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The renewable energy market is strong despite Trump.

Copley 25 [Michael (correspondent on NPR's Climate Desk; covers what corporations are and are not doing in response to climate change, and how they're being impacted by rising temperatures.), "America's clean-energy industry is growing despite Trump's attacks. At least for now," March 12, 2025, NPR, https://www.npr.org/2025/03/12/nx-s1-5319056/trump-clean-energy-electricity-climate-change] DOA 03-17-2025//abhi☺***Brackets in OG***

Despite the **Trump administration's wide-ranging attacks on renewables** like wind and solar power, the **clean-energy industry** is on pace for **record growth** this year, according to government analysts. The buildout of big solar and battery plants is expected to hit an all-time high in 2025, accounting for 81% of new power generation that companies will add to America's electric grids, the Energy Information Administration (EIA) said in a recent report. Including **wind** projects, the share of new **power capacity** that's expected to come **online this year** from **renewables and batteries jumps** to **93%**, the EIA said. The U.S. needs all the power it can get, because electricity **demand** is **surging** for the first time in decades, industry analysts and executives say. That means kickstarting development of nuclear power and geothermal projects, burning more natural gas and, in some cases, delaying retirement of old coal plants. But in the scramble for electricity, **renewable-energy** and battery plants are **crucial**, **analysts** and **executives** say, because **they're quick to build** and **provide electricity that's** relatively **cheap**. "There is no doubt that the increased demand for electricity over the next decade, coming from data centers and advanced manufacturing, will continue to require vast amounts of renewable energy and batteries," Andrés Gluski, chief executive of The AES Corporation, a power company that owns both clean-energy and fossil-fuel plants, told Wall Street analysts recently. Still, the renewables industry faces potential upheaval. The Trump administration tried to withhold federal funding Congress previously approved for climate and clean-energy projects. Trump also ordered the government to temporarily stop issuing or renewing leases for offshore wind projects in federal waters. The Department of the Interior limited who at the agency can issue permits for renewable energy projects on public lands, which could slow permitting. And conservatives are pushing Congress to wipe out tax incentives for clean energy. If the disruptions spread, companies could abandon plans to build new power plants. That could dampen economic growth and hamstring efforts to develop data centers for artificial intelligence, a priority of the Trump administration. In an interview that aired Sunday on Fox News, Trump declined to rule out the possibility of an economic recession this year. "At a time when we're all very concerned about energy abundance and this administration's broad goal of re-establishing energy dominance, just the idea that we'd be constraining the build of new energy [infrastructure] really feels like it's rowing in the wrong direction," says Rich Powell, chief executive of the Clean Energy Buyers Association, whose members range from Amazon to ExxonMobil to Walmart. Interior Secretary Doug Burgum chairs the Trump administration's National Energy Dominance Council. An Interior Department spokesperson, Elizabeth Peace, said in a statement that the agency supports renewable-energy development "where it makes sense while ensuring that all energy sources contribute to a reliable and affordable power grid." **Demand** for clean energy 'is certainly **not going away**' The clean-energy industry has exploded over the past decade. Solar, in particular, has accelerated. Meanwhile, growth in the wind industry has slowed because of problems ranging from inflation to pushback on siting projects. The industry overall has boomed thanks to falling technology costs, federal tax incentives and state renewable-energy mandates. The market got another big boost in 2022, when President Joe Biden signed the Inflation Reduction Act, which provided hundreds of billions of dollars in federal funding for clean-energy projects, among other climate investments. **Corporations like Amazon, Meta and Google** have also played a role, **signing contracts to buy** ever-larger amounts of **renewable energy**. "I expect that that will continue," says Powell of the Clean Energy Buyers Association. "The demand is certainly not going away." Some big investors seem to take a similar view. Led by Trump supporter Steve Schwarzman, the investment firm Blackstone said in February that it raised $5.6 billion for its "energy transition" business, which in the past has invested in companies that work in the renewable energy industry. Also last month, Brookfield Asset Management agreed to buy a U.S. renewable energy business for more than $1.7 billion. "Renewables will be the biggest beneficiary of growing electricity demand because they are **the cheapest option**, and [electricity buyers] will always absorb as much of the cheapest source of power before turning to more expensive forms of power," Brookfield's chief executive, Bruce Flatt, told Wall Street analysts in February. Congressional

Tariffs Supercharge the UQ

Bearak Last Week [Bearak, Max, et al. "How Tariffs Could Upend the Transition to Cleaner Energy." The New York Times, 3 Apr. 2025, www.nytimes.com/2025/04/03/climate/trump-tariff-clean-energy-transition.html.]

In **recent** years, many **solar, wind and battery manufacturers** had sought to open new factories in the United States, spurred by generous tax credits and incentives from the 2022 Inflation Reduction Act. The United States now has the capacity to make 50 gigawatts' worth of solar modules, enough to satisfy U.S. demand, although it still imports many of the underlying components such as cells and wafers.

This year, wind, solar and batteries are projected to make up 93 percent **of new electric capacity added to American grids.** In many places, building new wind turbines or installing solar panels are often the cheapest ways to generate additional electrons.

In theory, **tariffs could spur more domestic clean energy manufacturing in the United States.**

Government investment shifts private investment to nuclear

Melanie **Windridge 23**; April 13; PhD plasma physicist and science communicator best known for her book Aurora: In Search of the Northern Lights and her educational work on fusion energy with the Institute of Physics and the Ogden Trust; Forbes, "Investors Hold The Key To Fusion And Our Clean Energy Future," https://www.forbes.com/sites/melaniewindridge/2023/04/13/investors-hold-the-key-to-fusion-and-our-clean-energy-future/, Accessed 3-12-2025, ARC–recut Lex RR–SR

But **investors** also need government **support** and **certainty**. That's one reason why the U.K. is currently in a strong position for fusion energy development, because they have outlined their plans for a regulatory framework for fusion while other countries are still in discussion.

It goes further than technology regulation, however. **Policy** and **incentives** will be **required** in the financial services industry to **drive** the effective **reallocation** of **capital**.

Michelle Scrimgeour, Chief Executive of Legal & General Investment Management, gave evidence to a 2022 U.K. parliamentary inquiry entitled 'The financial sector and the U.K.'s net zero transition'.

Scrimgeour said: “A successful transition to a decarbonised economy, consistent with less than 1.5 degrees warming, will require a substantial change in capital allocation. Several trillion dollars a year of incremental capital will need to be invested into low carbon energy, energy infrastructure and energy efficiency. For this capital allocation to occur, a financial services industry that is aligned with net zero outcomes will be crucial. Equally, this requires global policy action at international governmental level, particularly on an effective regulatory structure to price carbon and other greenhouse gases.”

So while investors hold the key to the success of fusion and our clean energy future, it’s not just down to investors—**gov**ernment **policy** will be **crucial** in **enabling investors** to **drive** the **change**.

That kills renewables. It diverts attention, resources, and lacks grid compatibility, and it’s significantly more expensive and takes time to build.

CAN 24 Climate Action Network, 3-18-2024, "POSITION PAPER: The nuclear hurdle to a renewable future and fossil fuel phase-out," [Climate Action Network (CAN) Europe is Europe’s leading NGO coalition fighting dangerous climate change. We are a unique network, in which environmental and development organisations work together to issue joint lobby campaigns and maximise their impact], https://caneurope.org/position-paper-nuclear-energy/, DOA 3-25-2025 //Wenzhuo recut //cy–recut lexmas–recut Lex RR–SR

More than three-quarters of the EU’s greenhouse gas emissions stem from our energy consumption, therefore it is vital to stop burning fossil fuels to limit temperature rise to 1.5°C, the Paris Agreement target. Together with members, and external experts, we developed our Paris Agreement compatible (PAC) energy scenario, which provides a robust, science-based pathway for Europe’s energy landscape. On the basis of this work, CAN Europe advocates for a phase-out of coal by 2030, gas by 2035, and a 100% renewables-based energy system by 2040, which requires the phase-out of nuclear power by then. The disruption of nuclear power can be observed in many countries, not only in Europe. In Dubai, at COP28, CAN was strongly opposed to and called out countries, supporting and signing the pledge led by the USA, UK, France and 18 other countries to globally triple nuclear power in the next 25 years. This goal is much higher than the high bracket of International Energy Agency (IEA) scenarios, already based on improbable hypotheses and risks to distract from the tripling of Renewable Energy capacities that was agreed by a much larger group of countries at COP28. In 2023, there was an **alarming push** and a surge in support **for nuclear power** within the EU political space. This development is creating significant tension with proponents of energy sufficiency and a fully renewable energy system and marks a regressive step in efforts towards a sustainable and just energy transition. While nuclear champions claim that nuclear energy can work hand-in-hand with renewables, it is becoming increasingly clear that nuclear power acts as a significant hurdle to energy efficiency investments, the roll-out of renewables and fossil fuel phase-out in three spheres: the EU political debate, energy system planning, and decentralisation. Climate Action Network International, the global umbrella under which CAN Europe participates, with a community of almost 2000 members from civil society, in more than 130 countries, stands united in opposing new and existing nuclear power stations. In 2020, we reviewed and agreed the CAN Charta, the ‘highest’ document for all CAN members, the international secretariat and the regional nodes, and we listed under strategies “Promoting a nuclear-free future”. A hurdle in the policy debate The starting gun for a renewed attempt at a nuclear renaissance was the inclusion of nuclear in the EU Taxonomy in 2022, and can be seen as the nuclear lobby’s blueprint for its future ambitions – creating a large political debate using arguments of “technology neutrality” and a “level playing field” and forming alliances with fossil fuel advocates (in this case, fossil gas) in order to reduce ambition to sustainable solutions. Since then, a French-led campaign, manifested through the 14 Member State “Nuclear Alliance”, coupled alongside the lobbying activities of the nuclear industry, has run roughshod through EU energy and climate policy over the last two years. Continuing the narrative of “technology neutrality” and a “level playing field”, this mission has aimed at promoting nuclear energy at the direct expense of a transition to a 100% renewable-based energy system, in legislation such as the Renewable Energy Directive, Electricity Market Design and Net Zero Industry Act. Attempting to lower renewable ambition In the context of the Renewable Energy Directive (RED III) revision, France tested the waters in 2023 by calling for a low-carbon ‘weighting’ in EU renewables target in order to support a higher EU 2030 renewable energy target of 45%, where so-called ‘low carbon’ energy sources are taken into account when establishing national renewable energy targets. Though this did not see the light, a concession was won on renewable hydrogen and gained provisions to facilitate nuclear-produced hydrogen – risking further watering down a renewables-based technology pathway. The EU Commission launched its proposal for the Net Zero Industry Act (NZIA) in March 2023 as a response to the Inflation Reduction Act (IRA) of the United States. While nuclear was included as a list of technologies that were seen as making a contribution to decarbonisation, the EU Commission President, Ursula von der Leyen, refused to include it in the list of “strategic technologies”, which could receive additional support. The list was limited, as to be better targeted, at technologies such as solar, wind, energy storage, heat pumps and grid technologies. The final political agreement has led to the inclusion of “nuclear fission energy technologies” as strategic, while this debate allowed the list to become so extensive it practically loses any strategic element. Delaying fossil phase out via dirty trade-offs During the Electricity Market Design reform, nuclear and fossil fuel promoters in the Parliament attempted to **derail** a deal supporting renewables and flexibility. In the Council, due to the focus of the Nuclear Alliance on the Contracts for Difference (supported by some coal dependent countries) the negotiations were delayed by several months and conversations redirected away from renewables, leading to a deal supporting subsidies for existing and new nuclear reactors and a prolongation of subsidies to coal power plants via capacity mechanisms. Wasting time and diverting attention As the nuclear debate **aggressively** dominates political negotiations, media, and public discourse, it **blatantly diverts critical attention from** advancing the **existing,** affordable, sustainable solutions to the energy transition. This overwhelming focus on nuclear power not only overshadows but also poses a risk of **derailing** the European **energy transition**, hindering progress towards aligning with the ambitious yet achievable goal of a **100% renewable energy** system by 2040. A hurdle to a fully renewables based power system CAN Europe’s assessment of the draft National Energy and Climate Plans highlights that not a single Member State plan is aligned to a 1.5ºC compatible trajectory, nor minimum EU climate and energy requirements for 2030. **Increased ambition is required** on energy efficiency, energy savings, renewables and fossil fuels phase-out, while Member States are **betting on false solutions** to the challenge at hand, such as nuclear energy. As highlighted in our NECP analysis, the EU has inadequate renewables expansion, grossly insufficient investment in energy efficiency, late coal phase-out deadlines and gas dependence, while countries such as Bulgaria, Czechia, Estonia, France, Hungary, the Netherlands, Poland, Romania and Slovenia, are considering new nuclear that might never materialise. In 2023, Sweden has revised its 2040 target for 100% renewable electricity to 100% decarbonised electricity, to allow for continued and new nuclear power, and it is now clear that it can only happen with direct state aid. Italy, which voted against nuclear power in a referendum, is now investigating future nuclear power, while delaying quitting coal by 4 years. The largest nuclear power plant in Europe, the Zaporizhzhia Nuclear Power Plant in Ukraine, is currently occupied by the Russian military and Rosatom in an active warzone, but has not prevented Ukraine from including new nuclear power in its reconstruction. The Paris Agreement Compatible (PAC) scenario, on the other hand, emphasises renewables-based electrification, calling for determined and heightened attention to enable a 100% renewable-based EU energy system by 2040, and foresees no need for nuclear power in Europe. Nuclear power is too expensive When compared to renewables, the latest analysis from World Nuclear Industry Status Report, using the data from Lazard, determines that the levelized cost of energy (LCOE) for new nuclear plants makes it the most expensive generator, estimated to be nearly **four times more expensive** than onshore wind, while unsubsidized solar and wind combined with energy storage (to ensure grid balancing) is always cheaper than new nuclear. When compared against energy savings, analysis by Hungarian NGO Clean Air Action Group highlights that it is more economically efficient to invest in the renovation of households to save energy than in the construction, operation, and decommissioning of a new nuclear reactor. These findings were confirmed by a separate study by Greenpeace France, that showed that by investing 52 billion euros in a mix of onshore wind infrastructure/photovoltaic panels on large roofs, it would be possible to avoid **four times** more CO2 emissions than by investing the same amount in the construction of six EPR2 nuclear reactors by 2050, while electricity production triples. By investing 85 billion euros of government subsidies in energy savings by 2033, it would be possible to avoid six times more cumulative CO2 emissions by 2050 than with the construction program of six EPR 2 reactors. This would also make it possible to lift almost 12 million people out of energy poverty in a decade. Recent European projects in Slovakia, the UK, France, and Finland demonstrate the dramatic rising costs. EDF admitted that the costs for the British nuclear facility Hinkley Point C will skyrocket to 53.8 billion euros for the scheduled 3.2 GW power plant, more than twice as much as scheduled in 2015 when the plant was approved. The French project in Flamanville was originally projected to cost 3.3 billion euros when it began construction in 2007, but has since risen to 13.2 billion euros (16.87 billion euros in today's money). The Finnish Olkiluoto-3 project 1.6GW reactor cost 3 times more than the original forecast price, reaching 11 billion euros. Slovakia's second generation reactors Mochovce 3 and 4 ballooned costs to 6.4 billion euros from an initially estimated 2.8 billion. Slovenia's president announced that a new 1.6GW reactor would cost 11 billion euros, following the Finnish example, demonstrating that these high prices are here to stay. In order to finance new and ongoing projects, the EU has approved State Aid for nuclear, in the case of Hungary, Belgium, and the United Kingdom, while national governments seek support schemes. Despite making references to technology-neutrality, this creates an unlevel playing field slanted against renewable energy. Given the significant investment gap to achieve 2030 climate targets, and the limited fiscal space of many Member States, investments in nuclear risk **diverting precious public resources** into projects of poor value-for-money compared to alternatives in a renewables-based system, while reducing the availability of public resources for all other components of the energy transition. Such a choice would equally fail to reduce prices for consumers in the context of the current fossil fuel energy crisis. Finally, the costs would be even larger if accounting for "unpaid externalities" borne by taxpayers and the public at large, from nuclear accident risks that are impossible to insure against by private actors. The costs of decommissioning of a nuclear power plant, which can cost 1-1.5 billion euros per 1000 MW, are often borne by the public as these costs are poorly taken into account when planning a new nuclear installation. The cost associated with storing radioactive waste for hundreds of thousands of years is also often undervalued, alongside costs associated with radioactive leaks from plants or storage facilities, as demonstrated by the radioactive leaks in the UK Sellafield site, causing tension with Ireland and Norway. To lower costs, attempted lowering of safety and environmental standards can be expected, posing risks to communities, nature, and society at large, also as a burden to future generations. New nuclear construction is too slow A rapid transition requires the use of existing technologies and solutions which can most quickly be rolled-out such as renewables, primarily solar and wind, energy efficiency, and system flexibility. For years, new nuclear energy projects in Europe have been plagued with delays and, coupled with an untrained workforce, are unable to support the speed of decarbonisation necessary. New nuclear plants typically take 15-20 years for construction, hence failing to address immediate decarbonisation needs to 2030. Indicatively, France's six new reactors are estimated by its network operator to enter into use in 2040-2049, much too late to have any meaningful impact on emissions reduction needed already now, with a view to pathways to 2050, and beyond, for a sustainable future. The decision to build the UK's Hinkley Point C nuclear reactor was announced in 2007 with an operational start date of 2017, however it has been delayed several times over, and is now estimated to start in 2031. In France, the Flamanville project is 16 years into construction and hitting new delays, while Finland's Olkiluoto took a full 18 years to come online. Nuclear does not support energy autonomy Nuclear power units equally fail to pass an "energy security" test, and run counter to the RepowerEU target of enhancing Europe's autonomy, given that more than 40% of the EU's Uranium is imported from Russia and no EU country is currently mining uranium within its own borders . Though Kazakhstan is seen as an alternative, its uranium industry is directly tied to Rosatom. While import bans have been placed on Russian coal and liquified natural gas, and Russian oil and natural gas have been targeted, this has not been the case for uranium. A hurdle to a decentralised future The declaration to triple nuclear power by 2050 signed by only 22 countries, 5 of which do not have nuclear reactors, on the sidelines of COP28 describes nuclear power as "source of clean dispatchable baseload power", a common message of the nuclear industry used to argue against a 100% renewable system and nuclear's use as a substitute for traditional fossil fuel generation. This claim, however, is misleading and outdated. Europe is moving beyond a highly centralised energy system, towards one which is decentralised, digitalised, and able to flexibly adjust to changing patterns of generation and consumption. In a 100% renewable energy system, the need for traditional "baseload" power is obsolete and with distributed energy production, in a far more interconnected European Union, security of supply is better managed. Nuclear power production is not reliable Nuclear power units across Europe have been proven as **unreliable** in providing power when needed. Future climatic conditions, such as **heatwaves, droughts, flooding** and rising sea-levels only increase the likelihood of future nuclear power plant disconnections and pose further security risks. In 2022, on average French nuclear reactors had 152 days with zero-production. Over half of the French nuclear reactor fleet was not available during at least one-third of the year, one-third was not available for more than half of the year, and 98% of the year 10 reactors or more did not provide any power for at least part of the day. The myth of the need for nuclear baseload has been debunked for years. The energy system can be reliably and safely managed with 100% renewables and system flexibility. Blocking renewables integration into the electricity grid

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 **distribut**ed **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.

Prolonging the inevitable with nuclear extensions

While European governments may be tempted to prolong existing nuclear reactors beyond their original foreseen lifespans, in the context of phasing out Russian gas, costly **upgrades to** the ageing **nuclear** fleet, **just like investing in new ones**, **risks diverting investment** away **from more cost-effective** solutions such as **renewables**, energy efficiency, and system flexibility, in addition to risking lowered safety standards **and** security of supply as ageing increases unplanned outages.

Any prolongation of existing nuclear power plant units risks the continued **crowding out of renewable** energy **sources from the** electricity **grid**, **preventing** their **price-dampening** effects on the market. So-called "Small Modular Reactors" European lawmakers are increasingly persuaded by the empty promises of Small Modular Reactors (SMRs). Argued to be more flexible, decentralised, smaller, and cheaper than existing nuclear designs, countries are wasting public resources in favour of a non-existent product, riddled with the same limitations as their predecessors, and presenting poor value-for-money compared to existing alternatives. The focus on SMRs risks delaying the development of renewable energy technologies already available at the moment, and thereby prolonging the usage of fossil fuels., , Burdened by the same high capital costs, SMRs would have to run near constantly to reduce losses, thereby further congesting the grid and making them useless in providing back-up power needed for peak hours against renewables and energy storage. Nuclear energy is too risky and unsafe Nuclear technology inherently carries the risk of severe nuclear accidents with the release of large amounts of radioactivity as shown by catastrophic accidents in Fukushima or Chornobyl. **Extreme** and more frequent **weather** events due to climate change create **unprecedented** risks through storms or flooding that are not captured in planning standards for nuclear plants based on historic frequencies and severeness. Extreme weather events may also indirectly affect nuclear plants, such as breaking dams above nuclear plants or longer disconnection from electricity grids after storms. **Cyber attacks, military aggression** e.g. Russia's occupation of the Zaporizhzhia Nuclear Power Plant, and terrorist attacks, e.g. via drone attacks, could also lead to severe accidents of nuclear plants. Nuclear waste remains a risk worldwide to the health of all living creatures, including humans, for thousands of years after its use in energy production. Management of any future storage facility would still be at risk of natural disasters and decisions of future generations, whereas currently without any long-term solutions risks are increasingly shifting to interim storage which were not planned for the current supply and length of storage. Beyond decarbonisation For heightened climate ambition, renewables, energy efficiency, storage, interconnection and flexibility are best suited to make up this gap in generation and support increased renewables-based electrification, while phasing out fossil fuels in parallel. Given the poor speed and high costs of future nuclear projects, the difficulty to build several units at the same time, and the realities of SMRs, it is unlikely nuclear will be able to cover any significant part of Europe's energy needs by 2040. The future energy system will be far more decentralised, and active consumer and flexibility oriented, which are not the ideal conditions for new nuclear plants. For these reasons stated above, it is in the nuclear industry's interest to delay Europe's progress and keep in place the current centralised, fossil-based energy system, jeopardising climate goals, in the hope that projects are able to materialise in the future, and to lower safety standards to reduce costs. Nuclear energy is also at odds with an energy system based on democratic ownership of energy production, as opposed to renewables. A true democratic debate on nuclear has not been underway, but rather a capture by geopolitical interests and corporations. Problems in three identified spheres, the political debate, energy system planning, and decentralisation have been mapped as current and possible future areas where nuclear advocates may be actively hostile towards renewables and fossil fuel phase out. Though we must look beyond energy and decarbonisation, and have a holistic vision of nuclear power, incorporating drawbacks such as safety, waste, weapon proliferation, uranium dependency, operation in warzones and biodiversity.

Perception, siting, spent fuel, AND staffing independently zero investment.

William **Fletcher &** Craig B. **Smith 23**. **Served as an officer and engineer in the Navy working on the design and operation of nuclear-powered ships, as well as an engineer involved with the design and construction of commercial nuclear power plants. Later, he focused on industrial development and automation. **Engineer and former faculty member at UCLA. "Can we overcome the hurdles for nuclear power revival?" 4/14/23. https://thehill.com/opinion/energy-environment/3950501-can-we-overcome-the-hurdles-for-nuclear-power-revival/

The **spent fuel problem** must be resolved before we embark on an expansion of nuclear power. All reactors, including SMRs will have depleted nuclear fuel that **has to be disposed**. In over 50 years, the U.S. government hasn't been able to reach a politically acceptable **solution**. Today, all the spent fuel is stored at each reactor site, even for those reactors that have been decommissioned. Several other countries already have acceptable means to dispose of spent fuel.

Siting can be an issue. Where will we put new nuclear power plants? Most people **don't want to live near a nuclear power plant** even if the **experts tell** us that **new designs are** much **safer**. It can take a **long time to select and get approval** of a site for a new reactor.

Funding could be a problem. New nuclear plants are funded by private capital. It **takes 30 years** or so to **recover the large up-front investment** required to build a nuclear power plant. Nuclear power plants are expensive to build, but they are estimated to be less expensive to operate. However, if the cost of their electricity is not competitive, they will not be able to recover the investment involved.

Staffing and training could **take time.** The large number of skilled people needed have to see a reasonably secure future for nuclear power before they will commit their careers to this industry.

That's key to stopping climate change

Zero carbon energy production means renewables solve.

IRENA 17 [IRENA, 2017, "ISBN 978-92-9260-044-0", The International Renewable Energy Agency (IRENA) is a lead global intergovernmental agency for energy transformation that serves as the principal platform for international cooperation, supports countries in their energy transitions, and provides state of the art data and analyses on technology, innovation, policy, finance and investment. IRENA drives the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, and energy security, for economic and social resilience and prosperity and a climate-proof future.
IRENA's membership comprises 169 countries and the EU. Together, they decide on the Agency's strategic direction and programmatic activities, in line with the global energy discourse and priorities to accelerate the deployment of renewables-based energy transitions worldwide.
https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/IRENA_A_key_climate_solution_2017.pdf?la=en&hash=A9561C1518629886361D12EFA11A051E004C5C98]/dshah

The year 2016 was the world's hottest on record, surpassing 2015 and marking the third consecutive year of record average temperatures. In fact, of the 17 hottest years on record, 16 have occurred in the 21st century (NOAA, 2016). As it stands, the world is on track to massively miss the goals set forth in the Paris Agreement,[1] with nearly 1°C of global average temperature rise already witnessed since the pre-industrial era (WMO, 2016). To stay within the agreed Paris Agreement boundaries, the world can only afford 0.6°C to 1.1°C of additional average warming (NOAA, 2016). Current country pledges, or nationally determined contributions (NDCs), could initiate an emission decline in the coming years, but they are not sufficient to reach climate goals. Efforts must be strengthened.

Around **two-thirds of GHG emissions stem from energy production** and use, which puts the **energy sector at the core of efforts to combat climate change.** The largest CO_2-emitting sectors are electricity generation and industry, together responsible for about 65% of all energy-related CO_2 emissions today. The remaining 35% comes from transport, buildings and district heating (IRENA, 2017c).

[1] To limit global temperature increase to well below 2 degrees Celsius (2°C) above preindustrial levels.

The energy **sector needs** a total overhaul, with a transformation from fossil-based to **zero-carbon energy production** by the second half of this century. Today, 84% of energy use comes from fossil fuels, with 16% derived from renewables (IRENA, 2017c). Analysis by the International Renewable Energy Agency (IRENA) shows how, through accelerated uptake, 65% of energy use could come from renewables by 2050. This would be enough for countries to meet the Paris Agreement climate goals. Renewable energy currently represents about 25% of global electricity generation, with the rest generated by fossil fuels, according to IRENA's global energy roadmap, known as "REmap". Around 80% of all electricity in 2050 could be generated by renewable energy (IRENA, 2017c).

The transformation to a sustainable energy system with high shares of renewables would meet climate goals and pay for itself. It would lead to USD trillions in economic growth between now and 2050, and the health, environmental and climate benefits would save up to six times more than the additional costs associated with reconfiguring the energy sector, all while creating millions of jobs in the process (IRENA, 2017c).

Figure 1: CO_2 emissions reduction potential from all sectors under current plans and policies vs. accelerated uptake of renewables in 2050

Notes: Gt = gigatonnes; yr = year. CO_2 emissions include energy-related emissions (fossil fuel, waste, gas flaring) and process emissions from industry. If only fossil fuel emissions were displayed in this figure, CO_2 emissions would start from 32 Gt in 2015 and would reach 40.5 Gt and 9.5 Gt per year in 2050 in the Reference Case and REmap, respectively. The Reference Case (also called the baseline or business-as-usual), is the most likely case based on current and planned policies and expected market developments. It reflects NDCs if they are already an integral part of a country's energy plan, which is the case for around 60% of total global primary energy supply. The 2050 REmap scenario is a low-carbon technology pathway that goes beyond the Reference Case for an energy transition in line with the aims of the Paris Agreement. [2]

Accelerated deployment of renewable energy and energy efficiency measures form the key elements of the energy transition. Recent analysis shows that the world can meet around 90% of the decarbonisation needed to stay within the Paris Agreement boundaries through accelerated deployment of renewable energy and energy efficiency, with the remaining 10% to be met by other low-carbon solutions (IRENA, 2017c).

[2] Technologies covered under REmap include: renewable energy technologies for energy and as feedstock for production of chemicals and polymers; energy efficiency measures and widespread electrification that also improves efficiency; carbon capture and storage for industry; material efficiency technologies such as recycling.

Energy-related CO_2 emissions from all sectors totalled 36 Gt in 2015. These need to fall to 13 Gt in 2050 to achieve the REmap scenario, a reduction of 70% compared to the Reference Case, under which emissions are estimated to reach 45 Gt in 2050. Renewable energy could provide 44% of these reductions (20 Gt per year in 2050), as illustrated in Figure 1. **To enable thi**s dramatic emissions reduction, the share of **renewable energy must rise** from around 16% of the primary energy supply in 2015 to around 65% in 2050.

Renewable technologies could generate more than 80% of all electricity by 2050, with the remaining 20% generated by natural gas and nuclear. By 2050, **emissions** from electricity generation **would plummet** by **85%** in the REmap scenario, despite the fact that electricity generation is expected to increase by nearly 80% (IRENA, 2017c).[3]

Coal-based power generation would cease altogether. Besides increasing shares of renewables, the decrease in power sector emissions is also due to energy efficiency measures taken in industry and buildings to reduce electricity use for heating and cooling. Emissions in the buildings sector would decrease by about 70% by 2050. Transport emissions would be halved, while industry would become the largest emitter of CO_2.

Two-thirds of global greenhouse gas (GHG) emissions stem from the production and use of energy. This puts the energy sector at the core of efforts to combat climate change

The current electricity system evolved over many decades with fossil fuels at the centre. New power generation technologies require a new electricity system that is flexible and allows the integration of variable sources, such as solar and wind energy. Electricity generation from these variable renewables fluctuates according to resource availability and may not coincide with demand. This can cause difficulties in matching supply and demand, requiring flexibility to deal with variability. A range of flexibility options exist and will be needed as the role of variable renewables grows.

Under REmap, the share of wind and solar in power generation would increase to 52% by 2050, requiring a range of flexibility options to ensure grid stability, including time of-use electricity pricing, adaptation of market designs and new business models. Additional interconnectors, flexible fossil fuel generation and demand-side response can also increase flexibility, thus enabling higher shares of variable renewable energy. An often-discussed flexibility option is storage, which comes in many forms. Today, around 4 700 gigawatt hours (GWh) of electricity storage exists, 96% of which comes from pumped hydro (IRENA, 2017b). Under REmap, 11 900-15 300 GWh of electricity storage is expected by 2030, with only 51% from pumped hydro.[4] With an average battery pack of 50 kilowatt hours (kWh) per vehicle, electric vehicles alone could provide about 8 000 GWh of battery storage by 2030.

[3] Electricity generation is anticipated to increase to 43 000 terawatt hours (TWh) per year by 2050, up from 24 100 TWh in 2015. [4] Reference Case estimates 6 600-7 800 GWh of storage by 2030.

This would help to accommodate higher shares of wind and solar through flexible charging, when there is surplus generation and electricity prices are low. To achieve the conditions needed for electric vehicles to provide significant benefits to electric power systems by 2030, IRENA estimates that 160 million electric vehicles will be needed worldwide by then (IRENA, 2017a).

While the power sector holds great potential for renewables, electricity accounts only for around 20% of final energy use today. As a result, IRENA analysis points to an essential role for renewable energy technology deployment in end-use sectors. Such a role is especially important because together they account for approximately 80% of all global energy demand today. In the end-use sectors, REmap shows that the renewable energy share can grow to 78% in buildings, 38% in industry and 53% in transport by 2050 (IRENA, 2017c).[5] In transport, the number of electric vehicles needs to grow and new solutions will need to be developed for freight and aviation. New buildings will have to meet the highest efficiency standards, while existing buildings must be rapidly renovated. Buildings and city designs should facilitate renewable energy integration.

The energy transition can fuel economic growth and create new employment opportunities. The renewable energy sector alone could support around 26 million jobs in 2050,[6] with new job creation in renewables and energy efficiency more than offsetting job losses in the conventional energy sector (IRENA, 2017d). In fact, net energy sector employment in the REmap scenario (including in energy efficiency) would be higher by 6 million additional workers in 2050 compared to the Reference Case (IRENA, 2017c). Furthermore, global GDP would be 0.8% higher in 2050 compared to the Reference Case, a cumulative gain of USD 19 trillion from 2015 to 2050.[7] This overall improvement in GDP would induce additional job creation in other economic sectors as well.

The energy transition is technically and economically feasible. Drastic cost reductions have been instrumental in the unprecedented scale-up of renewable energy we are currently witnessing. Among the most transformative developments of the current decade has been the dramatic and sustained improvement in the cost-competitiveness of renewable electricity generation technologies. Technology learning and the opening up of new markets in countries with high resource potential continue to make renewables increasingly attractive.

Nine-tenths of the necessary emissions reduction can be achieved through accelerated uptake of **renewables** and energy efficiency

Since the end of 2009, solar photovoltaic (PV) module prices have fallen by around 80% and the price of wind turbines by 30-40% (IRENA, 2016). Biomass for power, hydropower, geothermal and onshore wind technologies can all now provide electricity that is competitively priced compared to fossil fuel-fired electricity generation.

The levelised cost of electricity from solar PV fell by more than 68% between 2010 and 2016, meaning it is also increasingly competitive with conventional power generation technologies at utility scale. Onshore wind has witnessed an 18% decline in its levelised cost of electricity since 2010, while offshore wind has seen a 9% decline over the same period. IRENA analysis predicts further substantial cost reductions in the coming decade (IRENA, 2016).

Cost reductions have opened the door to an energy transition that makes economic sense. Early action, however, is essential to capitalise on the economic opportunities available while avoiding the future costs of stranded assets. Delayed policy action would result in significant asset stranding in comparison to an energy transition where accelerated renewable energy and energy efficiency deployment begins today.

Early action is critical to reduce the stranding of economically valuable assets.[8] Delaying decarbonisation of the energy sector would require higher levels of investment to achieve the same objectives and would double stranded assets. In the REmap scenario, cumulative stranded assets from 2015 to 2050 would total USD 10 trillion, coming largely from buildings that need to be replaced because of low energy efficiency, and upstream energy infrastructure and assets (gas, oil and coal that must stay in the ground). This would double to USD 20 trillion to reach the same emissions objective by 2050 if effective mitigation policy was delayed by only one decade (IRENA, 2017e). To put this into context, USD 20 trillion is approximately 4% of global wealth in 2015 terms.[9]

Taylor 19 (Chris Taylor, graduate of Merton College, Oxford and the Columbia University Graduate School of Journalism., 2019, "The Catastrophe: Climate change and the 22nd Century," Mashable, https://mashable.com/feature/climate-change-future-22nd-century , DOA: 1-28-2022)**(MS)**

Many of my contemporaries found such comparisons overblown. In which case, I advised they read The Uninhabitable Earth by David Wallace-Wells, a round-up of the latest climate science currently giving a lot of readers nightmares. Often, scientists of our era mince their words and make conservative projections. Wallace-Wells, in stitching their research together, is unafraid to describe the interconnecting calamities of a relentlessly warming world. And it's hard to gainsay any of it. More droughts, more storms, rising seas, rising disease: all are coming, all will make each other worse. To take one minor aspect of The Catastrophe: air pollution, which **climate change** is already making worse, **will kill an estimated 150 million** more **people** worldwide **for every [1] degree celsius of warming**, researchers

C2: Cyber

Nuclear energy development is down right now

Dianne **Plummer 25**. "Power Play: The Economics Of Nuclear Vs. Renewables." *Forbes*. 02/12/2025. https://www.forbes.com/sites/dianneplummer/2025/02/12/power-play-the-economics-of-nuclear-vs-renewables// Accessed: 04/07/2025. Sachin

Government Subsidies and Investment Trends: Nuclear Vs. Renewables

Despite the **declining costs of renewables**, government **subsidies still play a crucial role** in energy economics. Nuclear research and **development has significantly decreased** in relative terms since the 1970s as investments have become more **diversified**. In 2015, the International Energy Agency reported that nuclear technologies received just 20% of the public R&D energy budget, a steep decline from nearly 73% in 1975. In contrast, funding for energy efficiency and renewable technologies has **grown substantially**, with both receiving shares of energy R&D comparable to nuclear in 2015. According to the "Energy Subsidies: Evolution in the Global Energy Transformation to 2050" report, global direct energy sector subsidies—spanning fossil fuels, renewables, and nuclear—totaled approximately USD 634 billion in 2017. Fossil fuel subsidies dominated, accounting for about 70% of the total (USD 447 billion), while renewable energy subsidies accounted for 20% (USD 128 billion), biofuels 6% (USD 38 billion), and nuclear received at least 3% (USD 21 billion). However, the actual total could be higher due to data gaps, particularly in sub-national subsidies. Their analysis of nuclear subsidies reflects a minimum estimate for existing nuclear power generation.

According to the report, total annual energy sector subsidies are expected to decline, with projections estimating a reduction to USD 466 billion per year by 2030, with a slight increase to USD 475 billion in 2050. This would represent a 25% decrease from 2017 levels and a 45% reduction (USD 390 billion) from the projected subsidy levels without the realistic acceleration of renewable energy deployment. In the U.S., the Inflation Reduction Act (2022) provides tax credits for wind and solar projects, contributing to a surge in renewable investments.

China leads the world in renewable energy investments, allocating $546 billion in 2022, according to Scientific American.

The Caribbean Context Renewables Vs. Nuclear

Caribbean governments have historically taken a project-by-project approach to renewable energy development. However, the region's small and isolated islands, combined with limited space for large-scale solar or onshore wind farms, have posed challenges to achieving economies of scale. Additionally, the lack of a local supply chain and the inability to procure at scale make renewable energy projects more expensive in the Caribbean. According to IRENA, Caribbean Community Member States have set a regional goal of generating 47% of their electricity from renewable sources by 2027. To meet this target, Caribbean islands need to add 4 GW of renewable energy capacity, requiring an estimated USD 9 billion in additional investments to fulfill their Nationally Determined Contributions. Through the Small Island Developing States Lighthouses Initiative, IRENA offers support to SIDS in their energy transition by providing policy, regulatory, and technical advisory services, as well as facilitating knowledge sharing, capacity building, and funding for early-stage projects. The 15 Caribbean islands participating in the LHI have a combined installed power capacity of approximately 1,936 MW, consisting of 743 MW of hydropower, 640 MW of bioenergy, 327 MW of solar photovoltaic, and 225 MW of wind energy. Additionally, SIDS are the countries that will feel the effect of climate change with the decimation of their coastlines.

On the other hand, nuclear energy remains absent from the region due to high capital costs, safety concerns, and lack of expertise. Jamaica is working to integrate nuclear power into its energy mix, having signed a memorandum of understanding with Canadian Nuclear Laboratories and Atomic Energy of Canada Limited. According to the Prime Minister, this initiative aims to leverage nuclear technology to produce clean electricity, while also promoting economic growth and enhancing energy security for the country. However, introducing nuclear power in Jamaica's energy mix is unlikely to significantly improve energy security due to the high costs, long lead times, and reliance on foreign expertise and resources for nuclear technology. Additionally, the raw materials required for nuclear power plants, such as uranium, would still need to be imported, further limiting the potential for true energy independence.

Nuclear and Renewables: Weighing the Future of Energy

As the global energy transition accelerates, the debate between nuclear power and renewables remains **complex**. While nuclear energy offers high-capacity, low-carbon baseload power, it is often hindered by **long construction timelines**, cost overruns, **waste issues** and **decommissioning** challenges. Conversely, renewables such as solar and wind continue to experience declining costs and rapid deployment, supported by government subsidies and technological advancements. However, integrating intermittent renewables into the grid requires significant investment in storage and infrastructure. In regions like the Caribbean, renewables face unique geographical and economic challenges, while nuclear remains largely absent due to financial, lack of expertise and logistical barriers. Although some nations, including Jamaica, explore nuclear options, the high costs and foreign dependency may limit its viability and will still leave them desiring energy security. Ultimately, **the choice between nuclear and renewables hinges on economic feasibility**, policy support, and **technological advancements**, and requires a balanced approach to ensure a sustainable and resilient energy future.

New nuclear energy is vulnerable

Chatham 24 [Chatham House, July 12, 2024, "Cybersecurity of the civil nuclear sector", Chatham House – International Affairs Think Tank, https://www.chathamhouse.org/2024/07/cybersecurity-civil-nuclear-sector/2-threats-and-risks-civil-nuclear-infrastructure]//dshah + spok + shassy + Lex RR–SR

A combination of factors – from energy security and decarbonization agendas to the emergence of small modular reactors (SMRs) that potentially make nuclear energy more accessible – are prompting many countries to consider adopting, or increasing their use of, nuclear energy. But the prospect of more nuclear power plants, many of them more digitally connected than in the past, coming into operation in more countries makes ensuring the cybersecurity of civil nuclear infrastructure more critical than ever. This paper considers the evolving cyberthreats that the civil nuclear sector faces both in peacetime and during conflict. It outlines key vulnerabilities in the sector, including the use of older or bespoke software, a **safety culture insufficiently attuned to digital and cyber risks,** and the emergence of novel risks around the use of SMRs and microreactors. The paper then outlines the existing international legal frameworks that already apply to the issue and can help protect the civil nuclear sector from cyberthreats, and proposes steps to improve cybersecurity. These steps include doing more to interpret and leverage international law in the relevant areas, and enhancing operational protections such as cyber incident-response planning.

This paper builds on previous Chatham House research into the cybersecurity of civil nuclear facilities. **The paper draws on an extensive review of existing work in the field,** as well as on interviews with a wide range of relevant stakeholders in the cybersecurity and nuclear industries.[6] Three themes emerged from our latest work in this area. Firstly, it is clear that **the nuclear industry was a** comparatively **late starter in considering cybersecurity,** at least relative to other industries associated with critical national infrastructure (CNI) or to commercial sectors such as finance. The nuclear industry's strong pre-existing physical security, and its use of bespoke or uncommon industrial control software, meant that there was a sense within the sector that all aspects of security were sufficiently covered. However, in recent years, as ever more systems in nuclear power plants have acquired digital elements, including commercial off-the-shelf software solutions, **more cyber vulnerabilities have been introduced.** This has increasingly left systems and facilities open to a potential attack vector that has been insufficiently addressed. In some respects, the civil nuclear industry is thus still playing catch-up. The UK's 2022 Civil Nuclear Cyber Security Strategy[7] exemplifies the problem by setting goals that, while sensible, should ideally have been reached several years earlier. Similar shortcomings in national cybersecurity frameworks have been pointed out repeatedly since the mid-2010s by a variety of actors, including the International Atomic Energy Agency (IAEA). Secondly, due to the specific regulatory environment involved, the nuclear industry is isolated from other industries when it comes to exchange of best practice. This makes learning from best practice on cybersecurity difficult, as pathways to knowledge exchange are ad hoc, often informal, and largely based on the personal drive and networks of individuals in cybersecurity roles. There is also a

lack of transparency about cybersecurity incidents, due to concerns both about acknowledging and **advertising** vulnerabilities, **and** about **how vulnerabilities might be perceived by the public.** The nuclear industry's preoccupation with perceptions can get in the way of transparency, even though stronger disclosures would help to bolster confidence in the safety of working practices.

The nuclear industry's preoccupation with perceptions can get in the way of transparency, even though stronger disclosures would help to bolster confidence in the safety of working practices.

Thirdly, governments often have limited ability to enforce cybersecurity standards. In part, this reflects the fact that nuclear energy installations are privately operated in many countries. Efforts to ensure private operators meet cybersecurity standards are often ineffective or inefficient, resulting in delays, slow progress and inconsistencies between operators. While government regulators, such as the Office for Nuclear Regulation (ONR) in the UK, typically conduct regular inspections and can recommend and mandate requirements, the nature of licensing systems for nuclear operators means that long periods of risky working practices are often tolerated, and that government often has limited power to intervene. Even where civil nuclear infrastructure is state-owned, moreover, facilities may operate at arm's length from government.

Some of the challenges in this area were highlighted by the investigation into cybersecurity at the Sellafield nuclear waste site in the UK. Sellafield was repeatedly flagged in ONR inspections for 'enhanced regulatory attention' on cybersecurity practices.[8] ONR then brought criminal charges against the operator Sellafield Limited for having gaps in its cybersecurity from 2019 to 2023, charges to which Sellafield Limited pleaded guilty in June 2024.[9] Concerns about regulators' ability to influence the cybersecurity practices of operators, and about the accessibility of best-practice recommendations, are not exclusive to the UK. A review by the George Washington University of cybersecurity practices across a range of nuclear operators in different countries found that 'none of the proposed guidelines have holistically provided detailed security procedures specific to the architecture and working of [nuclear power plants]'.[10] France's nuclear regulator, the Autorité de sûreté nucléaire (ASN), highlighted concerns about EDF's supply-chain management, especially for SMR projects, in a January 2024 press update.[11]

To address some of the challenges outlined above, the IAEA has done important work to standardize and improve cybersecurity guidance across the civil nuclear industry globally.[12] This can

help address the fact that some national regulators provide only general cybersecurity guidance that fails to take into account challenges specific to the civil nuclear industry.

Cybersecurity challenges require a higher level of attention across all levels of the industry, to ensure gaps in risk mitigation can be closed swiftly. Some of the barriers to achieving this exist globally. They include: 1) **a lack of transparency across the industry**, with regulators often discussing cybersecurity gaps only with specific operators rather than sharing concerns more widely, and operators reluctant to disclose their own cybersecurity gaps for fear of the impact on trust in their services; 2) the gap between guidance and implementation; 3) differing levels of capacity and investment in cybersecurity from one country to another.[13]

Civil nuclear infrastructure is vulnerable to cyber operations due to its high value as a target, and due to features inherent in the information technology required to run and operate facilities.[14] The nuclear sector's designation as critical national infrastructure (CNI) in many countries could encourage cyber operations originating from a range of actors – including both states and non-state groups – and for a range of motives. Such actors could, for instance, include: anti-nuclear-energy hacktivists; cybercriminals looking to blackmail facilities, operators or governments, seeking ransom, or intending to steal confidential information; state actors wanting to target another state's CNI to jeopardize that state's energy security or gain military advantage; or terrorists looking to advance their own agenda.[15]

Cyber incidents can also occur accidentally as a result of existing vulnerabilities in commercial software. These vulnerabilities include: entry poin**ts such as inadequate IT infrastructure maintenance; missing patches and updates; and unsafe working practices such as connection to unprotected networks, the use of portable storage devices, the use of legacy systems, and inadequate data protection**. **Crucially, these vulnerabilities can also open a backdoor for targeted cyber operations, providing an attack vector f**or hostile actors. This range of potential threats makes it doubly essential to ensure fundamentally secure working practices, as it is very difficult to **identify and protect against every individual vulnerability.**[16]

The cyber vulnerabilities of civil nuclear facilities are summarized in Table 1: significant limiting factor when assessing past cases of cyber operations targeting nuclear power plants is the lack of publicly available information on such incidents. This can reflect concerns on the part of operators, regulators and governments about the release of sensitive data, and about the potential for revelations of cybersecurity failures to reduce public trust in nuclear energy. However, publicly known past examples of cyber operations against civil nuclear infrastructure cover a range of scenarios. One of the earliest-known incidents was in 2003, when the Slammer worm infiltrated the management and operational information and communication technology (ICT) systems of the Davis-Besse nuclear power plant in the US.[18] Slammer was able to access the power plant's system through an IT consultant's infected device. While this was an accident, it exemplifies how malicious actors could go about engineering an attack.

Two other well-researched examples are the 2010 Stuxnet worm attack in Iran, and the 2014 hack of a South Korean nuclear power operator, Korea Hydro and Nuclear Power Co., Ltd (KHNP). These two examples show the range of harms that cyber operations can cause, from the theft of sensitive data to physical damage. The Stuxnet example was extraordinary in the extent of the damage it caused, whereas the KHNP example is more typical of other cyber operations against nuclear power plants. What both have in common is that the attackers were alleged to be states: Israel and the US in the case of the Stuxnet attack on Iran's nuclear facilities; and North Korea in the case of KHNP.

Stuxnet remains one of the most famous intentional cyber operations targeting nuclear infrastructure. The operation sought to disrupt operations at Iran's Natanz nuclear enrichment facility. Stuxnet was a computer worm targeting supervisory control and data acquisition (SCADA) systems. Once inside the industrial control system, the worm caused the control software to accelerate rotation of the centrifuges to the point of physical damage.[19] This makes it one of the only examples of a cyber operation having caused physical damage.

KHNP, South Korea's state-run nuclear power operator, was targeted in December 2014. In this cyber operation, sensitive information was stolen, including blueprints for reactors, electrical flow charts and personal details of employees. One of the hackers' goals was to undermine public trust in the safety of the nuclear power plant.[20] But the South Korean government said that the hackers had not managed to access any control systems.[21]

As the Stuxnet episode shows, cyber operations have the potential to cause tangible damage to physical assets.[22] **The impact of a cyber operation targeting civil nuclear infrastructure can** be as wide-ranging as the theft of sensitive information, the loss of access to or control over monitoring and control software, operating difficulties, or – in the worst-case scenarios **– reactor shutdown or difficulties controlling nuclear** storage, for example through loss of access to external power sources for cooling.[23] There is only a small possibility that a cyber operation would cause loss of control over a nuclear reactor to the point of meltdown or a significant release of radiation. This is because nuclear power plants have other redundant safety features such as back-ups for cooling.[24] However, the potential impacts if a meltdown or major radiation release did occur could be very significant, including deaths or long-term health problems among nuclear power plant workers or members of the public exposed to radiation, as well as long-term environmental damage and contamination. **A cyber operation targeting a nuclear facility also has the potential to disrupt the electric grid. States that have nuclear power plants often rely on nuclear power to provide a reliable baseload of energy to their electric grid. This dependency is increasing as countries transition away from fossil fuels.** A stable baseload is required for a steady availability of energy throughout the day. However, not all types of energy generation offer a uniform power supply over the course of a day. Solar and wind power rely on certain environmental conditions for optimal performance. On a rainy or windless day, for example, other forms of energy generation must make up for the lack of solar- or wind-generated power. Nuclear energy, in contrast, can always generate power. If an electric grid became unreliable because nuclear power was unable for some reason to provide a reliable baseload – for example, as a result of a cyber operation – this could disrupt many aspects of daily life. Affected areas could include economic activity, the functioning of government, transport links, healthcare facilities and other critical public services. This in turn could cause elevated levels of distress in the population, and even excess deaths if healthcare functions were compromised.[25] Given that many countries are considering nuclear energy due to increasing energy demand and a desire to transition away from fossil fuels, it is now all the more critical to ensure that new nuclear power plants and new reactor types are designed with cybersecurity in mind. The following section explores two emerging technological developments and their impacts on the risk landscape for civil nuclear infrastructure. The first is the evolution of nuclear reactor technologies themselves, as well as their increased distribution through the advent of small modular reactors (SMRs) and microreactors. The second is the rise of artificial intelligence (AI), in terms of both its increasing capabilities and widening usage. AI could lower the barrier to malicious cyber operations by making tools for cyber intrusions more accessible and affordable for a wider range of actors, including potential hackers or cybercriminals.[26]

The development of SMRs and microreactors provides an opportunity to increase energy security in areas where a traditional, larger nuclear power plant might be too difficult or expensive to build. In comparison to traditional nuclear infrastructure, which tends to take decades to plan and build, SMRs or microreactors could be deployed more quickly in areas where there is a significant energy need. Some SMRs are designed to be transported or deployed offshore, making them potentially more versatile than traditional nuclear power plants. The IAEA is aware of over 80 different SMR designs and concepts that are at different stages of development and implementation. As of early 2024, five SMR designs were under construction or operating.[27] The operating and monitoring software used in SMRs and microreactors will be less bespoke than in some older models of nuclear power plant. Indeed, one of the selling points of the newer designs is that SMRs and microreactors are easier to run, given that staff are more likely to be familiar with the operating software.

Likewise, one of the purported advantages of SMRs and microreactors is that it is possible to control several reactors remotely at the same time. In some cases, **SMRs and microreactors are intended to be operated fully remotely, without any staff on site**. This increases the requirements for software solutions that **are cloud-based or connected to the internet.**

Cybersecurity is typically a consideration in the design of newer reactors in a way that has not been the case with traditional nuclear power plants, as older plants were developed at a time when cybersecurity standards did not yet exist or were just emerging. The risk landscape around such designs is mixed. On the one hand, newer reactors are designed to be fundamentally safer and more secure from a cybersecurity point of view. Cybersecurity is typically a consideration in their design in a way that has not been the case with traditional nuclear power plants, as older plants were developed at a time when cybersecurity standards did not yet exist or were just emerging. In this way, some vulnerabilities might be removed at the design stage by drawing on cybersecurity best practice.

On the other hand, the fact that **SMR**s are less bespoke than many more traditional reactor designs, and in many cases **are connected to the internet, makes them more likely to have cyber vulnerabilities**. In turn, this makes newer reactors more of a target for opportunistic cybercriminals. Security solutions such as 'air gapping' (which means not connecting critical parts of the control system to the internet) are often not possible in such cases due to the requirement for remote access.

In addition, increased deployment of SMRs and microreactors could create novel risks. **First, if there are more reactors overall, the risk of any one reactor falling victim to a cyber operation increases**. Another risk stems from **the construction supply chain. Many companies** are likely to be involved in the production of parts for these reactors. It is **unclear whether such parts will consistently be designed with cybersecurity principles in mind. Therefore, the security of the supply chain could become very difficult to guarantee in its entirety.**[28] The IAEA is working with SMR designers to ensure that all new designs meet stringent safety standards for reactor and fissile-material safety. But ensuring the cybersecurity of the supply chain for SMRs and microreactors could present additional challenges, because a wide range of hardware manufacturers and software developers might all be suppliers for the same SMR or microreactor project. This highlights how important – and difficult – it will be for manufacturers to audit and monitor their supply chains for cybersecurity. In addition to these inherent risks, it is envisaged that many SMRs and microreactors will be deployed in countries that may have lower cybersecurity capacity to begin with.[29] Such countries might struggle to ensure the additional cybersecurity requirements of nuclear reactors. The IAEA provides guidance on how to ensure a high standard of cybersecurity for nuclear reactors. However, as implementation is down to national governments, standards can vary according to the awareness and capacity of each government or operator.

As mentioned, adding to the civil nuclear industry's risk of exposure to malicious cyber operations is the fact that **hacking is arguably getting easier.** Hacking tools are **more widely available**, and the emergence of **AI**-assisted programming tools may **lower the barrier to entry for cybercriminals**. Vulnerable sectors such as CNI could thus be targeted by a wider range of criminals who previously may not have been able to use cyber tools.[30]

Adversaries uniquely try to penetrate US critical infrastructure – Kushner 16

David Kushner. 2016. "The Geeks on the Front Lines." Rollingstone.com. 2016. https://www.rollingstone.com/interactive/feature-the-geeks-on-the-frontlines/. Spok

After decades of seeming like a sci-fi fantasy, the cyberwar is on. **China, Iran and other countries** reportedly **have armies of state-sponsored hackers infiltrating our critical infrastructure**. The **threat**s are the stuff of a Michael Bay blockbuster: downed power grids, **derailed trains, nuclear meltdowns.** Or, as then-Defense Secretary **Leon Panetta put it last year, a "cyber-Pearl Harbor... an attack that would cause physical destruction and the loss of life, paralyze and shock the nation and create a profound new sense of vulnerability."** In his 2013 State of the Union address, President Obama said that "**America must also face the rapidly growing threat from cyberattacks**. . . .We cannot look back years from now and wonder why we did nothing in the face of real threats **to our security and our economy**." The pixelated mushroom cloud first materialized in 2010 with the discovery of Stuxnet, a computer worm said to be designed by the Israeli and U.S. governments, which targeted uranium-enrichment facilities in Iran. Last fall, Iranian hackers reportedly erased 30,000 computers at a Middle Eastern oil company. In February, security researchers released a report that traced what was estimated to be hundreds of terabytes of stolen data from Fortune 500 companies and others by hackers in Shanghai. **A leaked report** from **the Department** of **Homeland Security** in May **found** "increasing **hostility**" aimed online **against "U.S. critical infrastructure** organizations" – power grids, water supplies, banks and so on. Dave Marcus, director of threat intelligence and advance research at McAfee Federal Advanced Programs Groups, part of McAfee Labs, a leading computer-security firm, says the effects would be devastating. "**If you shut off large portions of powe**r, you're not bringing people back to 1960, **you're bringing them back to 1860," he says**. "Shut off an interconnected society's power for three weeks in this country, **you will have chaos."**

Cyberattacks initiate meltdowns

Van Dine 16 [Alexandra Van Dine, Csis Poni, 5-17-2016, "The Cyber Threat to Nuclear Facilities", Nuclear Network, https://nuclearnetwork.csis.org/the-cyber-threat-to-nuclear-facilities/]//SPok + shassy

In April, a German company announced that it had suffered a cyber attack. This is not shocking. As retired Marine Gen. James Cartwright has said, there are two realities for companies today: "You've either been hacked and [are] not admitting it, or you're being hacked and don't know it." But this attack was on a nuclear power plant. **And the malware found inside the plant allo**wed hackers to access sensitive plant information from afar. Stuxnet illustrated the art of the possible in the cyber-nuclear space. **This malware defeated security systems, jumped airgaps (which disconnect networks from the internet) and, most importantly, caused physical consequences. Stuxnet's aim was limited—break centrifuges**. But what if hackers had more catastrophic ambitions? Well-resourced hackers can achieve physical consequences at nuclear facilities with cyber attacks, possibly resulting in theft of nuclear material or sabotage. For example, **surveillance systems** or **keycard readers could be disrupted**, allowing thieves to enter a **facility, steal nuclear material**, and depart uninterrupted. A sophisticated **cyber attack** could even **cut power to cooling systems**, **resulting in** a Fukushima-like **meltdown**. **Several factors exacerbate this threat. Increased reliance on digital** controls and technological vulnerabilities across the **nuclear enterprise increase opportunities for attackers.**

Meltdowns are deadly,

Christopher Allen **Slocum 15**, VP @ AO&G, "A Theory for Human Extinction: Mass Coronal Ejection and Hemispherical Nuclear Meltdown," 07/21/15, The Hidden Costs of Alternative Energy Series, http://azoilgas.com/wp-content/uploads/2018/03/Theory-for-Human-Extinction-Slocum-20151003.pdf

With our intelligence we have littered the planet with massive spent nuclear fuel pools, emitting **lethal radiation** in over-crowded conditions, with circulation requirements of **electricity**, **water**-supply, and neutron **absorbent chemicals**. The failure of **any** of these conditions for any calculable or incalculable reason, will release all of a pool's **cesium** in**to** the **atmosphere**, **causing 188 square miles to be contaminated, 28,000 cancer deaths and $59 billion in damage.**

2NC:

On Climate

1. **NU: Emissions down**

Gaffney et al 25 (Michael Gaffney: research analyst with Rhodium Group's Energy and Climate practice, attended UC San Diego School of Global Policy and Strategy where he earned a Master of Public Policy specializing in energy and environmental policy. He holds a bachelor's degree in political economy from UC Berkely. Ben King: associate director with Rhodium Group's Energy and Climate practice, focusing on the effects of policy and economic changes to the US energy system. He previously worked for the US Department of Energy in the Office of Energy Efficiency and Renewable Energy. John Larsen: partner at Rhodium group where he leads the firm's US energy system and climate policy research, a non-resident Senior Associate at the Energy and National Security program at CSIS. He has lectured at Johns Hopkins and Amherst College. He holds a master's degree in Environmental Policy and Planning from Tufts University. January 9, 2025, "Preliminary US Greenhouse Gas Emissions Estimates for 2024", Rhodium Group, https://rhg.com/research/preliminary-us-greenhouse-gas-estimates-for-2024/ . DOA March 17, 2025) CLS

Since peaking in 2004, emissions have trended downward in a bumpy fashion. But after a significant decline in 2023, we estimate that 2024 emissions were down by just 0.2% year-on-year while the economy grew by 2.7%, continuing a decoupling of emissions and economic activity. Emissions are still below pre-pandemic levels and remain about 20% below 2005 levels, the benchmark for US commitments under the Paris Agreement. Lower manufacturing output drove the overall decrease in 2024 emissions, with industrial sector emissions falling by 1.8%. In the oil and gas sector, continued reductions in methane emissions intensity led to a 3.7% drop in emissions. Increased air and road travel partially offset these reductions, which drove up transportation sector emissions by 0.8%. Demand for electricity—led by the residential sector—also rose by 3% and was met by higher natural gas, wind, and solar generation, while coal generation saw just a

slight decline. For the first time, combined solar and wind generation surpassed coal, although overall power sector emissions increased by a slight 0.2%. In the buildings sector, emissions crept up 0.4% due to slightly elevated fuel use. The modest 2024 decline underscores the urgency of accelerating decarbonization in all sectors. To meet its Paris Agreement target of a 50-52% reduction in emissions by 2030, the US must sustain an ambitious 7.6% annual drop in emissions from 2025 to 2030, a level the US has not seen outside of a recession in recent memory. Economic growth and slightly lower emissions in 2024 Economic growth is one of the major determinants of GHG emissions, and in 2024, the US gross domestic product (GDP) expanded at a projected annual rate of 2.7%. This growth was driven by strong consumer spending as well as public and private investment, despite persistent inflation, high interest rates, and elevated labor and materials costs. Clean technology played a significant role. Record-high investment in the manufacturing and deployment of clean technologies accounted for 5% of total private investment in structures, equipment, and durable consumer goods in Q3, according to the latest data from the Clean Investment Monitor, a joint effort between Rhodium Group and MIT's Center for Energy and Environmental Policy Research (CEEPR). While the economy grew, we estimate that US GHG emissions fell slightly in 2024. The US will get its final GHG report card for 2024 when the EPA finalizes its annual GHG inventory in spring 2026. However, using preliminary economic and energy activity data, we project that economy-wide emissions declined by just 0.2% in 2024 (Figure 1). This puts US emissions at about 20% below 2005 levels, and down by 8% from pre-pandemic levels.

Pref: we are only side analyzing emissions data, even if climate is bad right now, we have good process with out renewables becoming more powerful and increasing. Most recent piece of evidence right now

2. **Our CAN evidence which is the most recent says that nuclear energy has vast issues in impementation which is what causes it's failure**
3. **It's NOT clean.**

Anna **Kahler 24**. Communications Manager at Oregon PSR. "Small Modular Nuclear Reactors." Oregon Physicians for Social Responsibility. 3-5-2024. https://www.oregonpsr.org/small_modular_nuclear_reactors

NOT Clean Energy

Producing **nuclear energy** is **incredibly unclean** when you take into consideration all of the **steps** and **processes** in the **cycle**. It starts with **uranium mining**, then the ore is processed and **enriched**, transported for power production to the reactors themselves, and finally ends with **radioactive waste**. "Except for **power production**, CO2 emissions are **created throughout the nuclear fuel cycle**," causing climate change by warming the planet. The process creates nuclear waste, the possibility of radioactive contamination during transport, potential for accidents, and end of life decommissioning (when the plant reaches the end of its capacity to produce energy so the site must be demolished and cleaned up).

When you perform a Google search to define "**clean energy**," you will see pages of information about **renewable energy sources** (such as **wind** and **solar**) that are **non-polluting**. In 2021, a house bill was passed in Oregon state to set clean energy targets, but their narrow definition of what is considered "non emitting electricity" turns nuclear power into "clean energy." HB 2021 states that, "'Non emitting electricity' means electricity, including hydroelectricity, that is generated and may be stored in a manner that does not emit greenhouse gas into the atmosphere." This language lets nuclear power fall into the clean energy category and allows them to compete for funding with renewable energy that's clean, economical and available now.

4. **Affirming necessitates new transmission lines.**

Miet 24 [Hannah; October 14th; Founding Editor of The Red Deal, Commercial Real Estate Reporter for Urban Land; "Nuclear Power Makes a Comeback as Data Centers Adapt to Rising Power Demands"; Urban Land; https://urbanland.uli.org/resilience-and-sustainability/nuclear-power-makes-a-comeback-as-data-centers-adapt-to-rising-power-demands] cameron

Regulatory challenges

In the U.S., regulatory barriers can prevent green solutions from scaling. Utility grids are not connected, and renewable plants often exist far from population centers. Connecting them requires new transmission lines, but the process of getting them is plagued by lengthy schedules and delays, according to Daniel Crosby, CEO of Legend Energy Advisors.

That triggers permanent deforestation.

Williams 03 [Dr. James H.; October 3rd; Professor of Applied Mechanics in the Mechanical Engineering Department at the Massachusetts Institute of Technology, Ph.D. in Engineering from the University of Cambridge; "International Best Practices for Assessing and Reducing the Environmental Impacts of High-Voltage Transmission Lines"; Nautilus Institute; https://www.nautilus.org/wp-content/uploads/2015/06/Env_Best_Practices_Williams_final.pdf] cameron

Transmission line construction and maintenance can lead to the permanent removal of woody vegetation and in some cases to the complete conversion of strips of forest ecosystem into bare land or land covered by completely different vegetation communities. Fragmentation, pesticide use, and invasive plant species within the right-of-way can also affect surrounding forest areas.

5. On this land use idea realize that nuclear power plants are also extremelu

OV:

The thesis

Tariffs Mean Nuclear Energy is not going to do good

Pomper 25 [Miles A. Pomper, Yanliang Pan, 3-10-2025, Miles Pomper is a **Senior Fellow** in the Washington DC office of CNS. His work focuses on nuclear energy, nuclear nonproliferation, nuclear security, and nuclear arms control. He holds a master's degree in international affairs from Columbia University and a master's degree in journalism from Northwestern University. Before joining CNS he served as Editor-in-Chief of *Arms Control Today* from 2003-2009. Previously, he was the lead foreign policy reporter for *CQ Weekly* and *Legi-Slate News Service*, where he covered the full range of national security issues before Congress, and a Foreign Service Officer with the US Information Agency. "Trump's Tariffs on Canada Could Kill the U.S. Nuclear Energy Revival", World Politics Review, https://www.worldpoliticsreview.com/us-nuclear-energy-tariffs/]//dshah

Hopes for a U.S. nuclear energy revival may be **jeopardized by the tariffs that President Donald Trump continues to threaten to impose** on Canada, as well as his plans to similarly target the European Union moving forward.

That's because the **nuclear industry depends on a global supply chain** that can take uranium concentrate from Kazakhstani mines, for instance, convert it to uranium hexafluoride in Canada and enrich the product in France, before finally delivering it to a U.S. fuel fabricator. **Trump's tariffs will make that exceedingly complicated, costly and precarious, to the great detriment of the U.S. nuclear sector.**

Flexible global market mechanisms have allowed the U.S.—a country with negligible uranium mining activities and limited downstream conversion and enrichment capacity—to secure enough fuel to operate the largest fleet of nuclear reactors worldwide, producing some 20 percent of the country's electricity. All that will change if the Trump administration follows through on its threatened 10 percent tariff on uranium imports from Canada, among other products—which were imposed on March 4 but subsequently removed—amid threats of broadening the trade war to the EU. Trump left in place an additional 10 percent tariff he announced on March 4 on Chinese uranium imports, which were already under a 17.5 percent tariff as of Feb. 4.

As of 2023, more than **95 percent of** the **uranium purchased by U.S. utilities was of foreign origin.** Canada accounted for the largest share at just over 25 percent. Further downstream along the supply chain, only around one-third of the uranium conversion and enrichment capacity needed to keep U.S. reactors running are domestically located, with the rest sourced from the EU, Canada, Russia and China. For the U.S. nuclear industry, the tariffs would be all harm and no benefit, not least because U.S. nuclear fuel buyers will have to swallow much of the costs. Ever since the first Trump administration contemplated tariffs on uranium products in 2019, the Canadian uranium supplier Cameco has included provisions in its fuel contracts to ensure that any future U.S. tariffs would be passed on to the buyer. Nor will the impact on prices be confined to Canada and the EU, for **once tariffs kick in, all suppliers will have an incentive to raise their asking price**. And the **U.S. utilities will have** to pay given their inelastic demand and—in some cases—**limited inventories.**

To make matters worse, the same **uranium material may have to leave the U.S. for conversion,** enrichment and fuel fabrication before re-entering the country, thereby **triggering the tariff a second and even third time**, quickly compounding domestic fuel costs. Fuel prices have already spiked in recent years due to geopolitical turbulence as well as expectations that rising demand for low-carbon fuel sources and electricity—needed to power data centers and electric cars—will spark a nuclear renaissance. Recurring tariffs may further **erode utilities' thin operating margins,** further burdening an industry that is just beginning to recover from its post-Fukushima decline as well as competition with cheap natural gas from fracking.

Will U.S. domestic fuel producers benefit from these tariffs? The answer, for the most part, is no. Mining, conversion and enrichment are capital-intensive industries, and companies wait for long-term price signals when deciding whether to undertake the cumbersome and time-consuming process of restarting or expanding operations. For those companies previously on the verge of such a decision, skyrocketing uranium prices in recent years have already provided the necessary demand signal, and a tariff would make little difference. In conversion and enrichment, meanwhile, **domestic producers** would **lose** foreign **customers** reluctant to pay a tariff on any uranium feed material they ship to U.S. facilities for further processing. And if **reactors** do **shut down** due to higher fuel and operating costs, demand on uranium products and services will fall, thus threatening recent commitments to capacity expansion by U.S.-based fuel producers, which have given the domestic supply chain its first hopes of recovery in more than a decade.

In no small part due to the protests of U.S. utilities and foreign nuclear fuel suppliers alike, the first Trump administration in 2019 decided not to impose trade restrictions on uranium imports following a lengthy investigation into whether they threatened national security. Even the domestic uranium producers that petitioned for trade protection in the first place eventually applauded the "no action" decision as it ended 19 months of market uncertainty.

From a market perspective, the only thing worse than tariffs is arguably the uncertainty over future **tariffs.** Unfortunately, Trump's flip-flopping on the import duties threatened for Canada, combined with those expected for the EU, will likely represent only the **begin**ning of **an uncertain period**. There are still questions, for instance, over how long tariffs on various products that may be imposed will remain in place, given the administration's signals of sector-specific exemptions. Logistically, great uncertainty also remains over how tariffs would apply to book transfers and swaps that are common in the nuclear industry, as well as over how U.S.-origin material stored at foreign warehouses would count versus foreign-origin material at U.S. facilities. `

The expectation of tariffs leading into the March 4 announcement had already led to a price premium on uranium held within the United States. Any further tariffs would now risk bifurcating the market between U.S.- and foreign-origin uranium products, with the potential to disrupt supply chains. Uranium traders have not tracked the physical origins of traded material for decades. For an industry accustomed to a globally interconnected open market, a return to the practice of tracking uranium origins all the way through the supply chain could impose unforeseen logistical burdens and supply disruptions, if it can even be done.

Still, the greatest open question is over the retaliatory export restrictions that major nuclear fuel suppliers might impose on the U.S. in response. **The Canadian government has been contemplating retaliatory controls** and taxes on major export commodities bound for the U.S., **including uranium.** If **Canada wants to retaliate in the civil nuclear sector**, it can. **Beyond uranium, the leading U.S.-based vendor of reactor technology, Westinghouse Electric Company, is now Canadian-owned. And U.S.-based companies marketing small modular reactors, from NuScale to GE-Hitachi, have received their first crucial orders from European and Canadian customers. Without these demonstration projects, their reactor designs will remain confined to paper. To complicate matters further, U.S. companies, lacking heavy nuclear manufacturing capacity of their own, must rely on foreign suppliers of large reactor components** for future construction. North America's largest manufacturing facility for commercial reactor equipment, for instance, is the BWXT factory in Ontario, where the pressure vessel for GE-Hitachi's BWRX-300 reactor is supposed to be fabricated—that is, if the BWRX project is not canceled due to Trump's tariffs and the ensuing retaliatory turmoil.

In 2020, during the first Trump administration, the Department of Energy published a strategy paper titled, "Restoring America's Competitive Nuclear Energy Advantage," highlighting the importance of the industry for national security. Energy assurance is arguably an even bigger priority for Trump during his second term, and judging from his Jan. 20 executive order urging the return of uranium to the critical minerals list, the current White House clearly recognizes the importance of uranium as a strategic resource.

Yet imposing **tariffs** on major uranium-supplying allies is a poor way of guaranteeing the United States' uranium access, as it **risks undermining** the open market and the United States' position within it. Nor is alienating critical reactor development and deployment partners like Canada a winning strategy for restoring the U.S. civil nuclear industry, which already lacks both committed demand and supply capacity, and has for decades struggled to compete with vertically integrated Russian and Chinese state-owned enterprises. Unless the administration begins paying attention to the dangerous effects of its trade policy on the **nuclear industry, the U.S. will keep losing** in that competition.

On Space

1. **Other countries and competition solve**---creates the incentive to invest and develop.

Houser '24 [Kristin; Manager @ Freethink; April 1; Freethink; "China is one step closer to having a nuclear-powered spacecraft," https://www.freethink.com/space/nuclear-powered-spacecraft; DOA: 3-27-2025] tristan

Space race: In 2023, DARPA contracted Lockhead Martin to develop a nuclear-powered spacecraft, with the goal of having it ready for an in-space demo by 2027. Russia, meanwhile, announced in 2021 that it will have one ready for its first mission in 2030.

Now, researchers in China have reported that a nuclear reactor they're developing for the Chinese space industry has passed some initial ground tests.

According to their paper, published in the Chinese Academy of Sciences' peer-reviewed journal Scientia Sinica Technologica, they've designed a 1.5 megawatt reactor that can be folded into a package small and light enough to be delivered into space via a traditional chemical rocket.

2. **Nuclear is the worst choice.**

Engheim '19 [Erik Engheim, writer, conference speaker, video course author and software developer. 11-10-2019, "Why a Nuclear Powered Rocket is a Bad Idea", Medium, https://erik-engheim.medium.com/why-a-nuclear-powered-rocket-is-a-bad-idea-52b51f4d2c9c, doa 3-27-2025] //ALuo

Chemical rockets may be inefficient but they are **flexible**: You can relatively **easily refuel** in orbit. Feedstock to produce rocket fuel can be obtained a multitude of place: on asteroids, on the moon and on Mars. You can easily start and stop a chemical rocket, which makes them safer and more flexible to operate. Got a problem, just turn off the turbo-pump. The fuel can usually be handled by humans without too big concern for toxicity and pollution. Nuclear rocket engines are **the opposite**. Loading up with new fuel is going to be a **complicated operation**. Obtain nuclear fuel on asteroid, the Moon or Mars? Forget about it! That is going to be far into the future before we can do that effectively. With chemical rockets there is an **opportunity to** start building **space infrastructure** for **manufacturing** of fuel. This could be in orbit with material obtained from **asteroids** as well as on the **moon** or **Mars**. With a nuclear powered space future, we **kill the incentive** to start **building up** such an **industry**. This is unfortunate because it is exactly the kind of training wheels we need. The first **stepping stones** before we begin more advance manufacturing in space. **Nuclear engines** will **forever tie us to** using a **sophisticated industrial based** located on **earth**. But the future of **space exploration** is in establishing based outside of earth and being building up a **self sufficient industry**. When you start building up an industrial society from scratch it would be **madness** to base it off **nuclear power**. You are several months of travel away from a sophisticated industrial base on earth. You are **not going to have sophisticated tools, machines and nuclear physicists on site.** You need simple robust technology which you have some measure of hope of being able to maintain and fix without too specialized knowledge and advance tools.

3. T: Mars Colonization destroys ozone layer

Allen 22 (Gabe Allen, contributor for Discover Magazine, BA in Biology and Creative Writing from Skidmore. April 5, 2022. Discover Magazine. "Efforts to Colonize Mars Could Have a Negative Impact on Global Health", https://www.discovermagazine.com/environment/efforts-to-colonize-mars-could-ha v e-a-negative-impact-on-global-health . DOA: July 20, 2022.) ALP

In 1985, a group of atmospheric researchers led by Pawan Bhartia presented a terrifying satellite image to a room-full of scientists, policymakers and journalists at a conference in Prague: There was a gaping hole in the ozone layer of the stratosphere directly above Antarctica. The culprits were a group of chemicals used by refrigerator manufacturers called chlorofluorocarbons, or CFCs. Just two years later, the Montreal Protocol was signed by 46 countries; over the next decade, CFCs were phased out by industry around the globe**. Today, ozone levels are slowly rebounding. But space travel could endanger the ozone layer once again. Black carbon** is an excellent greenhouse gas — excellent in the sense that it **is very good at absorbing sunlight and converting it into heat. When rockets travel through the upper atmosphere, they raise temperatures in their wake. At the moment, there are too few space launches for this effect to be very pronounced. But** Toohey warns that **consistent launches, like the ones required to populate a Martian city, could pose a problem**. "The effect is to cause a slight temperature gradient between where the black carbon is warming things and other parts of the planet that aren't launching rockets," he says. "You end up with a change in the winds in the stratosphere and mesosphere, which may not sound like much, but those winds move ozone from one part of the planet to another. In a research project that is now more than a decade old, Toohey and his colleagues modeled **the atmospheric outcome of a scenario where 1,000 rockets were launched every year.** What they found was striking: Stratospheric **ozone levels were expected to shift by 1 percent in tropical regions and as much as 6 percent at the poles**. "You're not creating an ozone hole, but you're basically just changing things by the same amount," Toohey says. "Those are the same numbers that triggered the whole Montreal protocol." In a landmark 1995 paper, dermatologist Frank De Gruijl estimated that **even a 1 percent change in stratospheric ozone could increase the prevalence of skin cancer by 2 percent. As is the case with many environmental issues, the public health cost of emissions poses an ethical dilemma for those who are tempted by the prospect of space colonization. "Whose life is more important?" asks Toohey. "A billionaire astronaut or someone in Bangladesh?"**

4. **Fusion is impossible to achieve – too dangerous to contain and continuity is unachievable**

Feng 22 Henry Feng, 8-30-2022, "Continuous Fusion is Impossible Without a Star," [Henry Feng is a high school senior at Williamsville North High School. He is currently researching thin film nanostructured materials in The Department of Materials Design and Innovation at the State University of New York at Buffalo], https://intpolicydigest.org/the-platform/continuous-fusion-is-impossible-without-a-star/, DOA 3-29-2025 //wenzhuo

The concept of controlled nuclear fusion has been of increasing interest over the last few decades. However, the physical limitations that ultimately make controlled fusion **physically impossible** are simple and unavoidable. It is impossible to harness nuclear fusion because it is humanly **impossible** to create **continuous** fusion. Humanity has already been able to harness the power of fusion for nearly 70 years, with the testing of the first hydrogen bomb in 1954. A fusion reactor is, in essence, a repeatedly detonable hydrogen bomb used to create energy. The fundamental problem with fusion energy is that nuclear fusion is an **instantaneous** and violent release of energy. Unlike nuclear fission, which can be slowed by simply diluting the fissile material, or the number of neutrons via control rods, fusion cannot be slowed. Attempting to use fusion as an energy source is analogous to replacing gasoline with nitroglycerin in internal combustion engines. At best, we may be able to achieve a one-shot device that self-destructs in a single energy-producing cycle. Currently, leading programs have achieved fusion on tiny scales by using extremely powerful lasers to induce the implosion of a capsule filled with deuterium-tritium fuel. This method is conceptually analogous to the decades-old technology found in two-stage thermonuclear weapons, where a fission primary explosive implodes a fusion secondary charge. This advancement, where fusion ignition was achieved for a few tenths of a nanosecond, has been reported in a paper with over 1,000 listed authors in the Physical Review Letters. Nuclear fusion is the highest energy output process observed by man. The enormous release of energy results from the conversion of mass to energy during the fusion of light atoms such as hydrogen isotopes. Approximately two-thirds of the energy released during nuclear fusion is in the form of high-energy gamma rays. These gamma rays have **extreme penetrating power**, and due to their uncharged nature, cannot be contained by a magnetic field. Furthermore, neutrons are also an inevitable product of nuclear fusion. Like gamma rays, neutrons are uncharged and require many meters of dense shielding material to attenuate the ionizing power of the emitted particles. Neutron emission is particularly harmful as the ejected particles have very high kinetic energy and are around ten times more damaging to human tissue than gamma rays. Additionally, when materials are bombarded with neutrons, they can potentially become **radioactive**. Shielding material exposed to either of these emissions will **rapidly deteriorate** due to the ability of gamma rays and neutrons to destroy chemical bonds. Assuming that the ionizing radiation produced during nuclear fusion can be controlled, the infernal conditions required to initiate fusion, and produced upon successful fusion, simply cannot be contained by any fathomable means. Although it is claimed that the plasma can be contained using extremely powerful magnetic fields, it is impossible to control the electromagnetic waves produced in the 100 million kelvin reactor core. The electromagnetic radiation produced ranges the full optical spectrum, with most of the photons being released in the x-ray and gamma wavelengths. The high-intensity emission of energetic photons will heat the surrounding containment to a plasma, thus destroying the reactor. The feasibility of a fusion reactor relies on the assumption that the sun can be scaled down to produce fusion energy. Stars are simply not scalable objects as the mechanism by which they produce fusion relies on mass and gravity. Stars are born when huge clouds of hydrogen and other matter condense so that the gravitational force squeezes hydrogen atoms together, resulting in nuclear fusion. Gravity is the driving force that keeps stars lit, despite the explosive emission of energy following every fusion event; it ensures that the star does not lose mass through explosions. Gravity is the only viable containment system for continuous fusion. For this reason, it is **impossible** to achieve continuous fusion **without a star**. All other man-made fusions on smaller scales can only occur once and end in containment failure. As appealing as it may seem, and as much as we desire to utilize fusion energy, it is impossible to achieve as long as our understanding of physics is not improved. This glamorous and fancy technology is little more than the latest tech fad and is ultimately doomed to fail due to insurmountable physical limitations that can be understood by a high school student.