# 1NC

#### Nuclear energy has been a failure from the start.

Mark Z. Jacobson, a Stanford Professor writes in October, 10-10-2024 [Mark Z. Jacobson, 10-10-2024, "7 reasons why nuclear energy is not the answer to solve climate change", One Earth, Mark Z. Jacobson is a professor of Civil and Environmental Engineering & Director of the Atmosphere/Energy Program. Mark Z. Jacobson’s career has focused on better understanding air pollution and global warming problems and developing large-scale clean, renewable energy solutions to them. Toward that end, he has developed and applied three-dimensional (3-D) atmosphere-biosphere-ocean computer models and solvers to simulate and understand air pollution, weather, climate, and renewable energy systems. He has also developed roadmaps to transition countries, states, cities, and towns to 100% clean, renewable energy for all purposes and computer models to examine grid stability in the presence of 100% renewable energy. Jacobson has been a professor at Stanford University since 1994, <https://www.oneearth.org/the-7-reasons-why-nuclear-energy-is-not-the-answer-to-solve-climate-change/>, DOA: 3-1-2025]//TEA + RRM

7 reasons why nuclear energy is not the answer to solve climate change

There is a small group of scientists that have proposed replacing 100% of the world’s fossil fuel power plants with nuclear reactors as a way to solve climate change. Many others propose nuclear grow to satisfy up to 20 percent of all our energy (not just electricity) needs. They advocate that nuclear is a “clean” carbon-free source of power, but they don’t look at the human impacts of these scenarios. Let’s do the math...

One nuclear power plant takes on average about 14-1/2 years to build, from the planning phase all the way to operation. According to the World Health Organization, about 7.1 million people die from air pollution each year, with more than 90 percent of these deaths from energy-related combustion. So switching out our energy system to nuclear would result in about 93 million people dying, as we wait for all the new nuclear plants to be built in the all-nuclear scenario.

Utility-scale wind and solar farms, on the other hand, take on average only two to five years, from the planning phase to operation. Rooftop solar PV projects are down to only a 6-month timeline. So transitioning to 100% renewables as soon as possible would result in tens of millions fewer deaths.

This illustrates a major problem with nuclear power and why renewable energy -- in particular Wind, Water, and Solar (WWS) -- avoids this problem. Nuclear, though, doesn’t just have one problem. It has seven. Here are the seven major problems with nuclear energy:

1. Long Time Lag Between Planning and Operation

The time lag between planning and operation of a nuclear reactor includes the times to identify a site, obtain a site permit, purchase or lease the land, obtain a construction permit, obtain financing and insurance for construction, install transmission, negotiate a power purchase agreement, obtain permits, build the plant, connect it to transmission, and obtain a final operating license.

The planning-to-operation (PTO) times of all nuclear plants ever built have been 10-19 years or more. For example, the Olkiluoto 3 reactor in Finland was proposed to the Finnish cabinet in December 2000 to be added to an existing nuclear power plant. Its latest estimated completion date is 2020, giving it a PTO time of 20 years.

The Hinkley Point nuclear plant was planned to start in 2008. It has an estimated the completion year of 2025 to 2027, giving it a PTO time of 17 to 19 years. The Vogtle 3 and 4 reactors in Georgia were first proposed in August 2006 to be added to an existing site. The anticipated completion dates are November 2021 and November 2022, respectively, given them PTO times of 15 and 16 years, respectively.

The Haiyang 1 and 2 reactors in China were planned to start in 2005. Haiyang 1 began commercial operation on October 22, 2018. Haiyang 2 began operation on January 9, 2019, giving them PTO times of 13 and 14 years, respectively. The Taishan 1 and 2 reactors in China were bid in 2006. Taishan 1 began commercial operation on December 13, 2018. Taishan 2 is not expected to be connected until 2019, giving them PTO times of 12 and 13 years, respectively. Planning and procurement for four reactors in Ringhals, Sweden started in 1965. One took 10 years, the second took 11 years, the third took 16 years, and the fourth took 18 years to complete.

Many claim that France’s 1974 Messmer plan resulted in the building of its 58 reactors in 15 years. This is not true. The planning for several of these nuclear reactors began long before. For example, the Fessenheim reactor obtained its construction permit in 1967 and was planned starting years before. In addition, 10 of the reactors were completed between 1991-2000. As such, the whole planning-to-operation time for these reactors was at least 32 years, not 15. That of any individual reactor was 10 to 19 years.

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.

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.

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.

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.

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 emissions 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 alone, with additional deaths in years prior and since.

7. Waste Risk

Last but not least, consumed fuel rods from nuclear plants are radioactive waste. Most fuel rods are stored at the same site as the reactor that consumed them. This has given rise to hundreds of radioactive waste sites in many countries that must be maintained and funded for at least 200,000 years, far beyond the lifetimes of any nuclear power plant. The more nuclear waste that accumulates, the greater the risk of radioactive leaks, which can damage water supply, crops, animals, and humans.

Summary

To recap, new nuclear power costs about 5 times more than onshore wind power per kWh (between 2.3 to 7.4 times depending upon location and integration issues). Nuclear takes 5 to 17 years longer between planning and operation and produces on average 23 times the emissions per unit electricity generated (between 9 to 37 times depending upon plant size and construction schedule). In addition, it creates risk and cost associated with weapons proliferation, meltdown, mining lung cancer, and waste risks. Clean, renewables avoid all such risks.

Nuclear advocates claim nuclear is still needed because renewables are intermittent and need natural gas for backup. However, nuclear itself never matches power demand so it needs backup. Even in France with one of the most advanced nuclear energy programs, the maximum ramp rate is 1 to 5 % per minute, which means they need natural gas, hydropower, or batteries, which ramp up 5 to 100 times faster, to meet peaks in demand. Today, in fact, batteries are beating natural gas for wind and solar backup needs throughout the world. A dozen independent scientific groups have further found that it is possible to match intermittent power demand with clean, renewable energy supply and storage, without nuclear, at low cost.

Finally, many existing nuclear plants are so costly that their owners are demanding subsidies to stay open. For example, in 2016, three existing upstate New York nuclear plants requested and received subsidies to stay open using the argument that the plants were needed to keep emissions low. However, subsidizing such plants may increase carbon emissions and costs relative to replacing the plants with wind or solar as soon as possible. Thus, subsidizing nuclear would result in higher emissions and costs over the long term than replacing nuclear with renewables.

#### Because nuclear energy is built on broken promises, Tharoon and I proudly negate the resolution, Resolved: The United States Federal Government should substantially increase its investment in domestic nuclear energy

## 1NC---Accidents

#### Contention one is accidents.

#### Trump’s attack on nuclear regulation ensures that accidents are much more likely and severe---empirically, a single reactor meltdown is extremely costly.

Alison MacFarlane, a professor of Public Policy at Columbia writes in February 2-21-2025, "Trump just assaulted the independence of the nuclear regulator. What could go wrong?", Bulletin of the Atomic Scientists, <https://thebulletin.org/2025/02/trump-just-assaulted-the-independence-of-the-nuclear-regulator-what-could-go-wrong/> [Allison M. Macfarlane is professor and director of the School of Public Policy and Global Affairs at the University of British Columbia. She chaired the US Nuclear Regulatory Commission from 2012-2014. Macfarlane holds a doctorate in geology from MIT and a bachelor in science from the University of Rochester. Macfarlane served on the White House Blue Ribbon Commission on America’s Nuclear Future.] DOA: 4/10/2025 //RRM

President Trump, through his recent Executive Order, has attacked independent regulatory agencies in the US government. This order gives the Office of Management and Budget power over the regulatory process of until-now independent agencies. These regulatory agencies include the Federal Elections Commission, the Federal Trade Commission, the Securities and Exchange Commission, the Federal Energy Regulatory Commission—and my former agency, the Nuclear Regulatory Commission, which I chaired between July 2012 and December 2014.

An independent regulator is free from industry and political influence. Trump’s executive order flies in the face of this basic principle by requiring the Office of Management and Budget to “review” these independent regulatory agencies’ obligations “for consistency with the President’s policies and priorities.” This essentially means subordinating regulators to the president.

In the past, the president and Congress, which has oversight capacity on the regulators, stayed at arm’s length from the regulators’ decisions. This was meant to keep them isolated, ensuring their necessary independence from any outside interference. Trump’s executive order implies there are no longer independent regulators in the United States.

Independent regulators should not only be free from government and industry meddling; they also need to be adequately staffed with competent experts and have the budget to operate efficiently. They also need to be able to shut down facilities such as nuclear power plants that are not operating safely, according to regulations. To do this, they need government to support their independent decisions and rulemaking.

Independence matters. When I was chairman, I traveled the world talking about the importance of an independent regulator to countries where nuclear regulators exhibited a lack of independence and were subject to excessive industry and political influence. It is ironic that the US Nuclear Regulatory Commission—often called the “Gold Standard” in nuclear regulation—has now been captured by the Trump administration and lost its independence. So much for the Gold Standard; the Canadian, the French, or the Finnish nuclear regulator will have to take on that mantle now.

To understand what is at stake, one needs to look no further than the Fukushima accident in March 2011, which showed the world how a country’s economic security is vulnerable to a captured regulator. After a magnitude 9.0 earthquake followed by a massive tsunami, the Fukushima Daiichi nuclear power plant, with its six reactors on Japan’s east coast, lost offsite power. The tsunami flooded their backup diesel generators, and the plant fell into the station blackout, leading to the complete loss of all power on site.

With no power to operate pumps to get cooling water into the reactors’ cores or into spent fuel storage pools, three reactor cores melted down—the first within hours of loss of power—with a concomitant release of large amounts of radionuclides due to containment breaches from hydrogen explosions.

RELATED:

Memo to Trump: Cancel US Air Force's Sentinel ICBM program

Firefighters desperately tried to get water into the spent fuel pool of Unit 4 to ensure that pool water did not boil off since the pumps were no longer working. Should the spent fuel rods have become uncovered and no longer cooled, the fuel’s temperature would rapidly increase, and the fuel rods would melt, causing the release of even larger amounts of radiation material into the atmosphere threatening the Tokyo metropolitan area. Fortunately, the emergency workers got water to the pool within a few days of the fuel being uncovered.

Nonetheless, 160,000 people evacuated from the area near the reactors and along the corridor of radiation contamination to the northwest of the Fukushima Daiichi plant. Overnight, the agricultural and fishing industries near Fukushima were devastated. Within a year after the accident, all 54 reactors in Japan were shut down—a loss of about a third of the country’s electricity supply. More expensive diesel plants had to be set up to compensate for some of the missing power. The direct economic costs of the accident were estimated to be on the order of $200 billion—and even that number excluded the costs of replacing the lost power and multiple reactor shutdowns due to the reassessment of seismic hazards. Nearly 14 years later, only 13 nuclear reactors have been turned back on, and 21 have been permanently shut down. (The other 20 reactors are waiting for regulatory and prefecture approval.)

An independent investigation by the Diet (Japan’s house of parliament) into the cause of the Fukushima accident concluded unequivocally that: “The TEPCO Fukushima Nuclear Power Plant accident was the result of collusion between the government, the regulators and TEPCO, and the lack of governance by said parties. They effectively betrayed the nation’s right to be safe from nuclear accidents.” Japan’s government and nuclear industry continue to struggle with the clean-up of the Fukushima site, and it purposely began in 2023 to release still-contaminated water into the Pacific Ocean. Nearby countries responded by banning fishing products from the region.

As the industry often says, a nuclear accident anywhere is a nuclear accident everywhere. After the Fukushima accident, the US nuclear industry spent over $47 billion in safety upgrades to respond to lessons learned from the Fukushima accident. These included the realization that not only more than one reactor could fail at a single power plant, but also that backup generators needed to be in safe locations, not subject to flooding and other forms of failure; that generic fittings for pumps and equipment were needed so that any nearby equipment could be connected during an accident; that containments should be able to be vented remotely; that natural events such as earthquakes and flooding could be underestimated in the original reactor designs; and that spent fuel pools needed to provide real-time data in accident conditions. The upgrades that resulted from these lessons have greatly increased the safety of reactors in the United States and elsewhere. They were required because each of these upgrades was deemed necessary to address the lessons learned by the independent regulator. On its own, the industry might not have undertaken any of these measures.

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Memo to Trump: Modify the US policy of sole authority to launch nuclear weapons

What could go wrong? Several possible outcomes could occur because of Trump’s new executive order assaulting the independence of the Nuclear Regulatory Commission (NRC).

#### This deregulation has opened the door for interest groups and politicians to meddle in the NRC, destroying any safety standards and guaranteeing reactors will fail before they’re even operational.

Alison MacFarlane 2-21-2025, "Trump just assaulted the independence of the nuclear regulator. What could go wrong?", Bulletin of the Atomic Scientists, <https://thebulletin.org/2025/02/trump-just-assaulted-the-independence-of-the-nuclear-regulator-what-could-go-wrong/> [Allison M. Macfarlane is professor and director of the School of Public Policy and Global Affairs at the University of British Columbia. She chaired the US Nuclear Regulatory Commission from 2012-2014. Macfarlane holds a doctorate in geology from MIT and a bachelor in science from the University of Rochester. Macfarlane served on the White House Blue Ribbon Commission on America’s Nuclear Future.] DOA: 4/10/2025 //RRM

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Proponents of small modular reactors, for instance, have pressured Congress and the executive branch to reduce regulation and hurry the NRC’s approval of their novel—and unproven—reactor designs. They wish their reactors could be exempted from the requirements that all other designs before them have had to meet: detailed evidence that the reactors will operate safely under accident conditions. Instead, these proponents—some with no experience in operating reactors—want the NRC to trust their simplistic computer models of reactor performance and essentially give them a free pass to deploy their untested technology across the country.

An accident with a new small modular reactor (SMR) would perhaps not make such a big mess: After all, the source term of radiation would be smaller than with large reactors, like those currently operating in the United States. But the accident in Japan demonstrated that countries should expect that more than one reactor at a given site can fail at the same time, and these multiple failures can create even more dire circumstances, impeding the authorities’ ability to respond to such a complex radiological emergency. At Fukushima, the first explosion at Unit 1 generated radioactive debris that prevented emergency responders from getting close to other damaged reactors nearby. Since designers plan to deploy multiple SMR units to individual sites, such an accidental scenario appears feasible with SMRs.

Since its creation in 1975, the Nuclear Regulatory Commission has had an excellent and essential mission: to ensure the safety and security of nuclear facilities and nuclear materials so that humans and the environment are not harmed. Trump’s incursion means the agency will no longer be able to fully follow through with this mission independently—and Americans will be more at risk as a result. If any US reactor suffers a major accident, the entire industry will be impacted—and perhaps its 94 reactors in operation will even be temporarily shut down. Can the industry and the American people afford the cost of losing the independence of the nuclear regulator?

#### Any accident would immediately kill thousands of people and destroy the environment.

**Wasserman** '08 [Harvey Wasserman; Author of The Last Energy War; 2008; "Nuclear Power and Terrorism"; Earth Island Journal; <https://www.earthisland.org/journal/index.php/magazine/entry/nuclear_power_and_terrorism> ; accessed 03-07-2025] leon

**A terrorist assault at Indian Point could yield three infernal fireballs of molten radioactive lava burning through the earth and into the aquifer and the river**. Striking water, **they would blast gigantic billows of horribly radioactive steam into the atmosphere**. Thousands of square miles would be saturated with **the most lethal clouds ever created, depositing relentless genetic poisons that would kill forever**.

**Infants and small children would quickly die en masse**. Pregnant women would spontaneously abort or give birth to horribly deformed offspring. Ghastly sores, rashes, ulcerations and burns would afflict the skin of millions. **Heart attacks, stroke and multiple organ failure would kill thousands on the spot**. Emphysema, hair loss, nausea, inability to eat or drink or swallow, diarrhea and incontinence, sterility and impotence, asthma and blindness would afflict hundreds of thousands, if not millions.

**Then comes the wave of cancers, leukemias, lymphomas, tumors and hellish diseases for which new names will have to be invented**.

Evacuation would be impossible, but thousands would die trying. **Attempts to quench the fires would be futile**. **More than 800,000 Soviet draftees forced through Chernobyl’s seething remains in a futile attempt to clean it up are still dying from their exposure**. At Indian Point, the **molten cores would burn uncontrolled for days, weeks and years**. Who would volunteer for such an American task force?

The immediate damage from an Indian Point attack (or a domestic accident) would render all five boroughs of New York City an apocalyptic wasteland.

As at Three Mile Island, where thousands of farm and wild animals died in heaps, **natural ecosystems would be permanently and irrevocably destroyed**. Spiritually, psychologically, financially and ecologically, our nation would never recover.

This is what we missed by a mere 40 miles on September 11. Now that we are at war, this is what could be happening as you read this.

**There are 103 of these potential Bombs of the Apocalypse operating in the US**. They generate a mere 8 percent of our total energy. Since its deregulation crisis, California cut its electric consumption by some 15 percent. Within a year, the US could cheaply replace virtually all the reactors with increased efficiency.

Yet, as the terror escalates, Congress is fast-tracking the extension of the Price-Anderson Act, a form of legal immunity that protects reactor operators from liability in case of a meltdown or terrorist attack.

Do we take this war seriously? Are we committed to the survival of our nation?

If so, **the ticking reactor bombs that could obliterate the very core of our life and of all future generations must be shut down**.

## 1NC---Oil

#### Contention two is the Middle East.

#### Oil prices are stabilizing despite recent losses and the trade war.

The RTT news, 4-8-2025, "Oil Prices Hold Steady After Recent Losses", RTTNews, <https://www.rttnews.com/3527349/oil-prices-hold-steady-after-recent-losses.aspx> [RTT news is a media outlet that specializes in procuring news for investors. It was founded in 1990 by Andrew Mariathasan and has been used by multiple investors] DOA: 4/8/2025 //RRM

Oil prices held steady on Tuesday after tumbling to a four-year low the previous day on tariff-related demand worries.

Benchmark Brent crude futures edged up by 0.1 percent to $64.27 a barrel in European trade, while WTI crude futures were up 0.2 percent at $60.82.

Some calm returned to markets even as trade tensions escalated, with Beijing saying that the U.S. threat to escalate tariffs against China is a 'mistake on top of a mistake' and amounts to blackmail.

Goldman Sachs has warned that Brent crude could drop below $40 a barrel by late 2026 under extreme scenarios involving both a global GDP slowdown and a full unwinding of OPEC+ cuts.

Geopolitical tensions remained on investors' radar after U.S. President Donald Trump announced Monday that the United States and Iran are set to engage in direct negotiations on Tehran's nuclear program.

"I think everybody agrees that reaching a deal would be preferable to the obvious," he said, adding, "Hopefully, those talks will be successful. And I think it would be in Iran's best interests if they are successful."

An Iranian official later told Reuters that the talks would be held in the Sultanate of Oman in an indirect manner, with Omani mediation.

Trump also proposed a U.S. takeover of Gaza while suggesting a permanent displacement of Palestinians from the enclave.

#### But, increased investment in net-zero emissions kills the oil industry.

IEA, 11-xx-2023, "The Oil and Gas Industry in Net Zero Transitions – Analysis", IEA, <https://www.iea.org/reports/the-oil-and-gas-industry-in-net-zero-transitions> [Since 2015, the IEA has opened its doors to major emerging countries to expand its global impact, and deepen cooperation in energy security, data and statistics, energy policy analysis, energy efficiency, and the growing use of clean energy technologies.] DOA: 3/22/2025 //RRM

* NZE = Net Zero

The smaller opportunity for exports causes international oil and gas prices to fall and a number of export-oriented producers are forced to reduce production.4 In 2040, a 4 mb/d reduction in production by exporters would mean the oil price for exporters would fall to around USD 20/barrel in 2040. OPEC’s share of the oil market in this case is 39% in 2040 and 41% in 2050, much lower than the levels seen in the NZE Scenario (44% in 2040 and 51% in 2050). This case would see a major fragmentation of international oil and gas markets. Importers choose to forego cheap oil and gas available on the market to protect their domestic oil and gas industry. The overall cost for oil and gas supply is also much higher than in the NZE Scenario. To 2050, cumulative capital and operating costsfor oil and gas supply is around USD 1 500 billion higher than in the NZE Scenario (a 25% increase). This case also includes some potential policy inconsistencies, with importers looking to protect – or even subsidise – domestic oil and gas companies even as they rapidly scale up clean energy investment and move away from fossil fuel use. 4 High-cost exporters are assumed only to reduce production designated for export so that they can always meet their own consumption with domestic production to avoid becoming net importers. Egypt India China Russia Saudi Arabia Canada -1.0 -0.5 0 0.5 1.0 1.5 Oil Africa Asia Pacific Eurasia Europe Middle East North America C & S America mb/d India China Russia Qatar United States Mexico -60 -30 0 30 60 90 Natural gas bcm IEA. CC BY 4.0 Chapter 1 | Oil and gas in net zero transitions 57 1 Conclusions The cases examined here highlight that different supply pathways are possible in a net zero emissions world (Figure 1.28). In general they achieve their starting aims, but they also see major potential downsides for producers, markets and net zero transitions. Figure 1.28 ⊳ Differences in oil and gas production from the NZE Scenario in the sensitivity cases, 2040 IEA. CC BY 4.0. Changes in preferences can reshape oil and natural gas production across regions, but increases in one part of the world must be matched by faster declines elsewhere. Note: C & S America = Central and South America.  In the low-income preference case, oil and gas production in low-income countries is around 4.5 mb/d and 300 bcm higher in 2050 than in the NZE Scenario. But in the context of oil and gas prices in the NZE Scenario, many of these new projects would fail to generate a reasonable return and could become stranded assets.  In the emissions preference case, emissions from oil and gas operations are reduced globally by around 200 Mt CO2-eq in 2030. But this reduction is much smaller and more expensive than the reduction in emissions in the NZE Scenario, in which producers undertake targeted action to reduce their emissions intensity and emissions are cut by 2 200 Mt CO2-eq in 2030.  In the cost preference case, the total cost of supplying oil and gas to 2050 is 7% lower than in the NZE Scenario. But this case sees a further concentration of production – already visible in the NZE Scenario – among a small number of countries, and so may lead to heightened security of supply concerns. This case also sees lower commodity prices than in NZE Scenario and some producer economies would likely struggle to withstand the impacts on their fiscal balances. - 6 - 3 0 3 6 Cost Emissions Low-income Energy security Oil mb/d bcm - 300 - 150 0 150 300 Natural gas Africa Asia Pacific Europe Eurasia Middle East North America C & S America Other IEA. CC BY 4.0 58 International Energy Agency | Special Report  In the security preference case, most countries successfully cut their reliance on imports, and global oil and gas imports in 2030 are around 20% lower than today (compared with a 13% drop in the NZE Scenario to 2030). But achieving this would lead to a major fragmentation of international oil and gas markets, and means the cost of supplying oil and gas is around 25% greater than in the NZE Scenario to 2050. A key assumption in the sensitivity cases is that overall demand levels do not change, with increases in production above the levels in the NZE Scenario by some countries matched by an identical level of reductions by others. Commodity prices could be the intermediary to allow for this, with new developments in one part of the world leading to lower prices and reductions in production in other parts of the world. Avoiding an increase in demand, however, may require policies to be further tightened above what already occurs in the NZE Scenario and there is a risk that this would not happen. Some of the cases examined would also imply a breakdown in international oil and gas markets as they are today, and it is not clear if prices would send a clear enough signal to avoid overproduction. Figure 1.29 ⊳ Selected security, cost and revenue indicators in the NZE Scenario and supply-side sensitivity cases IEA. CC BY 4.0. The cases examined involve trade-offs between security, cost and oil and gas revenue in low-income countries. The NZE Scenario aims to chart a middle ground between these. A world with rapidly declining oil and gas demand will inevitably involve trade-offs and compromises for producers and consumers between cost, security, emissions and equity concerns. In the NZE Scenario, the supply-side dynamics are based on the assumption that there is no development of new long lead time upstream conventional projects and that prices rapidly fall to the operating costs of the marginal project. While there is no single answer, this assumption means the NZE Scenario charts a middle ground between a number of the various trade-offs that exist (Figure 1.29). 1 2 3 4 Trillion USD (2022) Cumulative revenue in low income countries to 2050 NZE Low-income Emissions Cost Security 150 200 250 300 Billion USD (2022) Annual average oil and gas investment to 2050 45% 50% 55% 60% OPEC share in 2050 IEA. CC BY 4.0 Chapter 1 | Oil and gas in net zero transitions 59 1 The above analysis focuses on the NZE Scenario, but many of the considerations also apply in the context of the APS. For example, in the APS, investment to reduce the emissions intensity of existing operations is still a more effective way to reduce GHG emissions than developing new fields. New conventional crude oil and gas developments are required in the APS, but with falling oil and gas demand there could still be intense competition for market share. Increases in production in one part of the world would likely require reductions elsewhere to avoid making the later stages of the transition even more challenging. All producers can make arguments as to why their resources should be developed over others. In net zero transitions new project developments are, however, likely to face major commercial risks. Producers looking to undertake new resource developments need to explain how their plans are viable within a global pathway to net zero emissions by 2050 and be transparent about how they plan to avoid pushing this goal out of reach. 1.7 Investment Total energy investment in 2023 is estimated to be USD 2.8 trillion. Of this, around USD 1.8 trillion will be invested in clean energy, and USD 1 trillion in oil, gas, and coal (including extraction, refining, transmission and distribution, and power plantsthat use these fuels). Both the APS and NZE Scenario see a major increase in clean energy investment, rising to USD 3.1 trillion in 2030 in the APS and to USD 4.2 trillion in the NZE Scenario (Figure 1.30). This boost in clean energy investment is the principal driver behind the drop in fossil fuel use that can be achieved while ensuring there is no shortfall in meeting energy service demands. Figure 1.30 ⊳ Investment in clean energy and fossil fuels by scenario IEA. CC BY 4.0. In the NZE Scenario annual fossil fuel investment drops by USD 500 billion to 2030 while clean energy investment increases by more than USD 2 trillion. Note: 2023e = estimated values for 2023. 1 2 3 4 5 2023e STEPS APS 2030 NZE 2023e STEPS APS 2030 NZE Power Supply End use Energy efficiency Coal Oil Natural gas Trillion USD (2022, MER) Clean energy Fossil fuels IEA. CC BY 4.0 60 International Energy Agency | Special Report In the APS, investment is needed in both new and existing oil and gas projects: oil and gas investment in 2030 is around USD 650 billion, around 20% less than the expected level in 2023 (Figure 1.31). In the NZE Scenario, investment shifts entirely to maintaining production at existing fields, and to reducing the emissions intensity of oil and gas operations. Investment in oil and gas supply falls to USD 400 billion in 2030, half of the level in 2023. In both the APS and the NZE Scenario, the increase in clean energy investment is assumed to be synchronised with the scaling back of investment in fossil fuels. In reality, mismatches in investment levels are likely, and both over- and underinvestment in oil and gas could have important consequences for net zero transitions. Figure 1.31 ⊳ Investment in new and existing fields by scenario IEA. CC BY 4.0. Investment in oil and natural gas supply declines from current levels in both the APS and NZE Scenario. Capital spending in the NZE Scenario is focused entirely on existing fields. 1.7.1 Risks from overinvestment Overinvestment could occur if the oil and gas industry invests for long-term growth in demand that does not materialise. This risk has always been a feature of oil and gas markets, but net zero transitions – and the prospect of long-term structural declines in oil and gas demand – would present a new and pervasive set of risks and uncertainties. In such a situation, oil and gas prices would fall and new projects would face major commercial risks and may fail to recover their upfront costs. Existing projects could be at risk if oil and gas prices remain below operating costs for a prolonged period. Moreover, it could lead to difficulties for producer economies in which oil and gas sales make up a significant share of exports and fiscal revenues. Overinvestment in supply also risks locking in emissions that could push the world over the 1.5 °C threshold. This could be avoided by governments adopting resilient policies that prevent a drop in prices feeding through into a rebound in oil and gas demand. But in practice 100 200 300 400 2023e 2030 2050 2030 2050 2023e 2030 2050 2030 2050 Oil Natural gas Oil Natural gas Billion USD (2022, MER) Exisiting fields: New fields: APS NZE APS NZE IEA. CC BY 4.0 Chapter 1 | Oil and gas in net zero transitions 61 1 this may be difficult to stop. Additional emissions from new projects would therefore need to be compensated by even more robust emission reductions in the latter years of our projections to achieve net zero emissions by 2050. Assessing the risks of stranded assets A reduction in oil and gas production and prices could lead to widespread losses for the oil and gas industry and to stranded assets. There are multiple strands to this debate and it is therefore useful to distinguish between different impacts and losses that could be incurred by the oil and gas industry. In particular, it is helpful to distinguish between:  Stranded volumes: existing fossil fuel reserves that are left unexploited as a result of climate policies.  Stranded capital: capital investment in fossil fuel infrastructure that is not recovered over the operating lifetime of the asset because of reduced demand or reduced prices resulting from climate policies.  Stranded value: a reduction in future revenue generated by an asset or asset owner, as assessed at a given point in time, caused by reduced demand or reduced prices resulting from climate policies. The world currently has around 1.8 trillion barrels of oil and 220 trillion m3 of natural gas 2P reserves. With reasonable assumptions on possible deployment rates of CCUS and negative emission technologies such as DACS and BECCS, a large proportion of these reserves cannot be combusted if the temperature rise is to be limited to well below 2 °C or 1.5 °C. For example, in the NZE Scenario around 30% of today’s oil and natural gas reserves are produced by 2050. However, this does not necessarily mean that large volumes of reserves will be “stranded”. In the STEPS, around half of oil and gas reserves are produced to 2050. In other words, a large amount of existing oil and gas reserves will not be used even under much higher temperature outcomes. There is undoubtedly a large difference in fossil fuel use between the scenarios, but the assessment of risks to the industry is better focused on investment and value losses rather than reserves. In the NZE Scenario, despite the sharp reductions in demand, the risk of stranded capital is relatively low as it is mitigated by production decline rates that are consistent with no further investment in new projects. Some fields are closed before the end of their technical lifetimes, but most of these projects will have recovered their upfront capital by the time shut-in risks appear. In the upstream sector, stranded capital risks therefore exist primarily in the form of the sunk costs incurred in exploring for resources that are not ultimately developed in the NZE Scenario; we estimate that this amounts to around USD 400 billion in total

#### A massive loss in oil revenue would cause widespread instability and conflict in the Middle East.

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9. Conclusions: This paper discusses the impacts and the implications of low oil prices on the regional stability and security in the Gulf region. As per theoretical related aspects, the paper has considered empirical evidence that shows a correlation between high oil prices and inter-state conflict potential and instability. The paper has focused on discussing how Gulf countries have developed their nation-building processes. They have evolved and developed by considering the importance of engaging in integration processes which would ensure domestic cohesion and regional security. These strategies have been underpinned and funded by oil revenues and these nations despite being aware of their dependency on these resources have made little progress in successfully diversifying their economies. The internal stability in Gulf countries has been equally funded by revenues from oil by establishing a social contract with the aiming of guaranteeing loyalty to the regime and a sense of belonging. Although important episodes of low oil prices have challenged these economies in the past, the radical changes that conduced to explosion of the Arab Spring and the following aftermaths have added increasing quotas of uncertainty to the entire economic, political, social and diplomatic ecosystem of the Gulf. The Gulf monarchies pressed by these societal, economic, cultural and political forces have tried to mitigate their potential meltdown by sponsoring and by buying with high sums of money and resources new loyalties, new balances and new alliances. In parallel these economies have been investing massively in weaponry considering the long-standing rivalries and conflicts with neighboring countries such as Iran. This investment strategy has been spurred by high oil prices between 2010 and 2014. From mid-2014 onwards, international oil prices plummeted and Gulf countries started to experience fiscal deficits which did not allow them to continue with their generous subsidies and policies to ensure both domestic and international security and stability. Despite the negative economic and financial prospect, these countries continued their policy of high investments on weaponry, especially Saudi Arabia and Oman. Gulf countries challenged by an international context where the disengagement of the US has been progressive, had tried to rehearse new diplomatic, political and economic formulas to allow them to progress as a Union, although lately the GCC has been acting more as a Council undergoing several pressures and transformations. A long-lasting context of sliding oil prices have generated more regional atomization as Gulf states aim at maximizing, individually or in coalition, their benefits within an environment of latent conflict. In this vein, low oil prices have generated more uncertainty and insecurity in the entire region, endangering the continuity of the current regimes and boosting the potential for conflict and instability. Considering this scenario, and in accepting that the global oil demand will diminish over the next years if Gulf states fail in [to] efficiently and sustainably implement economic diversification policies, the collapse of the gulf monarchies will be a matter of time. However, this process of possible meltdown may entail long processes of readjustments and will increase the potential of conflict and instability across the entire Middle Eastern space.

#### The next conflict would become World War III.

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I do not wish to say that Iran’s present government is without serious faults. However, any use of violence against Iran would be both ~~insane~~ and criminal. Why ~~insane~~? Because the present economy of the US and the world cannot support another large-scale conflict; because the Middle East is already a deeply troubled region; and because it is impossible to predict the extent of a war which, if once started, might develop into World War III, given the fact that Iran is closely allied with both Russia and China. Why criminal? Because such violence would violate both the UN Charter and the Nuremberg Principles. There is no hope at all for the future unless we work for a peaceful world, governed by international law, rather than a fearful world, where brutal power holds sway. An attack on Iran could escalate We recently passed the 100th anniversary World War I, and we should remember that this colossal disaster escalated uncontrollably from what was intended to be a minor conflict. There is a danger that an attack on Iran would escalate into a large-scale war in the Middle East, entirely destabilizing a region that is already deep in problems. The unstable government of Pakistan might be overthrown, and the revolutionary Pakistani government might enter the war on the side of Iran, thus introducing nuclear weapons into the conflict. Russia and China, firm allies of Iran, might also be drawn into a general war in the Middle East. In the dangerous situation that could potentially result from an attack on Iran, there is a risk that nuclear weapons would be used, either intentionally, or by accident or miscalculation. Recent research has shown that besides making large areas of the world uninhabitable through long-lasting radioactive contamination, a nuclear war would damage global agriculture to such a extent that a global famine of previously unknown proportions would result. Thus, nuclear war is the ultimate ecological catastrophe. It could destroy human civilization and much of the biosphere. To risk such a war would be an unforgivable offense against the lives and future of all the peoples of the world, US citizens included. Recent research has shown that thick clouds of smoke from firestorms in burning cities would rise to the stratosphere, where they would spread globally and remain for a decade, blocking the hydrological cycle, and destroying the ozone layer. A decade of greatly lowered temperatures would also follow. Global agriculture would be destroyed. Human, plant and animal populations would perish.

#### Moreover, it incentivizes oil companies to burn more oil in the short term to maximize profit.

Don Grant et. al, 8-29-2024, "A worldwide analysis of stranded fossil fuel assets’ impact on power plants’ CO2 emissions", Nature, <https://www.nature.com/articles/s41467-024-52036-8> [Grant: Department of Sociology, University of Colorado Boulder, Boulder, CO, USA Renewable and Sustainable Energy Institute, University of Colorado Boulder, Boulder, CO, USA. Hansen: Department of Environmental Studies, Dartmouth College, Hanover, NH, USA. Jorgenson: Department of Sociology, University of British Columbia, Vancouver, BC, Canada Department of Theoretical Economics, Vilnius University, Vilnius, Lithuania. Longhofer: Goizueta Business School, Emory University, Atlanta, GA, USA] DOA: 4/1/2025 //RRM

* Green Paradox: policies meant to reduce emissions cause spikes in emissions
* Stranded assets: assets that cannot produce revenue before the end of their lifetime

The baseline model (model 1) reveals that plants release more carbon when they emitted at high levels in 2009, use coal or gas as their primary fuels, have more electrical capacity, use a higher percentage of their capacity, and have capacity utilization rates that have increased over time. Plants also emit more carbon in countries that are highly dependent on the fossil fuel industry to generate power. After accounting for the effects of these and other controls, the baseline model shows that in countries with more potentially stranded fossil fuel assets, plants have significantly higher emission levels compared to plants whose countries have fewer assets at risk. Specifically, a 1% change (measured in millions of euros) of potentially stranded assets results in a .050% change in emissions, holding constant all other variables in the model. This finding is consistent with our first prediction that stranded assets increase plants’ emissions by fostering a more lenient regulatory climate.

In models 2 through 5, we examine whether changes in coal, oil, and gas prices influence plants’ emissions and can explain the effect of stranded assets observed in model 1. Findings indicate that none of the price variables has a significant effect on emissions regardless of whether they are added individually (models 2, 3, and 4) or as a group (model 5) to the equation. Their inclusion, therefore, has a negligible effect on the stranded assets effect across all four specifications. These results contradict the conventional green paradox thesis that fossil fuel suppliers will induce more emissions in the short run by lowering the price of coal, oil, and gas inputs. Instead, they comport with Di Maria et al.’s argument that plants’ long-term future contracts with fossil fuel suppliers often prevent them from responding to spot market changes in coal, oil, and gas.

To determine whether contractually constrained plants might still burn fossil fuels faster in countries where more carbon reserves are financially at risk, we interact our measures of stranded assets and change in plant capacity utilization rate in model 6. Results indicate there is a statistically significant interaction between these two factors. This is in keeping with our second prediction that when located in countries with more at-risk assets, plants have a stronger incentive to speed up the processing of the fuels they have already purchased and thus increase their CO2 emissions in the short term. Figure 2 shows the predicted effect of changes in plants’ utilization rate on their CO2 emission levels at a mean level of (logged) stranded assets (9.1), at 1 standard deviation below the mean (5.5), and at 1 standard deviation above the mean (12.8). Here we see that where more fossil fuel reserves are in jeopardy, plants utilize a larger percentage of their capacity over time, causing their emissions to rise. (Supplementary Table 1, which shows the determinants of plants’ CO2 emission levels under a 2 °C climate stabilization scenario that would regularly expose close to three times as many people to extreme heat, reports results nearly identical to those shown in Table 1).

Fig. 2: How the predicted effect of change in plant capacity utilization rate on power plants’ CO2 emission levels varies depending on total stranded assets.

figure 2

Reports the predicted effect of changes in plants’ capacity utilization rate on their (logged) CO2 emission levels at a mean level of (logged) stranded assets (9.1), at 1 standard deviation below the mean (5.5), and at 1 standard deviation above the mean (12.8).

Full size image

In Table 3, we assess the robustness of the association between our dependent and key independent variables. Models 1 and 2 are estimated for only plants that officially report their emissions, and the latter model includes the interaction between stranded assets and change in plant capacity utilization rate. In Model 3, we operationalize total stranded assets using an inverse hyperbolic sine function. The results of these three models are nearly identical to those reported in models 5 and 6 in Table 2. In models 4, 5, and 6, we examine whether plants emit more carbon because particular types of fossil fuels are at risk. Findings reveal that unburnable coal, gas, and oil are each significantly related to plants’ CO2 emission levels, providing further proof that the effects of our key independent variable – total stranded assets – are robust.

Table 3 Robustness checks of the association between the dependent and key independent variables

Full size table

Relative magnitude of the stranded assets effect

Having determined that stranded assets have a statistically significant effect on plants’ CO2 emission levels, we now consider the relative magnitude of that effect. In Table 4, we compare the total annual tonnes of carbon released by (the world’s or a nation’s) plants solely in response to at-risk assets to the remaining annual carbon budgets31 of the world’s and individual nations’ electricity sectors (see Methods). The first two columns of Table 4 reveal that for the world as a whole, the increase in annual CO2 emissions triggered by potentially stranded assets is 12.08 million metric tonnes per year or 0.21% of the electricity sector’s annual carbon budget when the chance of limiting global warming to 1.5 °C above pre-industrial levels is set to 50%. The third column shows that when the world’s annual budget is constrained further to have a 66% chance of staying below 1.5 °C, the relative magnitude of plants’ emissions is 0.28%.

Table 4 Magnitude of extra annual electricity-based CO2 emissions associated with stranded assets under a 1.5 °C scenario

Full size table

The first three columns of Table 4 also report the same estimates for the five countries with the most absolute CO2 emissions. Here we see, for instance, that the additional annual emissions associated with at-risk assets in China (3.09 million metric tonnes) are 0.19% to 0.26% of the budget for this country’s electricity sector. The extra emissions triggered by at-risk assets amount to even smaller percentages for India (0.02% to 0.04%) and Japan (0.0010% to 0.0013%). The relative magnitudes of plants’ extra emissions in the United States and Russia are higher, ranging, respectively, from 1.12% to 1.61% and .84% to 1.19%.

Although these findings might suggest that the percentage of carbon budgets used up by plants due to potentially stranded assets is modest, when one adds up these percentages over time, a more concerning picture emerges. As the last column reveals, during a period when the carbon budget will almost surely be breached and, therefore, every fractional “expenditure” of that budget matters32, the extra emissions associated with stranded assets could amount to between 2.1% to 2.8% of the world’s carbon allowance over a ten-year period. In the United States and Russia, the situation is even more troubling. These countries could exhaust 11.2% to 16.1% and 8.4% to 12%, respectively, of their electricity sectors’ carbon budgets due just to the stranded assets effect. This suggests that the financial pressures to “use it or lose it” are especially great among these two key incumbents of the carbon regime. In fact, the United States and Russia stand to lose the most profits from the physical stranding of assets12 and their power plants are older, on average, (30.3 and 30.6 years, respectively) than those in other countries (25.5 years).

Discussion

Past research on the green paradox has emphasized reactions on the supply side, whereby fossil fuel companies accelerate the extraction of carbon reserves, leading to a reduction in current fossil fuel prices and, in turn, an increase in CO2 emissions. While there is ample evidence that suppliers extract more fossil fuels and sell them at cheaper prices in anticipation of stronger environmental policies, there is less support for the idea that price decreases result in more CO2 emissions, which has cast doubt on the green paradox thesis. In contrast, our study redirects attention to the demand side, positing that regulatory leniency and power plants’ vested interest in their long-term fossil fuel contracts make plants more willing to burn fossil fuels earlier and thus are the mechanisms that produce the green paradox. In keeping with our argument that at-risk fossil fuel assets give government actors a financial incentive to relax environmental standards, results show that plants emit more carbon pollution in countries where vast amounts of fossil fuel reserves would be stranded under the Paris Agreement. And in keeping with our other argument that at-risk reserves motivate contractually constrained plants to speed up the processing and burning of their purchased inputs, findings indicate that stranded assets and plants’ capacity utilization rates positively interact, causing plants to further increase their emissions. While the extra amount of carbon released each year due to the stranded asset effect is moderate, its cumulative impact on the electricity sector’s remaining carbon budget could be significant in certain key countries. In addition to encouraging more theory building on the green paradox, therefore, our study’s findings suggest that if important policy-making communities are to develop effective transition strategies, they, too, must pay greater attention to the demand side of fossil fuel consumption.

An important topic for future research is whether the effect of stranded fossil fuel assets on plants’ emissions is strengthening over time33. The volume of emissions from the effect could dwindle as the fossil fuel sector shrinks. Or it could grow if more fossil fuel reserves are discovered through new production technologies. Additional research is also needed on the mechanisms we have theorized linking the key independent variable to the dependent variable. Although stranded assets’ direct and interactive effects on power plants’ CO2 emissions can be plausibly explained by countries’ regulatory leniency and plants’ vested interest in their long-term fossil fuel contracts, measures of these concepts are needed to determine to what extent they, as variables, mediate the observed effects of stranded assets in a causal chain of relationships34.

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