Affirmative Case

We affirm, Resolved: The United States federal government should substantially increase its investment in domestic nuclear energy.

Contention One – Grid Stability

The U.S. is one of the worst developed countries for grid instability with rolling blackouts and outages the norm across the country

Kimani 25 [Kimani, Alex. 02-20-2025, "Blackouts Are Becoming the Norm—Can the U.S. Power Grid Be Saved?," Oil Price, https://oilprice.com/Energy/Energy-General/Blackouts-Are-Becoming-the-NormCan-the-US-Power-Grid-Be-Saved.html]

Last week, a monkey snuck into a substation in Sri Lanka and knocked out power, plunging the island nation into darkness that lasted six hours. The major blackout forced medical facilities and water purification plants in the country to turn to backup generators to maintain critical operations while traffic was gridlocked because traffic lights were not functioning. Unlike many developing nations, Sri Lanka has ample installed power generation capacity and has plenty to spare even during peak demand periods. Unfortunately, Sri Lanka, like many countries, has an outdated power grid that's vulnerable to widespread disruptions. And, **the U.S. is not much better [than developing nations], with rolling blackouts, freezing homes and skyrocketing electricity prices now the norm** rather than the exception. A few decades ago, power outages in vast swathes of the United States were relatively rare and would normally be seen as black swan events. Unfortunately, mass blackouts have now become a regular feature of modern American life. **Power outages have increased 64% from the early 2000s while weather-related outages have soared 78%**. According to one analysis, the United States now records more power outages than any other developed country, with people living in the upper Midwest losing power for an average of 92 minutes every year compared to just 4 minutes in Japan. Related: Drill Baby Drill Is Dead, Oil Executives Say Climate change and extreme weather events are largely to blame for this sad state of affairs. However, the U.S. is not an exceptional case, with Europe feeling the adverse effects of a rapidly changing climate just as keenly as, if not worse than, the U.S. A closer look at the problem reveals that one fuel could be at the center of the conundrum: natural gas.

AND The U.S. grid is the current weak link in the energy sector – the biggest issue is a lack of funding

Kimani 25 [Alex Kimani, 2-20-2025, "Blackouts Are Becoming the Norm—Can the U.S. Power Grid Be Saved?", OilPrice, https://oilprice.com/Energy/Energy-General/Blackouts-Are-Becoming-the-NormCan-the-US-Power-Grid-Be-Saved.html]

Some experts suggest that extending the existing gas infrastructure can help solve the problem. Many, however, believe that grid upgrades and incorporating more renewable energy is the long-term solution. For decades, **the United States has been relying on an aging electrical grid that's increasingly unstable, underfunded and incapable of taking the country to a new energy future**. Despite

being the wealthiest country in the world, **the U.S. only ranks 13th in the quality of its infrastructure**. Indeed, **the U.S. power grid is considered the weakest link in the ongoing energy transition**. A study by UC Berkeley and GridLab found that it will be economically feasible for renewable energy to power 90% of a reliable grid by 2035, while only depending on natural gas for 10% of annual electricity production. Unfortunately, whereas renewable power sources have grown dramatically in recent years, the country's aging electrical grid is simply incapable of fully integrating them into our energy use, leading to so much potential power wasted. But, **as is usually the case, the biggest challenge remains funding**: a Wood Mackenzie analysis has estimated it would cost a staggering $4.5 trillion for the U.S. to fully decarbonize, including constructing and operating new generation facilities; investing in transmission and distribution infrastructure, making capacity payments, delivering customer-facing grid edge technology and more. Suddenly, the $13 billion that the previous administration allocated to upgrading the national grid looks puny.

Increasing investment in nuclear power solves the issue of energy demand and reliability for the grid. This is true for two reasons.

First, nuclear energy is incredibly efficient, providing ample amounts of power.

Office of Nuclear Energy 24 [No Author, 11-12-2024, "U.S. Sets Targets to Triple Nuclear Energy Capacity by 2050", Energy.gov, https://www.energy.gov/ne/articles/us-sets-targets-triple-nuclear-energy-capacity-2050

It's no secret that nuclear power will need to play a role in helping us avoid the worst impacts of climate change and enhance the energy security of the United States, along with our allies and partners. **Nuclear energy is the nation's largest source of clean power and avoids more than 470 million metric tons of carbon dioxide emissions each year**, which is the equivalent of removing 100 million cars from the road. The U.S. Department of Energy estimates **we'll need an additional 200 gigawatts (GW) of new nuclear capacity to keep pace with future power demands and reach net-zero emissions by 2050.** But how will we get there? The United States just set new deployment targets at the U.N. climate summit (COP29) in Baku, Azerbaijan. The plan is to add 35 GW of new capacity by 2035 and achieve a sustained pace of 15 GW per year by 2040 to help keep us on track toward our ultimate goal. The new framework is the first of its kind for our nuclear sector and identifies more than 30 actions the U.S. government can take, along with industry and power customers, to help expand our domestic capacity. The targets also align with last year's historic pledges at COP to triple global nuclear capacity by 2050 and to secure a nuclear fuel supply chain that's free from Russian influence.

AND – funding is key

IEA 25 [IEA, 1-16-2025, "A new era for nuclear energy beckons as projects, policies and investments increase", https://www.iea.org/news/a-new-era-for-nuclear-energy-beckons-as-projects-policies-and-investments-increase]

Innovations in nuclear technologies are helping to drive momentum behind new projects, the report finds. SMRs, a type of smaller scale nuclear power plants that are quicker to build with greater scope for cost reductions, are drawing increasing interest from the private sector. The report highlights how the introduction of SMRs could lead to lower financing costs. With the right support, SMR installations could reach 80 GW by 2040, accounting for 10% of overall nuclear capacity globally. However, the success of the technology and speed of adoption will hinge on the industry's ability to bring down costs by 2040 to a similar level to those of large-scale hydropower and offshore wind projects. A new era for nuclear energy will require a lot of investment. In a rapid growth scenario for nuclear, annual investment would need to double to USD 120 billion already by 2030. Given the scale of the infrastructure **investment** required, the rollout **of new nuclear projects** cannot rely exclusively on public finances. IEA analysis shows that ensuring **[ensure] the predictability of future cash flows** is key **to [bring]** bringing **down financing costs and [attract]** attracting **private capital to the nuclear sector**. The report highlights that the private sector is increasingly viewing nuclear energy as an investible energy source with the promise of firm, competitive, clean power that can serve energy-intensive operations 24/7. Notably, big names in the technology sector are signing power purchase agreements with developers to provide electricity for data centres and artificial intelligence. To take advantage of the opportunities that nuclear power offers, governments must be prepared to provide the strategic vision alongside stable

regulatory frameworks that will give the private sector confidence to invest. The report details how incentives and public finance more broadly can unlock the investment needed to deliver greater clean and reliable power from nuclear.

Second, nuclear power provides 24/7 grid stability

Birol 19 [Birol, Faith. May 2019, “Nuclear Power in a Clean Energy System,” Executive Director International Energy Agency, https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system]

Nuclear power plants contribute to electricity security in multiple ways. **Nuclear plants help to keep power grids stable**. To a certain extent, **they can adjust their operations to follow demand and supply shifts.** As the share of variable renewables like wind and solar photovoltaics (PV) rises, the need for such services will increase. **Nuclear plants can help to limit the impacts from seasonal fluctuations in output from renewables and bolster energy security by reducing dependence on imported fuels**. Lifetime extensions of nuclear power plants are crucial to getting the energy transition back on track Policy and regulatory decisions remain critical to the fate of ageing reactors in advanced economies. The average age of their nuclear fleets is 35 years. The European Union and the United States have the largest active nuclear fleets (over 100 gigawatts each), and they are also among the oldest: the average reactor is 35 years old in the European Union and 39 years old in the United States. The original design lifetime for operations was 40 years in most cases. Around one quarter of the current nuclear capacity in advanced economies is set to be shut down by 2025 – mainly because of policies to reduce nuclear’s role. The fate of the remaining capacity depends on decisions about lifetime extensions in the coming years. In the United States, for example, some 90 reactors have 60-year operating licenses, yet several have already been retired early and many more are at risk. In Europe, Japan and other advanced economies, extensions of plants’ lifetimes also face uncertain prospects.

AND – this is empirically validated. Georgia’s nuclear power plant Vogtle proves

Lambermont 24 [Paige Lambermont • 05, 5-10-2024, "In spite of burdensome regulation, Georgia opens new nuclear reactor", Competitive Enterprise Institute, https://cei.org/blog/in-spite-of-burdensome-regulation-georgia-opens-new-nuclear-reactor/]

But, the new units will also provide 60 to 80 years of reliable electricity for Georgia ratepayers Thanks to the newest reactor, Plant Vogtle will now be the largest nuclear power plant in the United States, and the country’s second-largest power plant by capacity at 4,800 megawatts (MW). It is second only to the 7,079 MW Grand Coulee Dam in Washington State. Although it doesn’t equal the Grand Coulee’s potential generating capacity, Plant Vogtle is likely to exceed the dam in actual output because of its capacity factor. Capacity factor is the percentage of time that a power plant is generating at its maximum capacity. Nuclear reactors have incredibly high capacity factors—**with 92.5% reliability throughout the year**. Because of this, a nuclear plant can often produce more energy in a given year than a much higher nameplate capacity facility **This is beneficial to the electrical grid because this capacity can be consistently relied upon.** Plant Vogtle is projected to generate more than 30 million MW hours of electricity every year and will be one of, if not the largest, electricity-generating facilities in the country. There are certainly lessons to be learned from the development process for both Vogtle reactors. The primary lesson is that for new nuclear to be successful, a streamlined and consistent regulatory framework is essential. Nuclear reactors have incredible potential to benefit the electrical grid, and poor regulation is one of the major barriers to the deployment of new reactors.

The impact is twofold.

First, lives

Larson 15 [Aaron Larson, 7-22-2015, "Expert: 90% of U.S. Population Could Die if a Pulse Event Hits the Power Grid", POWER Magazine, https://www.powermag.com/expect-death-if-pulse-event-hits-power-grid/]

When a large electromagnetic pulse (EMP) or geomagnetic disturbance (GMD) event occurs—which, according to Sen. Ron Johnson (R-Wis.), there is “100% certainty” will happen at some time in the future—as many as 9 out of 10 people in the U.S. could die. Johnson, chairman of the U.S. Senate Committee on Homeland Security & Governmental Affairs, posed questions to witnesses testifying on Capitol Hill before his committee. He asked R. James Woolsey, chairman of the Foundation for Defense of Democracies and former director of the Central Intelligence Agency, what would happen to society **if the electrical grid were to be down for an extended period of time,** such as a year or two,

following an EMP event? Woolsey responded, "It's briefly dealt with in the commission report of [2008]. There are essentially two estimates on how many **people would die from hunger,** from **starvation,** from **lack of water, and from social disruption. One estimate is** that within a year or so, **two-thirds of the United States population would die. The other estimate is that** within a year or so, **90% of the U.S. population would die**. We're talking about total devastation. We're not talking about just a regular catastrophe." What Are GMDs and EMPs? Woolsey may have been the most pessimistic of the witnesses, but he wasn't the only one who was worried. Joseph H. McClelland, director of the Federal Energy Regulatory Commission's Office of Energy Infrastructure Security, reviewed some of the possibilities in his testimony. He explained that GMD and EMP events are generated from either naturally occurring or man-made causes. In the case of GMDs, naturally occurring solar magnetic disturbances periodically disrupt the earth's magnetic field, which in turn, can induce currents on the electric grid that may simultaneously damage or destroy key transformers over a large geographic area. EMPs can be generated by devices that range from small, portable, easily concealed battery-powered units all the way through missiles equipped with nuclear warheads. In the case of the former, equipment is readily available that can generate localized high-energy bursts designed to disrupt, damage, or destroy electronics, such as those found in control systems on the electric grid. The EMP generated during the detonation of a nuclear device is far more encompassing and generates three distinct effects, each impacting different types of equipment; a short high energy radio frequency–type burst called E1 that destroys electronics; a slightly longer burst that is similar to lightning termed E2; and a final effect termed E3 that is similar in character and effect to GMD targeting the same equipment including key transformers. Any of these effects can cause voltage problems and instability on the electric grid, which can lead to wide-area blackouts. Richard L. Garwin, PhD, fellow emeritus at the IBM Thomas J. Watson Research Center, noted in his testimony that "very serious consequences are estimated for such an event of a magnitude that can be expected to occur at random once per century, with greater events occurring with lower probability and lesser events more frequently." Has It Ever Happened Before? McClelland and Garwin provided some examples. The largest event ever recorded—called the Carrington Event—occurred in 1859, during the pre-electric-grid era. McClelland estimated that it was roughly a K8 or K9 level event. The K-index quantifies disturbances in the horizontal component of earth's magnetic field with an integer in the range 0–9 with 1 being calm and 5 or more indicating a geomagnetic storm.

Second, grid reliability key to every aspect of the military -- BMD, command and control, forward operating missions, and humanitarian operations

Keys et al. 15 [Rob, Former Commander of Air Combat Command, writing with the CNA Military Advisory Board, "National Security and Assured U.S. Electrical Power", https://www.cna.org/CNA_files/PDF/National-Security-Assured-Electrical-Power.pdf]

As highlighted in our report, Powering America's Defense, military installations across the country rely heavily on the same grid as our communities, towns, and cities. The Department of Defense (DOD) requires a reliable and secure power supply for a multitude of critical systems that **must be online every hour, every day, year-round**. For example, **our** land-based **B**allistic **M**issile **D**efense **systems are critical to protecting our homeland 24/7**. At the same time, numerous **command-and control headquarters provide support to** forward **bases.** These **installations** receive and analyze threat data, **provide direction and support to forward operating forces**, and **stand ready to respond to threats or** other calls to action from the United States or from our allies. Increasingly, remotely piloted vehicles and other direct support for remote battlefield operations are controlled from military bases here in the United States. Despite the military's redundant systems for critical operations and logistics, a prolonged widespread electrical outage would impact numerous domestic installations, placing at risk domestic military operations and those in-theater conducing combat, humanitarian, and other operations. Although most military installations have backup power generation capabilities, these generators rely predominately on fossil fuel–based generators (i.e., diesel, propane, JP-8). To date, the Defense Department has always been able to procure and transport the fuel it needs to domestic and overseas installations. However, under the scenario of a prolonged large-scale electrical power outage, if the commercial transportation sector comes to a standstill—as it likely will—there is the risk that the supplies needed to keep the military's domestic backup power equipment running may not be available. The Defense Science Board noted that "the military's backup power is inadequately sized for its missions and military bases cannot easily store sufficient fuel supplies to cope with a lengthy or widespread outage" [18]. Even accessing the U.S. Strategic Petroleum Reserve may be problematic if U.S. refineries do not have the needed electrical power to operate. Military installations are not the only concern. Most of the active-duty military, civilian, and contract personnel supporting military operations live in communities surrounding the installations. In the event of a widespread power outage, critical personnel may not be able to report to work because they have transportation problems or because they may be addressing emergency situations with their own families and neighbors. Mission effectiveness can be maintained only when the personnel who perform vital mission functions are able to report to work and operate productively without distraction. The installations where these people work may have backup power, fresh water, medical services—and they will be able to operate temporarily during a grid failure—yet they do not have the capacity to serve as safe havens for surrounding communities while maintaining mission effectiveness, nor to unburden operators worried about their families at risk.

Fast-paced military decision-making solves global war

Garamone 17 [(Jim Garamone, Reporter for DoD News) "Dunford: Speed of Military Decision-Making Must Exceed Speed of War," Department of Defense News, 01-31-2017, https://www.defense.gov/News/News-Stories/Article/Article/1066045/dunford-speed-of-military-decision-making-must-exceed-speed-of-war/]

Military decision-making needs to exceed the speed of events, the chairman of the Joint Chiefs of Staff wrote recently in Joint Forces Quarterly. Since Marine Corps Gen. Joe Dunford became the chairman in September 2015, he has emphasized innovations and changes that speed the military's ability to respond to rapidly changing situations. While America's joint force is the best in the world, he said, it must continue to innovate to stay ahead of potential foes and to adapt to constantly changing strategies. "As I reflect back on four decades of service in uniform, it is clear that the pace of change has accelerated significantly," Dunford said. He noted that when he entered the Marine Corps in the 1970s, he used much the same equipment that his father used during the Korean War. "I used the same cold-weather gear my dad had in Korea 27 years earlier," he said. "The radios I used as a platoon commander were the same uncovered PRC-25s from Vietnam. The jeeps we drove would have been familiar to veterans of World War II, and to be honest, so would the tactics." Marine units, he added, fought much the same way their fathers did at Peleliu, Okinawa or the Chosin Reservoir. Accelerated Pace of Change Today, "there are very few things that have not changed dramatically in the joint force since I was a lieutenant," Dunford said. He spoke of visiting a Marine platoon in Farah province, Afghanistan. "This platoon commander and his 60 Marines were 40 miles from the adjacent platoons on their left and right," he said. "His Marines were wearing state-of-the-art protective equipment and driving vehicles unrecognizable to Marines or soldiers discharged just five years earlier. They were supported by the High Mobility Artillery Rocket System, which provided precision fires at a range of 60 kilometers." The platoon, Dunford recalled, received and transmitted voice, data and imagery via satellite in real time, something only possible at division headquarters just five years before his visit. These changes are mirrored across the services and combatant commands, the chairman said, giving commanders amazing capabilities, but also posing challenges to commanders on how to best use these new capabilities. "Leaders at lower and lower levels utilize enabling capabilities once reserved for the highest echelons of command," Dunford said in the article. "Tactics, techniques and procedures are adapted from one deployment cycle to the next." This accelerated pace of change is inextricably linked to the speed of war today, the general said. "Proliferation of advanced technologies that transcend geographic boundaries and span multiple domains makes the character of conflict extraordinarily dynamic," the chairman said. "Information operations, space and cyber capabilities and ballistic missile technology have accelerated the speed of war, making conflict today faster and more complex than at any point in history." Shortened Decision-Space Adds New Risks The **American military must stay ahead of this pace because the United States will not have time to marshal the immense strength at its command as it did in World War I and II and during Korea**, Dunford said. "Today, the ability to recover from early missteps is greatly reduced," he said. "The speed of war has changed, and the nature of these changes makes the global security environment even more unpredictable, dangerous and unforgiving. Decision space has collapsed and so **our processes must adapt to keep pace with the speed of war**." The situation on the Korean Peninsula is a case in point, the chairman said. In the past, he said, officials believed any war on the peninsula could be contained to the area. However, with the development of ballistic missile technology, the North Korean nuclear program and new cyber capabilities that is no longer possible, Dunford said. A war that once would have been limited would now spiral, almost immediately, with regional and global implications, he said. "Deterring, and if necessary, defeating, a threat from North Korea requires the joint force to be capable of nearly instant integration across regions, domains and functions," Dunford said. "Keeping pace with the speed of war means changing the way we approach challenges, build strategy, make decisions and develop leaders." This means seamlessly integrating capabilities such as information operations, space and cyber into battle plans, the chairman said. "These essential aspects of today's dynamic environment cannot be laminated onto the plans we have already developed," he said. "They must be mainstreamed in all we do, and built into our thinking from the ground up." Integrated Strategies Improve Responsiveness Dunford said the joint force must also develop integrated strategies that address transregional, multidomain and multifunctional threats.

AND preventing a global war is key to the future of humanity

Ijaz 24 [Zonaisha Ijaz, 11-30-2024, "Prediction of World War 3 and Its Global Impact", Modern Diplomacy, https://moderndiplomacy.eu/2024/11/30/prediction-of-world-war-3-and-its-global-impact/]

Following World Wars I (1914–1918) and II (1939–1945), World War III (WWIII or WW3), commonly referred to as the Third World War, is a fictitious future worldwide battle. It is often believed that, like its predecessors, this war would involve all of the major nations and use nuclear or other weapons of mass destruction, outstripping all previous confrontations in terms of territory, destruction, and casualties. For many years, we believed that a nuclear holocaust would avert global conflict. Is that faith no longer relevant? World War 3 prediction is quite uncertain and speculative. But as possible triggers, tensions between superpowers, technological developments, and unresolved international issues are frequently mentioned. Let's examine the potential origins, situations, and effects of a significant world conflict while highlighting the value of diplomacy and peace. Battles involving territorial claims, economic rivalry, or ideological disagreements between superpowers such as the United States, China, and Russia. Russia-NATO disagreements and tensions in the Taiwan Strait are two examples: **The growing competition between the United States and China is one of the most discussed potential triggers for global conflict**. The two nuclear-armed neighbors have fought multiple wars over Kashmir. A **small skirmish**

could escalate into a nuclear exchange. Such as rare earth minerals, oil, and water, may lead to resource wars. Examples include conflicts over freshwater resources or in the Arctic. Rivers and water basins shared by multiple countries (e.g., Nile, Indus) could become flashpoints for conflict. As technology advances, countries might fight over rare earth minerals essential for electronics and batteries. As our reliance on technology increases, disputes over artificial intelligence systems, satellites, or cyber networks may arise. For instance, a cyberattack that destroys a nation's military or economy may lead to reprisals. Localized battles could turn into world wars if nuclear weapons are misused or mishandled. For instance, hostilities between nations with nuclear weapons, such as India and Pakistan. Mass migrations may be prompted by resource scarcity, natural disasters, and rising sea levels, which could result in war zones. Conflict over resources and land in areas impacted by extreme weather occurrences is one example. Crop failures and water scarcity could lead to conflicts between nations vying for resources to sustain their populations. Collapsing governments in unstable regions might allow extremist groups to gain power, triggering international interventions and wars. The rise of nationalist leaders could create aggressive foreign policies, increasing the likelihood of conflict. **A world war would have disastrous effects on both the planet and humans.** These include, among other things, endemic poverty, malnutrition, infirmity, social and economic deterioration, and psychosocial disorders. The development of cohesive and successful strategies for addressing conflicts and the plethora of mental health issues they give rise to requires a deeper comprehension of conflicts. The health and well-being of nations are severely impacted by war. Conflict circumstances cause more deaths and disabilities than any major disease, according to studies. Communities and families are destroyed by war, which also frequently impedes the growth of a country's social and economic structure. Long-term physical and psychological injury to adults and children, as well as a decline in human and material wealth, are all consequences of conflict. This is just the "tip of the iceberg" of war-related deaths. The long-term effects of World War III could be even more severe. Massive debt accumulation, widespread destruction, and potential climate change impacts could stifle global economic growth for decades. The death toll from direct combat, bombings, and other forms of violence could reach millions. Refugee Crisis, as millions of people flee war zones, overcrowded camps and a lack of resources result. Wildlife Loss & Deforestation, Bombings and other military operations would wipe out natural habitats, driving certain species to extinction. Climate Impact, Earth would become less habitable as a result of fires, pollution, and explosions exacerbating climate change Disruptions to the world's communication and internet networks could render contemporary societies immobile. Conflict has the potential to topple current governments and leave power voids. Global Repression, during times of war, governments may enforce stringent monitoring and restrict liberties. Changes in Power, the political landscape of today may alter greatly from that of the post-war leading powers. A war may break out between Russia and Ukraine. Russia has mobilized more than 10,000 soldiers to Ukraine's border. If Russia invades Ukraine, it will likely aim to establish control, potentially sparking World War 3. Consistent communication and settlement of conflicts amicably between countries. Encouraging the UN and other international institutions to settle disputes and advance peace. lowering nuclear weapons stockpiles and outlawing specific technologies to stop escalation. Addressing problems like resource management, inequality, and climate change. In conclusion, despite how scary the prospect of World War 3 is, humanity has the means to stop it. To ensure a peaceful future, international collaboration, diplomacy, and education are essential. To overcome the urgent problems of the twenty-first century, such poverty and climate change, nations can cooperate rather than engage in conflict, resulting in a more secure and affluent global community

Contention Two – Maritime Shipping

The shipping industry is particularly difficult to decarbonize due to need for reliable consistent energy

Urban et al 24 [Frauke Urban A, Anissa Nurdiawati A, Fumi Harahap A B D, Kateryna Morozovska A C, 9-1-2024, "Decarbonizing maritime shipping and aviation: Disruption, regime resistance and breaking through carbon lock-in and path dependency in hard-to-abate transport sectors", No Publication, https://www.sciencedirect.com/science/article/pii/S221]

Aviation and maritime shipping are hard-to-abate transport sectors that are heavily dependent on fossil fuels. They **jointly account for nearly 10 % of global greenhouse gas emissions**, while infrastructure and investments are locked into high-carbon pathways for decades. Fuels and technologies to decarbonize include advanced biofuels, electrofuels, hydrogen and electric propulsion. This research aims to analyse the decarbonization strategies for maritime shipping and aviation from a comparative perspective, and analyzing the role of different actors for disruption to break through carbon lock-in and path dependency. The research uses Sweden as a case study and applies qualitative methods, including expert interviews, focus group discussions and site visits. Our research finds that aviation and maritime shipping are slowly changing, albeit with different dynamics. Both sectors show that incumbent regime actors play a major role in shaping transition pathways and disrupting the (quasi)equilibrium, while niche innovation is often developed together by incumbents and niche players.

policies, using a new model to quantify impacts on fuel use, emissions, revenues, production and economic costs, and on vulnerable states..

AND despite efforts, emissions have still increased

Sgaravatti 23 [Sgaravatti, Giovanni. Bruegel Until December 2024 As An Energy and Climate Research Analyst. He Studied Economics (Bsc) At University Of Venice, 9-25-2023, "The struggle to cut emissions from international aviation and shipping", Bruegel | The Brussels-based economic think tank, https://www.bruegel.org/analysis/struggle-cut-emissions-international-aviation-and-shipping]

In combination, **international aviation and shipping contribute about 3 percent of greenhouse gases put into the atmosphere each year**. Emissions in 2022 from international aviation were 436 million tonnes of carbon dioxide equivalent, while from international shipping the figure was 706 Mt/CO2eq – about the same as Germany (746 Mt of CO2eq) 1 . If within-country emissions are also counted, the figures rise significantly 2 . **So far, there has been a persistent failure to reduce these emissions. In the European Union, where overall emissions have dropped by 30 percent since 1990, emissions from international aviation and shipping increased by more than in any other economic sector** – by 29 percent and 26 percent respectively (Figure 1). A fundamental obstacle in dealing with shipping and aviation is the labelling of much of their emissions as 'international' under United Nations Framework Convention on Climate Change (UNFCCC) reporting. This accounting feature, a legacy of the Kyoto Protocol, means governments have less of an incentive to decarbonise the two sectors. They are not obliged to include clear emissions reduction pathways for the international portion of aviation and shipping in their Nationally Determined Contributions (NDCs) 3 . Furthermore, as they operate across borders, they escape national carbon-pricing schemes. The current accounting model, combined with the lack of a global carbon price, makes it very hard to impose the polluter-pays principle on international aviation and shipping. Aviation and shipping companies also receive special tax treatment. Neither sector pays value-added tax or excise duties on fuel (unlike the railway and road transport sectors). Their special tax status gives them a competitive advantage over other modes of transportation. This is particularly evident in aviation, where transporting passengers is five times more emissions-intensive than by train 4 , but buying a flight in Europe is cheaper than the equivalent train ticket in 70 percent of instances (Doll et al, 2020; Greenpeace, 2023). Companies in the two sectors also tend to profit from low corporate taxes, as they have more freedom to register anywhere in the world than other types of businesses. In maritime shipping for example, the majority of companies are registered in jurisdictions such as Liberia and Panama 5 , which have minimal corporate income tax rates 6 (McCow, 2023).

Voting aff solves

Simpson et al 23 [Simpson, Allan. Roman, Amy. Broadbent, Clare. 12-05-2023, "Nuclear Energy: Key to Decarbonizing Hard-to-Abate Sectors," https://www.iaea.org/topics/climate-change/the-iaea-and-cop/cop28/nuclear-energy-key-to-decarbonizing-hard-to-abate-sectors]

Nuclear energy represents a vital solution in our quest to decarbonize hard-to-abate sectors While electrification with clean power can largely decarbonize buildings and mobility, **other options are needed to replace fossil fuels in heavy industries, aviation and shipping. Nuclear power, with its 24-7, low emissions operation, offers a compelling solution. It can produce heat for industrial** applications as well as hydrogen, unlocking fossil-free alternatives in aviation and shipping. Integrating nuclear energy into the clean energy portfolio is essential for tackling the toughest abatement challenges and achieving a sustainable, low-carbon **future**.

Voting aff is key to developing commercial nuclear options

Pennella 23 [Patrick R. Pennella, 8-31-2023, "Nuclear Reactors Are a Clean Energy Solution for Civil Maritime", Bloomgberg Law, https://news.bloomberglaw.com/us-law-week/nuclear-reactors-are-a-clean-energy-solution-for-civil-maritime]

Although **nuclear power has been used successfully to power US military vessels since the 1950s**, use for civilian maritime purposes has never evolved beyond a few experimental designs. High initial capital costs and concerns about safety kept nuclear power for the civilian maritime fleet from reaching criticality. **However, innovations in nuclear technology,** combined with a push to decarbonize the civilian maritime industry**, now offer the opportunity to revitalize the concept at commercially viable costs.** The US Navy has employed dozens of nuclear-powered warships without any significant reactor-related safety events. The US, however, has built only a single nuclear-powered merchant ship—the proof-of-concept N.S. Savannah. A hybrid cargo and passenger vessel, the Savannah operated successfully from 1959 through 1972 but its limited cargo and passenger capacity made continued operation uneconomical. The intent behind the Savannah was merely to prove the concept. And it did. Several other countries successfully operated experimental nuclear-powered civilian vessels but, as was the case in the US, widespread adoption never occurred.

Nuclear power vessels are comparably better

Pennella 23 [Patrick R. Pennella, 8-31-2023, "Nuclear Reactors Are a Clean Energy Solution for Civil Maritime", Bloomgberg Law, https://news.bloomberglaw.com/us-law-week/nuclear-reactors-are-a-clean-energy-solution-for-civil-maritime]

Advantages of Nuclear-Powered Vessels Nuclear propulsion has always produced several key advantages over conventional fuel sources. First, nuclear-powered vessels can go years without refueling. Even though conventional vessels can typically refuel concurrently with cargo operations, owners of nuclear vessels could worry less about fuel price volatility since uranium pricing is not as volatile as oil. Relatedly, the large up-front capital cost of a nuclear reactor may be outweighed by the steady cost of fuel consumption, which for a large container ship can exceed $3 million a month. Second, the energy density of nuclear fuel eliminates the need to store millions of gallons of fuel oil. This benefit eliminates the traditional trade-off between fuel storage and cargo space. Nuclear vessels can repurpose the space occupied by fuel tanks for cargo. Even taking the necessary shielding into account, compared to a conventionally powered large container vessel, a similarly sized nuclear-powered vessel could hold more standard shipping containers and operate at higher speeds. Relatedly, **on nuclear-powered ships there would be no fuel tanks to rupture in the event of a maritime casualty, preventing the discharge of thousands of barrels of fuel oil into sensitive littoral environments and the associated costs of remediation**. A July 2023 study by the American Bureau of Shipping confirmed these first two points. Based on one model, the **study found that using two 30-MW fast reactors on a large container ship would increase cargo capacity and operating speed.** In another configuration, **employing four 5-MW heat-pipe microreactors on a large tanker would decrease cargo capacity but increase operational speed**. And, **in both examples, the fuel could last for 25 years—the typical operational life of a commercial vessel**. Third, the conventional fuel is bunker oil, and it emits combustion byproducts such as carbon dioxide and particulate matter. As environmental regulations regarding emissions tighten globally**, nuclear power offers a reliable source of clean, carbon-free energy**. Advancements in Reactor Technology Recent advancements in nuclear reactor technology enhance the competitiveness of nuclear-powered vessels. The advent of micro- and small-modular reactors offers a standardized design that can achieve the economy of scale to make SMRs cost-effective. Although these designs were intended for onshore power generation, their size and standardization make them suited for use on commercial vessels. The **high number of large commercial vessels creates the potential for mass deployment, creating benefits from economies of scale, standardized operator training, and stable supply chains. Several SMR designs in the** licensing stage before regulatory authorities in Canada, Japan, the UK, and the **US produce sufficient electricity to power the largest container ships**, and several smaller SMR designs would suffice for smaller vessels. New advanced reactor designs cooled by molten salts or liquid metal may offer a reactor type that could be well suited for maritime transportation applications. Because these reactors operate at ambient pressure and solidify if the reactor stops, there is little risk of environmental contamination in the event of a reactor emergency. Competitive power markets and behind-the-meter generation programs, which exist in much of the US, offer a supplemental source of revenue for nuclear-powered vessels. While many ships would tie into shore power to save fuel when docked, the nuclear reactor can continue to operate. These vessels would not only avoid having to consume electricity in port, but they could look to export power to the grid or facilitate net energy billing for energy-intensive port facilities. The next generation of advanced nuclear reactors is already being developed for onshore electricity production. These reactors can be readily adapted to civilian maritime uses, offering a safe, reliable, clean, and cost-effective source of energy.

The Impact is Biodiversity.

Oil spills by cargo ships in the status quo destroy biodiversity

Starmer 22 [Alyssa Starmer, 2022, "Impacts of Container Ship Disasters in a Surge of Global Trade", Seaside, https://www.seasidesustainability.org/post/impacts-of-container-ship-disasters-in-a-surge-of-global-trade]

As shipping increases so does the frequency of maritime shipping disasters, especially as ship size grows and conditions worsen from climate change. Container ship accidents can potentially destroy millions of dollars worth of goods, damage vessels, and threaten lives and the surrounding environment. As container ship disasters increase in frequency, corresponding environmental consequences intensify. Ship disasters emphasize the critical need for enhanced environmental regulations and emergency response mechanisms in global shipping. Potential environmental impacts from container shipping include oil spills, the release of physical pollutants, ship strikes, noise pollution, and the unintentional release of invasive species. **Oil spills contaminate coastlines and harm species through coating and toxin accumulation.** The NGO Oceana estimates that "if global shipping were a country, it would be the sixth largest producer of greenhouse gas emissions". The rapid acceleration of these emissions intensifies global warming and its impacts on our environment. Remarkably, the largest container ships create the same amount of pollution as 50 million cars. Bunker fuel, a cost-effective oil used to power these large container ships, is extremely harmful once entering the marine environment. Toxic components of bunker fuel that leach into the environment can be very harmful to humans and marine organisms, with the potential to cause long-term effects by entering the kidney and liver and suppressing the immune system **Physical pollutants released from ships** including waste and cargo**, can alter ocean chemistry and cause long-term effects on marine ecosystems**. The assessment of environmental impact in container ship disasters is complex due to the unpredictable nature of the contents of containers, with each potentially holding a different mix of products with varying ecological significance. Container shipments globally are generally comprised of chemicals (~33%), rubber and paper products (~20%), machinery and parts (~18%), agricultural products (~15%), textiles and furniture (~11%), and electronics (~3%), with 40% of container ship cargo being hazardous on average. Determining the environmental impact of container pollution is difficult due to the variety of cargo on a ship in an event. Oftentimes dangerous cargo goes undeclared due to inattention, ignorance, cost, or illegal activity. Lack of documentation adds to the difficulty in understanding container shipment composition and its corresponding ecological impacts. As 45% of major container ship fires result from undeclared goods, there is an urgent need for stronger regulations for reporting container ship goods. The total impact of container loss remains unclear due to the inaccuracy of container documentation and the difficulty of recovering and recording lost containers. Ships may lose containers as a result of incorrectly declared weights, faulty container connections, improper stacking, poor container conditions, and extreme weather conditions. Currently, there are relaxed procedures for reporting container ship loss and no international regulations to address this pressing issue.

Biodiversity loss causes extinction

Economist 21 [No Author, "Loss of biodiversity poses as great a risk to humanity as climate change." 6-15-2021. https://www.economist.com/technology-quarterly/2021/06/15/loss-of-biodiversity-poses-as-great-a-risk-to-humanity-as-climate-change

Human societies depend on healthy ecosystems. People consume their products in the shape of fish, meat, crops, timber and fibres such as cotton and silk. Medicines may be directly harvested from the natural world or inspired by molecules and mechanisms found within it. The ecosystems that crops depend upon are regulated by living things. Through photosynthesis, trees and other plants take in carbon and pump out oxygen. In doing so they remove roughly 11bn tonnes of carbon dioxide from the atmosphere each year, equivalent to 27% of what human industry and agriculture emits (the oceans absorb a further 10bn tonnes). The services that ecosystems provide to humanity depend, in turn, on there being a diversity of living things. **More than 75% of global food-crop types,** including coffee, cocoa and almonds**, are pollinated by animals.** The complex web underpinning every food chain and ecosystem means that the narrow range of species that humans eat and exploit cannot be sustained without the existence of a much greater diversity of animals, plants and bacteria. More diverse forests store more carbon than monocultures. **Skipjack tuna makes up roughly half of the global tuna catch for human consumption. As young animals, they eat zooplankton, which is to say very small floating animals like tunicates, ctenophores and small crustaceans as well as the larvae of larger animals. As adults, they eat smaller fish, squid and crustaceans. To conserve the skipjack, all this diversity in its food chain must also be conserved. Since the 1990s, alarmed by studies showing rapid declines in animal and plant species around the globe, ecologists have talked of an impending mass extinction. It would be the sixth in the Earth's history, but one unlike any that has come before. Surveys show that the loss of biodiversity is the result of a combination of factors: climate change, pollution, human exploitation of land, sea, plants and animals, and the displacement of some species into new territories where**

they play havoc with existing ecosystems. Uniquely in Earth's history, each of these drivers of ecological change is caused by a single species: Homo sapiens. When ipbes (the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, similar to the Intergovernmental Panel on Climate Change) published its assessment of the state of global biodiversity in 2019, it offered a sobering picture. Roughly 1m animal and plant species were deemed to be at risk of extinction, more than at any other point in human history. These included many that are used in farming. At least 9% of the 6,200 breeds of domesticated mammals that humans eat, or use to produce food, had become extinct by 2016, and at least 1,000 more are threatened. More than one-third of continental land area and nearly three-quarters of freshwater resources are used to produce crops or livestock, but environmental degradation has damaged the land's ability to support these activities. And one-third of marine fish stocks were being unsustainably exploited in 2015. The biodiversity crisis poses as great a risk to human societies as climate change. Yet it has a fraction of the public profile. In part that is because the loss of biodiversity cannot be neatly quantified, as climate change can, into parts per million of carbon dioxide, or degrees above pre-industrial average temperatures. And the webs that link species within and across ecosystems are even more complex than the processes that drive climate change.

C1 Frontlines/Extensions

AT Private Sector not interested in investment

1. **Turn. The private sector is interested in investing – government action is key to make it a viable option for private companies**

IEA 25 [IEA, 1-16-2025, "A new era for nuclear energy beckons as projects, policies and investments increase", https://www.iea.org/news/a-new-era-for-nuclear-energy-beckons-as-projects-policies-and-investments-increase]

Innovations in nuclear technologies are helping to drive momentum behind new projects, the report finds. SMRs, a type of smaller scale nuclear power plants that are quicker to build with greater scope for cost reductions, are drawing increasing interest from the private sector. The report highlights how the introduction of SMRs could lead to lower financing costs. With the right support, SMR installations could reach 80 GW by 2040, accounting for 10% of overall nuclear capacity globally. However, the success of the technology and speed of adoption will hinge on the industry's ability to bring down costs by 2040 to a similar level to those of large-scale hydropower and offshore wind projects. A new era for nuclear energy will require a lot of investment. In a rapid growth scenario for nuclear, annual investment would need to double to USD 120 billion already by 2030. Given the scale of the infrastructure investment required, the rollout of new nuclear projects cannot rely exclusively on public finances. IEA analysis shows that ensuring [ensure] the predictability of future cash flows is key to [bring] bringing down financing costs and [attract] attracting private capital to the nuclear sector. The report highlights that the **private sector is increasingly viewing nuclear energy as an investible energy source with the promise of firm, competitive, clean power that can serve energy-intensive operations 24/7**. Notably, **big names in the technology sector are signing power purchase agreements with developers to provide electricity for data centres and artificial intelligence**. To take advantage of the opportunities that nuclear power offers, **governments must be prepared to provide the strategic vision alongside stable regulatory frameworks that will give the private sector confidence to inve**st. The report details how incentives and public finance more broadly can unlock the investment needed to deliver greater clean and reliable power from nuclear.

AT Blackouts not a big issue

Blackouts in the United States are increasing year-over-year

Oak Ridge National Laboratory 24 [Oak Ridge National Laboratory Is Managed By Ut-Battelle Llc For The Us Department Of Energy, 5-13-2024, "Researchers compile US's most comprehensive power outage dataset", ORNL, https://www.ornl.gov/news/researchers-compile-uss-most-comprehensive-power-outage-dataset]

In a new study published in the journal Nature Scientific Data, researchers from the Department of Energy's (DOE) Oak Ridge National Laboratory (ORNL) have produced the most comprehensive power outage dataset ever compiled for the United States. This dataset, showing electricity outages from 2014-22 **in the 50 U.S. states**, Washington D.C. and **Puerto Rico, details outages at 15-minute intervals for up to 92% of customers for the eight-year period**. According to the researchers, this dataset will prove to be a vital tool in several ways, including assessing the consequences of extreme weather on electricity infrastructure and the power grid and in identifying vulnerability points. This information could also be used to quantify differences in grid resilience and explore changes in resilience over time, as well as to monitor changes by season. The researchers collected data from local utility providers with the help of a geographic information system and data visualization platform called Environment for Analysis of Geo-Located Energy Information, or EAGLE-I. EAGLE-I allowed them to record and organize reports of outages from 3,044 of 3,226 U.S. counties and other localities. "The ultimate goal of EAGLE-I is to provide comprehensive situational awareness about incidents impacting or potentially impacting the energy sector, including being the authoritative source for information about power outages," said Sarah Tennille, data engineer in ORNL's Computational Sciences and Engineering Division. "The release of this dataset as open-source, and subsequent annual data updates, is expected to facilitate advances in research of electric grid resilience and to support better understanding in areas such as energy justice and climate change impacts," added Aaron Myers, principal investigator of EAGLE-I and group leader of the lab's Geoinformatics Engineering group.

Growing energy and power demand in the United States means will quintuple demand on the energy grid in the United States

McLaughlin 25 [McLaughlin, Tim. Kearney, Laila. 01-24-2025, "Trump's high-wire act to transform US power grid won't be easy," Reuters, https://www.reuters.com/business/energy/trumps-high-wire-act-transform-us-power-grid-wont-be-easy-2025-01-24/]

The **grid's capacity of long-distance transmission lines would need to quintuple over the next decade to handle that big surge in power demand** outlined in the U.S. Energy Department's latest state of the grid report. "The clear message from (Trump) is that it's time to really put a heavier foot on the gas pedal and get things moving," said Larry Gasteiger, executive director of WIRES, a trade association for transmission line companies. Making that happen would be good news not just for fossil fuel-fired power, but also for hundreds of renewable energy projects - like solar and wind farms - that have struggled for access to the grid. Christina Hayes, executive director of Americans for a Clean Energy Grid, said one of the most promising parts of Trump's executive order, titled Unleashing American Energy, is a directive to develop recommendations for Congress for interstate energy infrastructure. She said that "could potentially lead to meaningful reforms in siting and permitting procedures." "Western states are likely to see the most immediate impact from these changes, given the concentration of federal lands in the region," Hayes said. Catie Hausman, a University of Michigan economics professor, has studied how some public utilities have blocked transmission buildout for renewables to protect the economic viability of their incumbent gas and coal power plants. She does not expect Trump's executive actions to make those turf battles disappear. "There have been so many impediments to building long-distance transmission lines," Hausman said. "It's hard to even know where to start."

AT Natural Gas Solves

The U.S.'s reliance on natural gas contributes to more blackouts

Kimani 25 [Alex Kimani, 2-20-2025, "Blackouts Are Becoming the Norm—Can the U.S. Power Grid Be Saved?", OilPrice, https://oilprice.com/Energy/Energy-General/Blackouts-Are-Becoming-the-NormCan-the-US-Power-Grid-Be-Saved.html]

Over the past two decades, the shale revolution unlocked a deluge of cheap natural gas, and made it easier for the country to transition from coal-fired generation to natural gas plants. Indeed, natural gas is widely touted as the 'bridge fuel' as the world gradually moves away from coal as the primary fuel used to generate electricity to renewables thanks to natural gas having a much cleaner emissions profile than coal. **Gas now makes up ~41% of U.S. power generation, more than double its share in Europe's energy mix at 19.6%.** The harsh reality is that natural gas plants, even relatively modern ones, are proving to have the worst failure rate when faced with extreme weather compared with other generation methods. During the massive Arctic Blast, **gas units accounted for 63% of the failures while representing just 44% of the total installed capacity.** The country's vast network of gas plants and pipelines--the largest in the world--and the regulations that govern them simply were never designed or built without the realities of extreme weather in mind. **Gas facilities aren't uniformly winterized, with many relying on single gas pipelines for supply.** Meanwhile, many generators lack the ability to burn an alternate fuel or keep back-up gas on hand in case of emergencies.

AT Nuclear power doesn't solve grid stability

1. **Nuclear power plants is key to grid stability – 24 hour power supply will be necessary as more renewables come onboard**

Birol 19 [Birol, Faith. May 2019, "Nuclear Power in a Clean Energy System," Executive Director International Energy Agency, https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system]

Nuclear power plants contribute to electricity security in multiple ways. Nuclear plants help to keep power grids stable. To a certain extent, they can adjust their operations to follow demand and supply shifts**. As the share of variable renewables like wind and solar photovoltaics (PV) rises, the need for such services will increase. Nuclear plants can help to limit the impacts from seasonal fluctuations in output from renewables and bolster energy security by reducing dependence on imported fuels**. Lifetime extensions of nuclear power plants are crucial to getting the energy transition back on track Policy and regulatory decisions remain critical to the fate of ageing reactors in advanced economies. The average age of their nuclear fleets is 35 years. The European Union and the United States have the largest active nuclear fleets (over 100 gigawatts each), and they are also among the oldest: the average reactor is 35 years old in the European Union and 39 years old in the United States. The original design lifetime for operations was 40 years in most cases**.** Around one quarter of the current nuclear capacity in advanced economies is set to be shut down by 2025 – mainly because of policies to reduce nuclear's role. The fate of the remaining capacity depends on decisions about lifetime extensions in the coming years. In the United States, for example, some 90 reactors have 60-year operating licenses, yet several have already been retired early and many more are at risk. In Europe, Japan and other advanced economies, extensions of plants' lifetimes also face uncertain prospects.

2. **Investment in nuclear energy is needed to secure the sustainability of the grid moving forward**

Birol 19 [Birol, Faith. May 2019, "Nuclear Power in a Clean Energy System," Executive Director International Energy Agency, https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system]

Countries that have kept the option of using nuclear power need to reform their policies to ensure competition on a level playing field. They also need to address barriers to investment in lifetime extensions and new capacity. The focus should be on designing electricity markets in a way that values the clean energy and energy security attributes of low-carbon technologies, including nuclear power. **Securing investment in new nuclear plants would require more intrusive policy intervention given the very high cost of projects and unfavourable recent experiences in some countries**. Investment policies need to overcome financing barriers through a combination of long-term contracts, price guarantees and direct state investment. **Interest is rising in advanced nuclear technologies that suit private investment such as** small modular reactors (**SMRs**). **This technology is still at the development stage**. There is a case for **governments to promote it through funding for research and development**, public-private partnerships for venture capital and early deployment grants. Standardisation of reactor designs would be crucial to benefit from economies of scale in the manufacturing of SMRs. Continued activity in the operation and development of nuclear technology is required to maintain skills and expertise. The relatively slow pace of nuclear deployment in advanced economies in recent years means there is a risk of losing human capital and technical know-how. **Maintaining human skills and industrial expertise should be a priority for countries that aim to continue relying on nuclear power**.

3. **Nuclear energy is necessary for grid stability**

Boudot et al 22 [Charly Boudot1,2*, Jean-Baptiste Droin1, Pierre Sciora1, Yvon Besanger2, Bruno Robisson3 and Anne-Laure Mazauric1,2, 8-25-2022, "Small Modular Reactor-based solutions to enhance grid reliability: impact of modularization of large power plants on frequency stability", No Publication, https://www.epj-n.org/articles/epjn/full_html/2022/01/epjn210026/epjn210026.html]

In the current renewable energies' expansion framework, the increasing part of intermittent electricity production sources (solar or wind farms) in the energy mix and the reducing part of thermal power stations that are nowadays useful to ensure grid stability will lead to a complete paradigm shift concerning the means to ensure grid stability. **Nuclear energy, which is carbon-free and dispatchable, may be a sustainable solution to this grid reliability issue** if it is adequately designed and implemented on the grid**. Several solutions aiming at improving the future nuclear power flexibility are** currently under investigation in the literature, among them are those based on Small Modular Reactor (**SMR) plants.** In order to demonstrate their potential ability to stabilize electric grids, it is necessary to perform electrical dynamic simulations taking into account a spatial and temporal discretization of the grid. In this paper, such calculations are performed using the PowerFactory software. This tool can reproduce electrical grids thanks to models of turbo generators, lines, transformers, loads, I&C systems, etc. The objective is to assess to what extent the innovative SMR features may enhance the frequency control of a grid. For this purpose, a short-circuit event and three frequency stability criteria are firstly defined. Then, a verification of the correct behaviour of the IEEE 39-bus (or New England) grid with regulations is carried out. The relevance of implementing Small Modular Reactors (SMR) instead of large power plants on such frequency stability criteria on this grid is finally assessed, in order to conclude in a preliminary way the possible contribution of small reactors to the future grid's sustainability.

4. Grid reliability key to every aspect of the military -- BMD, command and control, forward operating missions, and humanitarian operations

Keys et al. 15 (Rob, Former Commander of Air Combat Command, writing with the CNA Military Advisory Board, "National Security and Assured U.S. Electrical Power", https://www.cna.org/CNA_files/PDF/National-Security-Assured-Electrical-Power.pdf)

As highlighted in our report, Powering America's Defense, military installations across the country rely heavily on the same grid as our communities, towns, and cities. The Department of Defense (DOD) requires a reliable and secure power supply for a multitude of critical systems that **must be online every hour, every day, year-round**. For example, **our land-based Ballistic Missile Defense systems are critical to protecting our homeland 24/7**. At the same time, **numerous command-andcontrol headquarters provide support to forward bases.** These installations receive and analyze threat data, provide **direction and support to forwardoperating forces**, and **stand ready to respond to threats or other calls to action from the United States or from our allies**. Increasingly, remotely piloted vehicles and other direct support for remote battlefield operations are controlled from military bases here in the United States. Despite the military's redundant systems for critical operations and logistics, a prolonged **widespread electrical outage would impact numerous domestic installations**, **placing at risk domestic military operations and those in-theater conducing combat, humanitarian, and other operations**. Although most military installations have backup power generation capabilities, these generators rely predominately on fossil fuel–based generators (i.e., diesel, propane, JP-8). To date, the Defense Department has always been able to procure and transport the fuel it needs to domestic and overseas installations. However, under the scenario of a prolonged large-scale electrical power outage, if the commercial transportation sector comes to a standstill—**as it likely will**—there is the risk that the supplies needed to keep the military's domestic backup power equipment running may not be available. The Defense Science Board noted that **"the military's backup power is inadequately sized** for its missions and military **bases cannot easily store sufficient fuel supplies** to cope with a lengthy or widespread outage" [18]. Even accessing the U.S. Strategic Petroleum Reserve may be problematic if U.S. refineries do not have the needed electrical power to operate. Military installations are not the only concern. Most of the active-duty military, civilian, and contract personnel supporting military operations live in communities surrounding the installations. In the event of a widespread power outage, critical personnel may not be able to report to work because they have transportation problems or because they may be addressing emergency situations with their own families and neighbors. **Mission effectiveness can be**

maintained only when the personnel who perform vital mission functions are able to report to work and operate productively without distraction. The installations where these people work may have backup power, fresh water, medical services—and they will be able to operate temporarily during a grid failure—yet they do not have the capacity to serve as safe havens for surrounding communities while maintaining mission effectiveness, nor to unburden operators worried about their families at risk.

Readiness is key responding to sudden conflicts in multiple hotspots

Dunn 13, Richard, private consultant on international security affairs, retired army colonel, "The Impact of a Declining Defense Budget on Combat Readiness," Heritage Foundation, http://www.heritage.org/research/reports/2013/07/the-impact-of-a-declining-defense-budget-on-combat-readiness

Combat readiness is defined as "[t]he ability of US military forces to fight and meet the demands of the national military strategy."[1] This is **the most important factor to our war fighters**, but as basic as it is to them, it remains a complicated subject for others to understand. Due to its multidimensional and somewhat diffuse nature, it also has few natural supporters. For a state that builds ships, it is easy to support a policy that increases the number of ships in the Navy, but it is difficult to construct a constituency to support the complex issue of military readiness. Therefore, readiness may suffer significant harm in the increasingly fierce competition for resources. To fight effectively, the armed forces must be manned, equipped, and trained to operate under dangerous, complex, uncertain, and austere conditions—often with little warning. They require the right personnel operating the right equipment with the right training to win. Readiness is like a three-legged stool. The personnel, equipment, and training "legs" need to be balanced and in sync to support the load. The most modern equipment is useless without highly trained personnel to operate and employ it. Conversely, outmoded or unreliable equipment can hamper the effectiveness of the most highly motivated and skilled personnel. To fight effectively, personnel must train with their combat equipment, practicing their combat missions under realistic, demanding conditions. Quality personnel, equipment, and training are the essential dimensions of combat readiness. Failure to maintain an appropriate balance among these dimensions during the current period of budgetary uncertainty will significantly degrade America's ability **to respond to threats to its interests**. This can lead to **major strategic setbacks** and significant loss of life. The challenging balancing act requires wise and effective leadership across all defense-related institutions. History repeatedly shows that unanticipated events often catch us by surprise and that as a nation, we have paid a **high price** in blood and treasure to compensate for our lack of preparedness. Lower levels of defense resourcing have not been the sole cause of unpreparedness. In many cases, there is an inability to answer the fundamental question of "what are we preparing to do?" Absent an effective answer that guides the allocation of resources, we can end up with forces that are inadequately manned, equipped, or trained to meet a comprehensive range of threats, some of them unanticipated. Answering the "what, when, and where" question is particularly challenging and complicated in the current era of strategic uncertainty. The world is still a violent and dangerous place, and major existential threats remain vague and unfocused. In the Pacific, U.S. relationships with **emerging powers** and the **future threats** they may pose remain **unclear**. In the Middle East, the political instability that accompanied the Arab Spring may vastly alter the **geopolitical landscape** established in the 1920s, creating opportunities for a wide spectrum of Islamist parties to advance their undemocratic agendas. Terrorism by non-state actors like al-Qaeda continues to metastasize. At the same time, warfare is expanding into the **economically vital** cyberspace domain, and revolutionary developments in unmanned systems may be changing **the very nature of conflict.** Rapid reductions in the defense budget are leading to the restructuring or elimination of many programs. This will damage the ability to deter and, if necessary, defeat threats to vital U.S. national interests. Maintaining a military posture capable of achieving these aims requires both sufficient forces of various types and the readiness of those forces for combat. History's Painful Lessons All of these developments have the potential to harm U.S. interests significantly. Although we know that the future may hold significant dangers, they remain ill defined, creating a challenging analytical problem for national security policymakers. History can provide useful insights into how to approach strategic uncertainty. We know we cannot "get it entirely right." Therefore, we should strive not to get it so far wrong that we suffer unacceptable consequences when hit by unexpected threats. Under conditions of uncertainty, a hedging strategy that provides a range of options makes the most sense. Historically, maintaining effective balance among the different dimensions of readiness and having some ready capability to deal with a wide range of potential threats have been an effective way to hedge strategic bets. In times of defense budgetary retrenchment, combat readiness of the armed forces often becomes one of the first casualties of fiscal tightening. This was particularly true of the years between World War I and World War II, when the Great Depression and isolationism made military preparedness a very low national priority. Despite the threatening war clouds rapidly expanding in Asia and Europe, the U.S. was woefully unprepared for global conflict. The shock of Pearl Harbor mobilized both the industrial capability and the moral determination to overcome the early, disastrous reversals in the Pacific and tactical defeats in North Africa. Once focused on military production, the U.S. economy rapidly produced overwhelming quantities of ships, aircraft, tanks, ammunition, and other matériel needed for America to become the "Arsenal of Democracy." However, U.S. forces quickly learned that training for combat, particularly in developing military leaders, was just as complex and demanding. It took several years of internalizing battlefield lessons learned at high cost to train the leaders at all levels that brought the war to a victorious conclusion. After the war, "no more Pearl Harbors"[2] became the rallying cry of the supporters of a strong national defense. Regrettably, the record of U.S. military preparedness following World War II has been rather checkered. Since then, the U.S. has had less than a year (often much less) to prepare for any of its major conflicts. One of the earliest shocks hit in June 1950 when Soviet-supported North Korea invaded South Korea. After the Berlin Blockade in 1949, U.S. forces were focused on the Soviet threat to Europe. Less than five years after the defeat of Germany and Japan, they were ill prepared for more limited wars in areas of less than strategic interest. When the U.S. recognized that land forces would be required to stem the rout of the South Korean military, a hastily assembled force from an Army division on occupation duty in Japan was quickly committed to block the advancing North Korean army. Named after its commander, Task Force Smith was poorly equipped with World War II–era weapons and had no opportunity to train as a unit. In the opening battle between U.S. and North Korean forces, it was rapidly overrun and suffered disastrous losses.[3] Decades later, "no more Task Force Smiths" was still an object lesson in preparedness for U.S. Army leaders.[4] After ending the war in Korea, and concerned with the economic costs of maintaining a large standing army, President Dwight D. Eisenhower relied on strategic air forces to deter Soviet aggression with the threat of massive nuclear retaliation.[5] The subsequent reduction in ground forces contributed to the difficulty the U.S. faced in dealing with the "wars of national liberation" that cropped up in the early 1960s, most significantly in Southeast Asia. Committed to combat in Vietnam, the U.S. Army rapidly increased in size. This rapid expansion strained the Army's ability to induct and train new soldiers and junior officers. The conflict also strained the intellectual adaptability of the Army's senior leaders, most of whom had their formative combat experiences in the firepower-intensive, large-unit operations prevalent during World War II and the Korean War. Ultimately, this meant that leaders were slow in adapting to the different counterinsurgency requirements of

Vietnam. U.S. forces adapted relatively quickly to the realities of the post-Vietnam situation and refocused on the massive Soviet conventional threat to Europe, where combat readiness had suffered significantly during Vietnam. New equipment and doctrine prepared the new all-volunteer force to fight and win while outnumbered. Most notably, Army and Air Force leaders recognized the high value of synergistic air–land operations and developed the appropriate war fighting concepts and organizations.[6] The apparent requirement for large conventional forces evaporated when the Berlin Wall came down in 1989, and planning was put in place for significant reductions. However, Saddam Hussein's unexpected invasion of Kuwait in 1990 put that on hold. Saddam's decision not to press forward to seize Saudi Arabia gave the U.S. and its allies sufficient time to redeploy forces from Europe and elsewhere. During Operation Desert Storm in 1991, U.S. air and ground units that were trained, organized, and equipped to fight the Soviets proved devastatingly effective against Iraqi forces armed with Soviet equipment.[7] This again proved to be the case in 2003 when U.S. air and ground forces swept into Iraq, seized Baghdad, and toppled Saddam Hussein's government. However, when the U.S. occupation proved longer and more complicated than first thought, the U.S. Army was again slow in adapting to the changing nature of the conflict after having worked hard to put its Vietnam counterinsurgency experiences in its past. While history never exactly repeats itself, we can draw several useful insights from the historical record. First, our ability to predict rapidly emerging threats is imperfect at best. Even in cases in which employment of force was optional, such as the 2003 invasion of Iraq, we have had well less than a year to prepare. Thus, dependence on having sufficient time to bring forces back up to the desired level of readiness before employing them can be a recipe for disaster. As a corollary to this point, readiness can degrade **very quickly**, so maintaining it requires **continuous attention**. Readiness is also somewhat specific to each scenario. Forces prepared for one type of conflict may not be as capable in another. Additionally, leaders trained to operate in one type of conflict may not have the mental agility to perform well in another. The Complexity of Military Operations Understanding the personnel, equipment, and training dimensions of combat readiness requires some understanding of the operations that military organizations perform. Combat operations of almost any scale are exceptionally complex, requiring integration and synchronization of myriad activities ranging from individual actions to coordinated movements by large, geographically dispersed organizations. They are usually executed under dangerous, uncertain, austere, and urgent conditions that compound the challenge. At the basic level of combat operations, individuals and crews must operate their equipment, ranging from individual weapons to combat vehicles, aircraft, and ships. This involves operating all of the systems for communications, situational awareness, etc. Then they must employ their equipment as part of larger unit teams, executing their part in tactical operations. Each smaller unit is part of an even larger team that incorporates many different functions ranging from fire support to intelligence, surveillance, and reconnaissance to logistical and medical support. As required, these can be combined into joint task forces that include all of these functions in land, sea, air, space, and even cyberspace dimensions. All of these organizations, from the smallest units to joint task forces, must be tied together by command, control, and communications networks that provide them with awareness of the friendly and enemy situations and orchestrate their individual activities to achieve the commander's intended objectives. At the same time, they all require support, including transportation, refueling, rearming with ammunition, maintenance, and medical evacuation and care. Joint forces are composed of interdependent "teams" at many different levels that are only as strong as their weakest members. For example, the Army may have great airborne paratrooper units, but they are ineffective unless Air Force transport aircraft can deliver them to the right drop zone. These transports, in turn, may require tanker aircraft to refuel them in flight to reach the drop zone. Therefore, the readiness of a joint force to conduct major combat operations is determined by the readiness of its individual components, in turn a function of their manning, equipping, training, and leadership and the balance among these dimensions. Because of their complexity, combat operations are often vulnerable to single points of failure. The loss to enemy action or equipment failure of a key communications node, radar, or other "low density" but essential capability at a critical point can put an entire operation at risk.[8] The Dimensions of Readiness The readiness of military organizations to execute these complex operations is a function of the personnel, equipment, and training dimensions of combat readiness and an appropriate balance among them. Regardless of service, combat organizations are designed to accomplish a specific range of tasks. For this purpose, they are allocated specific numbers of personnel of appropriate ranks, skills, and skill levels to man and maintain the various types and numbers of equipment that they are authorized to have to accomplish those tasks. They also receive annual budgets to provide the resources (e.g., fuel, ammunition, and replacement parts) to train with their equipment. Personnel. High-quality, well-trained, and motivated personnel in the necessary numbers and ranks are essential to combat readiness. In the U.S. all-volunteer force, the first task is to recruit sufficient numbers of citizens with the required motivation and physical and mental capabilities to perform complex tasks under austere and often dangerous conditions. Here, the services compete with other opportunities afforded by the civilian economy. The challenge, then, is to provide appropriate incentives to make military careers attractive. While patriotism should never be underestimated as a motive for service, the armed forces have found it necessary to provide salaries, educational opportunities, quality of life, retirement benefits, and health care to attract and retain the required numbers of quality recruits. The recent economic recession has reduced civilian opportunities, and the reductions in force size have reduced the number of recruits required to sustain personnel numbers and quality. However, if the economy recovers and generates more civilian opportunities, recruiting and retaining quality personnel may become increasingly more difficult. Once recruited, service personnel must be taught the individual skills unique to their military missions. Teaching all of these required skill sets is a task of immense scale and scope, ranging from teaching rifle proficiency to Army privates to training naval aviators to operate high-performance aircraft from aircraft carrier flight decks. This requires relatively large training organizations staffed with the highest quality instructors, facilities, and equipment. Moreover, personnel require individual training throughout their careers. Initially, junior officers must be taught basic tactics and leadership skills. As they become more senior and assume higher-level responsibilities, they must learn advanced skills ranging from organizational management techniques to national-level strategy. Enlisted personnel must also progress to become effective and mature leaders and managers at higher and higher levels. As military operations and their enabling technologies become increasingly sophisticated and complex, the training required to master them demands even more time and resources. Thus, it is more effective and efficient to retain trained personnel by motivating them to remain in the service than it is to recruit and train replacements. Recruiting and training activities are both resource and time intensive, and limited assets are available to perform them. This reinforces the requirement to make continued military careers attractive by providing adequate salaries and benefits, especially for more mature personnel with families. Leadership is the catalyst for the personnel dimension of combat readiness. It depends on native ability honed by training and experience. Leadership is an irreplaceable force multiplier. It often spells the difference between disaster and victory under the most trying of circumstances. Thus, the selection, development, and retention of the best leaders, especially those with combat experience, should be a top priority. Napoleon said, "The moral is to the physical as three to one." This remains as absolutely true today as when he said it. Although intangible, morale is essential to readiness. It is very much a function of leadership, training, and the overall condition of the force. Poorly led and trained personnel trying to operate unreliable equipment and living in substandard conditions will most likely have low morale and not be very combat effective. Equipment. Based on their missions, military organizations are authorized to have specific quantities of particular types of equipment. For example, armor battalions in the Army are authorized to have a certain number of tanks and the necessary support equipment, such as refueling and maintenance vehicles. Air Force fighter squadrons are authorized to have a certain number of fighter aircraft of specific models and associated ground support equipment. Equipment readiness depends on two factors: the number and types of equipment in organizations and the operational status of that equipment. Service regulations authorize organizations to have specific numbers of specific models of equipment. However, the equipment they actually have (their "equipment fill") depends upon inventories of existing equipment and the procurement of new, usually more modern equipment to replace equipment that wears out, is destroyed, or becomes obsolete. As procurement accounts decline, procurement of new equipment can be delayed, affecting readiness in two ways. First, older generations of equipment are less effective than the newer generations. Second, delayed modernization means using older existing equipment, which is less reliable and more difficult and expensive to maintain. This tends to lower the operational status of equipment fleets. Maintenance and repair of equipment are essential to combat readiness. They are also tremendously time and resource intensive, requiring large numbers of highly skilled personnel, technically sophisticated tools, and a steady, reliable supply of replacement parts. The scope of maintenance and repair ranges from the daily checks and services performed by operators and crews to repairs by unit maintenance personnel to detailed refurbishing done by depots, shipyards, and commercial corporations. As available funding declines, equipment maintenance and repair can be one of the first bill payers. As such, it is often an early indicator of collapsing combat readiness. For example, reduced funding for repair parts can lead to a vicious downward spiral in equipment operational readiness rates. Without replacement parts, units are tempted to cannibalize parts from equipment that is already non-operational. Removing parts to keep other equipment operating or flying not only places additional demands on maintenance manpower, but also creates "hangar queens" missing so many parts that they become very expensive to repair. Because most military equipment is designed for a long service life, it usually is scheduled for

depot, shipyard, or commercial refurbishment several times during its "career." This is essential for corrosion control in aircraft and ships and replacement of major sub-assemblies, such as suspensions in ground vehicles. It is also economically smart because it can significantly extend the useful service life of the equipment. As budgets tighten, such maintenance may be deferred, creating large backlogs and leaving organizations with less reliable equipment that is prone to breakdown. Training. Advocates for demanding, realistic training often quote Field Marshall Erwin Rommel, who said, "The best form of welfare for the troops is first-class training, for this saves unnecessary casualties."[9] How well military organizations are trained for the full range of their assigned missions is a major determinant of success in combat. One reason that the U.S. armed forces have been world-class is that they trained more and better than any other nation's military. Institutions such as the Army's National Training Center, the Navy's Top Gun program, and the Air Force's Red Flag have set exceptionally high standards for realistic, demanding training that incorporates almost all of the functions and conditions of actual combat. Major large-scale joint exercises that include elements of all of the services and combined exercises with U.S. allies develop and refresh the critical abilities to deploy and sustain forces and train forces to operate together effectively. Realistic, demanding training is a tremendous confidence builder. It not only gives personnel confidence in their own units' capabilities, but also builds confidence in joint and combined teams. It is also a powerful leader development tool. Absent actual combat, intense training teaches invaluable lessons to junior leaders and gives their superiors unique opportunities to observe their ability to lead under highly stressful conditions. Training is also very time and resource intensive, a major consumer of operations and maintenance funding. Although simulators have advanced significantly, there is no substitute for operating actual equipment, and that can be very expensive. It consumes large amounts of fuel, and the resulting wear and tear significantly increase the requirement for repair parts. Training ammunition can be expensive as well. The service headquarters provide their operating organizations with annual budgets authorizing them to operate their equipment for a fixed amount of miles for ground equipment, flying hours for aircraft, and at-sea time for ships. Operating organizations are then responsible for planning and executing the training necessary to achieve proficiency in their assigned missions within these budgetary constraints. Time. Time is a major factor in all of the different dimensions of readiness. Recruiting and training personnel, acquiring and maintaining equipment, and training organizations from small units to joint task forces all require time. Therefore, the readiness status that an organization maintains should be determined by when its capabilities might be required. Organizations providing strategic **deterrence and defense**, immediate response **to terrorist threats and attacks**, and other capabilities that may be required on a moment's notice obviously need to maintain high levels of personnel and **equipment fill and training**. The same is true of units that are forward deployed in **crisis areas**, such as **Korea** or **the Persian Gulf**. Units whose capabilities are not as time sensitive and do not need to be deployed immediately can be kept at lower states of readiness, depending on the time available to bring them up to full readiness before they are needed. This is a key factor in determining which missions should be assigned to active-duty forces and which can be assigned to Reserve components. During peacetime, Reserve forces have less time available to train; therefore, they usually require additional time to train during mobilization. The biggest challenge lies in knowing how much time might be available to raise readiness to required levels before employing a force. Here, the historical record suggests erring on the side of caution. When we have unexpectedly found it necessary to employ force in defense of vital national interests, we have had to use the forces available regardless of their readiness. Why Readiness May Be at Risk As noted earlier, the dimensions of readiness are like the legs of a three-legged stool that must be in balance to be effective. However, the way that we manage the resourcing for each dimension can make it difficult to maintain this balance. This is compounded by the unpredictable length of time that might be available to increase readiness in a crisis. Personnel, procurement, and operations and maintenance accounts are managed separately, making it difficult to assess how reductions in funding for one dimension may affect overall readiness. Additionally, the managerial and political natures of some aspects of readiness make them easier to reduce than others. For example, equipment replacement and modernization is largely governed by the procurement accounts. In many cases, these buy large, major pieces of equipment, such as tanks and fighter aircraft. Expensive as these are, they become increasingly more expensive to produce if production rates are reduced below a certain economic optimum. This is particularly true in shipbuilding, in which it is impossible to buy a fraction of a ship. Additionally, manufacturing large equipment often involves interrelated chains of defense-specific industrial activities geographically spread around the country and employing relatively large numbers of highly skilled people in well-paying jobs. This can create large congressional constituencies who strongly support those programs. Operations and maintenance accounts are much easier to adjust downward. It is possible to reduce expenditures for training incrementally by decreasing the amount of fuel or repair parts purchased. Moreover, these expenditures are widely distributed around the country and do not create the strong constituencies that support procurement. The same thing is true of the individual training base where much instruction is provided under contract. It is even more difficult to understand the impact of reductions in personnel accounts. The challenge of sustaining the all-volunteer force through a decade of continuous conflict and deployment has significantly increased the per-person cost of personnel, not only in terms of salaries, but also in health care and retirement benefits. These benefits also have powerful constituencies in the widespread and vocal military retiree communities. Maintaining balance across the dimensions of readiness requires significant personnel reductions, but politically, these are increasingly difficult to achieve. The challenge, then, is to understand the relationships and interdependencies among the personnel, equipment, and training dimensions of readiness. Readiness clearly has **tipping points** unique to each organization, but they are **difficult to predict**. At what point does the lack of funds for training and maintenance so discourage promising junior leaders that they leave the service? Do salaries and benefits counterbalance this? What is the minimal amount of training required to sustain proficiency at mission-essential tasks at a sufficient level to avoid putting a unit in jeopardy in a crisis? These are difficult questions. Quantitative readiness reporting and analysis can help to a degree, but some answers lie only in well-reasoned professional judgment. What the U.S. Should Do The U.S. has experienced significant downturns in defense spending many times. In almost every case, we have pledged to avoid repeating past mistakes that compromised the readiness of our armed forces. Our record in honoring those pledges is imperfect. During World War II, the Korean War, the Vietnam War, and the Cold War, the size of U.S. armed forces increased significantly to meet the demands of those conflicts. Once those conflicts were resolved, the size of the armed forces and associated defense budgets declined to meet the perceived lower level of threats. Our approach to the conflicts in Afghanistan and Iraq following the September 2001 terrorist attacks was different. While defense spending increased significantly, the size of our ground forces increased only modestly, with few changes in air and maritime forces. Most of the increased spending was in overseas contingency operations funds to pay for the operations in Afghanistan and Iraq. These funds represented a significant percentage of the overall funding available to the services over the past decade, and their drying up has compounded the challenge that the services now face in meeting the requirements of the Budget Control Act. Attempting to manage this amount of budgetary change over a compressed time frame makes it difficult to maintain effective balance among the different dimensions of readiness. The exemption of some personnel accounts from sequestration has exacerbated this problem. Regrettably, world events and potential threats to U.S. strategic national interests are not driven by the same forces that drive the political and budgetary gridlock in Washington. North Korea's increasingly bellicose rhetoric and actions endanger **regional stability** in the economically vital Western Pacific. The maelstrom of conflict in Syria threatens to **engulf its neighbors** as Iran continues to pursue a **destabilizing nuclear capability** in the Middle East. The one-word descriptor for our strategic situation is "uncertain."

Nuclear's key to stability. Fluctuations are worse for their DA.

Mark J. **Perry 14** – Perry is a professor of economics at the Flint campus of the University of Michigan and a resident scholar at the American Enterprise Institute., (Mark J. Perry, 1-16-2014, "To balance

energy demand, we need nuclear power," AEI, accessed 8-16-2016, https://www.aei.org/publication/to-balance-energy-demand-we-need-nuclear-power/)

Should America's new growing dependence on natural gas for electricity production be a cause for concern? Despite America's abundance of natural gas from shale production, some parts of the country have already had **warnings** that **over-dependence** on gas for electricity generation exposes consumers to **soaring prices for electricity**. The problem is the declining use of coal and **nuclear power,** the two sources of electricity that provide the **greatest price stability** and serve as a **hedge against wide fluctuations** in gas prices. For the power industry to become increasingly dependent on a fuel with a history of price volatility could be **problematic**. Take PJM, the regional grid operator that covers the mid-Atlantic and parts of the Midwest. When plunging temperatures in the recent cold snap drove up demand for gas, spot prices for electric power in New Jersey, Delaware and large parts of Pennsylvania skyrocketed to $1,500 per megawatt-hour, well above the typical price of $40 or $50. And in Texas, where natural gas accounts for more than 50% of electricity production, wholesale power prices recently topped $5,000 per megawatt-hour. Several other **major markets** are also vulnerable to price spikes. Today Florida relies on natural gas for 70% of its electricity supply, up from 18% in 2000, and its use of gas is likely to increase further with the shutdown of the Crystal River nuclear plant. New York's gas-fired generation has climbed from 29% of electricity supply in 2000 to 44% in 2012. Natural gas accounts for more than 50% of power production in New England and 61% in California. Nationally, since 1995, the United States has built 342,000 megawatts of gas-fired power capacity, approximately 75% of all capacity additions. But coal and nuclear power account for only 6% of the total. Looking forward, at least 50,000 megawatts of gas capacity is expected to be added by 2020. But less than 10,000 megawatts of new coal and nuclear capacity is expected to be added by 2020, a **negligible amount**, because approximately **100,000 megawatts** of generating capacity — much of it coal — will be **retired this decade**. Long-term **energy fundamentals** support continued **reliance on and expansion of nuclear power.** Nuclear plants supply large amounts of carbon-free energy around the clock, safely and reliably. Nuclear plants provide forward **price stability** and are not subject to the **volatility** of natural gas prices. And they contribute to the fuel and technology diversity that is the **bedrock of a resilient electric sector**. These are among the economic and environmental values of nuclear power, but they are values that the public does not recognize. There's something seriously wrong with the **markets** in which nuclear plants are operating – which **do not value base-load capacity** that's available when needed; which do not provide value for fuel diversity, and which do not recognize the clean air compliance value of a nuclear plant. We need to ensure a **mix of energy sources**, so that we are not overly reliant on a single fuel. The Energy Information Administration forecasts a 28% increase in demand for electricity through 2040. To accommodate that increase, the U.S. would need 339,000 megawatts of new capacity to meet rising demand and to replace generating capacity that is past its prime. That's about 15,000 megawatts annually every year between now and 2040. Will we just keep ramping up gas-fired capacity while nuclear slips away? Or will policymakers and political leaders address **defects in market structure** that threaten our nation's energy security? One option worth considering is for states and regional independent system operators to provide purchasing agreements so that new and existing nuclear-generating capacity has a better market structure. This would encourage long-term investments of the sort needed for nuclear projects. How so? A nuclear plant is an asset with a 60-year lifetime that is carbon-free and doesn't pollute the air. And, unlike solar and wind power, it **is always on**. For the better part of a half-century, America has benefitted from a balanced energy program that has included nuclear power. Today our energy system is the world's best, but that doesn't mean we can let up. In a nation rightfully concerned about economic and environmental health, natural gas is not the only answer. It is not a substitute for a **diverse mix** of clean energy sources, since natural gas plants account for 25% of greenhouse-gas emissions from electricity production. For clean base-load power, we will **need nuclear energy**. And that's why it's important to craft policies that open up private investment in new nuclear plants.

Electricity markets are producing volatility—balancing them for nuclear is key

Caplan, MZConsulting Inc president, 2016

(Milton, "It Is Broken Markets, Not Uneconomic Plants That Are Putting Nuclear Plants at Risk", 6-7, http://www.theenergycollective.com/mzconsulting/2380366/it-is-broken-markets-not-uneconomic-plants-that-are-putting-nuclear-plants-at-risk-2)

There are many explanations as to the cause of this "crisis". Gas prices are currently very low, renewables are subsidized and the costs of some of the smaller oldest single unit nuclear plants in the country have been rising as they age. While all of these points are true, they are not in and of themselves, the direct cause of the problem. **They are symptoms of deep structural issues in those parts of the country where electricity is bought and sold in so called open or deregulated markets**.(Note: Watts Bar is in a regulated market.) This was the topic of a recent DOE summit on how to "save" the nuclear fleet ("Summit on Improving the Economics of America's Nuclear Power Plants") to address the crisis and take steps to avoid the unnecessary closing of a significant number of plants. So here we are and once again, we fall into the trap of incorrectly defining the problem as costly inefficient nuclear plants. After all the US summit is on how to improve the economics of nuclear plants, **not how to fix poorly structured markets – the real problem**. (Note: In Europe there are similar issues driven by a high level of subsidized renewables rather than low gas prices. But the need to find a solution is the same. A European Commission official assured delegates at a recent nuclear financing conference held in Paris that the design of European wholesale electricity markets and the emissions trading system (EU ETS) will be improved to help – and no longer hinder – nuclear energy as a low-carbon source of electricity.) In the guise of providing the lowest cost to ratepayers, most markets are completely focused on the short term. There is little consideration of risk built into the pricing mechanisms, only what is the lowest cost to generate electricity right now. **This means that there is no value attributed to any of the other important operating attributes required for a reliable and secure electricity supply system such as fuel availability, maneuverability, flexibility and price volatility**. **On top of this, things like government environmental policies and subsidies further distort the markets to ensure that mandated renewables have a role in the system.** (Of course nuclear has not benefited from such support even though it is a low carbon option.) This may have all worked fine 25 years ago when markets were opened with the objective of creating efficiencies in the existing operating fleet –a time when many jurisdictions were in oversupply**. But when it comes to adding capacity or making other substantive changes to the system, electricity markets are not nimbl**e. While there may be a desire to respond to price signals in the short term, building new plant takes time. And one thing is for sure, **no one will build new plant of any kind without some confidence that they will generate sufficient revenue to operate for their projected lives and earn a return on their investme**nt. Or as stated in the OECD report Project Costs of Electricity, "The structure of the electricity generation mix, as well as the electricity demand pattern, is quite inelastic in the short term: existing power plants have long lifetimes and building new capacity and transmission infrastructure may require a considerable lead time as well as significant upfront investments. In other terms, electricity systems are locked in with their existing generation mix and infrastructure, and cannot quickly adapt them to changing market conditions." It is also important to understand that not all market participants are equal. In most markets gas is the price maker, not a price taker. So when gas prices are high, everybody else in the market makes money and when gas prices are low, everybody struggles. And yes, today gas prices are very very low. Yet gas operators are relatively indifferent as they are the risk free players in the market. Even in this enviable position, gas generators did not have sufficient incentive to build new plant, so many markets have responded with the development of capacity markets. These capacity payments then compensate gas plants for sitting idle – effectively removing the risk to gas generators of building new plants. So you may ask, what's the problem with that as long as we have low energy prices? If open markets are so efficient then we should expect that prices in these areas should be lower than in areas where regulated markets have remained. **Not so, says an April 2015 study by the American Public Power Association.** In fact, in 2014 prices in de-regulated markets were as much as 35% more than those in regulated states. (Note: this study has been done by an organization with an interest in the result and as such may contain bias.) So let's go back to electricity system structuring. When it comes to managing risk, we know risk is generally reduced through a diverse portfolio of alternatives. The more diverse, the more risk can be reduced. The current path will result in systems that are not diverse, but rather all gas, currently the most economic alternative. **If markets do not adapt to better accommodate risk management into their pricing strategies, we face a future of volatile energy prices, possible energy shortages as new plant construction lags market needs and increases rather than decreases in carbon emissions; all in the guise of more efficient markets**. Back to the decision in Illinois. As stated in the referenced article, not only are these two plants Exelon's best performers, they "support approximately 4,200 direct and indirect jobs and produce more than $1.2 billion in economic activity annually. **A state report found that closing the plants would increase wholesale energy costs for the**

region by $439 million to $645 million annually. The report also found that keeping the plants open would avoid $10 billion in economic damages associated with higher carbon emissions over 10 years." **We only need one major market disruption to remind us all of the importance of truly reliable baseload power at a stable and economic price and how that protects us from the risk of higher prices and lower security of supply. And today, there is only one low carbon highly reliable baseload option, nuclear power.** So while a short term fix to keep operating nuclear plants open is required and more urgent than ever, let's stop talking about how plants are uneconomic and work to properly improve market structures to build and maintain the strong, reliable, economic and low carbon systems needed to power our modern economies.

Nuclear power plants are designed to provide grid stability

Matjaz 24 [Žvar, Matjaž. 2024, "Nuclear energy and security of supply," Energy I, https://www.i-energy.info/supply/nuclear-energy-and-security-of-supply/]

As the share of variable renewable energy in the generation mix grows, giving rise to advanced grid solutions, nuclear power plants are increasingly faced with the flexible operation challenge. In some power systems, nuclear power plants are expected to provide additional ancillary services such as frequency control by adjusting their output to respond to variations in demand**. In France and Germany,** for example, **most nuclear power plants contribute substantially to the provision of ancillary services by operating flexibly and meeting peak load demand**. The existing 2nd generation nuclear reactors are technically capable of implementing flexible operation modes. Meanwhile, the design of 3rd generation nuclear reactors is even better suited to flexible load following and frequency control, allowing for very quick changes in output with ramp rates of 5% of full power per minute. For a 1000 MW power plant, this means as much as 50 MW per minute. This development makes nuclear power one of the sources that can deliver a relatively quick response in providing ancillary services.

Phase out causes blackouts and create vulnerability to nat gas spikes

McGovern, energy consultant, 2014

(James, "Opinion: Nuclear power plants are crucial part of stable power grid", 2-26, http://www.nj.com/opinion/index.ssf/2014/02/opinion_nuclear_power_plans_maintain_a_stable_power_grid.html)

Once taken for granted, the stability and dependability of the nation's power grid can no longer be assured. The situation in the mid-Atlantic region is especially worrisome. Measures are being taken to protect the electricity infrastructure from weather-related outages, cyber attacks and sniper attacks like the one at a power station in San Jose, Calif. **But nothing has been done to prevent a loss of reliable electric power that could result from prematurely shutting down large power plants — both coal and nuclear — that supply base-load power 24/7.** Regional transmission organizations and state public utility commissions need to recognize that the loss of a large number of nuclear power plants due to economic reasons is a real possibility. Recently, Peter Lyons, the U.S. Department of Energy's assistant secretary for nuclear energy, warned that 30 percent of the U.S. nuclear fleet of approximately 100 nuclear plants might be shut down. **Nuclear power supplies about one-fifth of the nation's electricity** and almost 52 percent of the power in New Jersey. A typical plant like Oyster Creek produces power approximately 90 percent of the time, in response to demand for electricity. By contrast, a coal plant supplies power on average 70 percent of the time and a combined-cycle natural gas plant, 60 percent. Solar and wind power – which are subject to variable weather conditions — can be counted on to produce electricity no more than 20 percent of the time. Although it's a safe

and reliable source of electricity, nuclear power in some parts of the country can't compete with cheap natural gas and subsidized renewable energy. This matters because nuclear power has attributes that are not being recognized in unregulated energy markets such as the one that exists in New Jersey, Maryland and Pennsylvania. **Nuclear power gets no credit for producing about 20 percent of our national supply of electricity with no resultant carbon dioxide (greenhouse gas) emissions. Nor does it get any credit for providing voltage support to the grid. And nuclear power provides a hedge against soaring natural gas prices.** Witness the volatility of gas prices this winter in New England and the mid-Atlantic. Spot prices for immediate delivery of natural gas reached $140 per million BTUs. Usually, gas sells for approximately $4 per million BTUs. **Unless you think gas prices will stay at $4 for the next 20 to 40 years, there is no rational economic reason for shutting down the Vermont Yankee nuclear power plant or the Kewaunee nuclear plant in Wisconsin**. Yet both plants are slated to be shut down by the end of this year. And Exelon, which owns the largest fleet of nuclear plants in the United States, has warned that it might need to shut down its Clinton and Quad Cities plants in Illinois due to economic reasons. If a reliable nuclear plant that delivers base-load electricity around the clock is taken out of commercial service, we have a problem – even more so when other sources of energy, such as coal, are stressed as well. Certainly, here in the mid-Atlantic region, we can't afford to lose the Three Mile Island and Oyster Creek nuclear plants, but that could happen unless the grid operator and state public utility commission take action to preserve a balanced mix of energy sources. Our region already relies on natural gas for a growing share of its electricity, but with households and industries requiring gas, supplies can become constrained. That might sound strange in an era of shale gas abundance. **But even with a lot of gas in the ground, there is heavy demand for it combined with a shortage of pipelines, processing facilities and other infrastructure that can cause price spikes,** as they did this winter in New England. Since the Energy Information Administration forecasts a need for 339,000 megawatts of new electric capacity by 2040 — and there is no telling how many nuclear plants could close before then – we should not underestimate the potential damage to our economic and environmental health, and damage to our electric grid, **if there isn't enough power from base-load plants to provide voltage support, helping to maintain grid stability.**

C2 Frontlines/Extensions

AT nuclear power not safe

1. **Turn. US Navy proves empirically – nuclear power can be deployed as an energy sourc without any significant safety events**

Pennella 23 [Patrick R. Pennella, 8-31-2023, "Nuclear Reactors Are a Clean Energy Solution for Civil Maritime", Bloomgberg Law, https://news.bloomberglaw.com/us-law-week/nuclear-reactors-are-a-clean-energy-solution-for-civil-maritime]

Although nuclear power has been used successfully to power US military vessels since the 1950s, use for civilian maritime purposes has never evolved beyond a few experimental designs. High initial capital costs and concerns about safety kept nuclear power for the civilian maritime fleet from reaching criticality. However, innovations in nuclear technology, combined with a push to decarbonize the civilian maritime industry, now offer the opportunity to revitalize the concept at commercially viable costs. The US **Navy has employed dozens of nuclear-powered warships without any significant reactor-related safety events**. The US, however, has built only a single nuclear-powered merchant ship—**the proof-of-concept N.S. Savannah. A hybrid cargo and passenger vessel, the Savannah operated successfully from 1959 through 1972** but its limited cargo and passenger capacity made continued operation uneconomical. **The intent behind the Savannah was merely to prove the concept. And it did**. Several other countries successfully operated experimental nuclear-powered civilian vessels but, as was the case in the US, widespread adoption never occurred.

AT Wouldn’t be developed

This is false. Nuclear reactors are already being developed and would be effective

Office of Nuclear Energy 23 [Energy.gov, 4-13-2023, "5 Things You Should Know About Nuclear and Maritime Shipping", https://www.energy.gov/ne/articles/5-things-you-should-know-about-nuclear-and-maritime-shipping]

According to the International Maritime Organization (IMO), **maritime shipping emits more than 1 billion tons of carbon dioxide emissions each year.** If treated as a country, **international shipping would be the sixth largest CO2 emitter in the world.** These emissions are largely caused by the diesel engines and low-grade bunker fuel used to power shipping vessels—leading to higher levels of air pollution in nearby ports and surroundings communities. Enter nuclear reactors. It's estimated that the **world’s largest 17,000 ships account for roughly 80% of global shipping emissions** **Replacing diesel engines in these vessels with nuclear propulsion** systems could significantly clean up maritime emissions and put the industry well on its way to achieving the IMO’s carbon reduction goals. 2. Nuclear-Powered Vessels Are Nothing New N.S. Savannah The N.S. Savannah entered service as an experimental ship and spent three years sailing to U.S. ports. MARAD | U.S. Department of Transportation The U.S. Navy, along with five of other military forces around the world, currently use nuclear-powered submarines and aircraft carriers. The United States, Germany, Japan, and Russia tried demonstrating commercial vessels in the 1950s but all of them proved to be too expensive to build and maintain. This included the first U.S. nuclear-powered merchant ship, the N.S. Savannah. It was built in 1959 under the Atoms for Peace program but was never optimized for long-haul cargo. Advanced reactor demonstrations are an exciting next chapter in the evolution of this technology. New startup companies, supported by private-public partnerships, are using modern technology such as new simulations, higher-resolution modeling, and advanced construction techniques to optimize advanced reactor designs to power shipping vessels. 3. Nuclear-Powered Ships Could Run for a Long Time Many container and tanker ships require up to 50 megawatt systems, which is enough energy to power around 50,000 homes. This requires a lot of bunker fuel and constant refueling that can lead to high operating costs. Nuclear reactors could allow these same ships to run longer and on less fuel. Existing nuclear-powered submarines and aircraft carriers use highly enriched uranium and light-water reactor systems to run for 30 years or more without refueling. New advanced designs cooled by molten salts, liquid metal, or gas could serve a similar function using a lower-enriched uranium fuel that could be used for commercial purposes. 4. Nuclear Power Could Be Used for Multiple Applications Maritime Shipyard Maritime shipyard design concept by NuScale Power and Prodigy Clean Energy. NuScale Power **Advanced nuclear reactors have the potential to be used onshore, offshore, and to power vessels**. Onshore applications could use **reactors at ports to produce electricity, heat, or hydrogen to make carbon-neutral synthetic fuels.** Offshore applications could include reactors for floating data centers, water desalination plants, or power stations similar to this design concept by NuScale Power and Prodigy Clean Energy. The floating small modular reactor would be fully built in a shipyard factory and exported to other countries for access to clean electricity and a heat supply. Reactors can also be used to power a variety of vessels ranging from container ships and passenger vessels to icebreakers like the ones currently in operation in Russia. 5. Research and Development are Underway DOE is supporting several industry and university projects to explore maritime shipping applications, including a project with the American Bureau of Shipping (ABS), who is collaborating with the National Reactor Innovation Center (NRIC) to research and demonstrate new reactor technologies for commercial shipping. University project teams are also working to model, design, and evaluate the use of advanced reactors in nuclear-powered ships and to explore the potential of floating reactors. But, while these research and development efforts are underway, several regulatory hurdles need to be addressed before nuclear power can be widely applied to the maritime industry. That’s why NRIC helped form the Maritime Nuclear Application Group to connect experts from the maritime and nuclear energy sectors to support demonstrations of advanced reactor technologies in the maritime sector. NRIC is a national DOE program led by Idaho National Laboratory that supports the development and demonstration of advanced reactor systems.

Emissions result in more deaths

Louis Bergeron explains the danger, because there is a

Louis Bergeron, 1-3-2008, "Study links carbon dioxide emissions to increased deaths," Stanford University, http://news.stanford.edu/news/2008/january9/co-010908.html

A Stanford scientist has spelled out for the first time the direct links between increased levels of carbon dioxide in the atmosphere and increases in human mortality, using a state-of-the-art computer model of the atmosphere that incorporates scores of physical and chemical environmental processes. The new findings, to be published in Geophysical Research Letters, come to light just after the Environmental Protection Agency's recent ruling against states setting specific emission standards for this greenhouse gas based in part on the lack of data showing the link between carbon dioxide emissions and their health effects. While it has long been known that carbon dioxide emissions contribute to climate change, the new study details how for each increase of 1 degree Celsius caused by carbon dioxide, the resulting air pollution would lead[s] annually to about a thousand additional deaths and many more cases of respiratory illness and asthma in the United States, according to the paper by Mark Jacobson, a professor of civil and environmental engineering at Stanford. Worldwide, upward of 20,000 air-pollution-related deaths per year per degree Celsius may be due to this greenhouse gas.

Applications of maritime nuclear energy (extension)

Nuclear technology in shipping and aviation is uniquely preferable – more reliable and could run for 30 years without refueling

Office of Nuclear Energy 23 [Energy.gov, 4-13-2023, "5 Things You Should Know About Nuclear and Maritime Shipping", https://www.energy.gov/ne/articles/5-things-you-should-know-about-nuclear-and-maritime-shipping]

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Emissions in shipping and aviation expected to grow

This is expected to grow by 2040

Black et al 24 [Simon Black,Ian W.H. Parry,Sunalika Singh,Nate Vernon-Lin, 10-3-2024, "Destination Net Zero: The Urgent Need for a Global Carbon Tax on Aviation and Shipping", IMF, https://www.imf.org/en/Publications/staff-climate-notes/Issues/2024/10/01/Destination-Net-Zero-The-Urgent-Need-for-a-Global-Carbon-Tax-on-Aviation-and-Shipping-555090]

The need to decarbonize international aviation and maritime has long been overlooked. The two sectors account for a small but rapidly growing share of global CO2 emissions, and could rise to as much as 15 to 40 percent by 2040. Pricing these emissions could help global climate policy in two ways. First, it could accelerate technological development while incentivizing efficiency, kick-starting the sectors' transition to net zero while addressing the sectors' hitherto favorable tax treatment. Second, pricing could raise up to $200 billion a year in revenues by 2035, which could be allocated to climate finance or other uses. There are significant political obstacles, however, notably reaching consensus on revenue allocation and managing price impacts, which are substantive for flight tickets but less so for shipped goods. Pricing variants, like 'fee and rebate' schemes (feebates), have lower price impacts but raise fewer revenues. This paper discusses these