CASE

C1: Grid Instability

Nuclear energy has become a possibility. WNA '24

WNA, 04-26-2024, "Emerging Nuclear Energy Countries", World Nuclear Association, https://world-nuclear.org/information-library/country-profiles/others/emerging-nuclear-energy-countries

About 30 countries are considering, planning or starting nuclear power programmes. These range from sophisticated economies to developing nations. Bangladesh, Egypt and Turkey are all constructing their first nuclear power plants. **About 30 countries are considering, planning or starting nuclear power programmes, and a further 20 or so countries have at some point expressed an interest.** In the following list, links are provided for those countries that are covered by specific country pages: In Europe: Albania, Serbia, Croatia, Norway, Poland, Estonia, Latvia, Lithuania, Ireland, Turkey. In the Middle East and North Africa: Gulf states including Saudi Arabia, Qatar, Kuwait and Iraq; Yemen, Israel, Syria, Jordan, Egypt, Tunisia, Libya, Algeria, Morocco, Sudan. In west, central and southern Africa: Nigeria, Ghana, Senegal, Kenya, Uganda, Tanzania, Zambia, Namibia, Rwanda, Ethiopia. In Central and South America: Cuba, Chile, Ecuador, Venezuela, Bolivia, Peru, Paraguay. In central and southern Asia: Azerbaijan, Georgia, Kazakhstan, Mongolia, Bangladesh, Sri Lanka, Uzbekistan. In Southeast Asia and Oceania: Indonesia, Philippines, Vietnam, Thailand, Laos, Cambodia, Malaysia, Singapore, Myanmar, Australia. In east Asia: North Korea. Despite the large number of these emerging countries, they are not expected to contribute very much to the expansion of nuclear capacity in the foreseeable future – the main growth will come in countries where the technology is already well established. However, in the longer term, the trend to urbanisation in less-developed countries will greatly increase the demand for electricity, and especially that supplied by base-load plants such as nuclear. The pattern of energy demand in these countries will become more like that of Europe, North America and Japan.

There are 2 key issues with nuclear power. First is time.

Nuclear plants take too long to build. Jacobson '24

Mark Z. Jacobson, 10-10-2024, "7 reasons why nuclear energy is not the answer to solve climate change", One Earth, https://www.oneearth.org/the-7-reasons-why-nuclear-energy-is-not-the-answer-to-solve-climate-change/

The time lag between planning and operation of a nuclear reactor includes the times to identify a site, obtain a site permit, purchase or lease the land, obtain a construction permit, obtain financing and insurance for construction, install transmission, negotiate a power purchase agreement, obtain permits, build the plant, connect it to transmission, and obtain a final operating license. The planning-to-operation (PTO) times of all nuclear plants ever built have been 10-19 years or more. For example, the Olkiluoto 3 reactor in Finland was proposed to the Finnish cabinet in December 2000 to be added to an existing nuclear power plant. Its latest estimated completion date is 2020, giving it a PTO time of 20 years. The Hinkley Point nuclear plant was planned to start in 2008. It has an estimated the completion year of 2025 to 2027, giving it a PTO time of 17 to 19 years. The Vogtle 3 and 4 reactors in Georgia were first proposed in August 2006 to be added to an existing site. The anticipated completion dates are November 2021 and November 2022, respectively, given them PTO times of 15 and 16 years, respectively. The Haiyang 1 and 2 reactors in China were planned to start in 2005. Haiyang 1 began commercial operation on October 22, 2018. Haiyang 2 began operation on January 9, 2019, giving them PTO times of 13 and 14 years, respectively. The Taishan 1 and 2 reactors in China were bid in 2006. Taishan 1 began commercial operation on December 13, 2018. Taishan 2 is not expected to be connected until 2019, giving them PTO times of 12 and 13 years, respectively. Planning and procurement for four reactors in Ringhals, Sweden started in 1965. One took 10 years, the second took 11 years, the third took 16 years, and the fourth took 18 years to complete. Many claim that France's 1974 Messmer plan resulted in the building of its 58 reactors in 15 years. This is not true. The planning for several of these nuclear reactors began long before. For example, the Fessenheim reactor obtained its construction permit in 1967 and was planned starting years before. In addition, 10 of the reactors were completed between 1991-2000. As such, **the whole planning-to-operation time for these reactors was at least 32 years**, not 15. **That of any individual reactor was 10 to 19 years.**

Inevitably, the world shifts their reliance to natural gas. Gordon '24

Jay Gordon, 10-9-2024, "We can't afford to fall back on gas to fill nuclear gap", Institute for Energy Economics and Financial Analysis, https://ieefa.org/resources/we-cant-afford-fall-back-gas-fill-nuclear-gap]

A recent IEEFA report found nuclear power in Australia would raise electricity bills by $665 a year on average across the regions analysed. Given these plants take decades to build, what happens **during the transition period between coal retiring and nuclear coming online**? While the finer details of the Coalition's policy are yet to be released, it has confirmed that **gas will be a "huge feature**". Meanwhile, federal government modelling estimates that filling the energy gap with gas while waiting for nuclear power to be built would cost $70 billion. Gas has been part of Australia's electricity mix for decades – so why is ramping it up now such a bad idea? Gas generation is expensive, and in decline Burning gas is one of the most expensive forms of electricity generation in Australia. CSIRO research finds that the levelised cost of gas-fired electricity used for peaking can be up to twice that of renewable energy with integration costs. Gas is usually relied on mainly when other forms of generation aren't available, such as to ramp up electricity supply quickly during peak demand times, or as a back-up when there is an outage at a coal power station. And when gas is called on – the wholesale price of electricity goes up. When this coincides with volatility in international gas prices, the impact on electricity prices can be profound, as Australians learnt the hard way in 2022. The Australian Energy Market Operator (AEMO) tracks the "price-setting" dynamics of different technologies in the national electricity market (NEM). Their reports show that the more often gas generators are used, the more upward pressure is placed on wholesale electricity prices. Conversely, increasing renewable energy generation places downward pressure on prices. It's therefore unsurprising that as the level of renewable energy in the NEM has increased, the level of gas power generation in Australia has generally trended downwards.

Second is power.

Nuclear energy lacks the ramp power necessary to meet demand on the electric grid. Jacobson '24

Mark Z. Jacobson, 10-10-2024, "7 reasons why nuclear energy is not the answer to solve climate change", One Earth, https://www.oneearth.org/the-7-reasons-why-nuclear-energy-is-not-the-answer-to-solve-climate-change/

To recap, new nuclear power costs about 5 times more than onshore wind power per kWh (between 2.3 to 7.4 times depending upon location and integration issues). Nuclear takes 5 to 17 years longer between planning and operation and produces on average 23 times the emissions per unit electricity generated (between 9 to 37 times depending upon plant size and construction schedule). In addition, it creates risk and cost associated with weapons proliferation, meltdown, mining lung cancer, and waste risks. Clean, renewables avoid all such risks. Nuclear advocates claim nuclear is still needed because renewables are intermittent and need natural gas for backup. However, **nuclear** itself **never matches power demand so it needs backup. Even** in France **with** one of the most **advanced nuclear energy programs, the maximum ramp rate is 1 to 5 % per minute**, which means they need natural gas, hydropower, or batteries, which ramp up 5 to 100 times faster, to meet peaks in demand. Today, in fact, batteries are beating natural gas for wind and solar backup needs throughout the world. A dozen independent scientific groups have further found that it is possible to match intermittent power demand with clean, renewable energy supply and storage, without nuclear, at low cost. Finally, many existing nuclear plants are so costly that their owners are demanding subsidies to stay open. For example, in 2016, three existing upstate New York nuclear plants requested and received subsidies to stay open using the argument that the plants were needed to keep emissions low. However, subsidizing such plants may increase carbon emissions and costs relative to replacing the plants with wind or solar as soon as possible. Thus, subsidizing nuclear would result in higher emissions and costs over the long term than replacing nuclear with renewables

That’s why countries using nuclear power still need gas. Jacobson ‘24

Mark Z. Jacobson, 10-10-2024, "7 reasons why nuclear energy is not the answer to solve climate change", One Earth, https://www.oneearth.org/the-7-reasons-why-nuclear-energy-is-not-the-answer-to-solve-climate-change/

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Japan also proves. Despite decades of building nuclear reactors, Dascalu 24

C.Dascalu, 03-18-2024, "POSITION PAPER: The nuclear hurdle to a renewable future and fossil fuel phase-out", CAN Europe, https://caneurope.org/position-paper-nuclear-energy/

The inflexibility of nuclear, caused by technical limitations, safety requirements and economic factors, prevents the feed-in of renewable electricity into the grid, causing grid congestion and curtailment. Nuclear’s dominance over grid capacity can block the connection of new renewable energy projects, where even announced and then abandoned plans for a new nuclear unit can delay renewable projects connection, allowing for continued fossil fuel usage. Grid structures designed for large-scale, centralised nuclear power, make it more challenging, time-consuming and costly to introduce small-scale distributed renewable power. An example can be found in Romania where Cernavodă 3 and 4 reactors have reserved grid capacity for years, blocking new renewable energy projects in the Dobrogea region, the most wind-intensive region in the country. Delayed grid investments, due to uncertainty of new nuclear units, have also meant that capacity bottlenecks exist today for renewables online. In the Netherlands, the only current nuclear power station, Borssele is competing for landing space for off-shore electricity. Post-Fukushima, renewables were blocked from connecting to the grid in Japan as the government considered restarting the reactors, despite public opposition to nuclear restarts and support for renewables. Rather than taking the opportunity to invest in grids and integrate renewables twenty years ago, **Japan still heavily relies on fossil fuels today**.

Relying on gas is costly. Gordon '24

Jay Gordon, 10-9-2024, "We can't afford to fall back on gas to fill nuclear gap", Institute for Energy Economics and Financial Analysis, https://ieefa.org/resources/we-cant-afford-fall-back-gas-fill-nuclear-gap]

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Switching to nuclear energy kills millions. Jacobson 24

Jacobson 24 [Mark Z. (Professor of Civil and Environmental Engineering & Director of the Atmosphere/Energy Program @ Stanford University), "7 reasons why nuclear energy is not the answer to solve climate change," OneEarth, Oct. 10, 2024, https://www.oneearth.org/the-7-reasons-why-nuclear-energy-is-not-the-answer-to-solve-climate-change/)]DOA 03-17-2025//

There is a small group of scientists that have proposed replacing 100% of the world's fossil fuel power plants with nuclear reactors as a way to solve climate change. Many others propose nuclear grow to satisfy up to 20 percent of all our energy (not just electricity) needs. They advocate that nuclear is a "clean" carbon-free source of power, but they don't look at the human impacts of these scenarios. Let's do the math… One nuclear power plant takes on average about 14-1/2 years to build, from the planning phase all the way to operation. According to the World Health Organization, about 7.1 million people die from air pollution each year, with more than 90 percent of these deaths from energy-related combustion. So **switching** out **our energy system to nuclear would result in** about **93 million people dying, as we wait for** all the new **nuclear plants to be built** in the all-nuclear scenario. Utility-scale wind and solar farms, on the other hand, take on average only two to five years, from the planning phase to operation. Rooftop solar PV projects are down to only a 6-month timeline. So transitioning to 100% renewables as soon as possible would result in tens of millions fewer deaths. This illustrates a major problem with nuclear power and why renewable energy -- in particular Wind, Water, and Solar (WWS) -- avoids this problem. Nuclear, though, doesn't just have one problem. It has seven. Here are the seven major problems with nuclear energy: 1. Long Time Lag Between Planning and Operation The time lag between planning and operation of a nuclear reactor includes the times to identify a site, obtain a site permit, purchase or lease the land, obtain a construction permit, obtain financing and insurance for construction, install transmission, negotiate a power purchase agreement, obtain permits, build the plant, connect it to transmission, and obtain a final operating license. The planning-to-operation (PTO) times of all nuclear plants ever built have been 10-19 years or more. For example, the Olkiluoto 3 reactor in Finland was proposed to the Finnish cabinet in December 2000 to be added to an existing nuclear power plant. Its latest estimated completion date is 2020, giving it a PTO time of 20 years. The Hinkley Point nuclear plant was planned to start in 2008. It has an estimated the completion year of 2025 to 2027, giving it a PTO time of 17 to 19 years. The Vogtle 3 and 4 reactors in Georgia were first proposed in August 2006 to be added to an existing site. The anticipated completion dates are November 2021 and November 2022, respectively, given them PTO times of 15 and 16 years, respectively. The Haiyang 1 and 2 reactors in China were planned to start in 2005. Haiyang 1 began commercial operation on October 22, 2018. Haiyang 2 began operation on January 9, 2019, giving them PTO times of 13 and 14 years, respectively. The Taishan 1 and 2 reactors in China were bid in 2006. Taishan 1 began commercial operation on December 13, 2018. Taishan 2 is not expected to be connected until 2019, giving them PTO times of 12 and 13 years, respectively. Planning and procurement for four reactors in Ringhals, Sweden started in 1965. One took 10 years, the second took 11 years, the third took 16 years, and the fourth took 18 years to complete. Many claim that France's 1974 Messmer plan resulted in the building of its 58 reactors in 15 years. This is not true. The planning for several of these nuclear reactors began long before. For example, the Fessenheim reactor obtained its construction permit in 1967 and was planned starting years before. In addition, 10 of the reactors were completed between 1991-2000. As such, the whole planning-to-operation time for these reactors was at least 32 years, not 15. That of any individual reactor was 10 to 19 years.

Miller '21

Anna Miller, leads the media and external communication strategy at Harvard Chan C-CHANGE, translating the Center's research into messages that are actionable, accessible, and personal. She works with the media, policymakers, health care providers, and researchers to turn science into climate action that improves health. Miller received her Master's in Public Health from Harvard T.H. Chan School of Public Health in 2019, 2-9-2021, Fossil fuel air pollution responsible for 1 in 5 deaths worldwide, Harvard T.H. Chan School of Public Health,
https://hsph.harvard.edu/climate-health-c-change/news/fossil-fuel-air-pollution-responsible-for-1-in-5-deaths-worldwide/ , accessed 3-29-2025.

New research from Harvard University, in collaboration with the University of Birmingham, the University of Leicester and University College London, found that **more than 8 million people died in 2018 from fossil fuel pollution**, significantly higher than previous research suggested—**meaning** that air pollution from **burning fossil fuels** like coal and diesel **was responsible for about 1 in 5 deaths worldwide.** The study, "Global Mortality From Outdoor Fine Particle Pollution Generated by Fossil Fuel Combustion," published in Environmental Research, is based on a groundbreaking analysis that enabled the researchers to directly attribute premature deaths from fine particulate pollution (PM 2.5) to fossil fuel combustion. "Often, when we discuss the dangers of fossil fuel combustion, it's in the context of CO2 and climate change and overlook the potential health impact of the pollutants co-emitted with greenhouse gases," said Dr. Joel Schwartz, Professor at Harvard Chan School and co-author of the study. "We hope that by quantifying the health consequences of fossil fuel combustion, we can send a clear message to policymakers and stakeholders of the benefits of a transition to alternative energy sources."

Our 2nd argument is Renewables Tradeoff

Renewables are on the come up. Elbein 23

12-10-23, Renewables' growing price advantage over fossil fuels paves way for industry dominance
https://thehill.com/policy/energy-environment/4350563-renewable-energy-fossil-fuels-price-advantage-industry-dominance/

But new smart-grid technology allows homes and devices to communicate their specific electric demands to the collective grid — which in turn enables managers to reduce that demand by, say, turning smart thermostats in a given area down by a degree, or postponing EV charging until demand levels fall. Such technologies also open the possibility for "virtual power plants" that buy back power from EVs and home-scale battery storage. But they aren't yet sufficient to close the gap between rising electricity demand and current renewable levels, said Arshad Mansoor, CEO of the Electric Power Research Institute (EPRI), a public interest research and development firm. In general, however, Mansoor argued that the obstacles to cleaning up the U.S. grid aren't technological — they are political and regulatory. **The problems with renewables**' ability to produce power on demand **are getting smaller and smaller,** Nemet said — a "miracle" **driven in large part by the new** battery **technology.** Utility-scale batteries help hold onto the spiking electric supply from transient renewable power for a few hours until it's most needed. They have also benefited from plummeting prices. The price per hour of battery storage fell by 85 percent in the past decade. And that price fall appears to be accelerating: Investment bank Goldman Sachs estimated battery prices would fall from their current level of $139 per kilowatt to below $99 by 2025 — faster than researchers anticipated.
Amid the falling prices, the production of the batteries has rapidly expanded. Between June and September, the U.S. installed 3 gigawatts of new utility-scale battery storage. That's a large increase in absolute terms — enough to power 3 million households during the critical evening hours when solar production is decreasing and electricity demand is spiking as people come home from work. But it is also a sign of staggering growth: A 30 percent hike in battery installations over levels seen earlier that year — nearly twice the capacity installed just the previous quarter, for a threefold increase in total capacity in just two years **The rise of that** battery **technology,** for which Nelmet credited policy, "really **opens up the possibility to have clean energy that's affordable,** and **reliable, and** actually **address climate change in a way that** people really didn't think **was[n't] possible 15 years ago."**

Hence, renewables are the only way to solve the climate. Jacobson '24

Jacobson 24 [Mark Z. (Professor of Civil and Environmental Engineering & Director of the Atmosphere/Energy Program @ Stanford University), "7 reasons why nuclear energy is not the answer to solve climate change," OneEarth, Oct. 10, 2024, https://www.oneearth.org/the-7-reasons-why-nuclear-energy-is-not-the-answer-to-solve-climate-change/)]DOA 03-17-2025//

There is a small group of scientists that have proposed replacing 100% of the world's fossil fuel power plants with nuclear reactors as a way to solve climate change. Many others propose nuclear grow to satisfy up to 20 percent of all our energy (not just electricity) needs. They advocate that nuclear is a "clean" carbon-free source of power, but they don't look at the human impacts of these scenarios. Let's do the math… **One nuclear power plant takes** on average about **14**-1/2 **years to build**, from the planning phase all the way to operation. According to the World Health Organization, about 7.1 million people die from air pollution each year, with more than 90 percent of these deaths from energy-related combustion. So switching out our energy system to nuclear would result in about 93 million people dying, as we wait for all the new nuclear plants to be built in the all-nuclear scenario. Utility-scale **wind and solar farms**, on the other hand, **take** on average **only two** to five **years**, from the planning phase to operation. Rooftop solar PV projects are down to only a 6-month timeline. So transitioning to 100% renewables as soon as possible would result in tens of millions fewer deaths. This illustrates a major problem with nuclear power and why renewable energy -- in particular Wind, Water, and Solar (WWS) -- avoids this problem. Nuclear, though, doesn't just have one problem. It has seven. Here are the seven major problems with nuclear energy: 1. Long Time Lag Between Planning and Operation .The time lag between planning and operation of a nuclear reactor includes the times to identify a site, obtain a site permit, purchase or lease the land, obtain a construction permit, obtain financing and insurance for construction, install transmission, negotiate a power purchase agreement, obtain permits, build the plant, connect it to transmission, and obtain a final operating license. The planning-to-operation (PTO) times of all nuclear plants ever built have been 10-19 years or more. For example, the Olkiluoto 3 reactor in Finland was proposed to the Finnish cabinet in December 2000 to be added to an existing nuclear power plant. Its latest estimated completion date is 2020, giving it a PTO time of 20 years. The Hinkley Point nuclear plant was planned to start in 2008. It has an estimated the completion year of 2025 to 2027, giving it a PTO time of 17 to 19 years. The Vogtle 3 and 4 reactors in Georgia were first proposed in August 2006 to be added to an existing site. The anticipated completion dates are November 2021 and November 2022, respectively, given them PTO times of 15 and 16 years, respectively. The Haiyang 1 and 2 reactors in China were planned to start in 2005. Haiyang 1 began commercial operation on October 22, 2018. Haiyang 2 began operation on January 9, 2019, giving them PTO times of 13 and 14 years, respectively. The Taishan 1 and 2 reactors in China were bid in 2006. Taishan 1 began commercial operation on December 13, 2018. Taishan 2 is not expected to be connected until 2019, giving them PTO times of 12 and 13 years, respectively. Planning and procurement for four reactors in Ringhals, Sweden started in 1965. One took 10 years, the second took 11 years, the third took 16 years, and the fourth took 18 years to complete. Many claim that France's 1974 Messmer plan resulted in the building of its 58 reactors in 15 years. This is not true. The planning for several of these nuclear reactors began long before. For example, the Fessenheim reactor obtained its construction permit in 1967 and was planned starting years before. In addition, 10 of the reactors were completed between 1991-2000. As such, **the whole planning-to-operation time for these reactors was at least 32 years**, not 15. That of any individual reactor was 10 to 19 years.

Nuclear and renewables can't co-exist

Hockenos '22 Paul Hockenos, 11-24-2022, "Why Nuclear Power and Renewables Don't Mix", EnergyTransition.org, https://energytransition.org/2022/11/why-nuclear-power-and-renewables-dont-mix/

Even the SMRs that the IAEA touts, says Couture, do not ramp up and down easily. "Nuclear is inherently inflexible, and to accommodate the variability of wind and solar output, what we ultimately need is both flexible sources of supply, and greater flexibility of demand. The presence of nuclear actively hinders both." Couture explains that they compete against each other rather than working together. Nuclear, he argues, "wants to operate as much as possible, while solar and wind want to be dispatched all the time, for the simple reason that they have a near-zero marginal cost and outprice everything else on the market. Put those two together and you have the following situation: as soon as you reach modest levels of variable renewables in the mix, one of two things starts happening: either solar and wind start pushing out the nuclear, or nuclear starts pushing out the solar and wind. Like oil and water," he says. And Couture is not alone in his analysis. A University of Sussex Business School study concludes that **nuclear and renewable energy programs do not** tend to **co-exist** well together in low-carbon energy systems **but instead crowd each other out and limit effectiveness.** Beleaguered

France and its nuclear developer EDF, Couture underscores, is a case and point. “What many nuclear engineers, and much of EDF management, seem to have failed to appreciate is that power systems in the future need one thing, and lots of it, and that’s flexibility.” And flexibility, he says, is one thing that nuclear is ill-equipped to provide. “People who work in power markets know this,” says Couture, “but it merits underscoring: **nuclear is the least flexible power source on the grid.**”

Furthermore, nuclear energy crowds out investors. Lovins ‘21

Lovins 21 [Amory B. (Professor and Lecturer of Civil and Environmental Engineering @ Stanford University), “Why Nuclear Power Is Bad for Your Wallet and the Climate,” Bloomberg Law, Dec. 17, 2021, https://news.bloomberglaw.com/environment-and-energy/why-nuclear-power-is-bad-for-your-wallet-and-the-climate] DOA 03-17-2025//abhi ☺

As Congress and the Department of Energy pile new subsidies on nuclear power and the Nuclear Regulatory Commission seeks to gut its regulation, its marginal output additions have shrunk below 0.5% of the world market, says physicist Amory B. Lovins, adjunct professor of civil and environmental engineering at Stanford University. He explains why nuclear energy is not the answer to climate change, but actually worsens it due to climate opportunity cost. Does climate protection need more nuclear power? No—just the opposite. Saving the most carbon per dollar and per year requires not just generators that burn no fossil fuel, but also those deployable with the least cost and time. Those aren’t nuclear. Making 10% of world and 20% of U.S. commercial electricity, nuclear power is historically significant but now stagnant. In 2020, its global capacity additions minus retirements totaled only 0.4 GW (billion watts). Renewables in contrast added 278.3 GW—782x more capacity—able to produce about 232x more annual electricity (based on U.S. 2020 performance by technology). Renewables swelled supply and displaced carbon as much every 38 hours as nuclear did all year. As of early December, 2021’s score looks like nuclear –3 GW, renewables +290 GW. Game over. The world already invests annually $0.3 trillion each, mostly voluntary private capital, in energy efficiency and renewables, but about $0.015–0.03 trillion, or 20–40x less, in nuclear—mostly conscripted, because investors got burned. Of 259 US power reactors ordered (1955–2016), only 112 got built and 93 remain operable; by mid-2017, just 28 stayed competitive and suffered no year-plus outage. In the oil business, that’s called an 89% dry-hole risk. Renewables provided all global electricity growth in 2020. Nuclear power struggles to sustain its miniscule marginal share as its vendors, culture, and prospects shrivel. World reactors average 31 years old, in the U.S., 41. Within a few years, old and uneconomic reactors’ retirements will consistently eclipse additions, tipping output into permanent decline. World nuclear capacity already fell in five of the past 12 years for a 2% net drop. Performance has become erratic: the average French reactor in 2020 produced nothing one-third of the time. China accounts for most current and projected nuclear growth. Yet China’s 2020 renewable investments about matched its cumulative 2008–20 nuclear investments. Together, in 2020 in China, sun and wind generated twice nuclear’s output, adding 60x more capacity and 6x more output at 2–3 times lower forward cost per kWh. Sun and wind are now the cheapest bulk power source for over 91% of world electricity. Nuclear Power Has No Business Case Nuclear power has bleak prospects because it has no business case. New plants cost 3–8x or 5–13x more per kWh than unsubsidized new solar or windpower, so new nuclear power produces 3–13x fewer kWh per dollar and therefore displaces 3–13x less carbon per dollar than new renewables. Thus buying nuclear makes climate change worse. End-use efficiency is even cheaper than renewables, hence even more climate-effective. Arithmetic is not an opinion. Unsubsidized efficiency or renewables even beat most existing reactors’ operating cost, so a dozen have closed over the past decade. Congress is trying to rescue the others with a $6 billion lifeline and durable, generous new operating subsidies to replace or augment state largesse—adding to existing federal subsidies that rival or exceed nuclear construction costs. But no business case means no climate case. Propping up obsolete assets so they don’t exit the market blocks more climate-effective replacements—efficiency and renewables that save even more carbon per dollar. Supporters of new subsidies for the sake of the climate just got played. Fashionably rebranded “Small Modular” or “Advanced” reactors can’t change the outcome. Their smaller units cost less but output falls even more, so SMRs save money only in the sense in which a smaller helping of foie gras helps you lose weight. They’ll initially at least double existing reactors’ cost per kWh; that cost is ~3–13x renewables’ (let alone efficiency’s); and renewables’ costs will halve again before SMRs can scale. Do the math: 2 x (3 to 13) x 2 = 12–52-fold. Mass production can’t bridge that huge cost gap—nor could SMRs scale before renewables have decarbonized the US grid. Even free reactors couldn’t compete: their non-nuclear parts cost too much. Small Modular Renewables are decades ahead in exploiting mass-production economies; nuclear can never catch up. It’s not just too little, too late: **nuclear hogs market space, jams grid capacity, and diverts investments that** more-climate-effective **carbon-free competitors** then **can’t contest**. Meanwhile, SMRs’ novel safety and proliferation issues threaten threadbare schedules and budgets, so promoters are attacking bedrock safety regulations. NRC’s proposed Part 53 would perfect long-evolving regulatory capture—shifting its expert staff’s end-to-end process from specific prescriptive standards, rigorous quality control, and verified technical performance to unsupported claims, proprietary data, and political appointees’ subjective risk estimates. But that final abdication can’t rescue nuclear power, which stumbles even in countries with impotent regulators and suppressed public participation. In the end, physics and human fallibility win. History teaches that lax regulation ultimately causes confidence-shattering mishaps, so gutting safety rules is simply a deferred-assisted-suicide pact. Modern renewable generation keeps rising faster than nuclear output ever did in its 1980s heyday. During 2010–20, renewables reduced global power-sector carbon emissions 6x more than coal-to-gas switching (ignoring methane escape), and 5x more than nuclear growth. Among compelling examples, Germany replaced both nuclear and coal generation with efficiency and renewables: in 2010–20, generation from lignite fell 37%, hard coal 64%, oil 52%, and nuclear 54%; gas power rose 3%; GDP rose 11% (17% pre-pandemic); power-sector CO_2 fell 41%, meeting its target a year early with five percentage points to spare. Japan's savings and renewables meanwhile displaced 109% of lost nuclear output if adjusted for GDP growth, 95% if not, so its 21 "operational" reactors, shut for 10–14 years and counting, lost their market. And no country retains an operational need or business case for big "baseload" thermal plants—costly, inflexible, now superfluous for reliability—though inflexible mindsets retire even more slowly. Many in Washington mouth the mushy mantra that climate urgency demands "all of the above." Actually, no: the more urgent climate change is, the more we must invest judiciously, not indiscriminately, to buy cheap, fast, sure options instead of costly, slow, speculative ones. Only this strategy saves the most carbon per dollar and per year. Anything else worsens climate change. So the next time you hear some official, eager to appease every constituency, say we support "all of the above—we're not picking and backing winners," remember the retort by the dean of U.S. utility regulators, Peter Bradford: "No, we're not picking and backing winners. They don't need it. We're picking and backing losers."

"Nuclear energy's high capital costs often make it reliant on both government subsidies and private investment to be viable, particularly in the early stages of project development and deployment. Governments play a crucial role in providing stability and confidence to private investors through regulatory frameworks and financing mechanisms like loan guarantees and tax credits."

Funds are counterproductive. Smith 19

"Nuclear is too slow, costly to stop climate change, says status report," S&P Global Market Intelligence, 10-09-2019, https://www.spglobal.com/marketintelligence/en/news-insights/trending/eFMnDUPwWMQ76v3lL4U1dw2

Further, the report said construction of new reactors takes five to 17 years longer to build than utility-scale solar or onshore wind power. According to the report, the nine reactors that started up in 2018 took an average of 10.9 years to build. "In other words, nuclear power is an option that is more expensive and slower to implement than alternatives and therefore is not effective in the effort to battle the climate emergency, rather **it is counterproductive, as** the **funds are then not available for more effective options**," the report concluded.

The report's message was not lost on Diana Ürge-Vorsatz, professor of environmental science at the Central European University and vice-chair of a working group of the Intergovernmental Panel on Climate Change.

As several Intergovernmental Panel on Climate Change scenarios rely heavily on nuclear power to limit global warming to a 1.5 degrees C temperature rise by 2050, Ürge-Vorsatz wrote in the report's forward that "these scenarios raise the question whether the nuclear industry will actually be able to deliver the magnitude of new power that is required in these scenarios in a cost-effective and timely manner."

Worse, even a small delay of funding halts renewable progress. Waldron 18

Waldron, 07-24-18 "Decline in renewables investment is a warning signal for clean energy transitions" https://admin.iea.org/commentaries/decline-in-renewables-investment-is-a-warning-signal-for-clean-energy-transitions?

Renewables are an essential component of a sustainable energy future, and they will **have to grow quickly to meet the world's climate change, clear air and energy access goals**. As projected in the IEA Sustainable Development Scenario, new renewables generation needs to rise rapidly and **global investment in renewable electricity needs to *almost double*** to meet these goals, to nearly USD 550 billion per year by 2030.

For this reason, nuclear power can't solve energy and trades off with better options. Muellner 21

Muellner *PhD, Head of the Institute of Safety and Risk Sciences; **Researcher at the University of Natural Resources and Life Sciences; ***Senior Scientist at the Centre for Global Change and Sustainability, Professor at the University of Vienna, PhD in Physics and Mathematics from the University of Vienna; ****PhD, Professor at the University of Natural Resources and Life Sciences; *****PhD, Professor at the University of Natural Resources and Life Sciences.

*Nikolaus Muellner, Nikolaus Arnold, **Klaus Gufler, ***Wolfgang Kromp, ****Wolfgang Renneberg, *****Wolfgang Liebert, "Nuclear energy - The solution to climate change?," Energy Policy, 08-xx-2021, https://www.sciencedirect.com/science/article/pii/S0301421521002330#sec4

The current contribution of nuclear energy to climate change mitigation is small and, according to current planning, will stay at this level in the near-to mid term future. **Nuclear expansion strategies are not feasible due to resource limitations.** New nuclear technologies without those limitations will not be ready in the critical time frame 2020 to 2050 due to the long research, licensing, planning and construction times of the nuclear industry. Current plans would keep the nuclear capacity roughly at its current level mainly by life time extensions of existing reactors. But given the limited contribution to climate mitigation, complete phase out is a feasible option as well. **Society must decide**, given the drawbacks of the use of nuclear energy (risk of catastrophic accidents, proliferation, radioactive waste), **whether the nuclear option should be pursued, or** whether **other climate change mitigation tech**nologies should substitute the nuclear contribution.

Absent renewables, grids collapse. Heinberg 22

Heinberg Senior Fellow at the Post Carbon Institute and member of The Climate Mobilization advisory board (Richard Heinberg, November 24, 2022, "The renewable energy transition is failing," Alter Net, https://www.alternet.org/2022/11/renewable-energy-transition-is-failing)

The transition from fossil fuel to **renewables** faces an uphill battle. Still, this switch **is an essential stopgap strategy to keep electricity grids up and running**, at least on a minimal scale, as civilization inevitably turns away from a depleting store of oil and gas. **The world has become so dependent on grid power for communications**, finance, and the preservation of technical, scientific, **and** cultural **knowledge that, if** the **grids** were to **go down** permanently and soon, it is likely that billions of people would die, and the survivors would be culturally destitute. In essence, **we need renewables for a** controlled **soft landing**. But the harsh reality is that, for now, and in the foreseeable future, the energy transition is not going well and has poor overall prospects

Mitigating climate change through renewables is crucial. Bird '20

Susan Tierney and Lori Bird, 5-12-2020, "Setting the Record Straight About Renewable Energy", World Resources Institute, https://www.wri.org/insights/setting-record-straight-about-renewable-energy

In the U.S. and in virtually every region, when electricity supplied by wind or solar energy is available, it displaces energy produced by natural gas or coal-fired generators. The type of energy displaced by renewables depends on the hour of the day and the mix of generation on the grid at that time. Countless studies have found that because output from wind and solar replaces fossil generation, renewables also reduce CO_2 emissions. For example, an NREL study found that **generating 35% of electricity using wind and solar** in the western U.S. **would reduce CO_2 emissions by 25-45%**. Solar and wind farms have dominated new power plant builds in the U.S. in recent years, while fossil fuel plants—particularly coal-fired plants—continue to be retired at record pace. In 2019, wind (9.1GW) and solar (5.3GW) represented 62% of all new generating capacity, compared to 8.3GW of natural gas, while 14GW of coal-fired capacity was retired. The U.S. Energy Information Administration (EIA) has also projected that most new electric generation added in the U.S. in 2020 could come from wind and solar, with new natural gas plants projected to represent less than a quarter of new generating capacity. Certainly, some of these installations may be delayed by the COVID-19 pandemic. While natural gas builds exceeded those of renewables in 2018, reversing the earlier trend of renewables leading, there were 12.9GW of coal-fired capacity and 4.6GW of gas-fired capacity retired in that same year, according to EIA.

Climate change risks lives. Pearce '23

Pearce and Parncutt '23 [8/16/2023, "Quantifying Greenhouse Gas Emissions in Human Deaths to Guide Energy Policy," Professor in the Department of Electrical and Computer Engineering, and in the Ivey School of Businesses, Western University, Canda, Professor, University of Graz, Australia https://www.researchgate.net/publication/373281884_Quantifying_Global_Greenhouse_Gas_Emissions_in_Human_Deaths_to_Guide_Energy_Policy]//recut vagoon

The estimates made in sections 2.1 to 2.3 are very rough but provide a useful rule of thumb for gaging a first approximation. The 1000-ton rule makes it clear that there is a marginal human death cost to every amount of warming, no matter how small. Thus, **every 0.1 °C degree of warming** can be expected to **cause 100 million deaths.** Similarly, every 0.001 °C of warming will cause a million deaths. If humanity misses the 2°C target or any of the more granular goals to stop 'dangerous climate change' [67], which appears likely according to AI models [68], rather than relax and accept it, all efforts to reduce carbon emissions can be viewed as lifesaving.