# 1AC

## Contention One is Climate

### Climate change is existential – Every degree matters: warming is anthropogenic, fast, underestimated, and carbon alone triggers self-perpetuation AND acidification – its existential to humanity

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**Every degree** of warming up to 2°C will **add** at least 1.3 meters to sea levels from accelerated ice flow into the ocean and melting from the Antarctic Ice Sheet, while **warming** between 2°C and 6°C is predicted to add 2.4 meters per degree (Garbe, Albrecht, Levermann, Donges and Winkelmann, 2020).

While the IPCC Working Group III reports frequently refer to 'cost-effectiveness', the cost against which the effectiveness is being assessed never includes the cost that would arise from exceeding a climate tipping point.

It should also be noted that there are no credible technological solutions for many climate change impacts: for example, the Arctic and boreal permafrost contain 1460 to 1600 Gt of organic carbon, almost twice the carbon in the atmosphere (WMO, 2020), and if gigatonnes of methane are released from melting permafrost and warming oceans, the process cannot be reversed.

Fact 3.2: The deadly impacts and costs of increasingly acidifying oceans are also greatly underestimated.

When carbon dioxide combines with seawater it forms carbonic acid, which makes the **ocean** more **acidic**. Since around 1850, the oceans have absorbed between a third and a half of the $CO_2$ emitted to the atmosphere. As a result, the average pH of ocean surface waters has fallen from 8.2 to 8.1 units. This corresponds to a 30% increase in ocean acidity, a rate of change roughly 10 times faster than any time in the last 55 million years (CoastAdapt, 2017; Jiang et al., 2023).

If GHG emissions continue at the current rate (the RCP8.5 trajectory), by the end of the century average pH is projected to decrease by 0.3–0.4 units (~100%–150% increase in acidity) (Kwiatkowski et al., 2020). Increasing acidity will make it difficult for marine organisms such as corals, clams, mussels, crabs, and some plankton, to form calcium carbonate, the material used to build shells and skeletal material. The **survival** of many microscopic **marine species** will also be **threatened** (Bird, 2023). In addition, ocean acidification will disrupt pelagic **food webs** via the proliferation of toxic algal blooms (Doney et al., 2020). The increasing degradation of marine food chains will seriously damage fishing industries and tourism.

**Ocean** systems are **not** able to **adapt** to these **rapid** changes in **acidity**—a process that **naturally** occurs over **millennia**. Declining ocean pH levels will persist as long as concentrations of atmospheric $CO_2$ continue to rise. The stress on marine organisms will be exacerbated by rising temperatures and exposure to multiple biogeochemical changes. To avoid significant harm to critical marine ecosystems and the food security of **billions** of people, atmospheric concentrations of atmospheric **$CO_2$** must be rapidly **reduced** to at least 320-350 ppm or less (IUCN, 2017).

Fact 3.3: Virtually irreversible tipping points are already being passed. Acceleration of the rate of **climate** change is a real and **existential** risk.

Climate tipping points (CTPs) are irrevocable changes in the climate, such as the melting of ice sheets, or the dieback of rainforests. **These are points of no return**: once glaciers and ecosystems like coral reefs have disappeared, they cannot be restored. For example, warming oceans make the collapse of the West Antarctic Ice Sheet unavoidable (Naughten, Holland and De Rydt, 2023). Evidence is all around us that we are nearing or have already crossed CTPs associated with critical parts of the Earth system—we see catastrophic fires in rainforests, spreading deserts, degrading ecosystems, and shrinking sea ice (e.g., Walsh, 2016; Bochow and Boers, 2023; Kim et al., 2023).

Another example is rainfall in Greenland, which has increased by 33% since 1991, with flooding rain darkening and melting the ice sheet and baring rocks (Box et al., 2023). However, the accelerating rate of melt and the positive feedbacks of increasing rainfall and reducing albedo are not represented in IPCC models.

Armstrong McKay and colleagues (2022) identify six **tipping points** that **are likely to be crossed** within the Paris Agreement targets of 1.5°C - 2°C of warming. **These are:**

Greenland Ice Sheet collapse

West Antarctic Ice Sheet collapse

**Coral reef die off** at low latitudes

**Sudden thawing of permafrost** in northern regions

**Abrupt sea ice loss** in the Barents Sea

**Collapse of ocean circulation in the** high-latitude North **Atlantic**

They point out that crossing these climate tipping points can generate positive feedbacks that will increase the likelihood of crossing other CTPs. For example, Arctic permafrost may permanently thaw even if warming stays between 1.1 °C and 1.5°C. Above 1.5°C of warming, losing the permafrost becomes "likely," and we are currently on track for 2.7°C of warming in this century. If all the permafrost thawed, **emissions would be equivalent to 51 times all GHG emissions** in 2019.

Alarmingly, the ESCIMO climate model indicates that a self-sustaining process of permafrost thaw has already begun, which suggests that the world is already past a point-of-no-return for global warming. This cycle consists of decreasing surface albedo, increasing water vapour feedback and increasing thawing of the permafrost, which releases both methane and carbon dioxide, resulting in even further temperature rises, and so on. Even after no more man-made GHG are emitted, this cycle will continue on its own until all carbon is released from permafrost and all ice is melted (Randers and Goluke, 2020).

The likelihood of passing additional CTPs becomes non-negligible at ~2°C and increases greatly at ~3°C. Above 2°C the Arctic would very likely become summer ice-free, and land carbon sink-tosource transitions would become widespread.

Scientists are detecting warning signs for many CTPs. For example, researchers have found an almost complete loss of stability of the Atlantic meridional overturning circulation (AMOC). These currents are already at their slowest point in at least 1,600 years, and new analysis indicates that the AMOC could collapse between 2025 and 2095, with a central estimate of 2050, if global carbon emissions are not reduced (Ditlevsen and Ditlevsen, 2023). This would have catastrophic consequences, severely disrupting the rains that billions of people depend on for food in India, South America and West Africa; increasing storms and lowering temperatures in Europe; and raising sea levels in the eastern North America (Boers, 2021)

The IPCC's highest-end GHG concentration pathway, RCP 8.5, remains close to observations in many regions and may eventuate if negative feedback loops are activated, such as emissions from melting permafrost and forest die-backs (Schwalm, Glendon and Duffy, 2020). Both of the high-emission pathways considered in the IPCC's most recent Working Group I report contain 4°C increases in the "very likely" range for 2081 through 2100, temperatures that many scientists believe would pose a significant threat to civilization (Steel, DesRoches, Mintz-Woo, 2022).

Tipping elements have been identified in all earth systems including cryosphere, ocean circulation systems and the biosphere, and **a growing risk is** that even if the Paris Agreement targets are met, **a cascade of** positive **feedbacks could push the Earth** System irreversibly **onto a "Hothouse Earth" pathway** (Steffen et al. 2018; Klose, Karle, Winkelmann and Donges, 2020). During the last glacial period abrupt climate changes sometimes occurred within decades, with temperatures over the Greenland ice-sheet warming by 8°C to 16°C at each event (Corrick et al., 2020).

The IPCC has been cautious in its evaluation of climate tipping points. For example, its latest report stated that there was a chance of a tipping point in the Amazon by the year 2100. However, while most studies only focus on one driver of destruction, such as climate change or deforestation, in reality ecosystems are simultaneously impacted by multiple interacting threats, e.g., water stress, degradation and pollution. **Because tipping points can** amplify and **accelerate one another**, more than a fifth of **ecosystems** worldwide, including the Amazon rainforest, **are at risk of a catastrophic breakdown within a single human life**time (Willcock et al., 2023). Record drought in Amazonia in 2023 suggests **we are much closer to these** thresholds **than models predict**.

## Thankfully, Small Modular Reactors massively reduce emissions, alleviate construction burdens, and meet energy goals

University of Michigan News citing Max **Vanatta**, 11-4-20**24**, [Vanatta is a doctoral student in U-M's School for Environment and Sustainability and in the Department of Industrial and Operations Engineering] "Small modular nuclear reactors can help meet US energy and emission goals—if we let them," https://news.umich.edu/small-modular-nuclear-reactors-can-help-meet-us-energy-and-emission-goalsif-we-let-them/, accessed 3-22-2025 //cy

Interest in small modular nuclear reactors, or SMRs, is skyrocketing with tech companies including Google, Amazon and Microsoft investing in the emerging low-carbon energy technology. It has the potential to help these companies and the country meet their emissions goals while satisfying growing energy demands. But the United States has yet to power up its first SMR and the technology faces substantial deployment challenges with its cost and complexity. Still, new research from the University of Michigan shows that SMRs are economically viable and poised to start living up to their potential by 2050. "While expensive and challenging, SMRs do have the potential to be deployed," said Max Vanatta, lead author of the new study in the journal Nature Energy. Vanatta is a doctoral student in U-M's School for Environment and Sustainability and in the Department of Industrial and Operations Engineering. "Even though they're expensive, they can still be **the lowest cost option**," Vanatta said. The study predicts that enough SMRs could be deployed by then to reduce the country's annual carbon dioxide emissions by up to **59 million metric tons**. To get there, though, they'll need some help from **the government** and the industries building and implementing the technology. Projects not products One of the advantages of nuclear power is that how we end up using it is very similar to how we use energy from fossil fuels. Because of that, it integrates fairly seamlessly with the existing grid. But nuclear energy also has unique considerations—so unique that no two nuclear power plants are completely identical, the researchers said. "Nuclear reactors aren't products like we think about other technologies," said co-author Robb Stewart, chief technology officer of Alva Energy. "They're more like construction projects." For conventional nuclear power plants, those projects involve several specialized buildings and elements, including their famous cooling towers. The net result in the U.S. is, on average, a plant that produces about 1 gigawatt of electric power, according to the U.S. Department of Energy. SMRs are still projects, Stewart said, but smaller ones. They shrink down the reactor to fit into a more modular design, which comes at a cost to the maximum power capacity. The largest SMRs produce about 30% the power of an average conventional plant, but they can be housed in a single building on the site where the power will be used. In the new study, Vanatta, Stewart and Michael Craig, a U-M assistant professor in energy systems, considered the deployment of SMRs in more than 900 facilities using natural gas to meet their industrial heating needs. The facilities represented 14 heat-intensive industries, including paper mills, petroleum refineries and chemical manufacturers. "Providing cheap enough heat through **low-carbon means** is really hard," Vanatta said. "That's where **SMRs have a really good opportunity**." For its analysis, the team developed a model to project the degree and impact of SMR deployment in these settings in the context of three variables. How to make SMRs competitive One variable was the cost of natural gas. The team found that SMRs could compete when natural gas was priced at $6 or more per metric million British thermal units, or MMBtu, a standard unit of measurement for heat content. Although that's not the lowest number you'll see for the cost of natural gas, it is a realistic industrial price, Vanatta said. Another variable was how the government incentivized SMR development through policy. Here, the researchers found incentives like tax credits and carbon taxes made a huge difference, while direct subsidies did not. "If you were to just subsidize SMR development with a $10 billion pool, build as many modules as you can for that amount at the cheapest facilities, it still doesn't take off," Vanatta said. "Other policies had a very valuable impact. They go a long way." The final variable was how much the experience of building and installing an SMR would drive down the cost of future SMR projects. The team referred to this as learning, and it's a component of the project that stood out most to Stewart. "That capability of the model makes it a first of its kind," Stewart said. The model could thus help bring a new dimension to similar studies of other technologies, especially in the low-carbon energy field, he added. "There's a lot of technology that's just coming out of the lab," Stewart said. "Whether that's nuclear or battery storage or geothermal technology, we're going to want to capture how the costs evolve from building the first system to the 100th." Historically, there hasn't been much cost-reducing learning when it comes to conventional nuclear power plants. That's another consequence of how unique each nuclear project is, Vanatta said. But he's optimistic the smaller, modular designs of SMRs could help buck that trend. Even in the worst-case scenario, though, where SMRs experience negative learning and the cost goes up between projects, the team still saw potential for deployment. Still, the researchers stressed how much easier the path becomes with positive learning. "We need to make sure that we're **capturing that learning and scaling it**," Stewart said. "We need to make sure it doesn't get stuck inside a certain business or utility." Per the U.S. Energy Information

Administration, conventional nuclear plants currently provide the country with about 100 gigawatts of power capacity. The facilities analyzed by the team could deploy more than an additional 20 gigawatts in the best-case scenario for SMRs. "It's going to take everything, but it's all **in the service of reliable, low-carbon energy," Vanatta said.**

### SMRs solve traditional concerns – costs, scalability, safety

Brandon **Rakszawski**, 11-6-20**24**, [Director of Product Management at VenEck, a global investment management firm"Investment Opportunities in SMRs: The Future of Nuclear Power," Investment Opportunities in SMRs: The Future of Nuclear Power, VanEck, https://www.vaneck.com/us/en/blogs/natural-resources/smr-investing/, accessed 3-22-2025 //cy

Nuclear is a major component of the energy mix needed to satisfy growing electricity demand while the world transitions to cleaner energy sources. To see this trend play out in real time, look no further than the various announcements in recent months by tech companies to secure nuclear power sources. Nuclear offers **a long list of beneficial characteristics**: its emissions levels are some of the **lowest among energy sources**, it is very efficient and can produce **consistent power throughout the day**, and its land-use footprint is small compared to other energy sources.

Historically, one hurdle for broader nuclear power adoption has been the slow development pace. The infrastructure required to build a large-scale nuclear reactor can be significant, and the regulatory approval process can often move at a snail's pace. For this reason, industry, customers, and public officials have turned their attention to small modular reactors (SMRs). SMRs are expected to allow for more scalable and flexible installation of nuclear power that, once further developed, **may reduce the time to market significantly, with many other potential benefits.**

What Are Small Modular Reactors?

As their name implies, SMRs are small and modular. They are much smaller than large-scale traditional nuclear reactor facilities, in some cases as small as 1/10th the size of traditional nuclear reactors. Being modular allows them to be manufactured offsite and assembled on-site.

These features are important for several reasons. Their small scale may allow SMRs to be used in locations that could not otherwise support a large reactor. Also, SMRs can add additional capacity at existing nuclear power sites. The modular design allows reactors to be manufactured at scale and assembled on-site. This **can significantly reduce** the up-front capital costs associated with large reactor sites and significantly reduce construction times.

Safety is another attractive feature of SMR innovation. Traditional nuclear reactors rely on physical barriers between the radioactive reactor core and the environment, along with extensive protocols to monitor the reactor's safety and serve as backup to address human and computer errors. Many SMRs are designed with passive, self-cooling features that **don't rely on operator intervention or computer action.**

The elephant in the room when discussing SMRs is that they have long been in the design and innovation phase but have yet to be deployed in a meaningful way. The primary hurdle has been the cost associated with being first. Many plans have been canceled or reassessed as inflation and rising interest rates drove financing costs higher over the last several years. However, that is expected to change in short order as nuclear has been more widely recognized as an important "green" or "sustainable" power source, **and significant amounts of financing** have been made available to this space in recent years. Several projects are targeting completion by 2029, but the early 2030s may be a more reasonable timeline.

**And, decarbonization efforts are coming now, but current strategy lacks diversification – only increased investment solves**

Ejeong **Baik et al. 21**. Department of Energy Resources Engineering, Stanford University; Kiran P. Chawla, Emmett Interdisciplinary Program in Environment and Resources, Stanford University; Jesse. D Jenkins, Department of Mechanical and Aerospace Engineering and Andlinger Center for Energy and the Environment, Princeton University; Clea Kolster, Lowercarbon Capital; Neha S. Patankar, Andlinger Center for Energy and the Environment, Princeton University; Arne Olson, Energy and Environmental Economics, Inc; Sally M. Benson, Department of Energy Resources Engineering, Stanford University; Jane C.S. Long, Environmental Defense Fund. What is different about different net-zero carbon electricity systems? Energy and Climate Change, Vol. 2, December 2021, 100046. https://doi.org/10.1016/j.egycc.2021.100046. Accessed 10 August 2024

Cost-effective 100% decarbonization of the grid-and consequently the cost-effective **decarbonization** of the entire **economy**-appears to depend on the development and deployment of clean firm resources. This analysis has also demonstrated that having **multiple clean** firm **resources** provides more cost-savings than only developing a single clean firm resource. Furthermore, the analysis has shown that different clean firm resources with varying techno-economic abilities can provide similar cost savings value in decarbonizing the grid. However, the mechanism in which each resource operates to provide cost-savings varies, and each technology and its respective least-cost grid are shown to have different implications for California's system development. While not explicitly modeled, the results of the modeling imply that a system that **relies** heavily on high capacities of PV **in-state** (such as the scenario with ZCF) may encounter greater **land-use** and **siting challenges** that may potentially **limit** the **development** of PV, or may face **higher** system **costs** if expected cost declines in storage and PV do not materialize. On the other hand, CCS or nuclear generally face higher public opposition and may encounter siting challenges of their own that may slow the growth of clean firm capacity that is needed. The development of **multiple** clean firm resources thus provides a **hedge** against non-modeled **risks** associated with relying on technical and cost advances or social license for a **single** technology, especially if the risks associated with these technologies are not correlated. Furthermore, relying on multiple clean firm resources **distributes** the risk of system failure more broadly, by **mitigating** the risk of a **system failure** based on the failure of a single technology and increasing the flexibility of the system in adjusting to potential challenges.

In addition to reducing risk, utilizing multiple clean firm resources to decarbonize a grid is more cost-effective than solely relying on a single resource. While additional effort is required to develop more than one clean firm power option, the options are not limited to only the three technologies modeled in this analysis. There are also other clean firm resources that fit the identification of flexible base, intermediate, and firm cycler that can substitute for or supplement nuclear, CCS, or zero carbon fuels. Geothermal resources are also flexible base options that have high capital costs, but low variable costs when run. Allam cycle turbines are intermediate resources that are similar to natural gas with CCS. **Biomass**-fired power plants with CCS may also serve as intermediate resources. Firm cyclers can take the form of ZCF such as hydrogen with hydrogen turbines, or biogas or methanated hydrogen that run in conventional gas turbines. Running natural gas peakers that emit $CO_2$ with the use of negative emissions technologies or offsets can also be a form of **firm cycler**.

While long duration storage was also considered in this analysis, we find that long duration storage resources at current and future projects costs cannot serve as direct substitutes for clean firm resources, and the conclusion is consistent with recent literature [39]. This is because fully displacing firm generation with long duration storage requires very low marginal utilization rates for the final increments of storage capacity deployed. For this capacity to be economically competitive, energy storage capacity costs must be extremely low (on the order of $1 per kilowatt-hour of installed energy capacity) along with sufficient power cost and efficiency performance. A more detailed discussion on the long duration storage results can be found in the SI.

Regardless of the type, developing clean firm resources of any sort to scale by 2045 will likely require immediate action. Furthermore, recent policy signals have pointed to a possible goal to reach a net zero carbon grid by 2035 [40], greatly raising the urgency to take action. Planning and developing power system assets take multiple years, and the capacity installed in the next decade will likely persist through 2050. However, the development of clean firm resources explored in this analysis currently face a multitude of challenges in scaling up. Producing and distributing ZCF will likely require more affordable fuel production technologies and a wide range of fuel transport and storage infrastructure buildout. Similarly, CCS will require the development of $CO_2$ storage site development and protocols and pipelines, and nuclear will have to face public acceptance and siting challenges. Developing any clean firm technology at scale will require significant investment and a concerted effort to reduce barriers to deployment. Furthermore, all clean firm resources will need appropriate incentives or market mechanisms in place for them to participate and be profitable in the electricity system. Pursuing a **broader range** of possible clean firm resources, in addition to renewable technologies, will help build knowledge and experience, as well as **encourage** further **investment** across the energy sector to reach a **net zero** carbon **grid** sooner.

The result that having multiple clean firm resources within a decarbonized grid is more cost-effective than decarbonized grids with single clean firm resources is consistent across the three independent capacity expansion and dispatch models. This further emphasizes the robustness of the results and that the basis of the outcome was from the techno-economic characteristics of the resources instead of any unique set up of the models themselves. While this analysis focuses on California and the WECC, the techno-economic characteristics of flexible base, intermediate, and firm cycling resources imply that the results of this analysis will likely hold in **any region** with high share of renewable resources, and especially more so for regions such as the Northeast and Southeast US where the wind and solar resources may be of lower quality. Given the importance of affordably decarbonizing the electricity sector globally, this analysis highlights the integral role that multiple clean firm resources with varying techno-economic characteristics can play in decarbonizing the grid cost-effectively. Future work can be done to understand the role, value, and operation of clean firm resources in pathways for decarbonizing at less stringent emissions goals.

# Contention Two is the Economy

**US electricity relies heavily on fossil fuels, as the US Energy Information Association quantified in 2024 that** [U.S. Energy Information Association (The U.S. Energy Information Administration (EIA) is a principal agency of the U.S. Federal Statistical System responsible for collecting, analyzing, and disseminating energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment), 7-15-2024, https://www.eia.gov/energyexplained/us-energy-facts/ DOA 3/13/25] // SH

U.S. energy production has been greater than U.S. energy consumption in recent years U.S. total annual energy production has exceeded total annual energy consumption since 2019. In 2023, production was about 102.83 quads and consumption was 93.59 quads. **Fossil fuels**—petroleum, natural gas, and coal—**accounted for** about **84% of** total **U.S.** primary **energy production in 2023.** The percentage shares and amounts (in quads) of total U.S. primary energy production by major sources in 2023 were:2

**However, such reliance on fossil fuels is driving price spikes because of pipelines, which are necessary for electricity generation from fossil fuels**

**Lehigh University confirms that**[Lehigh University, no date, "ELI: Energy: Support Materials: Fossil Fuels", Lehigh University, https://ei.lehigh.edu/learners/energy/fossilfuels/fossilfuels11.html] // SH

Transportation of Fossil Fuels Despite their negative environmental impacts, **fossil fuels are** still in high demand. This means they need to be **transported around the countr**y--and sometimes—around the world. Petroleum (crude oil) is relatively easy to transport, but can cause catastrophic damage if spilled. **The safest and cheapest way to transport large amounts of petroleum (crude oil) over land is via pipelines.** Construction, placement of the pipeline and control of the pipeline often figure heavily in politics between states and countries. When petroleum (crude oil) needs to travel overseas, oil tankers are used. **Natural gas is easy to transport over land in pipelines**, but difficult to transport over oceans due to its low density and thus large volume. Increasingly, countries are importing and exporting natural gas in a liquefied form. If natural gas is chilled to about -260°F, it changes to liquid form and can be easily transported and stored. It takes up much less space and can be loaded into domed tanks, like the ones pictured on the tanker above. The **tanks hold the gas in liquefied form until it's needed, then it is converted back into gas and sent through pipelines to consumers.** Transporting coal can be costly but there are many ways to do it. Most of the coal in the USA travels by train, at least for part of its journey from mine to market. Near the mine, coal can be moved around by trucks and conveyors. River barges and ships are often a cheaper means of transport than trains but are obviously limited in where they can go. Finally, **if the coal is crushed and mixed with water, it can even travel through a pipeline**

**However, the US is facing a lack of pipeline space, hindering efficiency**

**Scott Disavino of Reuters wrote two weeks ago that** Scott Disavino, Scott Disavino Covers the North American power and natural gas markets. 3-13-2025, "AI, LNG demand to keep US natgas use at record highs but bottlenecks threaten", Reuters, https://www.reuters.com/business/energy/ceraweek-ai-lng-demand-keep-us-natgas-use-record-highs-bottlenecks-threaten-2025-03-12/

HOUSTON, March 12 - **U.S. natural gas use is** set to continue **hitting record highs** due to soaring liquefied natural gas (LNG) demand and power consumption from data centers, executives said at a conference this week, while also warning a lack of infrastructure could hurt the industry. The U.S. is the world's largest gas producer and is expected to produce some 105.2 billion cubic feet per day (bcfd) this year, according to U.S. government data. Demand has already hit a record nearly each year since 2010, but some **markets in the U.S.**

have been hampered by lack of available pipeline space. Pipeline capacity has not caught up with production after a series of project cancellations over the last eight years, according to Toby Rice, CEO of EQT (EQT.N), the No. 2 U.S. gas producer. This has contributed to a 35% rise in electricity costs for U.S. consumers in the last four years, he said. "We have the gas, we just don't have the pipelines to get it to places, so now you see a situation where it doesn't matter how much we produce," Rice said in an interview on the sidelines of the conference

## But thankfully, nuclear energy doesn't rely on pipelines

**According to the WNA in December** [World Nuclear Association, 12-3-2024, "Nuclear Power and Energy Security", World Nuclear Association, https://world-nuclear.org/information-library/economic-aspects/nuclear-power-and-energy-security DOA 3/13/25] // SH

Reliable: Nuclear power plants have, by far, the highest capacity factor of any generating resource. Capacity factor is a measure of how often a resource delivers its maximum operating capacity—basically, how often it's fully utilized and able to deliver electricity. In 2021, nuclear plants in the U.S. had a capacity factor of nearly 93%, meaning they generated at maximum capacity around 93% of the time. That's nearly twice the capacity factor of coal and natural gas, and triple that of wind and solar. That's how nuclear plants, at only 8% of total electric generating capacity in the U.S., can actually generate 19% of total electricity. Fuel-Secure: In traditional nuclear plants, fuel is only replaced every 18 to 24 months. This, in part, is how nuclear plants maintain such high capacity factors. However, it also makes nuclear plants fuel-secure resources, because they do not require rail or pipelines for fuel deliveries like coal and natural gas plants which can be impacted by weather and other events. Resilient: While nuclear plants have often been noted for their reliable operations during normal conditions, their track record in the face of extreme weather conditions hasn't been discussed as widely. However, given the increase in weather-related outages in recent years, this may be an important factor for policymakers to consider. A recent report from the Electric Power Research Institute looked at how nuclear power plants fared during extreme weather events between 2011 and 2020, and concluded that "it is rare that extreme weather events have a significant direct impact on nuclear plant generation," with an average of less than a 0.1% loss in capacity factor. The report concludes this can partly be attributed to the fact that nuclear power plants are required to be designed to withstand events that are far more severe than most other critical infrastructure, which enables them to continue operating through conditions that may take other generators offline.

**Making the switch to nuclear energy is absolutely critical – otherwise, millions of families are thrown into poverty**

**Yuru Guan of the University of Groningen writes** [Guan, Y. (Integrated Research on Energy, Environment and Society (IREES), Energy and Sustainability Research Institute Groningen, University of Groningen, Groningen, Netherlands), Yan, J. (Integrated Research on Energy, Environment and Society (IREES), Energy and Sustainability Research Institute Groningen, University of Groningen, Groningen, Netherlands), Shan, Y. (School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, UK) et al. Burden of the global energy price crisis on households. Nat Energy 8, 304–316 (2023). https://doi.org/10.1038/s41560-023-01209-8

High energy prices impose cost burdens on households in two ways. On the one hand, fuel price rises directly increase household fuel bills (for example, for heating and cooling, cooking and mobility). On the other hand, energy and fossil feedstock inputs needed for the production of goods and services for final household consumption will lead to higher prices of household-expenditure items12,13. Due to the unequal distribution of income, reflected in different household consumption patterns, surging energy prices could affect households in very different ways11,14,15. Unaffordable costs of energy and other necessities would push vulnerable populations into energy poverty and even extreme poverty16. Understanding how global energy prices are transmitted to households through global supply chains and how they are affected is crucial for effective and equitable policy design.

**This causes thousands of deaths**

**Paul Mueller of John Hopkins concludes** [Paul S. Muller, medical professor @ UT, 4-20-2023, NEJM Journal Watch: Summaries of and commentary on original medical and scientific articles from key medical journals, NEJM, https://www.jwatch.org/na56040/2023/04/20/poverty-leading-cause-death-us]

Current poverty is associated with 42% excess risk for death. Cumulative poverty (i.e., 10 continuous years of poverty) is associated with 71% excess risk for death. Survival of people in poverty diverges from those not in poverty at age 40. Divergence peaks at age 70 and diminishes thereafter. In 2019, among people who were 15 or older, cumulative poverty was the fourth leading cause of death (296,000 deaths), behind heart disease, cancer, and smoking, and ahead of dementia and obesity. Current poverty was the seventh leading cause (183,000 deaths), ahead of accidents, chronic lung disease, stroke, suicide, and homicide.

# 2NC

All analytics - lay.