be so restricted. We don't need to compute the caloric value of foods, for example, we just feel hungry. We don't need to calculate the waist-to-hip ratio of women or the shoulder-to-waist ratio of men in our quest for genetically healthy potential mates; we just feel attracted to someone and mate with them. We don't need to work out the genetic cost of raising someone else's offspring if our mate is unfaithful; we just feel jealous. We don't need to figure the damage of an unfair or non-reciprocal exchange with someone else; we just feel injustice and desire revenge. Emotions are **proxies** for getting us to act in ways that lead to an increase in reproductive success, particularly in response to threats faced by our Paleolithic ancestors. Anger leads us to strike out, fight back, and defend ourselves against danger. Fear causes us to pull back, retreat, and escape from risks. Disgust directs us to push out, eject, and expel that which is bad for us. Computing the odds of danger in any given situation takes too long. We need to **react instantly**. Emotions shortcut the information processing power needed by brains that would otherwise become bogged down with all the computations necessary for survival. Their purpose, in an ultimate causal sense, is to drive behaviors toward goals selected by evolution to **enhance survival** and reproduction. **AIs** -- even AGIs and ASIs -- will have **no need** of such emotions and so there would be no reason to program them in unless, say, terrorists chose to do so for their own evil purposes. But that's a human nature problem, not a computer nature issue. To believe that an ASI would be **"evil"** in any emotional sense is to assume a computer cognition that includes such psychological traits as **acquisitiveness**, competitiveness, vengeance, and bellicosity, which seem to be projections coming from the mostly **male writers** who **concoct** such **dystopias**, not features any **programmer** would **bother including**, assuming that it **could even be done**. What would it mean to program an emotion into a computer? When IBM's Deep Blue defeated chess master Garry Kasparov in 1997, did it feel **triumphant**, vengeful, or bellicose? **Of course not**. It **wasn't even "aware"** -- in the human sense of self-conscious knowledge -- that it was **playing chess**, much less feeling nervous about possibly losing to the reigning world champion (which it did in the first tournament played in 1996). In fact, toward the end of the first game of the second tournament, on the 44th move, Deep Blue made a legal but incomprehensible move of pushing its rook all the way to the last row of the opposition side. It accomplished nothing offensively or defensively, leading Kasparov to puzzle over it out of concern that he was missing something in the computer's strategy. It turned out to be an error in Deep Blue's programming that led to this fail-safe default move. It was a bug that Kasparov mistook as a feature, and as a result some chess experts contend it led him to be less confident in his strategizing and to second-guess his responses in the subsequent games. It even led him to suspect foul play and human intervention behind Deep Blue, and this paranoia ultimately cost him the tournamentt.[13] Computers don't get paranoid, the HAL 9000 computer in 2001 notwithstanding. Or consider **Watson**, the IBM computer built by David Ferrucci and his team of IBM research scientists tasked with designing an AI that could rival human champions at the game of Jeopardy! This was a far more formidable challenge than Deep Blue faced because of the prerequisite to understand language and the often multiple meanings of words, not to mention needing an encyclopedic knowledge of trivia (Watson had access to Wikipedia for this). After beating the all-time greatest Jeopardy! champions Ken

Jennings and Brad Rutter in 2011, did Watson feel flushed with pride after its victory? Did Watson even know that it won Jeopardy!? I put the question to none other than Ferrucci himself at a dinner party in New York in conjunction with the 2011 Singularity Summit. His answer surprised me: "Yes, Watson knows it won Jeopardy!" I was skeptical. How could that be, since such self-awareness is not yet possible in computers? "Because **I told it** that it won," he replied with a wry smile. Sure, and you could even program Watson or Deep Blue to vocalize a Howard Dean-like victory scream when it wins, but that is still a **far cry** from a computer feeling triumphant. This brings to mind the **"hard problem" of consciousness** -- if we don't understand how this happens in humans, **how could we program it into computers?** As Steven Pinker elucidated in his answer to the 2015 Edge Question on what to think about machines that think, "AI dystopias project a **parochial alpha-male psychology** onto the **concept of intelligence**. They assume that superhumanly intelligent robots would develop **goals** like **deposing their masters** or **taking over the world."** It is **equally possible**, Pinker suggests, that "artificial intelligence will naturally develop along female lines: fully capable of solving problems, but with **no desire to annihilate innocents** or **dominate the civilization**."[14] So the fear that computers will become emotionally evil are unfounded, because without the suite of these evolved emotions it will **never occur to AIs** to take such actions against us. What about an ASI **inadvertently** causing our extinction by turning us into paperclips, or tiling the entire Earth's surface with solar panels? Such scenarios imply yet another emotion -- the feeling of **valuing** or **wanting something**. As the science writer Michael Chorost adroitly notes, when humans resist an AI from undertaking any form of global tiling, it "will have to be able to **imagine counteractions** and **want to carry them out.**" Yet, "until an AI has feelings, it's going to be unable to **want to do anything at all**, let alone **act counter to humanity's interests** and **fight off human resistance**." Further, Chorost notes, "the minute an A.I. wants anything, it will live in a universe with rewards and punishments -- including punishments from us for behaving badly. In order to survive in a world dominated by humans, a nascent A.I. will have to develop a humanlike moral sense that certain things are right and others are wrong. By the time it's in a position to **imagine** tiling the Earth with solar panels, it'll **know that it would be morally wrong** to do so."[15] From here Chorost builds on an argument made by Peter Singer in The Expanding Circle (and Steven Pinker in The Better Angels of Our Nature[16] that I also developed in The Moral Arc[17] and Robert Wright explored in Nonzero[18]), and that is the propensity for natural intelligence to evolve moral emotions that include reciprocity, cooperativeness, and even altruism. Natural intelligences such as ours also includes the capacity to reason, and once you are on Singer's metaphor of the "escalator of reason" it can carry you upward to genuine morality and concerns about harming others. "Reasoning is inherently expansionist. It seeks universal application," Singer notes.[19] Chorost draws the implication: "AIs will have to step on the escalator of reason just like humans have, because they will need to **bargain for goods in a human-dominated economy** and they will face **human resistance to bad behavior**."[20] Finally, for an AI to get around this problem it would need to evolve emotions on its own, but the only way for this to happen in a world dominated by the natural intelligence called humans would be for **us** to **allow it to happen**, which we **wouldn't** because there's **time enough to see it coming. Bostrom's "treacherous turn" will come with road signs ahead** warning us that there's a sharp bend in the highway with enough time for us to grab the wheel. Incremental progress is what we see in most technologies, including and especially AI, which will continue to serve us in **the manner we desire and need**. Instead of Great Leap Forward or Giant Fall Backward, think Small Steps Upward. As I proposed in The Moral Arc, instead of Utopia or dystopia, think **protopia**, a term coined by the futurist Kevin Kelly, who described it in an Edge conversation this way: "I call myself a protopian, not a Utopian. I believe in progress in an incremental way where every year it's better than the year before but not by very much -- just a micro amount."[21] Almost all progress in science and technology, including computers and AI, is of a protopian nature. Rarely, if ever, do technologies lead to either Utopian or dystopian societies. Pinker agrees that there is **plenty of time** to plan for all conceivable contingencies and build safeguards into our AI systems. "They would not need any ponderous 'rules of robotics' or some newfangled **moral philosophy** to do this, just the same **common sense** that went into the design of **food processors**, **table saws**, **space heaters**, and **automobiles**." Sure, an ASI would be many orders of magnitude **smarter** than these machines, but Pinker reminds us of the **AI hyperbole** we've been fed for decades: "The worry that an AI system would be **so clever** at attaining one of the goals programmed into it (like commandeering energy) that it would **run roughshod over** the **others** (like human safety) assumes that AI will descend upon us **faster than we can design** **fail-safe** **precautions**. The reality is that progress in AI is **hype-defyingly slow**, and there will be plenty of time for feedback from incremental implementations, with humans wielding the screwdriver at every stage."[22] Former Google CEO Eric Schmidt agrees, responding to the fears expressed by Hawking and Musk this way: "Don't you think the humans would notice this, and start **turning off the computers**?" He also noted the irony in the fact that Musk has invested $1 billion into a company called OpenAI that is "promoting precisely AI of the kind we are describing."[23] Google's own DeepMind has developed the concept of an **AI off-switch**, playfully described as a **"big red button"** to be pushed in the event of an attempted AI takeover. "We have proposed a framework to allow a human operator to repeatedly safely interrupt a reinforcement learning agent while making sure the agent will not learn to prevent or induce these interruptions," write the authors Laurent Orseau from DeepMind and Stuart Armstrong from the Future of Humanity Institute, in a paper titled "Safely Interruptible Agents." They even suggest a precautionary scheduled shutdown every night at 2 AM for an hour so that both humans and AI are accustomed to the idea. "Safe interruptibility can be useful to take control of a robot that is misbehaving and may lead to irreversible consequences, or to take it out of a delicate situation, or even to temporarily use it to achieve a task it did not learn to perform or would not normally receive rewards for this."[24] As well, it is good to keep in mind that artificial intelligence is not the same as artificial **consciousness**. Thinking machines **may not be sentient** machines. Finally, Andrew Ng of Baidu responded to Elon Musk's ASI concerns by noting (in a jab at the entrepreneur's ambitions for colonizing the red planet) it would be "like worrying about overpopulation on Mars when we have not even set foot on the planet yet."[25] Both Utopian and dystopian visions of AI are based on a projection of the future quite unlike anything history has given us. Yet, even Ray Kurzweil's "law of accelerating returns," as remarkable as it has been has nevertheless advanced at a pace that has allowed for considerable ethical deliberation with appropriate checks and balances applied to various technologies along the way. With time, even if an unforeseen motive somehow began to emerge in an AI we would have the **time to reprogram it** before it got out of control. That is also the judgment of Alan Winfield, an engineering professor and co-author of the Principles of Robotics, a list of rules for regulating robots in the real world that goes far beyond Isaac Asimov's famous three laws of robotics (which were, in any case, designed to fail as plot devices for science fictional narratives).26 Winfield points out that all of these doomsday scenarios depend on a **long sequence of big ifs** to unroll sequentially: "If we succeed in building human equivalent AI and if that AI acquires a full understanding of how it works, and if it then succeeds in improving itself to produce super-intelligent AI, and if that super-AI, accidentally or maliciously, starts to consume resources, and if we fail to pull the plug, then, yes, we may well have a problem. The risk, while not impossible, is **improbable**."[27]

Directly answers 1NC Yoko

Our impact outweighs --- too many development hurdles means our impact happens before AI could be existential

Brooks et al 15 -- Panasonic **Professor of** Robotics (Emeritus), Computer Science and **Artificial Intelligence** Lab, **M**assachusetts **I**nstitute of **T**echnology; Founder, Chairman, and Chief Technology Officer, Rethink Robotics; Abhinav Gupta -- Assistant Research Professor, Robotics Institute, Carnegie Mellon University; Andrew McAfee -- Principal Research Scientist and Cofounder, Initiative on the Digital Economy, Sloan School of Management, Massachusetts Institute of Technology (Rodney, 2/27/2015, "Artificial Intelligence and the Future of Humans and Robots in the Economy," Malcolm and Carolyn Wiener Annual Lecture on Science and Technology: Artificial Intelligence and the Rise of Robots, http://www.cfr.org/technology-and-science/artificial-intelligence-future-humans-robots-economy/p36205)

BROOKS: People always want us to fight, but we don't really. I think, although I agree with the general themes that Andy talks about, I think **it's very easy for people who are not deep in the technology itself to make generalizations**, which may be a little dangerous. And we've certainly seen that recently with Elon Musk, Bill Gates, Stephen Hawking, all saying AI is just taking off and it's going to take over the world very quickly. And the thing that they share is **none of them work in this technological field.** So let me explain why—and they're all smart people, but I think they're making a fundamental error and it gets to NEIL, actually. THOMPSON: After taking down Bill Gates, Elon Musk and Stephen Hawking, he's going to take down the Dalai Lama. Please continue, Rodney. BROOKS: So let's go back to an example from the '90s, when IBM's Deep Blue beat Kasparov, beat the world chess champion. And Kasparov got up and said, well, at least it didn't enjoy beating me. That was his—holding on to his humanity. And now, today, you can get programs that run on—and that was on a supercomputer and now you can get programs that run on laptops. There's about twelve of them that have a better chess rating than any human being has ever had. So people see that -- MCAFEE: It's so bad now—let me underscore what Rod is saying. It's so bad now that they asked human grand master a couple years ago how he would prepare for a match against a computer and he said, I'd bring a hammer. BROOKS: So they can play chess really, really well. And I think people generalize that in the way that if a person can do some task really, really well, they can do adjacent tasks quite well. But none of those chess programs can play tic-tac-toe. Imagine a chess grand master who couldn't play tic-tac-toe. It doesn't make sense. None of those chess programs can give advice to an aspiring human on how to play better. All they can be is a sparring partner. MCAFEE: That program couldn't play tic-tac-toe without being substantially redirected, right? BROOKS: Right. So people, I think, are seeing some of the image labeling that's going on, for instance.

Google came out with image labeling, which is a great commercial problem for them. They want to be able to label images. And one of the examples was, that Jeff Hinton shows, one of the chief scientists, is, it's a picture and it says there's a baby holding a teddy bear or doll in there. You look at it, it's a baby holding a teddy—a doll. But then if you ask the program, where is the baby? All it can say is, well, this pixel has 10 percent probability of being a baby, this pixel has 80 percent. And people have done experiments. You have a mashup of, you know, a grotesque mashup of baby parts and it says it's a baby. It's a baby. It's got all the parts. But a person says, no, that's a grotesque mashup of baby parts in the image. THOMPSON: But Abhinav, you've solved this, right? GUPTA: No, no, no. BROOKS: Well, he's working towards-- GUPTA: So, can I-- BROOKS: He's working towards it because it's such a hard problem. GUPTA: Yeah, OK. Thank you. So since we are talking about images, I think I should chime in a little bit and tell you that—so what Andrew is talking about, that we have made big advances, again, they're very, very specific tasks. Given an image, tell me what label can you put on that image? We have gotten really good at this task. Some people claim even better than humans. I don't buy that, but let's assume that even better than humans. But that doesn't mean we can do anything else apart from that exact task. And that's what Rodney was talking about. They have no idea that—what does baby mean? What does having a baby mean in those images? No idea. You, as a human, would know, OK, if I'm saying there's a baby, it has a lot of meaning inside. You get a lot of meaning out of that thing. So while we have made significant advances in the last two years, I want to boil it down a little bit and say **we still are a long, long way to go** but Elon Musk or Bill Gates, everyone is talking about, we still have a long way to go. But there's hope, and that's what I think we have to see here. Two years ago, if you asked me can computers take an image and solve this problem, I would say I have invested seven years of my life but if you give me a random image, it will not work. And now, given a random image, it will work. So all it -- MCAFEE: This was the guy who was doing this for a living and if you asked him two years ago would this happen, he would say, no. This progress is weirdly fast and is surprising insiders in the field. GUPTA: Yeah. I agree. And I'm an insider in the field and I'm very surprised, I have to say. Now, at this point of time, I am like living in an awe of myself, in some sense, that—but it was like Rodney told—Rodney told us that in thirty-five years he never thought he'd do this all. I also thought some of it, like that, for thirty-five years, I will not solve—see this kind of classification performance. But as I'm saying this, still a long, long way to go and much harder way to go. What—where all the kind of gains have come from is the data. And I think—so technology, this like deep-learning technology has been there from '70s and '80s. Don't misunderstand that this technology came two years ago and everything's changed. **This has been there for thirty years**. It's just that for the first time in our technological advances we have data for this deep-learning technology to learn. MCAFEE: Let me jump on this because I think the three of us are really agreeing, instead of disagreeing. I chose my adjective pretty carefully. I said these advances are going to be economically significant. I completely agree with Rod that **they're not going to be existentially significant on any timeframe that we really need to worry about**, for exactly the reasons that you're bringing up. One way to think about this, the way I try to get my mind around it, is there are, from what I've been able to take in, there are something like between ten and twenty really fundamental challenges that these guys and their discipline have been working on. Common sense is a really great example of that. As I've looked around, these breakthroughs that we're seeing seem to be—kind of indicate that we're making real progress on **one of those challenges**, the challenges of learning in a pretty unstructured environment. That's a big deal. There are lots of other fundamental challenges in the discipline where the progress has not been as fast, and these are the ones that you're working on.

Safety codes check the impact --- people will build safety valves into computers to prevent their impact --- the codes are attached

Easttom 18- [CEC Consulting. Chuck Easttom, CECE Consulting, 03.09.2018, "The Role of Weaponized Malware in Cyber Conflict and Espionage." Proceedings of the 13th International Conference on Cyber Warfare and Security: National Defense University Washington DC, USA] 2. Rules of engagement

Traditional warfare involves clear **rules of engagement**. First the **Geneva** convention circumscribes the permissible activities within an armed conflict. In addition to such international restrictions, commanders of units in the field routinely issue specific rules of engagement for a particular mission. The goal of such rules of engagement are to give combatant troops clear guidance on what is and what is not permissible action. Strategically this allows resources to be focused on the actual mission target. Tactically this reduces **collateral damage**. Unfortunately, **cyber conflicts** currently have **no clear rules** of engagement (Bershidsky, 2017; Gronberg, 2016). This situation can lead even **responsible** nation states into engaging in cyber operations that would not be permissible in non-cyber operations. As one example, a given military might not utilize traditional ordinance: against civilian targets such as hospitals, but may be willing to deploy cyber weapons against that same target. As a general rule, similar rules to those in the Geneva convention should be adhered to. This would prohibit intentional targeting of hospitals and similar purely civilian institutions. However, beyond that general philosophical approach, each individual operation should have clear rules of engagement defined by the command structure. This identifies targets, non-combatants, specifically authorized techniques, and any explicitly denied techniques. This provides the operators in a cyber operation clear guidance as to how to effectively and ethically conduct the mission. Beyond these general rules of engagements, specific rules defining how much effort should be placed on operational deniability must be explicitly defined. Some operations are likely to be attributed to the attacker, regardless of any steps taken. For example, attacks on Iranian nuclear refinement are generally assumed to be. U.S. or Israeli based, with Saudi Arabia as a distant third candidate. No amount of concealment will prevent at least speculation as to the actors in any attack on Iranian nuclear facilities. This is just a single example, but illustrates the point. In some operational scenarios, operational deniability may not be a necessary element of the rules of engagement. However, in other scenarios it might be a key element of the rules of engagement. This need for obfuscation the originator of a malware attack should guide the selection of weaponized malware for ? a specific operation. 3. Limiting collateral damage In any conflict, limiting **collateral damage** is a **critical** element. This is true in traditional warfare **as well as** in cyber operations. Furthermore, in cyber **op**erations it may be desirable to

avoid detection of the attack, or at least **attribution** of the attack. And in cyber espionage, ideally the operation will be **completely** undetected. All three of these goals can be achieved using the same techniques. The first step in this process is to add code to malware that will detect the **target system** and gather basic identifying information (Easttom, 2016a). It is trivial to write code that can determine username, domain, IP address, language of the operating system, and other identifying characteristics. Such code can allow the malware to determine if the target is actually a valid target and if it is not to **cease the attack**. This can be true of spyware, or malware that initiates a direct attack. Such coding would both **limit collateral damage**, and make the malware less **virulent**. The latter quality would reduce the widespread impact of the malware, thus making it less noticeable, which is advantageous to operational security. An example of such code, written in the popular C++ programming language, is provided in figure 1. [[FIGURE 1 OMITTED]] The **second part** of the process is **self-destructing** malware. There exist, in the public domain, coding techniques for software to **delete itself** (Easttom, 2016a; Easttom 2016b). This type of program code can be used in two separate scenarios. In the first modality, the self-destructing code is combined with target detection code. In this scenario, should it be determined that the machine is not a valid target, the malware will delete itself. In the second modality, which occurs when malware has acquired valid target based on operational parameters, once the operation has been completed, the malware will self-destruct. This both mitigates the issue of **collateral damage**, and makes it more difficult to **detect the malware incident**. Both of these features will make **attribution** more challenging, and are thus **advantageous to operational security**. Figure 2, presents sample code, also written in the popular C++ programming language, for self-destruction. void SelfDestruct() { TCHAR szModuleName [MAX_PATH]; TCHAR szCmd[2 * MAX_PATH]; STARTUPINFO si = {0}; PROCESS_INFORMATIOIN pi = {0}; GetModuleFileName(NULL, szModuleName, MAX_PATH); StringCbPrintf(szCmd, 2 * MAX_PATH, SELF_REMOVE_STRING, szModuleName); CreateProcess(NULL, szCmd, NULL, NULL, FALSE, CREATE_NO_WINDOW, NULL, NULL, &si, &pi); CloseHandle(pi.hThread); CloseHandle(pi.hProcess); } Figure 2: Self destruction code example The code samples provided are exemplary. Both tasks are **fairly trivial programming tasks** and can be **readily integrated** into any **weapon**ized malware. The specific code utilized will be dependent upon operational parameters. Such parameters include: the nature of the attack, the level of deniability required, as well as both tactical and strategic goals. The specific programming language utilized will, of course, also be selected based on the target operating system and delivery mechanism. There are other, existing methods of obfuscating malware that can make it more difficult to detect. These include polymorphic code, encrypted viruses, sparse infector viruses, and similar, well-known techniques. Any of these might also be implemented, based on operational needs. But the addition of proper target identification and self-destruction can be useful modifications to state-sponsored weaponized malware. Sparse infection malware is particularly resistant to detection and it is relatively **trivial to program**. A spar