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#### Renewable energy is rapidly advancing in the US and solves energy needs by 2035

**Beinhocker 25** Eric Beinhocker, 2-28-2025, "The Clean Energy Revolution Is Unstoppable", [Eric Beinhocker is a Professor of Public Policy Practice at the Blavatnik School of Government, University of Oxford. He is also the founder and Executive Director of the Institute for New Economic Thinking at the University’s Oxford Martin School. INET Oxford is an interdisciplinary research center dedicated to the goals of creating a more inclusive, just, sustainable, and prosperous economy. Beinhocker is also a Supernumerary Fellow in Economics at Oriel College and an External Professor at the Santa Fe Institute.], https://www.wsj.com/business/energy-oil/thecleanenergyrevolution-is-unstoppable-88af7ed5, DOA 3-25-2025 //Wenzhuo recut //cy

Since Donald Trump’s election, clean energy stocks have plummeted, major banks have pulled out of a U.N.-sponsored “net zero” climate alliance, and BP announced it is spinning off its offshore wind business to refocus on oil and gas. Markets and companies seem to be betting that Trump’s promises to stop or reverse the clean energy transition and “drill, baby, drill” will be successful.¶ But this bet is wrong. The clean energy **revolution** is being driven by fundamental technological and economic forces that are too strong to stop. Trump’s policies can **marginally slow progress** in the U.S. and harm the competitiveness of American companies, but they cannot halt **the** fundamental dynamics of technological change or save a fossil fuel industry **that will** inevitably **shrink** dramatically in the next two decades.¶ Our research shows that once new technologies become established their patterns in terms of cost are surprisingly predictable. They generally follow one of three patterns.¶ The first is a pattern where costs are volatile over days, months and years but relatively flat over longer time frames. It applies to resources extracted from the earth, like minerals and fossil fuels. The price of oil, for instance, fluctuates in response to economic and political events such as recessions, OPEC actions or Russia’s invasion of Ukraine. But coal, oil and natural gas cost roughly the same today as they did a century ago, adjusted for inflation. One reason is that even though the technology for extracting fossil fuels improves over time, the resources get harder and harder to extract as the quality of deposits declines.¶ here is a second group of technologies whose costs are also largely flat over time. For example, hydropower, whose technology can’t be mass produced because each dam is different, now costs about the same as it did 50 years ago. Nuclear power costs have also been relatively flat globally since its first commercial use in 1956, although in the U.S. nuclear costs have increased by about a factor of three. The reasons for U.S. cost increases include a lack of standardized designs, growing construction costs, increased regulatory burdens, supply-chain constraints and worker shortages.¶ A third group of technologies experience predictable long-term declines in cost and increases in performance. Computer processors are the classic example. In 1965, Gordon Moore, then the head of Intel, noticed that the density of electrical components in integrated circuits was growing at a rate of about 40% a year. He predicted this trend would continue, and Moore’s Law has held true for 60 years, enabling companies and investors to accurately forecast the cost and speed of computers many decades ahead.¶ Clean energy technologies such as **solar, wind and batteries** all follow this pattern but at different rates. Since 1990, the cost of wind power has dropped by about 4% a year, solar energy by 12% a year and lithium-ion batteries by about 12% a year. Like semiconductors, each of these technologies can be mass produced. They also benefit from advances and economies of scale in related sectors: solar photovoltaic systems from semiconductor manufacturing, wind from aerospace and batteries from consumer electronics.¶ Solar energy **is 10,000 times cheaper** today **than when it was first used** in the U.S.’s Vanguard satellite in 1958. Using a measure of cost that accounts for reliability and flexibility on the grid, the International Energy Agency (IEA) calculates that electricity from solar power with battery storage is less expensive today than electricity from new coal-fired plants in India and new gas-fired plants in the U.S. We project that by 2050 solar energy will **cost a tenth** of what it does today, making it far cheaper than any other source of energy. ¶ At the same time, barriers to large-scale clean energy use **keep tumbling**, thanks to advances in energy storage and better grid and demand management. And **innovations** are enabling the electrification of industrial processes with enormous efficiency gains.¶ The falling price of clean energy has **accelerated** its adoption. The growth of new technologies, from railroads to mobile phones, follows what is called an S-curve. When a technology is new, it grows exponentially, but its share is tiny, so in absolute terms its growth looks almost flat. As exponential growth continues, however, its share suddenly becomes large, making its absolute growth large too, until the market eventually becomes saturated and growth starts to flatten. The result is an S-shaped adoption curve.¶ The energy provided by solar has been growing by about 30% a year for several decades. In theory, if this rate continues for just one more decade, solar power with battery storage could **supply all the world’s energy needs by** about **2035**. In reality, growth will probably slow down as the technology reaches the saturation phase in its S-curve. Still, based on historical growth and its likely S-curve pattern, we can predict that renewables, along with pre-existing hydropower and nuclear power, will largely displace fossil fuels by about 2050.¶ For decades the IEA and others have consistently overestimated the future costs of renewable energy and underestimated future rates of deployment, often by orders of magnitude. The underlying problem is a lack of awareness that technological change is not linear but exponential: A new technology is small for a long time, and then it suddenly takes over. In 2000, about 95% of American households had a landline telephone. Few would have forecast that by 2023, 75% of U.S. adults would have no landline, only a mobile phone. In just two decades, a massive, century-old industry virtually disappeared.¶ If all of this is true, is there any need for government support for clean energy? Many believe that we should just let the free market alone sort out which energy sources are best. But that would be a mistake. ¶ History shows that technology transitions often **need** a kick-start from **government**. This can take the form of support for basic and high-risk research, purchases that help new technologies reach scale, investment in infrastructure and **policies that create stability** for private capital. Such government actions have played a critical role in virtually every technological transition, from railroads to automobiles to the internet.¶ In 2021-22, Congress passed the bipartisan CHIPS Act and Infrastructure Act, plus the Biden administration’s Inflation Reduction Act (IRA), all of which provided significant funding to accelerate the development of the America’s clean energy industry. Trump has pledged to end that support. The new administration has halted disbursements of $50 billion in already approved clean energy loans and put $280 billion in loan requests under review.¶ The legality of halting a congressionally mandated program will be challenged in court, but in any case, the IRA horse is well on its way out of the barn. About $61 billion of direct IRA funding has already been spent. IRA tax credits have already attracted $215 billion in new clean energy investment and could be worth $350 billion over the next three years.¶ Ending the tax credits would be **politically difficult,** since the top 10 states for clean energy jobs include Texas, Florida, Michigan, Ohio, North Carolina and Pennsylvania—all critical states for Republicans. Trump may find himself fighting Republican governors and members of Congress to make those cuts.¶ It is **more likely that Trump** and Congress **will take actions that are politically easier,** such as ending consumer subsidies for electric vehicles or refusing to issue permits for offshore wind projects. The impact of these policy changes would be mainly to harm U.S. competitiveness. By reducing support for private investment and public infrastructure, raising hurdles for permits and slapping on tariffs, the U.S. will simply drive clean-energy investment to competitors in Europe and China.¶ Meanwhile, Trump’s promises of a fossil fuel renaissance ring hollow. U.S. oil and gas production is already at record levels, and with softening global prices, producers and investors are increasingly cautious about committing capital to expand U.S. production.¶ The energy transition is a one-way ticket. As the asset base shifts to clean energy technologies, large segments of fossil fuel demand **will permanently disappear**. Very few consumers who buy an electric vehicle will go back to fossil-fuel cars. Once utilities build cheap renewables and storage, they won’t go back to expensive coal plants. If the S-curves of clean energy continue on their paths, the fossil fuel sector will likely shrink to a niche industry supplying petrochemicals for plastics by around 2050.¶ For U.S. policymakers, supporting clean energy isn’t about climate change. It is about maintaining American economic leadership. The U.S. invented most clean-energy technologies and has world-beating capabilities in them. Thanks to smart policies and a risk-taking private sector, it has led every major technological transition of the 20th century. It should lead this one too.

#### However, nuclear energy risks derailing it by refocusing investment

**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

¶ 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. ¶

#### Grid technology for nuclear blocks off renewable energy, keeping fossil fuels on the grid.

**CAN 24 finds** “POSITION PAPER: The nuclear hurdle to a renewable future and fossil fuel phase-out.” CAN Europe. March 18, 2024. [https://caneurope.org/position-paper-nuclearenergy/.](https://caneurope.org/position-paper-nuclear-energy/) Accessed March 8, 2025.

**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[ing] the connection of new renewable energy projects,** where even announced and then abandoned plans for a new nuclear unit can **delay renewable projects connection, allowing for continued fossil fuel usage.** Grid structures designed for large-scale, centralised nuclear power, make it more challenging, time-consuming and costly to introduce small-scale distributed renewable power.

#### That’s terrible, as climate change is a looming crisis. Numerous experts confirm nuclear energy is too slow and expensive to help the environment, despite the affirmative’s claims

Luke **Haywood et. al**, No Publication, 8-16-20**23** // // Why investing in new nuclear plants is bad for the climate // https://www.sciencedirect.com/science/article/pii/S2542435123002817 // accessed 3-28-2025 // ashe

**There has been a strong push to promote** increased **investments in** new **nuclear power** as a strategy to decarbonize economies, **especially** **in the** European Union (EU) and the United States (**US). The evidence base for these initiatives is poor**. Investments in **new nuclear** power **plants are bad for the climate due to high costs and long construction times**. **Given the urgency of climate change** mitigation, which requires reducing emissions from the EU electricity grid to almost zero in the 2030s (Pietzcker et al.1), **preference should be given to the cheapest technology that can be deployed fastest**. On both costs and speed, **renewable energy** sources **beat nuclear**. **Every [dollar]** euro **invested in new nuclear plants** thus **delays decarbonization** compared to investments in renewable power. In a decarbonizing world, delays increase CO2 emissions. Our thoughts focus on new nuclear power plants (not phasing out existing plants) in the US and Europe. In Europe, new nuclear power plants are planned or seriously discussed in France, Czechia, Hungary, Poland, Bulgaria, Slovenia, Sweden, and the United Kingdom. We do not focus on China, where government-set electricity prices and subsidized capital costs make it more difficult to contrast the profitability of different types of energy sources.

# Thus, our sole argument concerns an environmental tradeoff

## Our first point is waste

#### Nuclear waste is long-lasting and highly hazardous even in small quantities, while efforts to dispose of it are costly and counterproductive

Martina **Igini 22** (Martina Igini, 9/12/2022, The Nuclear Waste Disposal Dilemma, Earth.Org, https://earth.org/nuclear-waste-disposal/, Accessed 3-29-2025, wayway)

**In the nuclear energy equation, the storage and disposal of nuclear waste play a huge role. This comes in two forms: from leftover fuels used in nuclear power plants and from facilities involved in nuclear weapons production.** Regardless of the source, this hazardous wast**e contains highly poisonous chemicals like plutonium and uranium pellets. These extremely toxic materials remain highly radioactive for tens of thousands of years**, posing a threat to agricultural land, fishing waters, freshwater sources, and humans. For this reason, it is crucial that they are meticulously and permanently disposed of. Two of the world’s biggest nuclear accidents – the Fukushima nuclear disaster (2011) and the Chernobyl disaster (1986) – were responsible for the release of a significant amount of radioactive isotopes into the atmosphere, which created huge consequences for people and the environment. These disasters raised concerns about the storage and disposal of nuclear waste and led governments to find safer alternatives to this form of energy. However, in recent years, countries like France, the US, China, and India have shown renewed interest in nuclear power, announcing plans to build new plants in the years ahead as part of their net-zero roadmaps. Take Action Join The Movement Today EARTH.ORG MEMBERSHIP According to Rystad Energy, investments in nuclear are projected to reach US$46 billion in 2023, up from $44 billion in 2021. Furthermore, following the energy crisis amid the conflict in Ukraine, European countries that are highly dependent on Russian oil like Belgium delayed their plans for a nuclear phaseout. While this form of electricity is emission-free and thus a better alternative to highly polluting fossil fuels, the decision of several nations to keep relying on nuclear energy sparked fears related to the dangers of highly radioactive spent fuel. Indeed, while 55 new reactors across the world are currently being built, not enough people are considering the complexity of dismantling plants and storing nuclear waste. You might also like: The Advantages and Disadvantages of Nuclear Energy How Are Countries Dealing With Nuclear Waste? Since the 1950s, when early commercial nuclear power stations started operating, more than 250,000 tonnes of highly toxic nuclear waste have been accumulated and spread across 14 countries worldwide. **In most cases, the highly radioactive material is collected and stored in inactive nuclear power plants**. In the case of Chernobyl, some of the plant’s reactors **still contain an enormous amount of waste that will remain dangerous for tens of thousands of years.** In 2019, one reactor was finally encased below an enormous steel and concrete structure. **However, the US$1.6-billion construction will safely store the radioactive material for only about a century and is thus [which is] just a temporary solution.** Ukraine is not the only country that decided to store nuclear waste in power plants that are no longer operating. The largest quantity of untreated nuclear waste on the planet is currently stored in the Sellafield plant in the UK. **Yet, the maintenance of these sites can be extremely costly and it requires a large amount of manpower.** Despite having shut down in 2003, more than 100,000 employees are involved in ongoing cleanup and nuclear-decommissioning activities at Sellafield that are expected to last more than a century and will cost the government a staggering US$118 billion. While these temporary measures prove to be a safe solution to nuclear waste storage, engineers are now studying ways to dispose of it permanently. You might also like: Nuclear & the Rest: Which is the Safest Energy Source? What About Nuclear Necropolis? The Example of Finland **One of the best solutions so far seems to be to bury nuclear waste underground** and about a dozen European countries have already made plans for deep geological repositories for their spent fuel. However, their plans have hit political roadblocks. **The first and only successful example of this kind to date is Finland’s plan to entomb its 2,300 tonnes of high-level waste in an underground hardrock mine. After decades of negotiations, planning, and long geological and environmental considerations, the Finnish government selected the Island of Olkiluoto – located in the municipality of Eurajoki and home to two of the country’s four reactors, which generate 32% of the total electricity in the country – as the most suitable location for a long-term storage facility.** In 2004, works began encapsulating waste inside copper canisters, which were buried in 400-450-metre deep underground tunnels below the island’s granite bedrock. Now, Finland is close to completing the world’s first long-term nuclear waste disposal site, which is expected to be operational in 2023. Despite the government ensuring that its disposal facility – **which cost approximately €2.6 billion (US$3.4 billion**) – is “final”, **doubts remain this can truly be a long-term solution. [b]ecause nothing of this kind has ever been built before in human history, Finland’s project does not come without huge technical uncertainties and unpredictable factors** that could compromise a facility that authorities hope will store nuclear waste for at least 100,000 years. If something were to go wrong, future generations could risk immense widespread pollution. A Future Outlook on Nuclear Waste Disposal Despite a growing number of countries around the world making plans to shift toward renewable energies in the race to meet their net-zero targets in the coming decades, not all governments are ready to abandon nuclear energy altogether, with many delaying the nuclear phaseout or even building new plants. An issue associated with this type of energy is the disposal and storage of highly radioactive leftover fuel. It is undeniable that significant progress in the safe and effective management of toxic materials has been made in recent years. However, no country in the world has yet come up with a reliable permanent solution to store nuclear waste. While Finland’s repository might be the world’s first-ever successful long-term storage facility, doubts remain that it will last that long. Furthermore, the extremely high costs associated with building the underground site as well as the potentially destructive consequences that the local community and the surrounding environment will face should something go wrong are not worth the risk. **Instead of relying on a potentially destructive energy source like nuclear power, countries should put more effort into shifting to renewables.**

#### Additionally, nuclear power is inefficient while disposing many forms of waste into our air and water

**Wasserman 16 finds** – wrote The People’s Spiral of U.S. History. (Harvey, "How Nuclear Power Causes Global Warming," Progressive.org, 9-21-2016, https://progressive.org/latest/nuclear-power-causes-global-warming/, Accessed 7-25-2021, LASA-SC)

**Every nuclear generating station spews** about **two-thirds of the energy it burns inside** its reactor core **into the environment. Only one-third is converted into electricity**. Another tenth of that is lost in transmission. According to the Union of Concerned Scientists: **Nuclear fission is the most water intensive method of** **the principal thermoelectric** **generation** options in terms of the amount of water withdrawn from sources. In 2008, nuclear power plants withdrew eight times as much freshwater as natural gas plants per unit of energy produced, and up to 11 percent more than the average coal plant. **Every day, large** **reactors** like the two at Diablo Canyon, California, individually **dump** about **1.25 billion gallons of water into the ocean** at temperatures **up to** **20 degrees Fahrenheit** **warmer** **than** **the natural environment.** Diablo’s “once-through **cooling system**” **takes water out** of the ocean **and dumps it back** **superheated,** **irradiated** **and laden with toxic chemicals. Many U.S. reactors use cooling towers which emit huge quantities of steam and water vapor that also directly warm the atmosphere. These emissions are often chemically treated to** **prevent algae and other growth that could clog the towers**. **Those chemicals can then be carried downwind, along with radiation from the reactors**. In addition, **hundreds of thousands of birds die annually** **by flying into the reactor domes** and towers. The Union of Concerned Scientists states: The **temperature increase** **in the bodies of water can** **have** **serious adverse effects on aquatic life**. **Warm water holds less oxygen** **than cold water, thus discharge from once-through cooling systems can create a “temperature squeeze” that elevates the metabolic rate for fish**. Additionally, **suction pipes** **that are used to intake water can** **draw plankton,** **eggs** **and larvae into the plant’s machinery, while larger organisms can be trapped against the protective screens of the pipes.** **Blocked intake screens have led to temporary** **shut downs** **and NRC fines at a number of plants.** And that’s not all. All nuclear **reactors emit Carbon 14, a radioactive isotope**, **invalidating** **the industry’s** **claim that reactors** **are “carbon free.”** **And** **the fuel** **that** **reactors burn is carbon-intensive.** The **mining, milling, and enrichment processes** **needed to produce the pellets that fill the fuel rods inside the reactor cores all involve** **major energy expenditures**, **nearly all of it based on** **coal, oil, or gas.**

#### Renewable energy produces waste that is less hazardous, more recyclable, and economically beneficial

Dianne **Plummer 25** (Dianne Plummer, 2-11-2025, Nuclear Vs. Renewables: Which Energy Source Wins The Zero-Carbon Race?, Forbes, https://www.forbes.com/sites/dianneplummer/2025/02/11/nuclear-vs-renewables-which-energy-source-wins-the-zero-carbon-race/, Accessed 3-29-2025, wayway)

**On the other hand, solar panels and batteries face end-of-life disposal challenges**. The rapid expansion of solar photovoltaic technology since the early 2000s has positioned it as a cornerstone of the clean energy revolution, but it also presents a looming environmental challenge: end-of-life waste. By the early 2030s, millions of decommissioned solar panels will contribute to a growing global waste stream, yet this challenge carries immense economic potential. According to the International Renewable Energy Agency and the IEA Photovoltaic Power Systems Program, **properly managed PV waste could yield 78 million tons of recoverable raw materials by 2050, valued at over $15 billion.** Establishing recycling and repurposing industries will be critical to mitigating environmental risks while maximizing resource efficiency. However, this requires forward-thinking policy frameworks, strategic investment, and a commitment to integrating circular economy principles into the renewable energy sector. **However, initiatives like First Solar’s closed-loop recycling are reducing environmental impacts, making solar more recyclable than nuclear fuel.**

#### The health effects are tremendous

Cindy **Folkers** 1,✉, Linda Pentz Gunter 1 **22** (Cindy Folkers 1,✉, Linda Pentz Gunter 1, 10-7-2022, Radioactive releases from the nuclear power sector and implications for child health, PubMed Central (PMC), https://pmc.ncbi.nlm.nih.gov/articles/PMC9557777/, Accessed 3-29-2025, wayway)

Nuclear power plants routinely release radioactivity as part of daily operation. In 2008, a landmark case-control study was published in Germany,43 known as the KiKK study. **It revealed an unsettling 1.6-fold increase in all cancers and a 2.2-fold increase in leukaemias among children under 5 years old living within 5 km of operating nuclear power plants.** In general, the incidences were higher the closer the children lived to the nuclear plant. The KiKK findings were backed up by other studies44 and a meta-analysis.45

## Our second point is the climate.

#### Nuclear energy contributes to climate change in multiple stages of its long development process

Joscha **Weber 21** (Joscha Weber, 11-29-2021, Fact check: Is nuclear energy good for the climate? – DW – 11/29/2021, dw, https://www.dw.com/en/fact-check-is-nuclear-energy-good-for-the-climate/a-59853315, Accessed 3-29-2025, wayway)

Is nuclear power a zero-emissions energy source? No. Nuclear energy is also responsible for greenhouse gas emissions. In fact, no energy source is completely free of emissions, but more on that later. **When it comes to nuclear, uranium extraction, transport and processing produces emissions. The long and complex construction process of nuclear power plants also releases CO2, as does the demolition of decommissioned sites. And, last but not least, nuclear waste also has to be transported and stored under strict conditions — here, too, emissions must be taken into account.** A nuclear plant cooling tower is being torn down in Mülheim-Kärlich, GermanyA nuclear plant cooling tower is being torn down in Mülheim-Kärlich, Germany Dismantling nuclear power plants — as seen here in Mülheim-Kärlich, Germany — also produces CO2Image: Thomas Frey/dpa/picture alliance And yet, interest groups claim nuclear energy is emission-free. Among them is Austrian consulting firm ENCO. In late 2020, it released a study prepared for the Dutch Ministry of Economic Affairs and Climate Policy that looked favorably at the possible future role of nuclear in the Netherlands. "The main factors for its choice were reliability and security of supply, with no CO2 emission," it read. ENCO was founded by experts from the International Atomic Energy Agency, and it regularly works with stakeholders in the nuclear sector, so it's not entirely free of vested interests. At COP26, environmental initiative Scientists for Future (S4F) presented a paper on nuclear energy and the climate. The group came to a very different conclusion. "Taking into account the current overall energy system, nuclear energy is by no means CO2 neutral," they said. Show additional content? This content is part of the text you are currently reading. The provider X / Twitter provides this content and may collect your usage data directly when you click “Show content”. Always show content from X / Twitter. Ben Wealer of the Technical University of Berlin, one of the report's authors, told DW that proponents of nuclear energy "fail to take into account many factors," including those sources of emissions outlined above. All the studies reviewed by DW said the same thing: Nuclear power is not emissions-free. How much CO2 does nuclear power produce? Results vary significantly, depending on whether we only consider the process of electricity generation, or take into account the entire life cycle of a nuclear power plant. A report released in 2014 by the UN's Intergovernmental Panel on Climate Change (IPCC), for example, estimated a range of 3.7 to 110 grams of CO2 equivalent per kilowatt-hour (kWh). It's long been assumed that nuclear plants generate an average of 66 grams of CO2/kWh — though Wealer believes the actual figure is much higher. New power plants, for example, generate more CO2 during construction than those built in previous decades, due to stricter safety regulations. Studies that include the entire life cycle of nuclear power plants, from uranium extraction to nuclear waste storage, are rare, with some researchers pointing out that data is still lacking. In one life cycle study, the Netherlands-based World Information Service on Energy (WISE) calculated that nuclear plants produce 117 grams of CO2 emissions per kilowatt-hour. It should be noted, however, that WISE is an anti-nuclear group, so is not entirely unbiased. Emissions Balance Energy Sources 2020Emissions Balance Energy Sources 2020 **However, other studies have come up with similar results when considering entire life cycles. Mark Z. Jacobson, director of the Atmosphere / Energy Program at California's Stanford University, calculated a climate cost of 68 to 180 grams of CO2/kWh, depending on the electricity mix used in uranium production and other variables. How climate-friendly is nuclear compared to other energies? If the entire life cycle of a nuclear plant is included in the calculation, nuclear energy certainly comes out ahead of fossil fuels like coal or natural gas. But the picture is drastically different when compared with renewable energy. According to new but still unpublished data from the state-run German Environment Agency (UBA) as well as the WISE figures, nuclear power releases 3.5 times more CO2 per kilowatt-hour than photovoltaic solar panel systems. Compared with onshore wind power, that figure jumps to 13 times more CO2. When up against electricity from hydropower installations, nuclear generates 29 times more carbon.**

#### The aff sacrifices a common sense solution: renewable energy

Enrique **Dans 23** (Enrique Dans, 9-18-2023, Here’s another, often overlooked reason why nuclear energy is a bad thing, Medium, https://medium.com/enrique-dans/heres-another-often-overlooked-reason-why-nuclear-energy-is-a-bad-thing-6522371f5e4f, Accessed 3-29-2025, wayway)

**Once commissioned, a nuclear power plant cannot be shut down without incurring enormous costs.** This results in a contribution to the energy fabric of a country that is virtually constant, predictable and generally considered to be cheap. In reality, the price assigned to nuclear power is a trap, because it ignores the fact that the “payback time” for a nuclear power plant is between 10 and 18 years, depending on the quality of the uranium ores used as fuel. **This means that a nuclear power plant must operate for at least a decade before all the energy consumed to build and fuel it has been recovered and the plant starts producing net power. That figure that is reduced to one year for wind power and less than three for solar power.**

#### Overall, in the long term

“Two’s a crowd: Nuclear and renewables don’t mix.” **ScienceDaily**, October 5, 20**20**, https://www.sciencedaily.com/releases/2020/10/201005112141.htm. Accessed March 9, 2025.

If **countries** want to lower emissions as substantially, rapidly and cost-effectively as possible, they **should prioritize support for renewables**, rather than nuclear power. That's the finding of **new analysis of 123 countries over 25 years** by the University of Sussex Business School and the ISM International School of Management which **reveals**

that **nuclear energy** programmes around the world **tend not to deliver sufficient carbon emission reductions** and so should not be considered an effective low carbon energy source. Researchers found that **unlike renewables,** countries around the world with larger scale national nuclear attachments do not tend to show significantly lower carbon emissions -- and in poorer countries **nuclear** **programmes** actually tend to **associate with** relatively **higher emissions.**

#### On the contrary,

**Khan**, Anwar et. al. “Efficacy of CO2 emission reduction strategies by countries pursuing energy efficiency, nuclear power, and renewable electricity.” Energy, August 1, 20**24**, https://doi.org/10.1016/j.energy.2024.131418. Accessed March 9, 2025.

As such, this research proposes hierarchical analyses using stepwise regression and pairwise correlation **for 133 countries over 31 years** to explain how they use their energy sources, including efficiency, nuclear, and renewable electricity pathways, to mitigate CO2 emissions. Firstly, the results discover that **renewable electricity effectively mitigates CO2 emissions**, further supported by the incremental change in the R-squared value. Secondly, the results do not support the idea that nuclear power mitigates CO2. In contrast, it is noted that the efficacy of nuclear power on CO2 emission mitigation is effective through the moderation of GDP..

#### At the end of the day, reducing climate change is key because every degree matters.

**Cassella 23** [Carly Cassella, 8-30-2023, "Scientists Warn 1 Billion People on Track to Die From Climate Change," ScienceAlert,

https://www.sciencealert.com/scientists-warn-1-billion-people-on-track-to-die-from-climate-change] //clairec 6

The fossil fuels that humanity burns today will be a death sentence for many lives tomorrow. A recent review of 180 articles on the human death rate of climate change has settled on a deeply distressing number. Over the next century or so, conservative estimates suggest a**billion people could die from climate**catastrophes, possibly more. As with most predictions for the future, this one is based on several assumptions. One is a rough rule of thumb called the '1000-ton rule'. Under this framework,**every thousand tons of carbon that humanity burns is said to indirectly condemn a future person to death.** If the world reaches temperatures 2°C above the average global preindustrial temperature, which is **what we are on track for in the coming decades, then that's a lot of lives lost. For every 0.1 °C degree of warming from now on, the world could suffer roughly 100 million deaths**. "If you take the scientific consensus of the 1,000-ton rule seriously, and run the numbers, anthropogenic global warming equates to a**billion premature dead bodies over the next century**," explains energy specialist Joshua Pierce from the University of Western Ontario in Canada. "Obviously, we have to act. And we have to act fast." The human death rate from climate change is extremely tricky to calculate, even in the present day. The United Nations reports that every year, environmental factors take the lives of about 13 million people, and yet it's not clear how many of these deaths are directly or indirectly due to climate change. Some experts argue abnormal temperatures on their own may already claim as many as five million lives a year. Other estimates are much lower. Part of the problem is that the global effects of climate change are manifold. Crop failures, droughts, flooding, extreme weather, wildfires, and rising seas can all impact human lives in subtle and complex ways. Predicting the future death toll of these climate catastrophes is inherently imperfect work, but Pierce and his coauthor, Richard Parncutt from the University of Graz in Austria, think it's worth pursuing. They argue measuring emissions in terms of human lives makes the numbers easier for the public to digest, while also underlining how unacceptable our current inaction is.

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## medicine

**Alr solving in more direct ways: we don’t need reactors to get medical isotopes**

Dave **Fornell 24** (Dave Fornell, 12-18-2024, U.S. moves closer to establishing domestic supply of Mo-99 for nuclear imaging, Health Imaging, https://healthimaging.com/topics/medical-imaging/nuclear-medicine/us-moves-closer-establishing-domestic-supply-mo-99-nuclear-imaging, Accessed 4-5-2025, wayway)

**In recent years since the Chalk River closure, Cutler the DOE and NNSA have invested heavily in fostering a domestic Mo-99 supply.** Despite initial successes, including Wisconsin-based NorthStar Medical Radioisotopes' entry into the market, economic challenges have hindered progress. NorthStar ceased production using its U.S.-based reactor supply line in October 2023, citing an inability to compete with subsidized international reactors. Medicare created an add-on payment to help incentivize purchase of domestically made Mo-99 products, but it was not enough. When NorthStar said it U.S. Mo-99 production was not profitable, investors lost interest in a couple of other companies that had accepted tens of millions in federal grants and now appear defunct, or they abandoned pursuit of Mo-99 production. **However, Cutler said a promising development remains on the horizon. Shine Technologies, another Wisconsin-based company exploring non-reactor-based production methods, recently secured $32 million in federal funding to advance its Mo-99 production capabilities.** Additionally, the University of Missouri is planning to build a second research reactor to support isotope production, though it is expected to take 8 to 12 years to become operational. “In five to 10 years, I believe we will see significant progress,” Cutler said. “But this requires ongoing support from Congress to ensure we meet the growing demand for nuclear imaging and therapeutic isotopes.”

**Everything else was analytics**