## **C1**

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## **The market’s sustainable now. P&S 25**

**P&S 25** [P&S Intelligence, P&S Intelligence is a leading market research and consulting services provider to clients across the globe, xx-xx-2025, U.S. Nuclear Power Market Size, Share & Trends Analysis, 2032, P&S Intelligence, https://www.psmarketresearch.com/market-analysis/us-nuclear-power-market, accessed 3-21-2025.] //aayush

**U.S. Nuclear Power Market Overview The U.S. nuclear power market valued USD 13.3 billion in 2024**, and **this number is expected to increase to USD 19.6 billion by 2032, advancing at a CAGR of 5.1% during 2025–2032**. The **market is driven by the growing demand for electricity due to a burgeoning population, rampant urbanization and industrialization, and booming construction sector**. Amidst all this, the rising emissions of GHGs and the country’s efforts to limit them drives the demand for green energy. The **existing nuclear reactors sustain the nation's electricity supply to a considerable degree, but must deal with higher operational expenses and several regulatory constraints.** Therefore, plant life is being expanded through modern techniques and advanced nuclear reactors, including small modular reactors, are being deployed. U.S. Nuclear Power Market Dynamics **Small Modular Reactors Are Biggest Trends** Small modular reactors (**SMRs**) **are attracting increasing interest because of their reduced costs and adaptive nature**. SMR development is **led by major power companies, such as NuScale, GE Hitachi, Toshiba, and Rolls-Royce. In January 2024, NuScale Power's VOYGR received the U.S. Nuclear Regulatory Commission certification**. Several small modular reactor installations at existing nuclear power facilities are currently in planning or execution. **In October 2024, Amazon.com Inc. announced three agreements in the area of SMRs**. The agreement with Energy Northwest in Washington state will entail the development of four advanced SMRs with a capacity of 320 Megawatts in the first phase and ultimate capacity of 960 MW. **The reactors will be developed by X-energy, which Amazon announced a significant investment to enable 5 GW of capacity. Amazon also signed an agreement** with utility company Dominion Energy **to develop SMRs** near the latter’s nuclear power station in North Anna. **The project will produce around 300 MW of nuclear power for the residents of Virgina**. Just like the conventional high-capacity reactors, SMRs are ideal for power generation, heat production, desalination, desalination, and many other purposes. The DoE is currently engaged in the development of SMRs cooled by light water, which would further bring down the cost of the technology. Moreover, they are being designed to be simpler in design yet highly safe. **Rising Demand for Clean Energy Propels Market** Nuclear power plays a crucial role in meeting the expanding electrical requirements due to **population increase, demand for transport electrification, and industrial growth**. **Nuclear power generates about 18% of the national electricity and almost 50% of the nation's emission-free electricity**. In 2023, 775 billion kilowatt-hours of nuclear power was produced in the country, as per the EIA. In 2024, utility-scale nuclear power plants in the U.S. had a cumulative capacity of 96,402.8 MW. The high operating efficiency of nuclear power plants enhances economic performance, which enables a stable and continuous power supply. As per the DoE, **nuclear power plants boast a capacity factor** (duration for which they operate at full power) of over 92%. This is on contrast to 56% for natural gas, 41% for hydropower, 40% of coal-based, 35% of wind, and 25% of solar power plants. **The price competition for nuclear power stands strong when compared to different forms of electrical power generation specifically in areas with limited easy access to cheap fossil fuel sources**. The **market is seeing increasing investment because the government at the federal and state levels supports nuclear power through tax credits, research and development funding, and loan guarantees**. The biggest reason behind this is the high GHG emissions of the U.S., which are only behind those of China. As per the EPA, the country emitted 6,343 million tCO2e of emissions in 2022, which is why it is aiming for a zero-emission grid by 2030.

#### In fact, demand increases are almost too quick — we’re on the brink. Szafron 25

**Szafron 25** [Jeremy Szafron, Kitco.com. “Uranium’s Turning Point: Supply Squeeze, AI Demand, and the Nuclear Energy Boom - Scott Melbye,” Mar 18, 2025. https://www.kitco.com/news/article/2025-03-18/uraniums-turning-point-supply-squeeze-ai-demand-and-nuclear-energy-boom. A graduate of Concordia University with a BA in Journalism, Jeremy's academic background laid the foundation for his diverse and dynamic career. Now, as an Anchor at Kitco News, Jeremy will continue to inform a global audience of the latest developments and critical themes in finance and commodities.] //arrguy

‌(Kitco News) - **The uranium market is at a breaking point, caught between skyrocketing demand for nuclear power and a crippling supply deficit. As data centers, AI, and national security concerns drive unprecedented energy consumption, the need for uranium has never been greater.** At the 2025 PDAC conference in Toronto, Scott Melbye, CEO of Uranium Royalty Corp. and EVP of Uranium Energy Corp., laid out the stakes: “The last three, four years and currently where we are today, I’ve never seen a better narrative around nuclear power, behind uranium.” Melbye, a 41-year veteran of the uranium sector, has seen boom-and-bust cycles, but this time is different. **“We’re building nuclear power plants and we’re proposing new nuclear power plants faster than we’re bringing on new uranium supply.”** Global uranium demand is surging – but supply isn’t keeping up The world is rapidly shifting toward nuclear power, with over 30 countries and 160 corporations pledging to triple nuclear power by 2050. “We now have… we’ve gone from a flat market where nuclear energy wasn’t growing or even declining after Fukushima to a point now where nuclear energy’s looking to double by 2040,” Melbye said. But supply isn’t keeping up with demand. “We need new mines tomorrow, and the easier mines, if there is such a thing in mining, are the restart of operations,” he said. “The U.S. needs baseload demand growth for electricity again, and data centers are making that an even greater challenge.”

#### Thus, sudden government investment would be devastating. Karasa 25

**Karasa 25** [Ignas Mikalauskas and Darius Karaša, Kaunas Faculty, Vilnius University, Muitines Street 8, 44280 Kaunas, Lithuania; Lithuanian Energy Institute, Breslaujos Street 3, 44403 Kaunas, Lithuania, 3-12-2025, The Risk of Financial Bubbles in Renewable Energy Markets, No Publication, https://www.mdpi.com/1996-1073/18/6/1400/pdf?version=1741778052, accessed 3-18-2025.] //aayush

**Particularly in high-growth industries such as solar** photovoltaics (PV) **and battery** storage, the **results of this study show that markets for renewable energy are prone to financial saturation and speculative bubbles**. The results underline the need for spotting bifurcation points (~70% saturation) and overheating phases (~90% saturation) to reduce **investment risk**. This part compares results with previous studies, places them in the larger framework of financial and energy policies and presents policy and investment ideas meant to stop financial instability.

5.1. Comparison with Existing Literature

**Bubbles in RE have not been deconstructed to identify their embedded pattern** and have not been evaluated through a **new perspective of capital flows, investments, and possible financial saturation in the market**. So far, **there has been no assessment of the impact on the invested capital and how it could affect the markets**. Although the **authors analyze the bubble** (e.g., Green Bubbles), **the analyses do not include financial saturation and the impact of capital/investment on bubble formation**. The existing body of research in this field, especially from a theoretical standpoint, is insufficiently developed and applied [ 35].

The following timeline summarizes the key saturation thresholds for the battery- storage market, illustrating its heightened risk of speculative overheating compared to solar and wind:

Particularly in technologically advanced sectors, the **results coincide with earlier research on financial market saturation and bubble dynamics**. Previous studies on financial Energies 2025, 18, 1400 16 of 20 bubbles imply that **when market expectations differ from basic values, speculative behavior gets more intense, which causes asset overvaluation and consequent corrections** [1 ,2 ]. **Driven by governmental** and environmental **aims, the renewable energy sector follows similar investment trends, whereby fast development can cause possible overheating** [3].

• **Battery storage is the most speculative sector**. The findings reflect earlier studies showing that **newer technologies with fast growth rates**—such as battery storage—**are more prone to financial speculation** [4 ,5]. **Early bifurcation of battery storage** (2031 in the medium term, 2042 in the long term) **and expected overheating** (~2048) **point to this industry being most vulnerable financially**.

• High investment volatility of **solar energy**. **Policy-driven incentives, including feed-in tariffs** (FiTs), **have helped overcome price rises and crashes** (e.g., Spain’s solar market collapse) **according to historical studies** of solar-energy investment cycles [ 6 ,9]. This work supports these results by determining 2030 (medium term) and 2039 (long term) as the crucial solar PV bifurcation point.

• Unlike solar and battery storage, **wind energy shows reduced saturation risks**, which corresponds with past research stressing **longer investment cycles and infrastructural restrictions as natural stabilizing forces** [10].

These comparisons show that **distinct investment and policy measures are needed for renewable energy financial risks since they are technologically specific**.

5.2. Policy and Investment Implications

5.2.1. Managing Speculative Risks in Renewable Energy Markets

**The existence of speculative investment cycles implies the necessity of government actions to stop market overheating**. Renewable energy markets may suffer asset price collapses without appropriate protections, much like prior financial bubbles in other sectors [11].

**Key policy recommendations include:**

**1. Gradual Phase-Out of Incentives**: • Governments should avoid abrupt subsidy removals, as seen in past crises (e.g., Spain’s FiT reduction in 2013) [6].

• Instead, **gradual reductions in incentives can help maintain investment stability while preventing speculative surges**.

**2. Stronger Financial Oversight:**

• **Regulatory bodies should** monitor financial saturation levels (~70% and ~90% thresholds) to **intervene if speculative risks increase**.

• **Financial stress tests** for high-growth renewable energy sectors **could prevent overleveraging and mitigate market crashes**.

**3. Diversification of Investment Models:**

• Encouraging **long-term infrastructure investments** (e.g., Power Purchase Agree- ments) **over short-term speculative capital flows would reduce financial instability**.

• Governments could support public–private partnerships that focus on sustainable financing.

5.2.2. Implications for Investors

The findings underline for investors the importance of risk-adjusted portfolio manage- ment in the markets for renewable energy:

• Battery-Storage Investment Risks: **Investors should carefully evaluate market val- ues and refrain from too strong short-term speculation** given the great chance of overheating in the battery sector by 2031 and 2038 in different periods.

• The **volatility of the solar business calls for hedging techniques like diversified portfolios balancing solar investments with more reliable energy sources**.

• Wind energy as a reduced-risk option: Because of its slower saturation trajectory and reduced speculative risks, investors looking for consistent, long-term returns might give wind energy top priority.

5.3. Long-Term Sustainability of Renewable Energy Markets

Beyond only financial concerns, the **possibility of speculative bubbles in markets for renewable energy has wider consequences for energy security and climate targets. A financial crisis in renewable energy could cause**:

**• Slowness in investments, postponing the energy changeover**.

**• Loss of public trust, so lowering political and financial backing for next initiatives**.

**• Market corrections, therefore raising the capital cost for sustainable energy.**

**• Energy markets should concentrate on sustainable, policy-driven investment strategies instead of speculative development patterns** if we are to guarantee long-term stability.

#### Bubbles cause collapse — China empirically proves. Wang 20

**Wang 20** [Wang, Kai-Hua, Chi-Wei Su, Oana-Ramona Lobonţ, and Nicoleta-Claudia Moldovan. “Chinese Renewable Energy Industries’ Boom and Recession: Evidence from Bubble Detection Procedure.” Energy Policy 138 (March 2020): 111200. https://doi.org/10.1016/j.enpol.2019.111200. Kai-Hua Wang is an associate professor in the School of Economics at Qingdao University, China. He has two years of research experience in an academic institution, and his research interests focus on energy economics, international finance and corporate finance. He presides over one Qingdao City Social Science Foundation Project and publishes more than ten papers in professional academic journals.] //arrguy

Introduction China has been the largest energy consumer and importer, which consumes 23.2% of world energy in 2017, and its primary energy demand would achieve 4800 million tons of coal equivalent by 2020. Meanwhile, its energy structure heavily depends on fossil fuels, especially coal, and has become the largest carbon dioxide (CO2) emitter in 2011 (Xu and Lin, 2018a). Hence, China does not just confront with energy pressure, but it also face environmental pollution problems (Liang et al., 2019). To optimize energy consumption structure, China begins to accelerate development and utilization of solar, wind and hydro industries. It has been the global leader and the expansion of renewable energy market brings obvious economic benefits (Zhang et al., 2017; Lin and Xu, 2018; Zeng et al., 2018; Zheng et al., 2018). The solar, wind and hydro industrial rapid development have gained growing attention from investors. In terms of China National Bureau of Statistic (CNBS), the investment for solar, wind and hydropower generation reaches 843.54 billion RMB in 2015, an increase of 33% compared to 2014. When experiencing double-digit growth since 2012, new investment growth rates sharply fall to 5% and 2% in 2016 and 2017, respectively. We further find there exist huge different investment trends among renewable energy industries. Solar industry confronts unprecedented development opportunities and its investment reaches 491.32 billion RMB in 2017, which is ten times than that in 2012. However, hydro industry presents a downward trend, its investment reduces to 165.37 billion RMB in 2017 from the highest point of 214.51 billion RMB. Wind industry does not have obvious upward or downward trend, which reflects investment frequent fluctuations. The different industrial trends provide motivation for investigating bubbles in solar, wind and hydro industries, respectively. Meanwhile, the stock indices of renewable energy industries are often influenced by industrial policies, financial crisis, and other incidents. The volatility would increase risks and further impact the confidence of investors such as banks, which make firms hard to obtain financial support and face bankruptcy situation. In particular, Suntech Power Holdings Co., Ltd, the leader of the Chinese solar industry and the world's major manufacturer of solar panels, bankrupts in 2013, which marks the arrivals of industrial depression. The process of booming and recession in the energy industry may turn into bubbles, and bring negative influences on the process of optimizing energy structure, mitigating energy crisis and improving environmental quality (Xu and Lin, 2018b). Therefore, it is practical to recognize bubbles for these industries and take measures to alleviate undesirable impacts on itself and the Chinese economy. (see Fig. 3, Fig. 4) The performance in renewable energy depends on the rapid development of Chinese corresponding industries, which can be shown as followings. First, supportive policies have been implemented (Kuik et al., 2019). The “The 13th Five Year Plan for Energy Policy” is implemented by the National Energy Administration, which clearly encourages renewable energy industries development (Zhang et al., 2017). Second, China has carried out a wide investment in renewable energy industries (Zhu et al., 2019). In 2015, the amount of the investment is 102.9 billion U.S. dollars that accounts for more than 30% of global renewable energy investment. Third, the number of renewable energy firms has increased five times since 2008 and exceeds ten thousand in 2014 (Sun et al., 2019). Even though renewable energy industry has made tremendous progress, but it plunges as fast as rising and present hump-shaped performance pattern. Taking the solar industry as an example, the boom phase starts from 2004 that accompanied with a new wave of startups, including Jinko Solar, Yingli and other firms (Quitzow, 2015). This trend suddenly stops in 2008 because the global financial crisis results in a slowdown in the overseas subsidized solar market (Binz and Anadon, 2018). After 2008, China starts to adjust its market deployment policies, hence the tumbling solar companies obtain large loans in time to overcome difficulties (Dong et al., 2015; Zhao and Luo, 2017). Suffering this boom-collapse period, some major firms become vertically integrated leaders in global solar industry chain. However, due to the weak economic environment, high corporate debt levels and U.S. and the European Union's anti-dumping investigation, a lot of firms file for bankruptcy. Similarly, wind and hydro industries also suffer bubble process in their development (Dai et al., 2018; Hayashi et al., 2018; Li et al., 2018; Chu et al., 2019). In terms of close link exists between economic growth and renewable energy industries, hence the industrial bubble behaviours would bring negative impacts on economic activities such as firm bankrupt and investment volatility (Narayan and Doytch, 2017). In short-term, it makes firms bankruptcy, raises unemployment rate and reduces local fiscal revenue (Zeng et al., 2018). In the long-term, the bubble process in renewable energy industries would affect energy structure optimization strategy, reduce economic growth speed and quality and further influence China's sustainable development (Xu and Lin, 2019). That provides motivation for recognizing bubble periods from origination to termination, analyzing the influencing factors, constructing early warning mechanism and keeping renewable energy industries' sustainable development. Previous studies pay attention to the volatility in the renewable energy industry. Sadorsky (2012a) indicates that after double-digit growth rate from 2002 to 2007, the investment in the renewable energy industry presents an obvious drop in the period 2008–2009. Sadorsky (2012b) argues that renewable energy firms tend to go public to finance and expand their scale, which provides motivation for investigating their stock price fluctuations. Ferstl et al. (2012) utilize event study of Fukushima nuclear disaster and discover renewable energy firms present a positive abnormal performance in the event window. Bohl et al. (2013) clearly carry out bubble detection in German renewable energy stocks through Markov regime-switching ADF (MS-ADF) method, finding that it performs well from 2008 to 2011. Inchauspe et al. (2015) reveal that the renewable energy industry's expansion is not only occurring in developed markets such as U.S. and Germany but also in emerging markets including China and Brazil. Gatzert and Vogl (2019) indicate that regulatory and policy risks have been regarded as major role for investors when evaluating investments in renewable energy industries. Dutta (2017) realizes that renewable energy stock returns show more volatile when facing the global financial crisis. Dodd et al. (2018) argue that renewable energy industry outlooks are associated with industry's progress evidence from the U.S., Australia, and Germany. Dutta et al. (2018) discover that it is essential for investors and policymakers to recognize fluctuations of renewable energy stocks and potential links to other associated financial markets. Sung (2019) finds that government subsidy, available organizational slack and market competition would influence Korean renewable energy industry innovation and its further development. Israel and Jehling (2019) demonstrate that despite successive policies have led to profound transformative dynamics in Peru's renewable energy industries, but there still exist practices disconnection from national policies. Harjanne and Korhonen (2019) show that renewable energy production heavily depends on local natural conditions such as illuminated time, which offers great challenge for industrial development. Nicolli and Vona (2019) find energy liberalization increases public support for cultivating renewable energy industry. Gurtler et al. (2019) demonstrate that renewable energy market expansion is a policy-driven phenomenon. Dhakouani et al. (2019) indicate that the successful industrial framework consists of integration of renewable energies and their efficiency improvement in developing countries. Gungah et al. (2019) identify that enacting well-conceived renewable energy laws and building relevant institutions are crucial for achieving sustainable industrial development in Nigeria. Fobissie, (2019) find that environmental values and political ideology would produce influence on public support on renewable energy industry. Some studies also provide investigation for Chinese renewable energy industries. Liu et al. (2011) put forward bottom-up models to analyze renewable energy supply processes deeply, which are related to conversion technologies and energy demand modes. Zhang et al. (2013) argue that China has taken equipment manufacturing as a priority in developing renewable energy industries. Li et al. (2015) indicate China has obtained achievements in renewable energy exploitation and utilization, but there are still obstacles in this industry that influences sustainable industrial development. Reboredo and Wen (2015) discover that Chinese energy legislation policies dampen stock price fluctuations in all renewable energy industries. Xu and Lin (2018a) also prove the hump-shaped performance pattern and find these industries have achieved rapid growth under tightened environmental regulations and active industrial policies. Zeng et al. (2018) demonstrate that renewable energy firms in the Western region of China such as Sichuan have the highest investment fluctuation, while their peers in the Central region have the lowest volatility. Liu et al. (2018) argue that the mismatch between excessive production and declining market demand provides challenge for Chinese renewable energy industries. Crowley et al. (2019) indicate the export-oriented Chinese solar firms suffer difficult time when European announces trade restriction for solar-related products. Yang et al. (2019) discover that state subsidies would produce threshold effect on Chinese renewable energy investment, which means more policy support may not bring equal rewards. Chang et al. (2019) show that renewable energy investment is influenced by financing environment and firms’ own features. Zhang and Farnoosh (2019) find that electricity futures should perform as tools to gain more profit for the plants and stabilize the risk renewable energy industry. Ji and Zhang (2019) show that financial development plays a key role in extension of renewable energy industry and market. Yu et al. (2019) construct an analyzing system, including economic conditions, environmental protection and technological progress, to evaluate development of renewable energy industry. The existing studies carry out detailed investigation to renewable energy industry from concept, volatility, industrial policy and influencing factors, which provide robust basement for our empirical analysis (Bohl et al., 2013; Chang et al., 2019; Ji and Zhang, 2019; Sung, 2019; Yu et al., 2019). However, there are shortcomings that need to improve. First, China owns the largest wind and hydropower capacity in the world, and construct a complete solar industrial chain successfully. But the studies about Chinese renewable energy industry is scant, particularly for the potential industrial bubble behaviour. Secondly, most of the studies just describe the trajectory of fluctuation in renewable energy industries, which do not provide robust evidence for defining bubbles and recognizing explosive periods. The bubble behaviours would lead to over- or under-investment for these industries, influence investors’ confidence, and exacerbate renewable energy stock price volatility. It is worse than no one or some reasons can interpret explosive behaviours, hence the powerful method is needed. Third, the existing test of MS-ADF that employed in Bohl et al. (2013) has low powerful in detecting multiple bubbles (Phillips et al., 2011). Hence, this paper employs powerful SADF and GSADF tests to investigate bubble behaviours in Chinese renewable energy industry. Meanwhile, depending on new date-stamping strategy, this paper recognizes originating and finishing points of each bubble, which is expected to construct an early warning mechanism. The major contributions of our study to prior literature are shown as follows. **First, China confronts a serious dilemma that the unreasonable energy supply structure cannot support the booming energy demand.** In order to solve this problem, China puts considerable resources such as capital and technology to develop renewable energy industry. **Boom and recession are accompanied by industrial development process, which supplies a unique and typical example to analyze renewable energy industries.** Especially, being different from existing studies used the overall sample data, we identify and analyze different characters among solar, wind and hydro industries, which can provide more accurate conclusion. Second, effective warning mechanism for detecting bubbles ought to be provided for all kinds of market practitioners. Hence, the Supremum Augmented Dickey–Fuller (SADF) and the Generalized Supremum Augmented Dickey–Fuller (GSADF) tests are employed to investigate bubble behaviours in renewable energy industries. Both methods perform better than other bubble detecting approaches since they allow testing nonstationary process period by period, which is against mildly explosive alternatives (Phillips et al., 2013). **The GSADF test employs flexible window process to extend sample sequence, which further increases detecting accuracy, especially when confronting multiple bubbles (Su et al., 2017a).** Third, compared to previous methods, this study depends on recursive procedures and cross-time occurrence to recognize starting and ending time points in each bubble behaviours. That clearly offers dating algorithm anticipation and could construct early warning diagnostic system to assist supervisors in monitoring market actions. **We conclude that multiple bubble behaviours exist in renewable energy industries, which are influenced by stock market collapse, macroeconomic condition, government policy changes and high operation costs.** Meanwhile, industrial policies, technology, infrastructure may result in special bubbles in wind, solar and hydro industries. The paper provides an explanation based on the bubble model and pays attention to the formation of the bubble part. Combing with bubble evolution, we should adopt policies to promote renewable energy industry development. These are evidenced in followings: government should keep persistent implement of renewable energy policies, perfect electric infrastructure and guide reasonable investment for these industries. Firms should accelerate technique innovation, industrial development stage, concern macroeconomic condition changes, and foreign competition. This paper is shown as follows: Section 2 illustrates Methodology. Sections 3 presents Data. Sections 4 shows empirical results. Section 5 draws conclusions and infer policy implications.

#### That’s devastating. In 2008, Boston University quantifies

**BU-13** (Boston University, 11-1-2013, “The Financial Crisis and The Great Recession,” BU. https://www.bu.edu/eci/files/2019/06/MAC\_2e\_Chapter\_15.pdf //everyone and their mother)

**The crisis** also **spread** **beyond U.S. borders.** As **consumption** and **income declined** **in** the **United States, many countries experienced** a **significant reduction in exports** as well as a **decline in the investments** that they **held in the United States**. As a result, global GDP declined by 2 percent in 2009. It has been estimated that between 50 million and **100 million people around the world** either **fell into,** or were prevented from escaping, **extreme poverty due** **to** the **crisis**. Why did this happen? Why were its effects so long-lasting? What lessons can be learned for the future? These are complicated questions to which this chapter provides some answers.The **economic** **impact** of the **financial crisis persisted for** an **unusually long** **period**. The **unemployment rate remained above 7 percent through late 2013** (see Box 15.1). Why was this? As we saw in earlier chapters, the circular flow economy can, in difficult times, producea vicious cycle. Unemployed workers generally have less income to spend. Families facing income losses and needing financial assistance can ordinarily borrow money—but after thefinancial crisis of 2007–8, banks and financial institutions introduced tougher standardsfor credit card loans and. home equity loans, in which an equity stake in a home is posted s collateral. This led to a “credit crunch” in which families and business were unable to obtain loans. Many families were therefore compelled to cut their spending further; in the period from 2008 to 2011, U.S. consumers on average reported spending $175 per month less than they would have in the absence of a recession. Many employers, suddenly facing lower profits, fired workers, contributing to a vicious unemployment cycle. While the values of MBSs and other newfangled securities seemed to plunge overnight, it took much longer for the ensuing credit contraction to affect business bottom lines, employment decisions, and consumer spending. Thus the crisis that began in 2007 led to a recession and **very slow recovery** that **lasted more than five years**.

## C2

#### Renewable energy is rapidly advancing and can address ALL 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.

**Indeed - Weiss 25** (Tim Weiss, Co-Founder & CEO of Optera. “What 2025 Means for the Climate Crisis and Businesses”, 1/17/25, SDC, <https://www.sdcexec.com/sustainability/carbon-footprint/article/22930386/optera-what-2025-means-for-the-climate-crisis-and-businesses> DOA 3/17/25)SRT

As a result, **investors, consumers, regulators and markets are paying closer attention to companies’ climate initiatives** than ever before. In the last few years, the U.S. government has introduced some initiatives to address climate change. However, the Trump administration is unlikely to accelerate emissions reduction activities through regulatory action. The president supports increased production of fossil fuels, rather than investing in new, forward-looking clean energy technologies. Because these technologies have not yet achieved economies of scale, a lack of federal investment will hamper their growth and adoption. The government’s opposition to ESG and sustainability initiatives may also curtail regulations like the SEC’s climate disclosure rules. Without federal guidance, the **private sector must take the lead** on decarbonization initiatives. Market Demand for a Low-Carbon Economy **Companies have a lot to gain from transitioning** to a low-carbon economy. Consumers and **investors demand this change**, **even if the federal government [is anti renewables] does not continue** actively incentivizing the transition. Investor pressure for supply chain sustainability has surged 25% in five years. Another study found that sustainability is one of the top three purchasing criteria for corporate buyers, and 75% of consumers believe practicing a sustainable lifestyle is important. U.S. survey respondents said they would pay 10% more for environmentally friendly products. **Renewable energy makes business sense,** too. These **sources are cheaper and less subject to dramatic price swings** than fossil fuels, **while also reducing transition risks** in the supply chain. Bloomberg projects that **market dynamics** alone **will drive renewables to account for 50% of energy production in the next five years**. Taking no action will be costly to the planet and the bottom line. McKinsey estimates that failure to reduce emissions could put 20% of a company’s profits at risk by 2030 because of the increased push toward sustainability. Companies are taking action toward this goal.

**Renewables up despite Trump cutting funding.**

Nick **Hedley TWO DAYS AGO**, Progress Playbook, 4-4-2025 // // Clean sources produce over 50% of US electricity for the first month on record // https://theprogressplaybook.com/2025/04/04/clean-sources-produce-over-50-of-us-electricity-for-the-first-month-on-record/ // accessed 4-5-2025 // ashe

For context, in March 2015, fossil fuels made up 65% of US electricity generation, while wind and solar combined made up just 5.7% of the mix. By 2024, wind and solar (17% of annual output) had overtaken coal’s contribution (15%). Solar’s rise has been particularly “extraordinary,” Ember said in a statement. A decade ago, the technology accounted for just 1% of US electricity generation. **By March 2025 [renewables]**, this had **grown to 9.2%.** And solar’s **advance is set to continue, despite** president Donald **Trump’s efforts** to effectively reverse the energy transition. The technology is set to account for more than half of new generating capacity installed in the US in 2025, with more than a third of new panels going to Texas.

**Affirming derails progress, every dollar spent on nuclear is a dollar taken away from renewables**

**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. ¶

#### The grid can’t handle both types of energy

**CANE 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 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.

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#### This has historically happened in a lot of places

Harvey **Wasserman**, Progressive.org, 04-22-20**23** // // Earth Day 2023: A Newly Post-Nuclear Germany vs. California’s Reactor Relapse // https://progressive.org/latest/earth-day-2023-germany-vs-california-wasserman-04222023/ // accessed 3-28-2025 // ashe

On April 15, **Germany** claimed a huge global landmark by becoming one of the world’s wealthiest nations to pull the plug on atomic power. The decision dates back to 2011, when Germany’s powerful Green movement led a national demonstration aiming to **shut** the **seventeen atomic reactors** that, at the time, provided around a quarter of the nation’s electricity. Before the rally took place, four reactors blew up in Fukushima, Japan, sending huge clouds of radioactive fallout into the air and ocean. Germany’s then-Chancellor Angela Merkel—who has a Ph.D. in quantum chemistry—ordered eight reactors immediately shut, and soon announced a plan to shut the remaining nine by December 31, 2022. This energiewende, or “energy transition,” substitutes wind, solar, battery storage, and increased efficiency for nuclear power reactors, **moving Germany toward full reliance on renewables**. Germany, **since then [Germany]**, **has invested billions** **in the renewables sector**, transitioning whole towns to locally owned, rooftop solar power and corporate wind power pumped in from large turbines in the North Sea. The shutdown of the final three reactors was delayed by nearly four months due to natural gas shortages caused by the Russian war in Ukraine. It was also complicated by a major atomic breakdown **in** neighboring **France**. **Heavily reliant on nuclear power**, France’s **more than fifty** standard-design **reactors succumbed to** a wide range of **problems**, **including** generic **structural flaws and warming rivers** too hot to cool their super-heated radioactive cores. In 2022, with more than half its fleet of reactors under repair, France made up for the energy shortfall by importing power from Germany, much of it fired by the burning of coal. This prompted the nuclear industry to criticize Germany’s plan by pointing to a rise in the country’s CO2 emissions from burning increased quantities of coal, failing to note that much of that power was being exported to France to compensate for its own shuttered reactors. **California**, **whose** economy may now be slightly larger than Germany’s, has taken an opposite route. Two of its **last four reactors**—at San Onofre, between Los Angeles and San Diego—**were shuttered** in 2012 and closed permanently **in 2013** after flaws were found in the turbines and other components. In 2016, a deal was reached to shut the Golden State’s last two reactors, located at Diablo Canyon, nine miles west of San Luis Obispo. In the 1970s and 1980s, thousands of protestors were arrested at Diablo Canyon, more than at any other American nuclear plant. The 2016 shutdown deal involved another energiewende, based on blueprints to replace Diablo’s power with a huge influx of new wind, solar, battery, and efficiency installations. The agreement was approved by the California state legislature, Pacific Gas & Electric (PG&E), the federal Nuclear Regulatory Commission (NRC) and the state Public Utilities Commission. It was signed by then-Governor Jerry Brown, then-Lieutenant-Governor Gavin Newsom, and a wide range of local governments, unions, and environmental groups, all of whom assumed the state would thus be nuke-free once Unit Two was shut in 2025—the date its original forty-year license would expire. But **along the way, the state experienced two** close calls with **partial blackouts**. During both incidents, Newsom, now the governor, asked consumers to dial back their energy use. Ironically, independent battery capacity—mostly controlled by individual owners—helped the state stay lit.

#### That’s terrible, renewables are preferable to nuclear

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#### In terms of emissions,

“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.**

**Renewables are more carbon efficient**

**B. Lovins 21** [Amory B. Lovins, "Why Nuclear Power Is Bad for Your Wallet and the Climate", 12/17/2021, No Publication, https://news.bloomberglaw.com/environment-and-energy/why-nuclear-power-is-bad-for-your-wallet-and-the-climate, Accessed 04/04/2025] //IA

Does climate protection need more nuclear power? No—just the opposite. Saving the most carbon per dollar and per year requires not just generators that burn no fossil fuel, but also those deployable with the least cost and time. Those aren’t nuclear. Making 10% of world and 20% of U.S. commercial electricity, nuclear power is historically significant but now stagnant. In 2020, its global capacity additions minus retirements totaled only 0.4 GW (billion watts). Renewables in contrast added 278.3 GW—782x more capacity—able to produce about 232x more annual electricity (based on U.S. 2020 performance by technology). **Renewables** swelled supply and **displaced carbon as much every 38 hours as nuclear did all year.** As of early December, 2021’s score looks like nuclear –3 GW, renewables +290 GW. Game over. The world already invests annually $0.3 trillion each, mostly voluntary private capital, in energy efficiency and renewables, but about $0.015–0.03 trillion, or 20–40x less, in nuclear—mostly conscripted, because investors got burned. Of 259 US power reactors ordered (1955–2016), only 112 got built and 93 remain operable; by mid-2017, just 28 stayed competitive and suffered no year-plus outage. In the oil business, that’s called an 89% dry-hole risk.

**Reducing climate change is key, every degree matters.**

**Cassella 23 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. Y u

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**Nuclear Energy is terrible for the climate**

**Z. Jacobson 24** [Mark Z. Jacobson, "7 reasons why nuclear energy is not the answer to solve climate change", 10/10/2024, One Earth, https://www.oneearth.org/the-7-reasons-why-nuclear-energy-is-not-the-answer-to-solve-climate-change/, Accessed 04/02/2025] //IA

There is a small group of scientists that have proposed replacing 100% of the world’s fossil fuel power plants with nuclear reactors as a way to solve climate change. Many others propose nuclear grow to satisfy up to 20 percent of all our energy (not just electricity) needs. They advocate that nuclear is a “clean” carbon-free source of power, but they don’t look at the human impacts of these scenarios. Let’s do the math... **One nuclear power plant takes on average about 14-1/2 years to build**, from the planning phase all the way to operation. According to the World Health Organization, about 7.1 million people die from air pollution each year, with more than 90 percent of these deaths from energy-related combustion. So s**witching out our energy system to nuclear would result in about 93 million people dying, as we wait for all the new nuclear plants to be built** in the all-nuclear scenario. Utility-scale **wind and solar farms, on the other hand, take on average only two to five years**, from the planning phase to operation. Rooftop solar PV projects are down to only a 6-month timeline. So transitioning to 100% renewables as soon as possible would result in tens of millions fewer deaths. This illustrates a major problem with nuclear power and why renewable energy -- in particular Wind, Water, and Solar (WWS) -- avoids this problem. Nuclear, though, doesn’t just have one problem. It has seven. Here are the seven major problems with nuclear energy: Cofrentes Nuclear Power Plant located about two kilometers southeast of Cofrentes, Spain. Image credit: Roberto Uderio, CC BY SA-3.0 1. Long Time Lag Between Planning and Operation The time lag between planning and operation of a nuclear reactor includes the times to identify a site, obtain a site permit, purchase or lease the land, obtain a construction permit, obtain financing and insurance for construction, install transmission, negotiate a power purchase agreement, obtain permits, build the plant, connect it to transmission, and obtain a final operating license. The planning-to-operation (PTO) times of all nuclear plants ever built have been 10-19 years or more. For example, the Olkiluoto 3 reactor in Finland was proposed to the Finnish cabinet in December 2000 to be added to an existing nuclear power plant. Its latest estimated completion date is 2020, giving it a PTO time of 20 years. The Hinkley Point nuclear plant was planned to start in 2008. It has an estimated the completion year of 2025 to 2027, giving it a PTO time of 17 to 19 years. The Vogtle 3 and 4 reactors in Georgia were first proposed in August 2006 to be added to an existing site. The anticipated completion dates are November 2021 and November 2022, respectively, given them PTO times of 15 and 16 years, respectively. The Haiyang 1 and 2 reactors in China were planned to start in 2005. Haiyang 1 began commercial operation on October 22, 2018. Haiyang 2 began operation on January 9, 2019, giving them PTO times of 13 and 14 years, respectively. The Taishan 1 and 2 reactors in China were bid in 2006. Taishan 1 began commercial operation on December 13, 2018. Taishan 2 is not expected to be connected until 2019, giving them PTO times of 12 and 13 years, respectively. Planning and procurement for four reactors in Ringhals, Sweden started in 1965. One took 10 years, the second took 11 years, the third took 16 years, and the fourth took 18 years to complete. Many claim that France’s 1974 Messmer plan resulted in the building of its 58 reactors in 15 years. This is not true. The planning for several of these nuclear reactors began long before. For example, the Fessenheim reactor obtained its construction permit in 1967 and was planned starting years before. In addition, 10 of the reactors were completed between 1991-2000. As such, the whole planning-to-operation time for these reactors was at least 32 years, not 15. That of any individual reactor was 10 to 19 years. Radiation hotspot in Kashiwa, Japan | Public Domain 2. Cost The levelized cost of energy (LCOE) for a new nuclear plant in 2018, based on Lazard, is $151 (112 to 189)/MWh. This compares with $43 (29 to 56)/MWh for onshore wind and $41 (36 to 46)/MWh for utility-scale solar PV from the same source. This nuclear LCOE is an underestimate for several reasons. First, Lazard assumes a construction time for nuclear of 5.75 years. However, the Vogtle 3 and 4 reactors, though will take at least 8.5 to 9 years to finish construction. This additional delay alone results in an estimated LCOE for nuclear of about $172 (128 to 215)/MWh, or a cost 2.3 to 7.4 times that of an onshore wind farm (or utility PV farm). Next, the LCOE does not include the cost of the major nuclear meltdowns in history. For example, the estimated cost to clean up the damage from three Fukushima Dai-ichi nuclear reactor core meltdowns was $460 to $640 billion. This is $1.2 billion, or 10 to 18.5 percent of the capital cost, of every nuclear reactor worldwide. In addition, the LCOE does not include the cost of storing nuclear waste for hundreds of thousands of years. In the U.S. alone, about $500 million is spent yearly to safeguard nuclear waste from about 100 civilian nuclear energy plants. This amount will only increase as waste continues to accumulate. After the plants retire, the spending must continue for hundreds of thousands of years with no revenue stream from electricity sales to pay for the storage. Nuclear missiles with warhead aimed at the skies. Image credit: © Victority | Dreamstime 3. Weapons Proliferation Risk The growth of nuclear energy has historically increased the ability of nations to obtain or harvest plutonium or enrich uranium to manufacture nuclear weapons. The Intergovernmental Panel on Climate Change (IPCC) recognizes this fact. They concluded in the Executive Summary of their 2014 report on energy, with “robust evidence and high agreement” that nuclear weapons proliferation concern is a barrier and risk to the increasing development of nuclear energy: Barriers to and risks associated with an increasing use of nuclear energy include operational risks and the associated safety concerns, uranium mining risks, financial and regulatory risks, unresolved waste management issues, nuclear weapons proliferation concerns, and adverse public opinion. The building of a nuclear reactor for energy in a country that does not currently have a reactor allows the country to import uranium for use in the nuclear energy facility. If the country so chooses, it can secretly enrich the uranium to create weapons-grade uranium and harvest plutonium from uranium fuel rods for use in nuclear weapons. This does not mean any or every country will do this, but historically some have and the risk is high, as noted by IPCC. The building and spreading of Small Modular Reactors (SMRs) may increase this risk further. Gundremmingen Nuclear Power Plant in Germany. Image credit: Felix König, CC BY-SA 3.0 4. Meltdown Risk To date, 1.5 percent of all nuclear power plants ever built have melted down to some degree. Meltdowns have been either catastrophic (Chernobyl, Ukraine in 1986; three reactors at Fukushima Dai-ichi, Japan in 2011) or damaging (Three-Mile Island in 1979; Saint-Laurent France in 1980). The nuclear industry has proposed new reactor designs that they suggest are safer. However, these designs are generally untested, and there is no guarantee that the reactors will be designed, built, and operated correctly or that a natural disaster or act of terrorism, such as an airplane flown into a reactor, will not cause the reactor to fail, resulting in a major disaster. The Chernobyl reactor #4 building as of 2006, including the later-built sarcophagus and elements of the maximum-security perimeter. Image credit: Carl Montgomery, CC BY 2.0 5. Mining Lung Cancer Risk Uranium mining causes lung cancer in large numbers of miners because uranium mines contain natural radon gas, some of whose decay products are carcinogenic. A study of 4,000 uranium miners between 1950 and 2000 found that 405 (10 percent) died of lung cancer, a rate six times that expected based on smoking rates alone. 61 others died of mining-related lung diseases. Clean, renewable energy does not have this risk because (a) it does not require the continuous mining of any material, only one-time mining to produce the energy generators; and (b) the mining does not carry the same lung cancer risk that uranium mining does. Old derelict uranium quarry in Russia | Shutterstock 6. Carbon-Equivalent Emissions and Air Pollution There is no such thing as a zero- or close-to-zero emission nuclear power plant. Even existing **plants emit due to the continuous mining and refining of uranium needed for the plant.** Emissions from new nuclear are 78 to 178 g-CO2/kWh, not close to 0. Of this, 64 to 102 g-CO2/kWh over 100 years are e**missions from the background grid while consumers wait 10 to 19 years for nuclear to come online or be refurbished,** relative to 2 to 5 years for wind or solar. In addition, all nuclear plants emit 4.4 g-CO2e/kWh from the water vapor and heat they release. This contrasts with solar panels and wind turbines, which reduce heat or water vapor fluxes to the air by about 2.2 g-CO2e/kWh for a net difference from this factor alone of 6.6 g-CO2e/kWh. In fact, **China’s investment in nuclear plants that take so long between planning and operation instead of wind or solar resulted in China’s CO2 emissions increasing 1.3 percent** from 2016 to 2017 rather than declining by an estimated average of 3 percent. **The resulting difference in air pollution emissions may have caused 69,000 additional air pollution deaths** in China in 2016 a

lone, with additional deaths in years prior and since.

# On energy independence

**Uranium mines take a long time**

**IAEA 18** [IAEA, "URAM-2018: Ebb and Flow — the Economics of Uranium Mining", 06/22/2018, No Publication, https://www.iaea.org/newscenter/news/uram-2018-ebb-and-flow-the-economics-of-uranium-mining#:~:text=Opening%20a%20uranium%20mine%20requires,before%20the%20mine%20begins%20operation., Accessed 04/06/2025] //IA

**Opening a uranium mine requires significant capital investment and is a long process that often involves 10 to 15 years of lag time before the mine begins operation.** The cost of the equipment for mining and milling uranium into uranium ore concentrate, which generally takes place on site, is over US $100 million and can even reach into the billions. Thus, private companies and state entities alike must carefully consider long-term economics before opening a mine. Many countries that are new to uranium mining, such as Botswana and Tanzania, have used the IAEA’s expertise and assistance to create the necessary infrastructure and the legal, environmental and regulatory framework to open mines. The mines are at an advanced stage of exploration, waiting for a more favourable economic environment.

**Uranium mining is increasing domestically. Moving away from russia**

**Zadeh 2 days ago** [John Zadeh, "US Uranium Production Soars to Highest Levels Since 2018", 4/4/2025, Discovery Alert, https://discoveryalert.com.au/news/us-uranium-production-surge-2025-factors-trends/, Accessed 04/05/2025] //IA

**US produces most uranium since 2018**, marking a significant turning point for the domestic nuclear fuel supply chain. T**he final quarter of 2024 saw remarkable growth in production**, **signaling a** potential **revival of an industry that has struggled for decades**. Record-Breaking Q4 2024 Production Numbers The United States produced an impressive 375,401 pounds of uranium concentrate in Q4 2024, according to data from the Energy Information Administration (EIA). This output not only exceeded the total production for each of the three prior years but represented more than triple the Q3 2024 output of 121,296 pounds. Production came primarily from two processing facilities located in Texas and Wyoming, leveraging existing infrastructure to meet growing demand. These **facilities** have operated well below capacity for years but **are now ramping up operations in response to improving market conditions**. The dramatic increase represents the highest quarterly production figure in six years, though it remains significantly below historical peak production periods when the US was the world's leading uranium producer in the 1970s and 1980s.

# On medicine

**shortage is over, November of last year.**

**University 24** [Vanderbilt University, "Global shortage of technetium is over", 11/22/2024, VUMC News, https://news.vumc.org/2024/11/22/global-shortage-of-technetium-is-over/#:~:text=A%20message%20from%20Dan%20Brown,dedication%20to%20serving%20our%20patients.%E2%80%9D, Accessed 04/06/2025] //IA

A message from Dan Brown, MD, FSIR, professor and chair, Radiology and Radiological Sciences: “The **global shortage** of Tc-99cm, also known as technetium, **is over.** The nuclear medicine schedules **impacted by the shortage since early November** are no longer limited. Please resume normal diagnostic care of your patients, including cardiac stress tests and bone scans. “Thank you for your patience during this unavoidable shortage. I appreciate your resilience and unwavering dedication to serving our patients.

**Domestic supply coming now, it's not from energy, shortage was a really short time**

**Imaging 24** [Health Imaging, "U.S. moves closer to establishing domestic supply of Mo-99 for nuclear imaging", 12/18/2024, Health Imaging, https://healthimaging.com/topics/medical-imaging/nuclear-medicine/us-moves-closer-establishing-domestic-supply-mo-99-nuclear-imaging, Accessed 04/06/2025] //IA

**The U.S. government has worked for several years to help establish a domestically produced supply of** molybdenum-99 (**Mo-99**)to stabilize access to this critical radio-isotope used for more than 75% of medical nuclear imaging exams. The U.S. currently relies on 100% of its Mo-99 supplies from foreign reactors overseas, making the country's medical imaging supply chain vulnerable. **This was the case in October and early November**, when one of the key aging European reactors was taken off line for emergency repairs. Health Imaging spoke with President of the Society of Nuclear Medicine and Molecular Imaging (SNMMI) Cathy Cutler, PhD, FSNMMI, and chair of the Isotope Research and Production Department at Brookhaven National Laboratory during the recent Radiological Society of North America (RSNA) 2024 meeting. She is a key expert in this area and spoke at the National Nuclear Security Administration (NNSA), Department of Energy (DOE), Molybdenum-99 Stakeholders Meeting on this topic in October. "I know the government has been looking into our reliance on foreign resources. I mean, 75% of our diagnostic scans are dependent on Moly-99. We need to make sure we have a robust stable supply of this material so patients have access when they need it. No one wants to have to wait a month because they can't get their diagnostic scan to determine what treatment they need to move forward. So these are really important tools," Cutler explained. The majority of these imaging scans are for oncology and cardiology. In oncology Mo-99 derived isotopes are used to determine the extent of disease, cancer staging, managing treatment options and assessing the impact of those treatments. In cardiology, the isotopes are used to determine if a patient needs to undergo surgical or interventional revascularization. So, the stakes are high. A global reliance on aging isotope reactors **Historically, Mo-99 has been sourced from** a handful of older **research reactors** outside the U.S., much of which came from the Chalk River reactor in Canada. But that 60-year-old reactor closed in 2018, and the reliance on reactors outside the states, including one Russian reactor for some medical isotopes, has left the U.S. vulnerable to supply chain disruptions.

**Isotopes not made in nuclear energy reactors, in special research facilities**

[IAEA](https://www.iaea.org/topics/radioisotope-production-in-research-reactors) finds

Research reactors and accelerators are also used to develop new radioisotopes for diagnostics and therapy in nuclear medicine, non-destructive testing and radiotracer industrial applications, as well as for radiotracer studies in scientific research. Radiopharmaceuticals, such as those extracted from radioisotope generators, are substances that contain a radioisotope and have the ability to perform the role of marker in medical diagnostic or therapeutic procedures. **Eighty per cent of all diagnostic medical scans** worldwide rely on the availability of the **radioisotope** molybdenum-99 (99Mo) and its daughter product, Technetium-99m (99mTc), which **are** presently **only produced at research reactors**

# On jobs

**Renewables are better for jobs**

**Bennet 22** [River Bennet, "Can Nuclear Energy Jobs Power a Just Transition?", 01/19/2022, No Publication, https://www.goodenergycollective.org/policy/can-nuclear-energy-jobs-power-a-just-transition]

By many metrics, the fossil fuel industry is the largest and most economically enmeshed on the planet. Oil, gas, and coal development depends on specific worker skillsets and geographies that make it difficult to develop one-to-one comparisons between jobs in fossil fuels and clean energy. However, primary and secondary employment associated with power plants offers an apples-to-apples comparison in terms of jobs produced per gigawatt-hour (GWh) using fossil energies or clean energies for electric power generation. Power plants provide the type of high-quality, well-paid employment that unions seek: Researchers from UC Berkeley have found that on a per GWh basis, conventional **nuclear power supports 0.14** full-time equivalent annual **jobs per GWh**, compared to 0.11 for coal and natural gas**. Renewable fields** vary greatly on this metric, from 0.17 jobs per GWh for wind to **0.87** for solar. However, much of the renewables job data is based on early- and mid-2000s data that predates the modern wind and solar industry. A more recent review confirmed a wide range exists in renewables job generation, including within technology classes. That review also found that nuclear power plant jobs slightly exceed those for coal and natural gas plants, and that renewable jobs exceed all three. By one estimate, the build-out of nuclear reactors to replace fossil fuels could boost overall sector employment by tens of thousands of jobs.

**New jobs don’t matter - nuclear worker shortage now**

**WNISR 24** [No Author, 8-12-2024, "Worker shortage barrier to nuclear ambitions", World Nuclear Industry Status Report,<https://www.worldnuclearreport.org/Worker-shortage-barrier-to-nuclear-ambitions>] Ishaan  
The lack of skilled workforce

The proposed nuclear power plant program, alongside increased activities in defence shipbuilding, critical minerals mining and processing, hydrogen plants and renewable energy infrastructure projects, will **exacerbate** the existing shortage of welders from 70,000 to nearly 100,000. In fact, of the 67,000 welders identified in the last census, fewer than 5,000 possess the expertise to weld to the highest standards required for nuclear power plants, submarines, and other critical infrastructure. And of those 5,000 welders, approximately **one third are nearing retirement**, further compounding the issue.