# **NC**

**C1:**

**There isn’t enough energy available for AGI, but nuclear is Big Tech’s solution – government support overcomes perception issues and regulatory concerns.**

**Yoko ‘25** [Chris Yoko, President & CEO of Yoko Co, Founder of Carbon Off, attended George Mason University, 2-4-2025, Going Nuclear: Why AI Will Lead the Next Energy Transition, POWER Magazine, https://www.powermag.com/going-nuclear-why-ai-will-lead-the-next-energy-transition/, Accessed 3-10-2025] fehmi + recut riki + jw

Certainly, reliance on legacy energy sources could be the path the new Trump administration takes the country down. His nominee for Secretary of Energy, Chris Wright, who was confirmed on Feb. 3, seems to be willing to embrace all forms of energy production, including natural gas as well as nuclear. In order to maintain the nation’s competitive advantage in the AI race, the new Energy Secretary could fire up every coal plant in the country, especially if he’s stymied in his attempt to embrace nuclear power.

The issue: it still wouldn’t be enough. Simply training these AI models consumes enormous amounts of energy; one estimate states that the energy required to train GPT-3 is the same as is consumed annually by 130 U.S. homes. And that’s not even the latest model.

Getting to the next stage of AI development—**AGI** or ASI—is going to **require more energy** than the U.S. **currently has access to**. The Biden administration’s recent executive order on AI energy production highlights the extent of the issues facing scalable AI infrastructure. The **standard renewable energy** forms **can’t measure up**. Even coated in solar panels, the world wouldn’t be able to provide enough solar energy to satiate the eventual demands of growing AI.

It’s why **nuclear** is being looked at as the **obvious next step** of the energy evolution—and in many ways, it should be the consensus choice for America. The capitalists get their energy, and the environmentalists get a clean source.

This emerging dynamic is every free-market politician’s dream: the market is, at long last, forcing the energy transition. But nuclear-curious companies can only get so far on their own.

As the Trump administration takes power, it’s increasingly clear that building nuclear energy capabilities is going to be a matter of national security, as well as competitiveness, over the next 10 years. China has ramped up its investment in nuclear power, and more nations are likely to follow suit, as the entire world wakes up to the clear energy demands of AI.

Right now, Big Tech is leading the way; they’re in an arms race with one another, and their enormous size and deep pockets mean they’re the only ones with the necessary capital to make the switch on their own. The last year has been littered with headlines about **Big Tech** companies investing in and buying out contracts with nuclear energy providers. Microsoft wants to re-open Three Mile Island while Amazon and Google are investing in their own smaller reactors. Meta, meanwhile, has an active “request for proposals” open to source and produce its own nuclear energy.

Nuclear is no longer strictly in the domain of government investment; much in the same way space exploration has been commercialized and expanded to the masses, so too is nuclear becoming a go-to solution for companies looking to power their AI innovations.

Of course, that doesn’t mean that government support wouldn’t be a relief. Especially as AI becomes more vital for everything from medicine to banking to the military, the government needs to have some chips on the table.

This could be the big push that the environmental movement has been waiting for. With so much riding on the development of AI, the **government** can step in, **backing** up its **commitment** to Big Tech companies by **supporting** them in their **nuclear energy efforts**. The energy issue is, in many ways, a continuation of the landmark CHIPs act, which invested billions of dollars to help bring chip manufacturing into the U.S. Nuclear energy is part and parcel of that conversation.

Having the **U.S. government** as a **partner** will be **especially important** as nuclear energy works to **overcome perception issues** and **regulatory concerns**. Microsoft’s Three Mile Island push has certainly raised eyebrows from those that still remember the initial disaster, though **safety** of nuclear plants has **increased significantly** over the decades.

There’s also the issue of cost. In its attempts to reinvest in nuclear, the state of Georgia spent billions of dollars building two new plants, expanding Plant Vogtle at a cost that’s certainly unsustainable as the world charges ahead.

Of course, nuclear energy isn’t renewable; eventually the Earth’s stores of uranium will run out unless experts figure out a way to make nuclear energy more efficient—a goal that certainly seems possible with greater investment and discovery.

Frankly, there aren’t any other good options. With AI growing and expanding at its current rate, energy production simply isn’t going to keep up. More effective energy sources are vital, and balancing energy investment with Big Tech’s AI ambitions is going to be a key issue for the next presidential administration.

Nuclear energy is a critical part of the AI future—one that we have the power to lead.

#### **AGI will misalign – RLHF training makes it inevitable.**

**Ngo ’25.** Richard Ngo, worked at open AI before quitting because it was too unethical. Research engineer on the AGI safety team at DeepMind. Lawrence Chan, Sören Mindermann. 03-03-2025. “The Alignment Problem from a Deep Learning Perspective v7,” https://arxiv.org/abs/2209.00626. Ghs-ee. //recut riki + jwilly in the hotel lobby next to Tristan Mankovsky from Potomac LM

Over the past decade, deep learning has made remarkable strides, giving rise to large neural networks with impressive capabilities in diverse domains. These networks have reached human-level performance in complex games like StarCraft 2 [Vinyals et al. , 2019] and Diplomacy [Bakhtin et al. , 2022], while also exhibiting growing generality [Bommasani et al., 2021] through improvements in areas including sample efficiency [Brown et al., 2020, Dorner, 2021], cross-task generalization [Adam et al. , 2021], and multi-step reasoning [Chowdhery et al. , 2022]. The rapid pace of these advances highlights the possibility that, within the coming years or decades, we may develop artificial general intelligence (**AGI**)—that is, AI which can apply **domain-general** **cognitive** **skills** (such as reasoning, memory, and planning) to perform at or above human level on a wide range of cognitive tasks 1 relevant to **the real world** (such as writing software, formulating new scientific theories, or running a company) [Goertzel , 2014]. 2

The development of **AGI** could unlock many opportunities, but also comes with **serious risks**. One prominent concern is the alignment problem: the challenge of ensuring that AI systems pursue goals that match human values or interests rather than **unintended** and **undesirable goals** [Russell , 2019 , Gabriel , 2020 , Hendrycks et al. , 2020]. An increasing body of research aims to proactively address the alignment problem, motivated in large part by the desire to avoid hypothesized large-scale risks from AGIs that pursue **unintended goals** [OpenAI, 2023c, Hendrycks et al., 2023, Amodei et al. , 2016 , Hendrycks et al. , 2021].

Previous writings have argued that AGIs will be highly challenging to **robustly align**, and that misaligned AGIs may pose risks on a sufficiently large scale to threaten **human civilization** [Bengio et al. , 2024 , Russell , 2019 , Bostrom , 2014 , Yudkowsky , 2016 , Carlsmith , 2022 , Cohen et al. , 2022]. However, most of these writings only formulate their arguments in terms of abstract high-level concepts (particularly concepts from classical AI), without grounding them in modern machine learning techniques, while writings that focus on deep learning techniques did so very informally, and with little engagement with the deep learning literature [Ngo , 2020 , Cotra , 2022]. This raises the question of whether any versions of these arguments are relevant to, and empirically supported by, the modern deep learning paradigm.

In this paper, we hypothesize and defend factors that could lead to **large-scale risks** if **AGIs** are **trained** using modern deep learning techniques. We focus on AGIs pre-trained using self-supervised learning and fine-tuned using reinforcement learning from human feedback (RLHF) [Christiano et al., 2017], potentially combined with other reward signals and access to tools. Although RLHF is the cornerstone for aligning recent state-of-the-art models, we argue that it will encourage the emergence of three problematic properties. First, human feedback rewards models for appearing **harmless** and **ethical**, while also **maximizing** useful outcomes. The **tension** between these criteria incentivizes **situationally-aware** reward hacking (Section 2) where policies exploit human fallibility to gain **high reward**. Second, RLHF-trained AGIs will likely learn to plan towards misaligned internally-represented goals that generalize beyond the RLHF **fine-tuning distribution** (Section 3). Finally, such misaligned AGIs would likely pursue these goals using unwanted power-seeking behaviors such as acquiring **resources**, **proliferating**, and avoiding **shutdown**. RLHF incentivizes AGIs with the above properties to obscure undesirable power-seeking during fine-tuning and testing, potentially making it **hard to address** (Section 4). AGI systems with these properties would be challenging to **align**. We ground these three properties in empirical and theoretical findings from the deep learning literature. This updated version of our paper (**March 2025**) also covers new direct evidence for the properties we hypothesized in 2022. However, a comprehensive update is left for future work. We also clarify the relationships between these and other concepts—see Figure 1 for an overview. If these risks will plausibly emerge from modern deep learning techniques, targeted research programs (Section 5) will be needed to ensure that we avoid them

#### **All forms of AGI result in the creation of something out of our control.**

**Gulchenko 24** (Victor Gulchenko [SSRN Independent], 7/12/24, “Navigating the Risks: An Examination of the Dangers Associated with Artificial General Intelligence and Artificial Superintelligence”, 2/7/25, https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=4941716) ghs-|aak|

Loss of human control over AI systems Furthermore, the rapid advancement of artificial intelligence (AI) technology raises concerns about the **potential loss of human control** over AI systems. Moreover, the possible loss of human control over AI systems will be **irrevocable**. As you might guess, in the case of any force majeure, you will have to return to very early "factory settings", so to speak. After all, machine intelligence does not preserve the procedure of its step-by-step self-learning. As AI systems become more complex and autonomous, there is a growing fear that **humans may no longer be able to predict** or **even understand the decisions** made by these systems. This **lack of transparency and explainability** can lead to unintended consequences and ethical dilemmas. For example, in the case of autonomous vehicles, if an AI system makes a decision that results in harm to humans, who should be held accountable? This loss of control over AI systems is particularly problematic when it comes to the development of Artificial General Intelligence (AGI) and eventually Artificial Superintelligence (ASI), where machines may **surpass human intelligence and autonomy**. Without proper safeguards and regulations in place, the consequences of **losing control** over AI systems could be **catastrophic**. For example, the 2016 case of an autonomous vehicle by Tesla resulted in a fatal accident due to a failure in the AI system's decision-making process. This incident underscores the need for stringent safety protocols and oversight mechanisms. Moreover, there is clearly a need to improve the institutions of criminal law. Otherwise, with the introduction of machine intelligence systems into corporate life, the state will have fewer and fewer grounds to bring anyone to criminal responsibility. Crimes will sort of lose the criminal as such. In the absence of proper innovations in the field of law, it is possible to reach the point where the illegal actions of machine intelligence will go unpunished in the same way as the actions of, for example, a tsunami or hurricane. If we do not carry out an appropriate modernization of the legal system, then an anecdotal example from antiquity will become a possible new reality. As you know, in preparation for the battle near the city of Salamis (480 BC), Xerxes ordered the construction of a bridge for the transfer of military forces. However, the bridge was destroyed by wind and waves. And then the angry Xerxes ordered to punish the sea – to flog it, which the executioners did. They beat the sea water with their swords. Potential for AI to surpass human intelligence and decision-making capabilities The further development of artificial intelligence, in my opinion, leads to the fact that at some point it will inevitably surpass human intelligence and the ability to make decisions. As AI systems become increasingly sophisticated, there is a growing possibility that they may eventually exceed human cognitive capacities. The most intriguing thing is that this **transition may turn out to be unnoticeable** (but **ultimately fateful**) for humanity. The concept of Artificial General Intelligence (AGI) and eventually Artificial Superintelligence (ASI) raises the question of whether AI could eventually outperform humans in **various domains**, including problem-solving, creativity, and strategic decision-making. While AI has already demonstrated remarkable abilities in areas such as image recognition and natural language processing, the prospect of AI surpassing human intelligence poses significant ethical and existential risks. Scenarios such as AI systems making **autonomous decisions** in critical areas like healthcare diagnostics or **military strategies** could lead to **unforeseen and possibly disastrous consequences**. The main risk in this case can be described as loss of controllability. Indeed, if AI really exceeds human cognitive abilities, then the human community will lose the tools to control it. Indeed, it is impossible to control what goes beyond one's own understanding. And the ethical nature of this problem lies in the fact that entire categories of people find themselves at potential risk (for example, patients in matters of diagnosis). As AI continues to evolve, it is essential for researchers, policymakers, and society as a whole to carefully consider the implications of advancing AI technologies and ensure that appropriate safeguards and regulations are in place to mitigate potential risks. But... only if such deterrence tools actually exist.

#### **This makes misalignment inevitable.**

**Mandel 23** (David R. Mandel [Department of Psychology, York University], 11/15/23, "Artificial General Intelligence, Existential Risk, and Human Risk Perception", DA: 2/7/25, https://arxiv.org/pdf/2311.08698) ghs-|aak|

The prospect of intelligence parity is not necessarily bad. AGI that could think as intelligently as humans but at much faster speeds—what Vinge (1993) calls weak superhumanity —could accelerate scientific and technological progress that humans might have eventually made but over much longer times. This process has even been given the sticky name, PASTA—Process for Automating Scientific and Technological Advancement (Karnofsky, 2021). If AGI (or PASTA) were necessary to avert an existential calamity (or worse, a mass extinction), having it would be a very good thing. The differential clock speeds of humans and machines, however, casts doubt on the parity notion. As soon as AGI could perform as well on any intelligence test (broadly defined) as the best performing human, it will have **exceeded human intelligence** since, if nothing else, it will have faster-than-human speed. Unlike humans, AGI would likely be able to **access its source code, modify it, and replicate** either original or modified copies. These abilities would **set off a positive feedback loop** constituting what Good (1966) referred to as an **intelligence explosion**. As a result, **AGI would evolve very quickly to be strongly superintelligent**; i.e., it would not only **think faster,** it would **think smarter** than the smartest human (Yukdowsky, 2008). It is the prospect of superintelligent AGI that **raises concern** regarding the continued existence our species and that has caused many AI experts and others alike to **call for a pause** in advanced AI development (e.g., Future of Life Institute, 2023). If AGI were more powerful than humans, a misalignment of human and AGI goals would likely **not end well for humanity**. This alignment problem—the question of whether AGI will become misaligned with human goals and values—is a threat analysis problem concerning a set of possible futures having **devastating consequences for humans as a species**. Since there are no tightly coupled reference classes to draw from in determining the probability of human extinction (or catastrophic demise) from AGI misalignment, estimating existential risk from AGI constitutes an extreme version of the reference class problem (Hájek, 2007; Reichenbach, 1949) with the various pro and con arguments drawing heavily on loose analogies. Therefore, it is of little surprise that estimates of risk vary greatly

#### **Misaligned AGI is the most likely existential risk**

#### Dr. Ilan **Noy 22**, Chair in the Economics of Disasters and Climate Change at the Victoria University of Wellington, Ph.D. from the University of California, Santa Cruz; Dr. Tomáš Uher, Professor at Masaryk University, Ph.D. “Four New Horsemen of an Apocalypse? Solar Flares, Super-volcanoes, Pandemics, and Artificial Intelligence,” SpringerLink, 1/15/2022, Economics of Disasters and Climate Change, p. 406-408 //riki

#### Misaligned Artificial Intelligence

#### Artificial intelligence (AI) refers to computer programs or machines which exhibit behaviour humans would perceive to be intelligent (Kaplan 2016). The **significant** scientific **progress** of the field in the last decades has caused many to wonder about the future of this technology and its societal implications. AI may create **significant risks**, depending on what kinds of systems we create and how we deploy them.

#### With respect to advances in the field of AI, **considerable improvements** have been made within specific narrow domains of intelligence (narrow AI) such as computer vision or natural language processing. **Notable progress** has also been made towards achieving a more **general** kind of **intelligence**, such that may eventually be able to employ multiple cognitive abilities, abstraction, and reasoning, as is typical for humans (Strogatz 2018; Badia et al. 2020; Silver et al. 2018). A system with this general reasoning ability is termed artificial general intelligence (**AGI**).

#### Broadly speaking, the use of AI can lead to harmful outcomes either if the AI is programmed to achieve a harmful goal, or if the AI is programmed to achieve a beneficial goal but employs a harmful method for achieving it (Future of Life Institute, n.d.; Turchin and Denkenberger 2018a). The latter case is especially relevant for AGI, as it is argued that application of such systems could lead to **catastrophic outcomes** without any bad intentions or development of harmful methods by its creators (Omohundro 2008).

#### The development of machines that may potentially become **smarter** and **more powerful** than humans could mark the end of an era characterized by humanity’s control of its future (Russell 2019). If such a powerful agent does not share our values, the result could be **catastrophic** (Bostrom 2014; Ord 2020). To prevent the potential disastrous outcomes of future AI, researchers argue it is crucial to align the value and motivation systems of AI systems with human values, a task that is referred to as the alignment problem (Bostrom 2014; Yudkowsky 2016; Critch and Krueger 2020). However, objectively formulating and programming human values into a computer is a complicated task. At present, we do not seem to know how to do it

#### Predicting the potential **catastrophic impacts** of AI is made **difficult** by **several factors**. Firstly, the risk posed by AI is **unprecedented** and **cannot be** reliably **assessed** using historical data and extrapolation, **unlike** the other types of existential risks explored in this review (space weather, super-volcanoes, and pandemics). Secondly, with respect to general and super-intelligence, it may be practically or even inherently impossible for us to predict how a system more intelligent than us will act (Yampolskiy 2020). Considering the difficulty of predicting catastrophic societal impacts associated with AI, we are limited here to hypothetical scenarios of basic pathways describing how the disastrous outcomes could be manifested.

#### When considering potential global catastrophic or **existential risks** stemming from AI, it is useful to distinguish between narrow AI and AGI, as the speculated possible outcomes associated with each type can differ greatly. For narrow AI systems to cause catastrophic outcomes, the potential scenarios include events such as software viruses affecting hardware or critical infrastructure globally, AI systems serving as weapons of mass destruction (such as slaughter-bots), or AI-caused biotechnological or nuclear catastrophe (Turchin and Denkenberger 2018a, b; Tegmark 2017; Freitas 2000). Interestingly, Turchin and Denkenberger (2018a) argue that the catastrophic risks stemming from narrow AI are relatively neglected despite their potential to materialize sooner than the risks from AGI. Still, the probability of narrow AI to cause an **existential catastrophe** appears to be relatively **low**er than in the case of AGI (Ord 2020).

#### With respect to the global catastrophic and **existential risk** of **misaligned AGI**, much of the expected risk seems to lie in an AGI system’s **extraordinary ability** to pursue its goals. According to Bostrom’s instrumental convergence thesis, instrumental aims such as developing more resources and/or power for **gaining control** over humans would be **beneficial** for achieving almost any final goal the AGI system might have (Bostrom 2012). Hence, it can be argued that almost **any misaligned AGI** system would be motivated to gain control over humans (often described in the literature as a ‘decisive strategic advantage’) to eliminate the possibility of human interference with the system’s pursuit of its goals (Bostrom 2014; Russell 2019). Once humans have been **controlled**, the system would be **free** to **pursue its** main **goal**, whatever that might be.

#### In line with this instrumental convergence thesis, an AGI system whose values are not perfectly aligned with **human values** would be likely to pursue harmful instrumental goals, including seizing control and thus potentially creating **catastrophic outcomes** for humanity (Russell and Norvig 2016; Bostrom 2002, 2003a; Taylor et al. 2016; Urban 2015; Ord 2020; Muehlhauser 2014). A popular example of such a scenario is the **paperclip maximizer**, which firstly appeared in a mailing list of AI researchers in the early 2000’s (Harris 2018); a later version is included in Bostrom (2003a). Most versions of this scenario involve an AGI system with an arbitrary goal of manufacturing paperclips. In pursuit of this goal, it will inevitably transform Earth into a giant paperclip factory and therefore destroy all life on it. There are other scenarios that end up with potential **extinction**. Ord (2020) presents one in which the system increases its computational resources by hacking other systems, which enables it to gain financial and human resources to further increase its power in pursuit of its defined goal.6

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# **TOC - Black Bear**

**DA2 is BLACK BEAR.**

**US-Russia relations are contained but vulnerable.**

**El-Fekki‎ 25** — (Amira El-Fekki‎ [*Amira El-Fekki is a Newsweek reporter based in Dubai. Her focus is reporting on politics and society in the Middle East. She has in depth knowledge of Arab communities and has covered human rights issues extensively. Amira joined Newsweek in 2025 from The Wall Street Journal and had previously worked at the Daily News Egypt. She studied journalism at the Modern Sciences and Arts University in Cairo. You can get in touch with Amira El-Fekki by emailing a.fekki@newsweek.com. You can find her on X @afekki Languages: English. Arabic. French.*], 4-1-2025, "Russia warns against U.S. strike on Iran nuclear sites: "Catastrophic"", Newsweek, https://www.newsweek.com/russia-warns-us-strike-iran-nuclear-sites-catastrophic-2053618, accessed 4-2-2025) //FK

In an interview with the Russian International Affairs magazine, Ryabkov said **Russia** opposed military strikes on Iran if Tehran refuses to agree to a nuclear deal, **warning of "catastrophic" consequences**, "especially if the nuclear infrastructure is hit." Trump threatened to bomb Iran if it does not agree to a new nuclear deal. Tehran has rejected a U.S. proposal to engage in direct negotiations under "maximum pressure" policies. "Threats are really heard, and ultimatums are also heard. We consider such methods inappropriate, we condemn them," Ryabkov added. Iran said it "will have no choice" but to seek nuclear weapons if attacked, a senior adviser to Khamenei Iranian Supreme Khamenei said. The U.S. has significantly increased its military presence in both the Persian Gulf and Indian Ocean, in a move signaling heightened U.S. preparations for potential conflict. In response, Iran has bolstered its missile capabilities, positioning advanced air defense systems around the Strait of Hormuz while ramping up military activities. Russia and China recently held military naval drills with Iran in the Gulf of Oman, a strategic waterway. **Despite an improvement in U.S.-Russia relations under Trump, they show signs of strain after Trump threatened** to impose secondary **tariffs** on nations that purchase oil from Russia if Moscow fails to agree to a ceasefire in Ukraine. Deadlock increases risks of direct confrontation if Washington intensifies its threats, amid the growing danger of a broader regional conflict if diplomatic avenues fail.

**Trump's remarks push us to the brink**

Digges 25 — (Charles Digges [*Charles Digges has written for a number of major newspapers and media companies worldwide such as The Moscow Times, the International Herald Tribune, the BBC, and Mother Jones. He has covered major conflicts and climate change issue, focusing for Bellona on the Russian nuclear industry and questions of environmental justice. He has worked with Bellona's Russian team since 2001 and edits Bellona's English langues website.*], 4-2-2025, "Russia rebuffs US notion of taking over embattled Zaporizhzhia nuclear plant", Bellona.org, https://bellona.org/news/nuclear-issues/2025-04-russia-rebuffs-us-notion-of-taking-over-embattled-zaporizhzhia-nuclear-plant, accessed 4-2-2025) //FK

Days **after** the **Trump** administration **floated the idea of assuming control of Ukraine’s embattled Zaporizhzhia nuclear plant** as part of the nascent peace deal the US is trying to broker between Kyiv and the Kremlin, **Russia**’s foreign ministry **has pushed back**, warning the US to keep its hands to itself. The bluntly worded statement released last week offers one of the first outright claims of ownership to the plant iterated by the Russian side since its troops overran it in early 2022. The Foreign Ministry’s remarks go on to describe the plant not as something captured by Moscow from Ukraine, but rather as real-estate Russia is simply repatriating, offering a notable glimpse into what conditions the Kremlin may demand of any lasting peace deal. Since its capture, the ZNPP has sat perilously close to the frontlines of the biggest war in Europe since World War II. Though its reactors have been idled to avoid a larger nuclear accident should they suffer a direct hit, the plant’s outside power sources— necessary to keep the reactors cool and prevent meltdowns—have been repeatedly cut in military skirmishes. In August, a drone struck the cooling tower of one of the plant’s reactors, casting into bold relief the plant’s precarious position. The International Atomic Energy Agency—which has warned repeatedly of the dangers of fighting a war around a nuclear power plant—has proven unable to keep the plant safe, though its on-site inspectors report regularly on near misses. The possibility of the US assuming control of the ZNPP, which operates six reactors, had initially arisen during a telephone conversation between Donald Trump and his Ukrainian counterpart Volodymyr Zelensky, both leaders confirmed last week. But Russia has other ideas. **“ZNPP is a Russian nuclear facility,” wrote the Russian Foreign Ministry**, referring to the abbreviation for the Zaporizhzhia nuclear power plant. “The return of the plant to Russia’s nuclear sector is a long-established fact—one the international community simply has to acknowledge.” It added that: **“Transferring the plant** itself, or control over it, **to** Ukraine **or any other country is out of the question.”** In the following days, Rosatom, Russia’s state nuclear corporation, which previously had been reluctant to acknowledge its oversight of the plant following the invasion, published plans on restarting the ZNPP in its weekly PR newsletter—also a first.

**The aff invests into the private sector.**

**Fisher 25** — (Joe Fisher [*In 2017, I graduated from the University of Iowa with a Bachelor's Degree in Journalism and Mass Communication and a minor in Sports Studies. On Aug. 26, 2017, I began working for Iowa Information Publishers as a news and sports writer. My work can be seen in several publications produced by IIP including The N'West Iowa Review.* - https://www.linkedin.com/in/joe-fisher-3a6483115/], 1-3-2025, "U.S. nuclear energy 'revival' led by tech companies, government investment", UPI, https://www.upi.com/Top\_News/US/2025/01/03/nuclear-energy-revival-tech-ai/5801735919080/, accessed 4-2-2025) //FK

Jan. 3 (UPI) -- A string of announcements about big investments in nuclear energy production signal a revival for the industry that already produces about 20% of U.S. electricity. **Google, Microsoft and Amazon** are among the technology companies looking to nuclear power to produce energy with a smaller carbon footprint. Environmental organizations remain skeptical, if not outright opposed to the use of nuclear energy. Disasters at nuclear plants in Chernobyl in 1986 and the Fukushima Daiichi plant in Japan in 2011 play a large role in the minds of opponents. "Anyone who thinks the public perception is overwhelmingly pro-nuclear is probably kidding themselves," Dr. Lane Carasik, assistant professor in the Virginia Commonwealth University Department of Mechanical and Nuclear Engineering, told UPI. "A lot of work needs to continue to be done by organizations to make sure the public is appropriately informed about the benefits and dangers of nuclear power. There are both." The benefits touted by companies making the investments and the U.S. government center around reducing carbon emissions. This goal has been a crucial point of emphasis for the Biden administration in the face of increasingly destructive and frequent extreme weather events around the globe. The U.S. **D**epartment **o**f **E**nergy announced **in October** it is **opening applications for $900 million in funding to build s**mall **m**odular nuclear **r**eactor**s**. The program is part of the Bipartisan Infrastructure Law that passed in 2021. "Revitalizing America's nuclear sector is key to adding more carbon free energy to the grid and meeting the needs of our growing economy -- from A.I. and data centers to manufacturing and healthcare," Jennifer M. Granholm, U.S. secretary of energy, said in a statement. Earlier in the fall, the Biden administration announced the approval of a $1.52 billion loan to restart the Palisades nuclear plant in Covert Township, Mich. It would be the first restart of a nuclear plant once believed to be permanently out of commission in U.S. history. Carasik said he is not surprised that the government is playing a role in revitalizing the nuclear energy industry. Along with the need for a diverse slate of energy sources, he said it is imperative that the United States nurture the field of nuclear science or risk losing experts to other countries.

**The private sector is tied with nuclear energy in Ukraine.**

**Digges 25** — (Charles Digges [*Charles Digges has written for a number of major newspapers and media companies worldwide such as The Moscow Times, the International Herald Tribune, the BBC, and Mother Jones. He has covered major conflicts and climate change issue, focusing for Bellona on the Russian nuclear industry and questions of environmental justice. He has worked with Bellona's Russian team since 2001 and edits Bellona's English langues website.*], 3-21-2025, "Could the US assume control of Ukraine’s Zaporizhzhia nuclear plant? Bellona considers the possibilities", Bellona.org, https://bellona.org/news/nuclear-issues/2025-03-could-the-us-assume-control-of-ukraines-zaporizhzhia-nuclear-plant-bellona-considers-the-possibilities, accessed 4-2-2025) //FK

Ukraine’s Soviet-era nuclear power plants have been the backbone of its energy network during the war, supplying up to two-thirds of the country’s electricity. While Moscow has relentlessly attacked Ukraine’s thermal and hydroelectric power plants in an effort to cripple its grid, it has seemingly avoided striking nuclear facilities out of fear of triggering a radiological disaster. It is here where US involvement could make sense. Shortly **before the war**, Westinghouse, an **American nuclear technology company, signed a deal with** Energoatom, **Ukraine**’s state-owned nuclear corporation, **to build** five **reactors**. After Russia attacked, the number was increased to nine and the two companies agreed to further cooperate to deploy smaller plants in Ukraine. With Westinghouse already acting as the main fuel source for the ZNPP—which to supplied some 20 percent of Ukraine’s electricity before the war—the US corporation would clearly profit should the plant become a ward of the US. Gorchakov said “a proposal for US involvement in the management of the plant or even its transfer to US ownership could be part of a broader package of agreements between the US and Russia, potentially covering issues beyond just the situation in Ukraine.” But Gorchakov also asserted that, whatever comes of the negotiations, the future of the ZNPP has to be decided with the Ukrainians, and not just between the US and Russia. “The best outcome would be the return of the plant to full Ukrainian control through negotiations. However, there is little hope for such a scenario, as it remains unclear what Putin would gain from such a move, and he is certainly not going to hand over the station to Ukraine for nothing,” he said. **It remains unclear whether Trump discussed the fate of the ZNPP with Putin of Russia** in a call on Tuesday. Bellona will continue to report on developments with the ZNPP. More News

**Exactly what Russia is actively trying to prevent.**

**Blank 25** — (Stephen Blank [Journalist @ Real Clear Defense], 2-18-2025, "Russia Strives to Stifle U.S. Nuclear Industry in Ukraine and Bulgaria", RealClearDefense, https://www.realcleardefense.com/articles/2025/02/18/russia\_strives\_to\_stifle\_us\_nuclear\_industry\_in\_ukraine\_and\_bulgaria\_1092127.html, accessed 4-2-2025) //FK

Russia's war against Ukraine has long since morphed into a war upon Europe to prevent it from helping Ukraine in any way. **The Kremlin’s newest target** in this long war **is the transfer of** Bulgarian **nuclear reactors to Ukraine.** This process for Ukraine to acquire the nuclear reactors, which the Ukrainian parliament intelligently approved earlier this week, is critical to expanding Ukraine’s nuclear power generation as quickly as possible. **Moscow** knows this and **is deploying its agents** on payroll in Bulgaria **to stop the** Bulgarian parliament from greenlighting **the transfer of** the **nuclear equipment while flooding the information space** with systematic **disinformation** about the deal. Ukraine’s efforts to acquire nuclear reactors from Bulgaria is the Kremlin’s newest assault on truth. At issue is the plan to sell unused nuclear equipment from the erstwhile Soviet-built nuclear power plant (NPP) in Belene to Ukraine to expand Ukraine's Khmelnitsky NPP, bringing **reactors** no. 3 and 4 online **with U.S.-made fuel from Westinghouse.** Seeking to discredit the deal, the pro-Moscow “Rebirth” party (Vazrazhdane) has tabled a resolution in Bulgaria’s Parliament blocking the transfer of the reactors for the incomplete Belene power plant to Ukraine, deploying blatant disinformation that the reactors are incompatible with U.S. fuel. There can be no doubting of Vazrazhdane’s Russian connections. Indeed, party leaders openly flaunt them. So in this respect, Vazrazhdane is the Bulgarian analogue of Germany’s Alternativ fur Deutschland (AfD) party and France’s National Rally (Rassemblement National) party that also publicly display their pro-Russian stance. Apart from subsidizing the French and German pro-Russian parties, and others as well, Moscow uses them to conduct its disinformation and influence campaigns across Europe.

**Nuclear escalation likely.**

**Trevelyan 24** — (Mark Trevelyan [*Chief writer on Russia and CIS. Worked as a journalist on 7 continents and reported from 40+ countries, with postings in London, Wellington, Brussels, Warsaw, Moscow and Berlin. Covered the break-up of the Soviet Union in the 1990s. Security correspondent from 2003 to 2008. Speaks French, Russian and (rusty) German and Polish.*], 11-27-2024, "Russia warns US against 'spiral of escalation' but says it will keep …", archive.is, https://archive.is/sIisg, accessed 4-2-2025) //FK

Nov 27 (Reuters) - **Russia warned the U**nited **S**tates on Wednesday to halt what it called a **"spiral of escalation" over Ukraine,** but said it would keep informing Washington about test missile launches in order to avoid "dangerous mistakes". The comments from Deputy Foreign Minister Sergei Ryabkov sent a signal that **Moscow**, which last week approved a new policy that **lowered its threshold for the use of nuclear weapons**, wants to keep communication channels open at a time of acute tensions with the U.S. Ryabkov was speaking six days after Russia launched what it described as a new intermediate-range hypersonic ballistic missile called the Oreshnik against Ukraine - something he said had sent a clear message to the West. "The signal is very clear and obvious - stop, you should not do this any more, you mustn't supply Kyiv with everything they want, don't encourage them towards new military adventures, they are too dangerous," state media quoted Ryabkov as saying. "The current (U.S.) administration must stop this spiral of escalation," Ryabkov added. "They simply must, otherwise the situation will become too dangerous for everyone, including the United States itself." President Vladimir Putin said last week that Russia fired the Oreshnik in response to Ukraine's first use of U.S. ATACMS ballistic missiles and British Storm Shadow cruise missiles to strike at Russian territory with permission from the West. Ukrainian President Volodymyr Zelenskiy said Russia's use of the new missile - which Kyiv said reached a speed of 13,600 kph (8,450 miles per hour) - amounted to "a clear and severe escalation" in the war and called for strong worldwide condemnation. The U.S. military said the missile was experimental and that Russia likely possessed only a handful of them.

**Extinction.**

**Sarg 15** — (Stoyan Sarg, Director of the Physics Research Department at the World Institute for Scientific Exploration, 10-9-2015, "The Unknown Danger of Nuclear Apocalypse", Foreign Policy Journal, https://www.foreignpolicyjournal.com/2015/10/09/the-unknown-danger-of-nuclear-apocalypse/, accessed 2-7-2025) //Tesu jungkook

With the new NATO plan for installation of nuclear tactical weapons in Europe, nuclear missiles may reach Moscow in only 6 minutes, and the opposite case is also possible in the same time. The question is: how can we be sure that this will not be triggered by a human error or computer malfunction. An adequate reaction dictated by the dilemma “to be or not to be” and the concept of preventive **nuclear strike** may lead to a nuclear consequence that is difficult to stop. At the present level of distributed controlled systems and military global navigations, this will lead to **unstoppable global nuclear war**. However, there is something not predicted, of which the military strategists, politicians and powerful forces are not aware. Probably, it will **not** be a **nuclear winter** that they hope to survive in their **underground facilities**. The **most probable** consequence will be a **partial loss** of the **Earth’s atmosphere** as a result of one or many **powerful simultaneous tornadoes** caused by the **nuclear explosions**. In a tornado, a powerful **antigravitational** effect takes place. The official science does not have an adequate explanation for this feature due to an incorrect concept about space. The antigravitational effect is not a result of the circling air. It is a specific physical effect in the aether space that is dismissed in physics as it is currently taught. Therefore, the effective height of this effect is not limited to the height of the atmosphere. Then in the case of many simultaneous **powerful tornadoes**, an **effect** of **suction** of the **earth atmosphere into space** might take place. Such events are **observed on the Sun** and the present physical science does not have an explanation for them. The antigravitational effect is accompanied by specific electric and magnetic fields with a twisted shape. This is observed in tornado events on the Sun. Some effects in the upper Earth atmosphere known as sprites have a similar combination of electrical and magnetic fields but in a weaker form. They are also a mystery for contemporary physical science. At the time of **atmospheric nuclear tests**, made in the last century, a number of **induced tornadoes** are observed near the **nuclear mushroom** as shown in Figure 1. The strongest anti gravitational effect, however, occurs in the central column of the formed nuclear mushroom. The analysis of underwater nuclear tests also indicates a strong anti gravitational effect. It causes a rise of a vertical column of water. In the test shown in Figure 2, the vertical column contains millions tons of water. Thermonuclear bombs are **multiple times more powerful**. The largest thermonuclear bomb of the former Soviet Union tested in 1961 is 50 megatons. It is 3,300 times more powerful than the bomb dropped by USA on Hiroshima at the second world war and may kill millions. It is known that Mars once had liquid water and consequently an atmosphere that has mysteriously disappeared. If the scenario described above takes place, the Earth will become a **dead planet like Mars**. The powerful politicians, military adventurers and their financial supporters must be aware that even the most secured **underground facility** will not save them if a global nuclear conflict is triggered. Their disgraced end will be more miserable than the deaths of the billions of innocent human beings, including the animal world.

**DA3 is black gold**

#### **Middle east is diversifying now - but its shaky**

Jabari 25 --- (Mahmoud Jabari, [*Lead, Global Community Engagement, YGL Foundation, World Economic Forum*], 2-24-2025, "Saudi Arabia’s balancing act: peace talks, a new economy and straddling the energy transition", https://www.weforum.org/stories/2025/02/saudi-arabia-economy-diplomacy-energy/) //doa3-5-2025 + master chen 💆

Saudi Arabia's current transformation is concentrated along three lines: economic, diplomatic and the energy transition. Talks on Ukraine, with Saudi Arabia as a broker, show the delicate balancing act the country must maintain in a complex new geopolitical reality. If the country can navigate the challenges ahead, its transformation could showcase a dynamic new role for the Middle East. The World Economic Forum Annual Meeting 2025 in Davos shed light on the **transformation** taking place in the Middle East, particularly in Saudi Arabia. As the global community grapples with economic uncertainties and geopolitical tensions, the country is emerging as a pivotal player in what can only be described as a delicate diplomatic and economic **balancing** act. The Kingdom's strategy is three-pronged: diversifying its economy away from oil dependency, positioning itself as a bridge between competing global powers and maintaining its role as a crucial energy supplier. At the heart of this transformation is **Vision 2030,** Saudi Arabia's ambitious blueprint for economic diversification. The statistics shared at Davos paint a promising picture of success: non-oil activities now constitute **52**% of Saudi GDP, marking a historic **shift** in an economy traditionally dominated by hydrocarbon revenues. With projections of 6.2% growth in non-oil sectors by 2026, the country is demonstrating that its economic diversification isn't merely aspirational – it's becoming a reality. Have you read? How Saudi Arabia is moving towards a quantum economy How Saudi Arabia is unlocking the power of the blue economy Why Saudi Arabia is spending $64 billion on entertainment The most striking aspect of Saudi Arabia's diplomatic balancing act is its careful navigation of increasingly complex global power dynamics. Faisal Alibrahim, Minister of Economy and Planning, declared: "We want to be in the middle; our partnerships should remain strong with all stakeholders." This diplomatic positioning is yielding tangible results, with Riyadh hosting high-level talks between US and Russian officials on ending the Ukraine war, a development that showcases Saudi Arabia's emerging role as a global diplomatic broker. The numbers back up this strategic positioning. Saudi Arabia's $770 billion investment in the United States, with potential expansion to $1 trillion, shows that the Kingdom isn't abandoning its traditional Western partnerships. However, this commitment to the US doesn't come at the expense of other relationships. The Kingdom is clearly signalling that it intends to maintain productive relations with all major powers. The broader geopolitical context makes this moment particularly significant. According to the Global Cooperation Barometer 2025 presented at Davos by McKinsey & Company, international cooperation has plateaued since 2020. As McKinsey's Global Managing Partner Bob Sternfels noted: "Peace and security indices are at their worst levels since the Cold War." Against this backdrop, Saudi Arabia's emergence as a potential peace broker takes on added significance. The energy transition discussion at Davos revealed another dimension of Saudi Arabia's evolution. As BlackRock CEO Larry Fink highlighted: "AI data centres in the US alone will require 300 GW of power within five years – six times the current levels." This projection places Saudi Arabia in a unique position as both a traditional energy powerhouse and a potential enabler of the AI revolution. **At the same time**, with the country **diversifying** away from fossil fuels, Saudi Arabia can position itself in the global climate finance landscape. The Forum revealed that only 10% of required funding for net-zero commitments has been secured globally. More alarmingly, as Bob Sternfels pointed out: "The insurance industry faced $135 billion in costs due to natural disasters in 2024 alone – an all-time high." These facts present both a challenge and an opportunity for Saudi Arabia. The country's $700 billion Public Investment Fund could help fill the massive global climate finance gap, positioning it as an essential partner in clean energy transitions. Rising disaster costs threaten fossil fuel infrastructure, yet create demand for Saudi expertise in heat-resilient construction and water management. By becoming a major climate financier, Saudi Arabia could maintain global influence even as oil markets decline, while gaining preferential access to emerging green technologies. What makes this transformation particularly noteworthy is how it's taking place against a backdrop of global economic uncertainty. While IMF Managing Director Kristalina Georgieva reported strong US GDP growth projections of 2.7% (up from 2.2%), she also noted that "emerging markets are struggling due to declining productivity growth". Saudi Arabia's ability to maintain its transformation amid these global headwinds, while simultaneously stepping up as a diplomatic facilitator, is remarkable. Looking ahead, Saudi Arabia faces multifaceted challenges. Its emerging mediator role carries diplomatic risks, while US investments remain vulnerable to policy shifts. Non-oil growth targets face regional competition, while pressure is building from a youth-heavy population demanding jobs. The country's core dilemma lies in energy: Davos discussions revealed both increasing climate costs and AI-driven energy demand growth. This requires Saudi Arabia to simultaneously manage fossil fuel assets while establishing clean energy leadership – a balancing act becoming increasingly difficult. Discover 'Reimagining Growth' at Davos 2025 If the country can surmount these issues, we could be witnessing not just the transformation of a single nation, but potentially the emergence of a new model for how resource-rich nations can navigate the complex interplay between economic transformation, energy transition and geopolitical realignment. As the discussions at the Annual Meeting 2025 have shown, Saudi Arabia – and more broadly, the Middle East – are no longer merely reacting to global trends; they’re actively shaping them.

#### **AFF decks oil prices**

Fuchs 24 [Ilan Fuchs, [*Dr. Ilan Fuchs is a scholar of international law and legal history. He holds a B.A. in humanities and social science from The Open University of Israel and an M.A. in Jewish history from Bar-Ilan University. Ilan’s other degrees include an LL.B., an LL.M., and a Ph.D. in law from Bar-Ilan University. He is the author of “Jewish Women’s Torah Study: Orthodox Education and Modernity,” and 18 articles in leading scholarly journals. At the University, Ilan teaches courses on international law while maintaining a law practice in several jurisdictions.*], 5-20-2024, Nuclear Fusion and Its Impact on International Relations, No Publication, https://www.apu.apus.edu/area-of-study/security-and-global-studies/resources/nuclear-fusion-and-its-impact-on-international-relations/] colon + recut Master chen + jwilly

Other Countries Could See Their Political and Economic Power Decline

If Budil’s prediction is correct and we are four to six decades away from the goal of large-scale nuclear fusion, it is worthwhile to pay attention to how it will affect the global arena. Once nuclear fusion production gains momentum – and many believe it is a question of “when” not “if” – there would be a decline in the need for oil.

Consequently, oil-producing countries such as Saudi Arabia, Iraq, Iran, Venezuela, Russia, Nigeria and China will have a rude awakening. Their economies rely on natural resources, and once their oil markets decline, they will lose a significant source of income. For Saudi Arabia, losing its market for oil could have a particularly devastating effect on its entire economy.

#### **ME gets spooked - they know it will affect their economy - they preemptively flood the market**

Soummane 21--- (Salaheddine Soummane, [*Salaheddine was a senior associate in Consulting. His current work scopes include energy market restructuring, modeling, and regulation.*], 03-xx-2023, "Impacts of Global Climate Policies on Middle Eastern Oil Exporters: A Review of Economic Implications and Mitigation Strategies", https://www.sciencedirect.com/science/article/pii/S0301421521002330) //doa3-4-2025 + master chen 💆

Assessing the economic implications of advanced global climate policies for oil exporting countries is a major focus of policymakers, particularly in the Middle East (Barnett 2008; Ramady and Mahdi 2015). These implications are among the most debated topics in climate negotiations. Various modeling tools are used to determine whether climate policies will create economic losses or benefits for oil exporters and the magnitudes of these impacts. The models’ results depend on a wide range of modeling characteristics, including the regional breakdown, the scope of emissions, and the time horizon. Various assumptions that cannot be determined with certainty may also alter the models’ outcomes. For instance, models use different assumptions about the coverage of international policy regimes. The ability to substitute between various energy sources and the costs of doing so vary across models. Models assume different rates of technological innovation and future energy supply availability as well (Ansari, Holz and Al-Kuhlani 2019; Dagnachew et al. 2019; Nikas, Doukas and Papandreou 2019). Barnett, Dessai and Webber (2004) review six different estimates of the expected implications of the Kyoto Protocol for oil exporting countries published in 1999 and 2000. The Kyoto Protocol aimed to reduce the emissions of 37 industrialized countries. All six models indicate that **oil exporting countries will suffer losses** if climate policies are implemented in industrialized countries. The specific estimates of these losses differ across the six models owing to their different approaches and assumptions. However, the expected losses from the Kyoto Protocol’s implementation compared to a business-as-usual scenario are generally estimated to be about 10% of oil revenues. Table 4 provides an updated literature review, presenting estimates from models of climate policy impacts published since 2003. Seven of the nine studies referenced in Table 4 find that climate policies mainly result in **losses** for oil exporting countries.

2nc

On energy

1. Been behind forever and no escal, their int link card is from 2021

Luckenbaugh, ‘23 <https://www.nationaldefensemagazine.org/articles/2023/7/17/us-falling-behind-china-in-critical-tech-race-report-finds> //ms

However, the picture of the industrial base Ark.ai currently paints is not encouraging for the United States, the report said. Govini found that **in all 12 technology areas, “the United States is falling behind China in the core science as measured by the patents granted in each country.” Patents are “a leading indicator of technological dominance in the future,”** said Govini Chairman and former Deputy Secretary of Defense Bob Work. They are “the seed corn for making new discoveries that put you on the top of the competitive food chain. And that's what scares me the most: China's doing far better than us in terms of the overall number of patents.” For most of the critical technologies, “the United States is largely stagnating in patents in these areas, [and] in many cases United States patent grants are actually declining,” Govini CEO Tara Murphy Dougherty said during the company’s release briefing for the report. And for the capabilities actually in development, the United States heavily relies upon Chinese suppliers, she said. “This is not just a defense problem,” Dougherty said. “This isn't just a microelectronics problem. This is an overriding trend that spans all U.S. federal programs and activities.” All 12 of the critical technologies Govini analyzed “are highly dependent on Chinese entities for completing their projects, for developing their products, for bringing their goods and services to the market, and that market includes some of our most sensitive national security programs.”

1. Delineated TF
2. The evidence on their c3 concedes we still have nuclear deterrence until 2027 at the earliest
3. You prefer our path to extinction – unprecedented and hasn’t been disproven time and time again in the past
4. Our card specifically does the comparative and determines AGI is the most likely path to extinction, prefer over their scenario
5. China only has 5% of their energy from nuclear and is still ahead, we can def catch up without nuclear using their methods

On smrs

#### **[1] SMR’s aren’t economically viable – no mass manufacturing, recalls, and capital cost escalation.**

**Makhijani ‘21** [Arjun Makhijani, President of IEER, holds a Ph.D. in engineering (specialization: nuclear fusion) from the University of California at Berkeley, March 25, 2021, Why Small Modular Nuclear Reactors Won’t Help Counter the Climate Crisis, Environmental Working Group, https://www.ewg.org/news-insights/news/why-small-modular-nuclear-reactors-wont-help-counter-climate-crisis, Accessed 3-4-2025] fehmi  
Economics and scale

Nuclear reactors are large because of **economies of scale**. A reactor that produces three times as much power as an SMR does not need three times as much steel or three times as many workers. This **economic penalty** for small size was one reason for the early shutdown of many small reactors built in the U.S. in the 1950s and 1960s.

Proponents of SMRs claim that modularity and factory manufacture would compensate for the poorer economics of small reactors. Mass production of reactor components and their manufacture in assembly lines would cut costs. Further, a comparable cost per kilowatt, the argument goes, would mean far lower costs for each small reactor, reducing overall capital requirements for the purchaser.

The road to such **mass manufacturing** will be **rocky**. Even with optimistic assumptions about how quickly manufacturers could learn to improve production efficiency and lower cost, thousands of SMRs, which would all be higher priced in comparison to large reactors, would have to be manufactured for the price per kilowatt for an SMR to be comparable to that of a large reactor.

If history is any guide, the capital cost per kilowatt may not come down at all. At a fleet-wide level, the learning rate in the U.S. and France, the two countries with the highest number of nuclear plants, was negative – newer reactors have been, on the whole, more expensive than earlier ones. And while the cost per SMR will be lower due to much smaller size, several reactors would typically be installed at a single site, raising total project costs for the purchaser again.

Mass manufacturing aspects

If an error in a mass-manufactured reactor were to result in safety problems, the whole lot might have to be **recalled**, as was the case with the Boeing 737 Max and 787 Dreamliner jetliners. But how does one recall a radioactive reactor? What will happen to an electricity system that relies on factory-made identical reactors that need to be recalled?

These questions haven’t been addressed by the nuclear industry or energy policy makers – indeed, they have not even been posed. Yet recalls are a predictable and consistent feature of mass manufacturing, from smartphones to jet aircraft.

The problem is not merely theoretical.

One of the big economic problems of pressurized water reactors, the design commonly chosen for light water SMRs, including the NuScale design, which has received conditional certification from the Nuclear Regulatory Commission, was the need to prematurely replace the steam generators – the massive, expensive heat exchangers where the high-pressure hot water from the reactor is converted to the steam that drives the turbine-generators. In the last decade, such problems led to the permanent shutdown of two reactors at San Onofre, in Southern California, and one reactor at Crystal River, in Florida.

Several SMR light water designs place steam generators inside the reactor vessel (Figure 1). Replacement would be exceedingly difficult at best; problems with the steam generator could result in permanent reactor shutdown.

<<IMAGE OMITTED>>

Figure 1. Schematic of an SMR light water design with steam generator inside the reactor vessel

Source: Glaser et al. 2015

We have already seen **problems** with modular **construction**. It was a central aspect of the design of the Westinghouse AP1000 reactor, yet the AP1000 reactors built in the U.S. and China have had significant construction cost overruns and schedule delays. In 2015, a former member of the Georgia Public Service Commission told The Wall Street Journal, “Modular construction has not worked out to be the solution that the utilities promised.”

The need for mass manufacturing also creates a chicken-and-egg economic problem. Without the factories, SMRs can never hope to achieve the theoretical cost reductions that are at the heart of the strategy to compensate for the lack of economies of scale. But without the cost reductions, there will not be the large number of orders to stimulate the investments needed to set up the supply chain in the first place.

The SMR track record so far

The track record so far points to the same kind of dismal economic failure for SMRs as their larger cousins. Figure 2 shows the **capital cost escalation** for the proposed NuScale reactor and actual costs of two foreign SMRs. As a result, the total cost of a proposed project in Idaho using the NuScale design has already risen from around $3 billion, in 2015, to $6.1 billion, in 2020, long before any concrete has been poured.

<<IMAGE OMITTED>>

Figure 2. NuScale cost estimate escalations and SMR reality so far

Source: Ramana 2020

This pattern of escalations can also be anticipated for other SMR concepts, especially those not based on light water reactors. For instance, the proposed Natrium reactor – at 345 MW, slightly bigger than an SMR – is sodium-cooled. Despite about a hundred billion dollars spent worldwide since 1950, sodium cooled reactors have been commercial failures globally.

The process of getting **safety approvals** for such designs will likely take **long**er and be more **expensive**. In many cases, even setting up the certification process will take years, since the safety and accident modes differ with each design type. For instance, one risk with high-temperature gas-graphite reactors is fires, rather than meltdowns. To give a sense of scale of the expense, the NuScale SMR, which is the familiar light water design, is expected to cost roughly $1.5 billion just for **development** and **certification**. New non-light water designs will very likely cost more and take longer to develop from the concept stage to licensing review and approval.

For SMRs to consistently achieve the same cost of power production as the present large reactors would be a monumental task – and given the high costs of large reactors, SMRs would still be an **economic failure**. The costs of wind and solar electricity have been declining consistently and are projected to decline more.

Lazard, a Wall Street financial advisory firm, estimates the cost of utility-scale solar and wind to be about $40 per megawatt-hour. The corresponding figure for nuclear is four times as high, about $160 per MWh – a difference that is more than enough to use complementary technologies, such as demand response and storage, to compensate for the intermittency of solar and wind.

**[1] SMRs make cyber security worse - different security, lack of oversight, supply chain pinch points**

**Shaw 24** --- (Alfie Shaw; writer @ Power Technology, 7-19-2024, "Nuclear industry faces acute cybersecurity threats – report", https://www.power-technology.com/news/nuclear-industry-faces-menacing-cyber-security-threats-according-to-chatham-house/) //doa3-15-2025 + master chen 💆

Firstly, a lot of the existing nuclear power infrastructure is dated and does not possess up-to-date cybersecurity technology.

Chatham House notes that, currently, many nuclear plants rely on software that is “built on insecure foundations and requiring frequent patches or updates” or “has reached the end of its supported lifespan and can no longer be updated”. The think tank pointed out that civil nuclear industries are thus playing catch up with other critical national infrastructure (CNI) industries when it comes to cybersecurity.

The fact that nuclear infrastructure is considered to be CNI also makes it an attractive target for hackers. As demonstrated by the Sellafield incident, nuclear sites can have implications beyond energy, including national security. Foreign actors could target another state’s nuclear industry to not only jeopardise the state’s energy security but also gain a military advantage, says Chatham House.

Another vulnerability highlighted by the report is the industry’s reliance on ‘security by obscurity’. Hubristic systems managers have often neglected adequate security measures due to the assumption that ICT (information and communication technology) systems in older NPPs are too small-scale to have well-known vulnerabilities that can be exploited.

The **SMR** threat

The Chatham House report also details how t**he uptake of small modular reactors (SMRs)** could lead to **increased cybersecurity risks.**

Due to their diminutive size, SMRs can be deployed in disparate areas that lack the physical conditions necessary for the deployment of large-scale energy infrastructure. The inherent versatility of the advanced technology has made it popular among governments across the world as they seek to widen access to more forms of renewable energy.

However, SMR-centred nuclear infrastructure would **look different to that of traditional reactors, requiring different security measures.**

For one, there will be a larger number of SMRs in more locations due to their easily deployable nature. It might not be practical to have staff at each site, with operators instead opting to run the facility by a central computer system without human presence. Increased reliance on cloud systems to run infrastructure is bound to **enhance the cybersecurity risks**, Chatham House says.

Furthermore, SMRs present additional **supply chain pinch-points for cybersecurity**, as the materials for SMRs tend to be prefabricated by a larger number of varying suppliers than in traditional nuclear plants, according to Chatham House.

**[3] SMRs rely on autonomous and wireless components for miniaturization – worsens cysec**

**Grey 23’**

[Cristina Siserman-Gray is a legal and regulatory specialist at Pacific Northwest National Laboratory (PNNL) with more than 10 years of experience as an international lawyer specialized in arms control and nonproliferation. Guy Landine is a National Security Specialist at Pacific Northwest National Laboratory

07-2023, “Cybersecurity for Small Modular Reactors (SMRs): Regulatory Challenges and Opportunities”, Pacific Northwest National Laboratory (PNNL),<http://resources.inmm.org/sites/default/files/2023-07/finalpaper_378_0512115036.pdf>, //DS]

SMR concepts are currently at very different stages of development. While most of them only exist as concept studies, in several countries, SMR designs have already been certified by regulatory authorities on their safety design, and contracts for the construction of such plants have been signed (e.g., USA, Britain, Romania or Poland). Given that many governments are just beginning to grapple with the emerging cybersecurity risk specific to nuclear industry, regulatory standards are insufficient in addressing cybersecurity. In effect, only a small number of countries have issued regulatory requirements or other standards on cybersecurity at nuclear facilities, and even the few existing ones, do not contain specific cybersecurity references to SMR technology10. While this is understandable, given that the SMR technology is relatively new, it is however recommended that special attention is dedicated to this area as more regulators will have to go through the process of certifying SMRs as more designs are developed. This paper first identifies and analyses several cybersecurity vulnerabilities applicable to SMRs. Then, it highlights several cybersecurity national regulatory approaches and best practices that international organizations and several countries have proposed to address these challenges. Lastly, it identifies a series of recommendations on how these cybersecurity challenges could be potentially mitigated from a legal and regulatory perspective.

2. Cybersecurity risks and vulnerabilities for SMRs

SMRs are expected to be very flexible as they can be scaled up or down to meet the energy demands and help power areas where larger plants are not needed. Yet, these nuclear technologies can be very different from the current operating nuclear fleet, as they are relying on digitally controlled operations, miniaturization of components, wireless and automated technologies, as well as artificial intelligence, all providing the promise of delivering innovative solutions for complying with nuclear security standards for SMRs11. At the same time, their use also presents several significant cybersecurity challenges, which will be discussed in the following section.

2.1 Remote Supervisory Control

It appears that many companies developing SMRs intend to operate them in a mostly remote manner. This is likely driven by the potential for cost savings. Some potential use-cases for SMRs may include siting these reactors in "off-grid" locations such as isolated communities, remote mining camps, and distant industrial sites that require consistent and reliable power generation. Use of SMRs in such environments would necessitate remote operation and monitoring of the deployed reactors by licensed operators presumably located a considerable distance from the site. This poses a challenge as existing IAEA guidance effectively recommends that “command and control” of the reactor be conducted from a main control room located within the protected area of a site by a sizeable team of licensed operators12. Until now, the subject of remote operation of a commercial nuclear reactor was never envisioned or contemplated. As such, it represents a “paradigm shift” with respect to traditional nuclear plant operations13 .

Cyber security regulations associated with traditional NPPs characteristically require licensees to develop, apply, and maintain defense-in-depth protective strategies capable of detecting, responding to, and recovering from cyber-attacks. Central to these strategies is the implementation of a data flow model defining acceptable types of communications flowing between digital systems maintained at different security levels within the facility14. To facilitate such data transfer, it is recommended that licensees implement a robust Defensive Computing Security Architecture (DCSA) using devices and mechanisms to ensure that systems performing significant safety and security functions have the requisite level of protection15. Communications necessary to support command and control functions from an offsite location (e.g., a remote-control room) appear to be incompatible with SMRs data flow models.

Remote operation of SMRs also creates an adversarial pathway or vector of attack that was otherwise mitigated by onsite control rooms. Because control of the physical communications medium extends far beyond the physical boundaries of the site, it no longer inherits the benefits of the plant’s Physical Protection System (PPS). As such, certain disruptive attacks cannot be effectively prevented and may not be responded to in a timely manner. The severity of such an event is dependent upon the systems involved, the functions that they provide, and consequences resulting from loss or impairment of those functions.

Additionally, a new dependency relationship likely exists with an external entity, specifically that of a telecommunications provider to facilitate communications between the reactor and the remote-control room. This could create significant issues from both a liability and a regulatory perspective. For instance, if a service disruption or misconfiguration occurs on the network owned by the telecommunication provider that results in damage or loss of generation capacity of the reactor, legal questions arise on the financial liability being assumed. Further, since the telecommunication provider may have the ability to impact reactor operations by virtue of the newly established telecommunications link, the issue of whether the telecommunications provider should become a regulated entity under the Competent Authority also becomes a relevant question.

2.2 Autonomous Operations

Operating costs associated with NPPs has historically been expensive. According to the World Nuclear Organization (WNO), Operations and Maintenance (O&M) costs account for approximately 66% of the total operating cost of an NPP16. A significant percentage of this cost can be attributed to the large number of operations and technical personnel required to operate, calibrate, maintain, and test various plant systems to ensure their functionality. These staffing requirements are primarily driven by resource demands to respond to transients and accidents and are based on traditional operational models with limited automation17. To avoid the prospect that high staffing levels relative to unit power production will lead to unsustainable O&M costs for SMRs, a significantly higher degree of automation will be necessary18 .

It is important to note that much of the recent developments regarding autonomous control systems or digital twin technologies19 are based on using existing off-the-shelf algorithms developed for non-nuclear applications. In this context, the vulnerability of such solutions to infiltrations is relatively higher compared to scenarios in which such technologies are adapted or modified to be more secure, while implemented as an independent solution for each SMR design. Given that SMRs designs are unique to their manufacturers, the vulnerability of a SMR to cyberattack will depend on the specific design of the reactor being attacked.

Regulations concerning licensed operator staffing at nuclear power plants are largely based on the specificities of traditional larger power reactor designs that rely primarily on active safety systems and operator actions to address plant transients and design basis accidents20. Highly autonomous reactor designs envisaged for SMRs will interface directly with safety-related and important-to-safety systems and functions. Providing appropriate cybersecurity will be complicated if the design implements an offsite control room to support a remotely sited reactor21.Therefore, cybersecurity will be an important consideration for any highly autonomous SMR reactor design to demonstrate adequate physical protection.

2.3 Artificial Intelligence and Machine Learning

Artificial Intelligence (AI) refers to a collection of technologies that produce systems capable of tracking complex problems in ways similar to human logic and reasoning. Machine learning (ML) technologies learn how to complete a particular task based on large amounts of data. Numerous applications for AI/ML exist within NPPs including but not limited to improvements in reactor design, thermal-hydraulic simulation analysis, radiation shielding design, safety, monitoring, operations, and security22. Automation via AI/ML is expected to reduce SMR installation costs, shorten construction times and better meet user needs through greater flexibility or non-electric applications.23. In this light, the use of AI/ML technologies for SMRs is currently underway24, with certain vendors already demonstrating prototypes25 .

However, while there are great benefits possible with the use of AI/ML in NPPs, and SMRs alike, there are some potential issues as well that will need to be considered and reflected in regulatory guidance. AI platforms are vulnerable to cyber-attacks and exploitative code is widely available. The attacks targeting ML systems differ significantly when compared to traditional hacks that exploit poorly written code or utilize a vulnerable library. AI systems are vulnerable to a variety of attacks including, including “evasion attacks”, in which attackers discover imperfections in the model and then exploit these weaknesses in the deployed model with carefully crafted inputs26. Other types of attacks include “data poisoning”, in which attackers make changes to the training data to embed malicious patterns for the machine to learn27, as well as the “model extraction”, in which the attacker records the inputs and outputs of the victim model enough times to build a close facsimile of the model to be attacked28. In many cases, the vulnerabilities within AI-based systems cannot be patched because the flaw being exploited is related to the fundamental design of the system.

Consequently, it becomes apparent that continuous uses of AI in the nuclear industry, including for SMRs, will rapidly require the transformation of the regulatory landscape. In 2019, there were more than 70 AI regulatory frameworks in existence around the globe, with many other national jurisdictions making significant progress in developing their frameworks in this field.29 Therefore, these initiatives provide timely opportunities for fresh approaches in the redesign of regulatory systems to keep pace with technological changes in the nuclear industry, particularly as it concerns the new generation of SMRs. This includes ensuring regulators’ readiness for decision-making in this area, but also establishment of organizational frameworks to review AI applications for these novel technologies.

**[4] Catastrophic cyberattacks are just hype – Ukraine proves**

**Johansmeyer 23’**

[[Thomas Johansmeyer](https://www.weforum.org/stories/authors/thomas-johansmeyer/), Now Global Head of Index Classes at Inver Re, Tom was formerly Head, Property Claim Services (PCS) at Verisk, Jan 25 2023, What everyone misses when it comes to cyber attacks, *World Economic Forum,*<https://www.weforum.org/stories/2023/01/theres-one-key-advantage-when-it-comes-to-cyber-attacks/>, //DS]

The conflict in Ukraine has, in many ways, defied expectations, especially for the cyber security community.

The “cyber war” that many expected failed to materialize as these operations [failed](https://carnegieendowment.org/2022/12/16/russia-s-wartime-cyber-operations-in-ukraine-military-impacts-influences-and-implications-pub-88657) to levy any strategic impact, and the cyber domain of Russia’s offensive has largely been relegated to the background.

Likewise, while the Ukrainian “IT Army” provided captivating headlines, the international and Ukrainian voluntary hackers that purport to help the national defence ministry to target Russian infrastructure and websites have shown to offer no more than marginal contributions. The conflict has remained predominantly kinetic, and that seems unlikely to change.

However, this outcome raises a simple but important question. Why hasn’t cyber played a greater role in the conflict in Ukraine? The answer could provide insight into future conflicts where there’s a concern about outsized cyber engagement or other forms of hybrid warfare.

The debate on the role of cyber in conflict is not new; but its “Pearl Harbour moment” is yet to occur. Political scientist [Thomas Rid](https://www.csl.army.mil/SLET/mccd/CyberSpacePubs/Cyber%20War%20Will%20Not%20Take%20Place%20by%20Thomas%20Rid.pdf) says “cyber war” hasn’t happened and isn’t likely, while another scholar in the space, [Lorenzo Franchesci-Biccherai](https://www.vice.com/en/article/88qgqz/ukraines-decentralized-cyber-army), says such a term is “used in the wrong situations” and likely to result in “hyperbole.”

There is little precedent to challenge Rid’s and Franchesci-Biccherai’s views. Only a handful of cyber operations have captured the public’s attention – e.g. [Operation Olympic Games](https://securityanddefence.pl/Operation-Olympic-Games-nCyber-sabotage-as-a-tool-of-American-nintelligence-aimed,121974,0,2.html) directed at Iranian nuclear facilities and [Operation Glowing Symphony](https://www.npr.org/2019/09/26/763545811/how-the-u-s-hacked-isis) against terror outfit ISIS – but there is no clear instance of moving the needle as part of a hybrid warfare approach, let alone by themselves.

Reversible cyber attacks

Frankly, cyber attacks don’t have much impact, as counterintuitive as that may feel, given oft-cited catastrophic-level scenarios such as the potential hacking of nuclear weapons or complete disruption of the financial system. Even if the latter were possible, the fundamental limitation of cyber operations would soon be realized – [reversibility](https://sofrep.com/news/cyber-warfare-hasnt-made-sense-in-ukraine-and-likely-wont-anywhere-else/).

The major difference between cyber operations and their kinetic alternatives is that when kinetic attacks occur, what goes down is more likely to stay down for longer. To appreciate this point, it helps to look at reversibility – or permanence – of attacks along a spectrum.

At one end is the permanence of nuclear attacks. Physical or kinetic attacks can have varying degrees of permanence. For example, significant damage to buildings from artillery strikes can take years to remedy, particularly if a conflict persists for years and the number of structures to be repaired increases. Even small arms damage may last a while, as evident in the Bosnian cities of Mostar or Sarajevo. The scale of damage itself can impede repair (and reduce reversibility).

Cyber, on the other hand, has proven to be relatively reversible. For example, Colonial Pipeline, the largest US oil pipeline, which was subject to a ransomware attack in May 2021, was down for only [five days](https://saisreview.sais.jhu.edu/insurance-instead-of-deterrence-a-pivot-in-cybersecurity-strategy/), compared to several [wind farms](https://thebulletin.org/2022/04/damage-to-ukraines-renewable-energy-sector-could-surpass-1-billion/) in Ukraine that experienced physical damage, affected for months so far and maybe longer yet as the conflict continues.

The argument could be made that cyber operations are an economic security threat rather than a military one, resulting in the opportunity for indirect warfare. However, data from the conflict in Ukraine casts doubt on this position.

As a reference point, the CEO of cleantech company IB Centre Inc., [Vitaliy Daviy](https://www.pv-magazine.com/2022/05/02/ukraine-is-there-a-pessimistic-solar-scenario-no/), suggests that the conflict has caused 60% of Ukraine’s industrial enterprises to be shut down or destroyed, with [Kosatka Media](https://kosatka.media/en/category/vozobnovlyaemaya-energia/news/zelenaya-energetika-v-ukraine-razrushena-voynoy-i-na-grani-bankrotstva-chto-dalshe) estimating that 30-40% of renewable energy capacity has been damaged.

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It has become clear that the threat posed by cyber operations is different from what was expected before the conflict in Ukraine. Of course, this doesn’t mean that cyber poses no threat or that cyber risks can be downplayed.

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— Thomas Johansmeyer, Head of Property Claim Services (PCS), Verisk

Further, [PCS](https://www.verisk.com/insurance/products/property-claim-services/), the team I lead at data and analytics firm Verisk, estimates that cyber is likely to account for [less than 1%](https://www.reinsurancene.ws/ukraine-conflict-insurance-industry-loss-pcs/) of industry-wide insured losses from the conflict – with the bulk coming from such classes as marine, energy and industrial. Finally, economic losses from physical damage could be as high as $127 billion, according to the [Kyiv School of Economics](https://kse.ua/about-the-school/news/the-total-amount-of-damage-caused-to-ukraine-s-infrastructure-is-more-than-127-billion-kse-institute-s-report-as-of-september-2022/).

The reversibility of cyber attacks needs to become a fundamental consideration in cyber security. That applies whether we are talking about a cyber warfare campaign or an individual and independent attack against a commercial target.

On subs

1. Invasion costs China a fortune – they would never risk it

Peter **Wonacott**”, 10-9-20**24**, "Costly Conflict: Here’s How China’s Military Options for Taiwan Backfire", United States Institute of Peace, <https://www.usip.org/publications/2024/10/costly-conflict-heres-how-chinas-military-options-taiwan-backfire> //ms

Bloomberg Economics has estimated a **war with Taiwan would cost** a staggering **$10 trillion, equivalent to 10% of global GDP** — far outpacing the economic toll from Ukraine’s war, the COVID pandemic and the 2007-2008 global financial crisis. **China’s GDP would suffer a 16.7% blow** compared to 40% for what would be a devastated Taiwanese economy. Bloomberg Economics also modeled the fallout **from a military blockade of the island,** including retaliatory measures between China and the U.S. **It estimated a** 12.2% **hit** to Taiwan’s economy, **8.9% for the Chinese mainland** and 3.3% for the U.S. Some experts say **the economic damage from a China-Taiwan clash is steeper if the final price tag includes the costs of foreign investors exiting the** Chinese **mainland** and neighboring island for safer but less-productive — and less-lucrative — locations.

**And they care about their economic heg first**

Simone **Mccarthy**, 11-10-20**23,** "China has a sweeping vision to reshape the world – and countries are listening", CNN, <https://www.cnn.com/2023/11/09/china/china-xi-jinping-world-order-intl-hnk/index.html> //ms

For decades, **China has built its international influence around its economic clout,** using its own rapid transformation from a deeply impoverished country to the world’s second largest economy as a model it could share with the developing world. It was in this vein that Xi launched his flagship Belt and Road financing drive in 2013, drawing dozens of borrowing nations closer to Beijing and expanding China’s international footprint a year after he became leader with the pledge to “rejuvenate” the Chinese nation to a place of global power and respect.  **“China’s traditional (foreign policy) thinking was very heavily focused on economic capability** as the foundation for everything else. **When you become an economic power, you also naturally acquire greater political influence and soft power,** et cetera — everything else will fall in line,” said Tong Zhao, a senior fellow at the Carnegie Endowment for International Peace think tank in Washington.

1. Taiwan is extremely difficult to invade
   1. Logistically

Alex **Gatopoulos**, 4-4-20**22**, "How difficult would it be for China to invade Taiwan?", Al Jazeera, <https://www.aljazeera.com/features/2022/4/4/how-difficult-would-it-be-for-china-to-invade-taiwan> //ms

**First, the distance a**n invasion **fleet would need to travel** before it even gets to the island **is daunting.** The Taiwan Strait is 128km (79.5 miles) at its narrowest point between mainland China and Taiwan and much wider if embarkation ports where an invasion force would gather are to be considered. While airlifts and vast fleets of planes can move a few thousand troops and keep them supplied, **the sheer number of soldiers and** vast quantities of **supplies** – armoured vehicles, artillery, ammunition, food, medical supplies and fuel – needed for a successful invasion **could only move by sea.** A huge fleet would have to be assembled; colossal stores of equipment would have to be packed into hundreds of ships. This heavily-laden **fleet would only be able to move slowly and would be extremely vulnerable to long-range missile and air attacks** and attacks by submarines. Advertisement Despite the best efforts of the Chinese navy and air force, **the invasion fleet,** in the open for hours, **would be massively exposed** before it even got into a position where it could begin its attack on the Taiwanese shoreline. These assaults would have to be timed to hit the island’s beaches and ports simultaneously in order to overwhelm the defending forces. By far the quickest way for this giant fleet of ships to offload all the troops, weapons, vehicles and supplies needed for a successful invasion would be using the facilities of captured ports. They would therefore need to be taken quickly and remain reasonably intact. At the same time, airports and airfields would need to be seized and held from counterattack until Chinese military transport planes could land, carrying elite troops and armoured vehicles. Taiwan’s air defences and air force would need to be suppressed and ideally destroyed in the opening phase of the invasion.

* 1. Geographically

Alex **Gatopoulos**, 4-4-20**22**, "How difficult would it be for China to invade Taiwan?", Al Jazeera, <https://www.aljazeera.com/features/2022/4/4/how-difficult-would-it-be-for-china-to-invade-taiwan> //ms

The island is made up of a heavily-forested mountain ridge that runs down the length of the roughly oval-shaped island, which from north to south is 395km (245 miles). To the west of the mountain ridge lie fertile plains and large sprawling cities. **Taipei**, the capital, is in the north, **Taichung** is in the centre **and Kaohsiung** to the south are spread out, **form**ing **a natural defensive barrier** that would slow any advance by the Chinese People’s Liberation Army (PLA) to a crawl. **Soldiers would have to fight their way through dense, urban sprawls** and blocks of apartments that can easily be turned into heavily defended strongpoints. Advertisement The whole western side of the island is crisscrossed with rivers and canals. **Taiwan has few beaches suitable for amphibious landings and any force would immediately have to fight its way ashore while deadly counterfire poured down** from the surrounding high buildings and cliffs overlooking the beaches. But the ROC is not just the main island of Taiwan, it includes **many little islands scattered across the Taiwan Strait.** Some chains like Matsu and Kinmen lie just off the coast of mainland China. The other main island chain, Penghu, is an archipelago of 90 islands and islets. Lying off the coast of Taiwan, these **would be a deadly obstacle to any invading force.** Extremely well fortified, **the largest islands bristle with anti-ship and anti-aircraft missiles, early warning radar systems and well-trained troops.** Advertisement They would easily detect the presence of a large invasion fleet and would be able to report on its movements and inflict damage on the PLA navy’s slow-moving transport ships before the fleet even made it to the target ports and beachheads. These islands, therefore, would need to be taken at the very start of any conflict. Tens of thousands of commandos would be needed to quickly seize them and render the islands’ many defences inert before any invasion could commence. As soon as this happens, Taiwan and its allies would be immediately alerted that an invasion has started.