Resolved: The United States should increase its use of nuclear energy for commercial energy production.

# All

### A2: Struvio

Poverty is the root cause of structural violence.

Kathleen **Ho, 2007**, is currently pursuing her MA degree in Human Rights at the University of Essex under a Rotary Ambassadorial Scholarship. She received her undergraduate degree in Comparative Literature and International Studies at Northwestern University. After her undergraduate degree she travelled to China on a Princeton-in-Asia Fellowship to teach oral English and English writing at the Zhejiang University of Technology. After her MA degree she will begin her law degree at the University of Virginia. “Structural Violence as a Human Rights Violation” Essex Human Rights Review,

To substantiate the claim made above, this essay will examine the structural causes of severe global poverty and the impacts of poverty on agency. Poverty is a prime example of how structural violence leads to an understanding of structural violations of human rights since, as Farmer notes, ‘**the world’s poor are the chief victims of structural violence…the poor are not only more likely to suffer**; **they are less likely to have their suffering noticed’**.15 It is the poor whose agency is severely compromised and whose actual fulfillment of fundamental human needs is visibly below the potential. Examining the position of the poor illuminates the unequal suffering of human rights violations that are the result of power differentials as exercised through global economic as well as social structures. 4. Poverty as structural violence So far, this essay has established the nature of structures and a theory asserting that power inequalities are built into these structures, yielding violent results. Here, severe or absolute poverty (according to the World Bank, people with incomes at less than about $1 per day) will be considered as a manifestation of economic inequality resulting from structural violence. To apply the theoretical framework of structural violence, then, what structures have unequal distributions of power to create this global inequality? Further, what constitutes an avoidable disparity between actual and potential abilities to satisfy basic human needs? Structural violence theorists characterize the world system as vastly unequal, exemplified by a growing disparity between those who are rich and getting richer and those who are poor and getting poorer. Taking this observation as a point of departure, further examination of the general distribution of severe poverty and understanding what this indicates about the causal role of structures in poverty persisting in the world today is necessary. According to Thomas Pogge, ‘nearly a fifth of all human beings alive today, 1,175 million, live below $1/day.’16 The recent 2006 Helsinki-based World Institute for Development Economics Research of the United Nations University (UNU-WIDER) ‘reports that the richest 1% of adults alone owned 40% of global assets in the year 2000, and that the richest 10% of adults accounted for 85% of the world total.’ It also notes that ‘average wealth amounted to $144,000 per person in the USA in year 2000, and $181,000 in Japan…India [had] per capita assets of $1,100, and Indonesia with $1,400 per capita.’ Another striking finding is that ninety per cent of the total world wealth is concentrated in North America, Europe, and high income Asia-Pacific countries.17

### A2: Epsitiosmotmoetly

“US Should” means definitive policy action – not an ideological or epistemological frame

**Ericson, 03** (Jon M., Dean Emeritus of the College of Liberal Arts – California Polytechnic U., et al., The Debater’s Guide, Third Edition, p. 4, AA)<https://books.google.com/books?id=FRZjE1GsjPMC&printsec=frontcover&dq=The+Debater%27s+Guide,+third+edition&hl=en&sa=X&ved=0ahUKEwiQ1qGtjL_jAhUIv54KHfJTBO0Q6AEIJzAA#v=onepage&q=The%20Debater's%20Guide%2C%20third%20edition&f=false>

The Proposition of Policy: Urging Future Action In policy propositions, each topic contains certain key elements, although they have slightly different functions from comparable elements of value-oriented propositions. 1. An **agent doing the acting ---“The United States”** in “The United States should adopt a policy of free trade.” Like the object of evaluation in a proposition of value, the agent is the subject of the sentence. 2**. The verb should—the first part of a verb phrase that urges action**. 3. An **action verb to follow should in the should-verb combination**. For example, should adopt here means to put a program or policy into action though governmental means. 4. A **specification of directions or a limitation of the action desired.** The phrase free trade, for example, gives direction and limits to the topic, which would, for example, eliminate consideration of increasing tariffs, discussing diplomatic recognition, or discussing interstate commerce. Propositions of policy deal with future action. Nothing has yet occurred. The **entire debate is about whether somehing ought to occur. What you agree to do, then, when you accept the affirmative side in such a debate is to offer sufficient and compelling reasons for an audience to perform the future action that you propose.**

# Ovws

### Inc nrg good - electrification

See wip args

**Inc nrg bad - oil industries**

### RE Bad - REMs

### FF Good - Carbon Bubble

Shift to renewable -> econ harm

1. Undermining petrostate economies
   1. [all Mathiesen 17] Oil companies are valued based on oil reserves
   2. Biggest oil companies are state owned - many petrostates borrow against the value of their state-owned oil reserves
   3. Falling oil prices = can no longer service debt + can’t borrow more money
   4. Debt is used to fund social programs and subsidize basic necessities
2. Stranded Assets
   1. All [Harvey 18] trillions of $ in investments in ff capital in squo (mines, wells, etc)
   2. Shift to renewable = all value of investment lost
   3. Find actual link to bubble -
   4. Financial crisis - 4 trillion usd
3. FL: No alts to stop collapse
   1. petrostates are authoritarian - lack the economic buffers that democracies naturally forms
   2. Previously high oil prices remove any incentive to diversify away

FL: investors know

<http://theconversation.com/why-stranded-assets-matter-and-should-not-be-dismissed-51939>

Harvey 18

Fiona Harvey 18, 6-4-2018, "What is the carbon bubble and what will happen if it bursts?," Guardian, https://www.theguardian.com/environment/2018/jun/04/what-is-the-carbon-bubble-and-what-will-happen-if-it-bursts

**Investments amounting to trillions of dollars in fossil fuels – coal mines, oil wells, power stations, conventional vehicles – will lose their value when the world moves decisively to a low-carbon economy. Fossil fuel reserves and production facilities will become stranded assets, having absorbed capital but unable to be used to make a profit. This carbon bubble has been estimated at between $1tn and $4tn (£3tn), a large chunk of the global economy’s balance sheet.**

What will happen when it bursts?

**Investors with high exposure to fossil fuels in their portfolios will be hurt, as those companies and assets cease to be profitable. Jobs will be lost in fossil fuel production and related industries. If the bubble bursts suddenly, as a new paper in Nature suggests it might, rather than gradually deflating over decades, then it could trigger a financial crisis.**

Arguably yes, in that it corrects what has long been a market failure. Currently, fossil fuel prices do not reflect the environmental damage the fuels do, in climate change and air and water pollution. If they were priced to take these external factors into account, they would cost much more and businesses would seek alternatives – that is the idea behind carbon pricing. However, adding those external costs at a stroke would send energy prices soaring, with far-reaching effects across the economy. That is why economists prefer to phase in more realistic pricing for carbon-rich fuels over time. And the converse is also true: if renewables and energy efficiency were to result in an unexpected plunge in demand for fossil fuels, independently of government actions, that could send fossil fuel prices through the floor, triggering a crisis among the millions of investors in those assets.

Probably, but it could encourage some countries to pump out more, at least in the short term. For instance, if demand for fossil fuels drops suddenly then the OPEC countries could flood the market with cheap oil and gas, leaving those with more expensive assets – shale, tar sands, Arctic drilling – unable to compete.

**Middle Eastern oil-rich states have built their economies on fossil fuels,** so would need to diversify, which some are beginning to talk about. **Russia could see its domestic fossil fuel industries collapse. Canada and the US could also be at risk:** with their production of high-cost unconventional oil and gas from tar sands and shale, they are vulnerable both to a drop in demand and a drop in fossil fuel prices, unless their industries have invested in renewable energy and greater efficiency.

Karl **Mathiesen 17**, Climate Home News' editor, former environment writer for the Guardian, “Into the abyss: oil states face turmoil as climate policies bite,” 4/1/17, https://www.climatechangenews.com/2017/01/04/into-the-abyss-oil-states-face-turmoil-as-climate-policies-bite/

The world is ever more committed to shaking the carbon monkey from its back. At 2015’s landmark Paris summit, 195 governments effectively agreed to phase out fossil fuels during the second half of the century, unless they come with an emissions abatement technology attached.

While US president-elect Donald Trump may want to reverse the trend, other leaders reaffirmed that commitment last November in Marrakech. As demand for oil and gas is curbed, could other countries follow Venezeula into the abyss?

“We must be very careful, so that the mistakes of the people at the top do not result in popular uprisings due to suffering of the masses,” says retired major general ANM Muniruzzaman, chairman of the Global Military Advisory Council on Climate Change.

**The idea of a carbon bubble has gained traction in recent years as one of the major economic risk factors** associated with climate change. If leaders are serious about winding down carbon emissions, **reserves from which oil companies derive their value will become worthless**. Proponents of this analysis, which include the International Monetary Fund and Bank of England governor Mark Carney, warn that **shareholders in oil companies could be holding onto toxic assets**.

In the past two years, **the oil price crash has exposed a similar weakness across the petroeconomies of the world**. The companies with **the biggest oil and gas reserves on earth are owned by states, including Saudi Arabia**, Russia, Venezuela and Iran. Many of **these countries have borrowed heavily against the value of these reserves**.

In Venezuela, the oil price drop aggravated a multi-faceted failure of governance, but the value of its single major export halving was a sledgehammer blow.

Since the late 1990s, income from this wealth has been used to secure the popularity of the Hugo Chavez and Nicolas Maduro governments. Venezuelans had grown used to the subsidisation of products; from oil more than 100 times cheaper than water, to rice and toilet paper, and luxury items such as DVD players and cars.

**To service these programmes, the government bought in huge debts, underwritten by the seemingly unending value of the country’s huge oil reserves**. All this meant that by 2014, the oil price required by Venezuela’s budget to break even was well over US$100 per barrel – one of the highest of all members of the Organization of the Petroleum Exporting Countries (Opec).

“The characteristics of the countries who are **fossil fuel suppliers**, partly because they are fossil fuel suppliers, means that they **have some really deep structural instabilities** and the **governments were planning on much higher long term oil prices**,” says chief executive of the E3G consultancy Nick Mabey.

The subsequent collapse has not been immediately replicated across the oil-producing world because other countries don’t have the in-built decrepitude of the Chavist economic model. But many are vulnerable to a longer term downturn.

For reasons both chicken and egg, **many oil-rich states are ruled over by regimes that tend towards authoritarianism. These states lack the buffers against unrest provided by democracy**.

“The dynamics are very simple,” says Mabey. **When oil prices are high, governments have little incentive to diversify their economies. Alternative income sources are squeezed out**. This is known as “Dutch disease”, coined to explain why a huge 1950s gas discovery in the Netherlands destroyed that country’s manufacturing industry.

Governments ride the bubble of an appreciated currency. **In many countries, they use the economic bump to placate unhappy or disenfranchised parts of their population by subsidising basics, providing welfare payments or large public works projects.**

“Now **when prices fall**,” says Mabey, “**there is a high risk of instability because you’ve squeezed out other alternatives** for them to move to.”

Saudi Arabia’s sovereign wealth fund can last eight years with low oil prices, the country’s former lead climate negotiator Mohammad Al Sabban told the BBC last year. In a future of electric vehicles and hyper-efficiency, what happens when those cash reserves peter out?

“It is a non-trivial security threat,” says Mabey. “Imagine Saudi in 15 years time with a lot of disgruntled young men and Isis and Al Qaeda running around fomenting threats against the regime and they can’t afford to pay for such an elaborate security apparatus as they have now.”

During the build up to (eventually catastrophic) UN climate talks in 2009, al Sabban provoked international scoffing by claiming that the oil-soaked kingdom needed support to ease the pain a new climate deal would cause. The talks were, he said, “a matter of survival” for the country, “we are among the most vulnerable countries, economically”.

Verbeek says that time may prove al Sabban correct. “In a way you could say that they raised [this issue],” he says. But experts on Saudi Arabia have told Climate Home that the transition there is making its first, faltering steps. We discuss it in more depth here.

# A2: Aff

### OVWS

#### This stuff fails

1. Loan Defaults
   1. **Xu 20 -** nuclear plants are not competitive
      1. **Xu 20** - Not cost comparative compared to renewables or ff - not profitable and close down
      2. **Xu 20 -** Perception of nuclear energy as high risk means that they have to borrow at high interest rates bc banks are unsure if they can pay them back
   2. 2 implications
      1. **Xu 20** - bc of these higher cost and lack of profitability more and more plants are shutting down - that delinks all of their impacts bc of plants fail in the near future
      2. **Xu 20 -** bc capital costs are so high, nuke plants are shutting down before they even have time to reach a profitable stage. This means that banks lose millions to billions in assets, causing bank failures. Unfortunately, nuclear plants borrow from multiple banks in order secure funding, which is why Xu concludes that an increase in the share of nuclear nrg could trigger a series of bank failures, threatening the financial system
2. Water shortages
   1. **Kincaid 15**- supply of US water is dwindling due to CC and growing demand
   2. **Green 07-** A single nuclear plant is incredibly water intensive, consuming 65 mill liters/day
   3. **Smith 15**- Reactors can’t function during droughts bc of this water demand
   4. **Rice 18**- 38% of the US is in drought
3. 1 failure stops all nuke nrg in the long term
   1. **Cherp 12**  - govt support for nuclear nrg based on public opinion, but public opinion is easily swayed by nuclear accidents
      1. Accidents -> barriers to investment
   2. **Amadeo** **20**- After 3 mile island accident, development of nuclear energy in the US was halted for 30 years

[Xu](https://sci-hub.tw/https://doi.org/10.1016/j.energy.2020.116910) 20 (AK)

Particularly, the share of renewable energy decreases electricity price in the short-term, but rises it in the long-term. Increases in the share of renewable energy reduce the number of failed banks at scales of one to four years. Nevertheless, **an increase in the share of nuclear energy** has potential **lead[s]**ing effect on **[to] bank failures**, thus may **threaten[ing] the financial system**. No significant leading effect of the electricity price and energy sources on the interbank connectivity is found, regardless of time and frequency domains.

[Xu](https://sci-hub.tw/https://doi.org/10.1016/j.energy.2020.116910) 20 (AK)

**The rise in shale gas and wind power makes current nuclear plants investments less profitable or unprofitable [45], thus limiting prospects for new nuclear plants and even threating the viability of existing plants.** The utility sector is finding it increasingly difficult to attract investment because of the perception of **a high**er **financial risk associated with nuclear power,** which **raises** a higher **interest rate at which utilities can borrow. As a result, more nuclear plants were phased out of use ahead of schedule. As a capital-intensive technology, nuclear investments and thus nuclear powered productions are led by the interbank connectivity, thus may contribute to the possibility of cascades of banks failures**

[Kincaid 15](https://www.businessinsider.com/americas-about-to-hit-a-water-crisis-2015-4) (AK)

Western states have been dealing with water problems for a while, but they won't be alone for long. As **drought, flooding, and climate change restrict America's water supply**, demands from population growth and energy production look set to increase, according to a report from the U.S. Government Accountability Office. These two changes **[and] squeeze our** natural **water reserves** from both directions. **The stress** is becoming clear and **will soon manifest** as water scarcity problems all over our country. The California problem Over the last four years, Californians have gotten a big wake-up call, as drought forces them to reconsider water as a scarce commodity.

[Green](https://www.sciencealert.com/nuclear-power-and-water-scarcity) 07

Some problems associated with nuclear power are much discussed – such as its connection to the proliferation of weapons of mass destruction. Less well known is the fact that **nuclear power is the most water-hungry of all energy sources, with a single reactor consuming** 35-**65 million litres of water each day.** Water scarcity is already a serious problem for Australia's power-generation industry, largely because of our heavy reliance on water-guzzling coal-fired plants. Current problems in Australia's power industry resulting from water shortages include: expensive long-distance water haulage to some power plants as local supplies dwindle; reduced electrical generating capacity and output at some coal and hydro plants; higher and more volatile electricity prices; increased risks of blackouts; and intensified competition for water between power plants, agriculture, industries, and environmental flows. Introducing nuclear power would exacerbate those problems. A December 2006 report by the Commonwealth Department of Parliamentary Services notes that the water requirements for a nuclear power station are 20-**83 per cent higher than for other power stations.** Moreover, those calculations do not include water consumption by uranium mines. The Roxby Downs mine in South Australia uses 35 million litres of water each day, with plans to increase this to 150 million litres each day. Mine operator BHP Billiton does not pay one cent for this water despite recording a record $17 billion profit in 2006-07. Water outflows from nuclear power plants can damage the local environment.

[Smith](http://vjel.vermontlaw.edu/nuclear-energy-and-drought-a-recipe-for-disaster/) 15

In 2006, the Department of Energy warned that consumption of water for electricity production could more than double by 2030 to 7.3 billion gallons per day in the US if developers continue to build new power plants with evaporative cooling, an amount equal to the entire country’s water consumption for 1995. The three stages of nuclear fuel cycle—uranium milling and mining, plant operation, and nuclear waste storage—all consume, withdraw, and contaminate water supplies. Due to this large need for water resources, **most nuclear facilities cannot even operate during drought conditions**, and in some cases can actually cause water shortages. A proposed [single] nuclear facility in Green River, UT would have consume[s]d about 53,000 acre feet of water annually from the Green River (a valuable tributary to the severely depleted Colorado River) to cool its reactors and generate steam to power its turbines. That’s enough water to supply 200,000 people a year, roughly the size of Tacoma, WA. When thinking about the scarcity of available freshwater in the world and the increased drought-like conditions in many parts of the country, those numbers add up to major impacts not just to our economy, but our survival. Just look at the increasing amount of tension and war-like conditions currently developing between local communities and their government over water supply in politically unstable areas such as the Middle East.

[Rice 18](https://www.usatoday.com/story/weather/2018/02/02/u-s-drought-worst-level-nearly-4-years/300850002/)

Drought has returned with a vengeance across much of the United States, with the worst conditions across southern and western parts of the nation.

As of Thursday, **38.4% of the continental U.S. is in a drought**, according to the [U.S. Drought Monitor](http://droughtmonitor.unl.edu/). That is the highest percentage since the 40% recorded in May 2014.

In California, which emerged from a brutal four-year drought last year, 44% of the state is now considered to be in a moderate drought. That's a dramatic jump from just last week, when the figure was 13%.

#### 

#### Three mile island destroyed nuclear industry

Kimberly Amadeo, 1-31-2020, "Did the Three Mile Island Nuclear Accident Help Kill Nuclear Power?," Balance, https://www.thebalance.com/three-mile-island-nuclear-accident-facts-impact-today-3306337

The Three Mile Island accident was a meltdown at a nuclear power plant in Middletown, Pennsylvania. It occurred on March 28, 1979. Officially, it caused no deaths. But unofficial investigations and lawsuits claimed there were above-average rates of cancer and birth defects in the surrounding area. **The accident halted the development of the U.S. nuclear power industry for 30 years. During that time, no new nuclear power plants were approved.** Several that were under construction at the time of the accident were completed.

#### Nuclear power not happening; accidents control public opinion—popularity key to government backing and investor support.

**Cherp 12** [Aleh; Professor of Environmental Sciences and Policy, Central European University; 2012; “Chapter 5 – Energy and Security. In Global Energy Assessment – Toward a Sustainable Future”; Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria; pp. 325-384] [Premier] <https://iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/GEA_Chapter5_security_lowres.pdf>

As a result, strong government backing is necessary for the development of nuclear power (Finon and Roques, 2008 ). Such political backing depends on the public support of nuclear power, which has been very uneven. In particular, public opinion is swayed by nuclear accidents such as the ones at Three Mile Island in the United States in 1979, Chernobyl in the USSR in 1986, and Fukushima in Japan in 2011. Each such change of public opinion and the resulting change in the government policy may affect energy security both in the short term (e.g., as a result of shutting down nuclear power plants immediately affected by the accident 9 and those deemed unsafe) and in the longer term (through complicating the investment climate). Unlike other energy sources and electricity-generating technologies, for nuclear energy the risks associated with accidents extend beyond the plant level or national level to the entire nuclear power plant fleet. Thus, nuclear power globally faces the systemic risk of nuclear accidents.

#### It takes longer to build nuclear plants

1. [Jacobson 19](https://www.leonardodicaprio.org/the-7-reasons-why-nuclear-energy-is-not-the-answer-to-solve-climate-change/)- 14.5 years from planning to completion, only 2-5 for wind/solar
   1. Prefer because it doesn’t just take into account the physical construction
      1. Concludes this delay causes 93 mill to die from pollution
2. [World Nuclear 20](https://www.world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power-policy.aspx)- Takes 3-5 years for US to approve construction
3. [Zau 18](http://large.stanford.edu/courses/2017/ph241/zau1/)- Nuclear has long time to secure returns on investments
   1. That means nuclear also just takes longer because it's harder to secure funding
4. !Climate
   1. **Mann 14**- Earth reaches 2 degree C increase by 2036
   2. **Loria 18**- Runaway climate effect means after 2 degrees, there is irreversible increasing of warming 4-5 degrees due to escaping carbon and increased greenhouse effect cycle
      1. Loria notes in the squo, a 5% increase in share of renewables pushes back the timeline for disaster by 10 years
   3. **Nuccitelli 12-** 4 degree warming or greater will cause a catastrophy harming hundreds of millions due to droughts, water shortages, famine, etc.
   4. **Chestney 13-** any delays are critical for enabling us to adapt to the impacts of climate change and preventing any further damages

[Jacobson](https://www.leonardodicaprio.org/the-7-reasons-why-nuclear-energy-is-not-the-answer-to-solve-climate-change/) 19 from Stanford writes that

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% of these deaths from energy-related combustion.

Compared to

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. Utility-scale **wind and solar farms,** on the other hand, **[which] take** on average **only 2 to 5 years [to build]**, 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.

[World Nuclear 20](https://www.world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power-policy.aspx)

**Yet, the government remains more involved in commercial nuclear power than in any other industry in the USA. There are lengthy, detailed requirements for the construction and operation of all reactors and conversion, enrichment, fuel fabrication, mining and milling facilities. The review process preceding the construction of new reactors can take 3-5 years.** The US government, through its own national research laboratories and projects at university and industry facilities, is the main source of funding for advanced reactor and fuel cycle research. It also promises to provide incentives for building new plants through loan guarantees and tax credits, although owners have to raise their own capital. US domestic energy policy is also closely linked to foreign, trade and defence policy on such matters as mitigating climate change and nuclear non-proliferation (of weapons).

[**Zau 18**](http://large.stanford.edu/courses/2017/ph241/zau1/)

**The primary issue with nuclear power is the enormous upfront cost. There are certain obstacles specific to the nuclear industry, such as the "ballooning cost estimates for construction of reactors", that make it harder to get investor funding. [2] Although the returns have potential to be very high, they are also very slow and can take up to decades to recoup initial costs. Nuclear power plants have a very high capital cost and technical complexity, subsequently leading to high construction and operation risks such as delays, cost overruns, unplanned outages and equipment failures. [1] Economically speaking, higher risks demand higher returns, meaning that the cost of capital depends significantly on the risks involved. For example, two of the four nuclear power plants under current construction are extremely behind schedule and have run over cost. Furthermore, the 2011 Fukushima nuclear disaster created new requirements for on site spent fuel management and elevated design basis threats, therefore significantly increasing costs for both current and potential power plants. [3] This combination of financial volatility in the electricity market and long-term investment requirement do not necessarily benefit getting more nuclear reactor projects off the ground, particularly when other forms of natural energy are relatively cheap in the electricity market.**

[**Mann 14**](https://www.scientificamerican.com/article/earth-will-cross-the-climate-danger-threshold-by-2036/)

**New calculations by the author indicate that if the world continues to burn fossil fuels at the current rate, global warming will rise to two degrees Celsius by 2036, crossing a threshold that will harm human civilization.**

[**Loria Business Insider 18**](https://www.businessinsider.com/global-warming-point-of-no-return-temperature-2018-8)

**On the other hand, if the share of renewables were to grow by 5% a year instead of 2%, that could push the date back 10 years. The development of negative emissions technology that could suck greenhouse gases out of the air could also push back that no-return date. But even that would only give us six to 10 extra years — and the switch to renewables still would be required.**

**Furthering**

**That's because research suggests that certain natural systems on the planet could be activated by warming and consequently trigger further warming. A** [**recent paper that explained this concept:**](https://www.businessinsider.com/hothouse-earth-climate-change-tipping-point-2018-8) **if those systems are triggered at 2 degrees, it said, that might cause temperatures to spike even higher regardless of how we control emissions. The study dubbed this scenario "hothouse Earth."**

**In that situation, Earth's average temperature could rise 4 or 5 degrees Celsius above pre-industrial levels, leading to sea levels up to 200 feet higher than they are now.**

Nuccitelli 12 (Dana, environmental scientist at a private environmental consulting firm, Bachelor's Degree in astrophysics from the University of California at Berkeley, and a Master's Degree in physics from the University of California at Davis, “Realistically What Might the Future Climate Look Like?,”)

We're not yet committed to surpassing 2¬∞C global warming, but as Watson noted, we are quickly running out of time to realistically give ourselves a chance to stay below that 'danger limit'. However, 2° C is not a do-or-die threshold. Every bit of CO2 emissions we can reduce means that much avoided future warming, which means that much avoided climate change impacts. As Lonnie Thompson noted, the more global warming we manage to mitigate, the less adaption and suffering we will be forced to cope with in the future. Realistically, based on the current political climate (which we will explore in another post next week), limiting global warming to 2¬∞C is probably the best we can do. However, there is a big difference between 2 C and 3 C, between 3¬∞C and 4° C, and anything greater than 4°C can probably accurately be described as catastrophic, since various tipping points are expected to be triggered at this level. Right now, we are on track for the catastrophic consequences (widespread coral mortality, mass extinctions, hundreds of millions of people adversely impacted by droughts, floods, heat waves, etc.). But we're not stuck on that track just yet, and we need to move ourselves as far off of it as possible by reducing our greenhouse gas emissions as soon and as much as possible.

#### It’s not too late—emissions reductions can avoid and delay catastrophic impacts.

Chestney 13 – Nina, senior environmental correspondent, “Climate Change Study: Emissions Limits Could Avoid Damage By Two-Thirds,” 1/13

The world could avoid much of the damaging effects of climate change this century if greenhouse gas emissions are curbed more sharply, research showed on Sunday. The study, published in the journal Nature Climate Change, **is the first comprehensive assessment** of the benefits of cutting emissions to keep the global temperature rise to within 2 degrees Celsius by 2100, a level which scientists say would avoid the worst effects of climate change. It found 20 to 65 percent of the adverse impacts by the end of this century could be avoided. "Our research clearly identifies the benefits of reducing greenhouse gas emissions - less severe impacts on flooding and crops are two areas of particular benefit," said Nigel Arnell, director of the University of Reading's Walker Institute, which led the study. In 2010, governments agreed to curb emissions to keep temperatures from rising above 2 degrees C, but current emissions reduction targets are on track to lead to a temperature rise of 4 degrees or more by 2100. The World Bank has warned more extreme weather will become the "new normal" if global temperature rises by 4 degrees. Extreme heatwaves could devastate areas from the Middle East to the United States, while sea levels could rise by up to 91 cm (3 feet), flooding cities in countries such as Vietnam and Bangladesh, the bank has said. The latest research involved scientists from British institutions including the University of Reading, the Met Office Hadley Centre and the Tyndall Centre for Climate Change, as well as Germany's Potsdam Institute for Climate Impact Research. It examined a range of emissions-cut scenarios and their impact on factors including flooding, drought, water availability and crop productivity. The strictest scenario kept global temperature rise to 2 degrees C with emissions peaking in 2016 and declining by 5 percent a year to 2050. FLOODING Adverse effects such as declining crop productivity and exposure to river flooding could be reduced by 40 to 65 percent by 2100 if warming is limited to 2 degrees, the study said. Global average sea level rise could be reduced to 30cm (12 inches) by 2100, compared to 47-55cm (18-22 inches) if no action to cut emissions is taken, it said. Some adverse climate impacts **could also be** delayed by many decades. The global productivity of spring wheat could drop by 20 percent by the 2050s, but the fall in yield could be delayed until 2100 if strict emissions curbs were enforced. "Reducing greenhouse gas emissions won't **avoid** the impacts of climate change altogether of course, but our research shows it **will buy time** to make things like buildings, transport systems and agriculture **more** resilient to climate change," Arnell said.

### A2: Direct Air Capture

1. NU: Direct air capture is already being developed by fossil fuel companies because they want to use it for enhanced oil recovery. This is the preferred path for DAC because in the squo it is not economically feasible. The technology becomes cheaper when it is innovated for profit incentives.
2. Mulligan 19/DAC being done right now by petro companies
   1. FF have incentive to stop harms of co2 from happening - public/govt support, stop competition of renewables
   2. Mulligan 19/captured co2 can be used to realese even more trapped oil - economic motivation to capture and reuse co2

[Mulligan 19](https://www.wri.org/blog/2019/07/co2-direct-air-capture-plant-will-help-extract-oil-texas-could-actually-be-good-climate) (EH)

Earlier this year, **Occidental Petroleum announced plans to draw half a million tons of carbon dioxide (CO2) out of the atmosphere each year with Carbon Engineering's "direct air capture" technology. Occidental will then pump that CO2 into its oil fields in Texas, where it will release trapped oil and increase production. The pumped CO2 will remain stored underground.** On its face, boosting oil production seems counterproductive: To limit global temperature rise to 1.5 degrees C (2.7 degrees F) and prevent the worst climate impacts, the Intergovernmental Panel on Climate Change (IPCC) tells us we need to cut oil consumption roughly 40-80% by 2050. Can pumping CO2 into the ground to extract more oil actually help in the fight against climate change? Surprisingly, yes—but the details matter. Climate models show that **removing CO2 from the atmosphere at a large scale will be critical for limiting global warming to 1.5 or even 2 degrees C. But first, we need to develop the technology further and lower its cost enough to scale it around the world. Right now, coupling direct air capture with enhanced oil recovery (known together as CO2-EOR) is the most economically viable strategy to do this.** CO2-EOR, largely overlooked to date, could also be a powerful strategy to reduce emissions from oil consumption until the world completes the transition to clean energy. Under the right conditions it is even possible to achieve net CO2 removal from the atmosphere by combining direct air capture with CO2-EOR. But whether this technology will reduce net emissions depends on several key factors, which we discuss below.

### A2: Carbon Capture

1. T: Forbes 17/ carbon capture increases net emissions for three reasons.
   1. CCS delays the sunsetting of fossil fuels companies, which now have an excuse to keep operating
   2. CCS replaces investment in renewables, which are carbon neutral
   3. Sequestered CO2 is used in enhanced oil recovery, which enables more oil to be pumped and burned. After CO2 is pumped, it leaks from the wells back into the atmosphere
      1. Hbf is link into this
2. Journal of Energy and Environmental Science 19 - CO2 reduction is 10-11% effective, and CCS fails to account for other chemical pollutants.
   1. T: reliance on an nrg method that's still polluting - only carbon neutral RE solves

[Energy and Environmental Science 19](https://outline.com/nGduAD) (RL)

Or at least, that's what we've thought. New research published in the journal Energy & Environmental Science shows that this **[CO2] reduction may actually only amount to between 10 and 11 percent.** Scrubbing 85 to 95 percent of CO2 from the gas produced by a coal plant is what CCS technology should do in theory. But in practice, **the nature of CCS tech actually incurs further, additional costs that affect this rate, and researchers often ignore the upstream and downstream costs of CO2 scrubbing.** Rather than use CCS, the researchers found, it would be far more beneficial to just use renewable energy like wind or solar power in place of coal or natural gas. In coal or natural gas plants, **there are upstream emissions associated with [fossil fuel]** those **industries that can't be accounted for by CCS, such as the emissions associated with extracting and transporting fuel or fuel leaks. Furthermore,** fossil fuel plants pollute in a wide variety of ways, not just through CO2. **CCS technology is only geared towards scrubbing CO2 from gases, not carbon monoxide, nitrous oxides, mercury, or other chemicals. Then there's the fact that CCS technology also requires a significant amount of electricity to run, increasing our reliance on fossil fuels.** Then there's perhaps the most fundamental issue with CO2 capture — **there's no incentive to store [CO2]** it **long term, while there are incentives to use it for fundamentally counterproductive purposes.** Funnily enough, **extracted CO2 is often sold to oil and gas companies who can use it to coax more crude oil out of depleted wells**. This is actually presented as a positive thing, since it traps the CO2 underground. But it doesn't get around the fact that we're just replacing the CO2 we take out of the atmosphere with more CO2. To get around the costs associated with powering CCS technology, the researchers also analyzed the scenario where a CCS solution in a coal or natural gas plant was powered by wind turbines or solar panel array. While this did improve the CCS technology's efficiency, it still didn't account for the upstream emissions or other pollutants released by the plant.

[Forbes 17](https://outline.com/4wGEHt) (RL)

<https://www.forbes.com/sites/quora/2017/05/16/the-long-term-effects-of-carbon-capture-technology/#7bc8109f6473>

<https://outline.com/4wGEHt>

Delay the sunsetting of fossil fuels **Carbon capture and sequestration is highly ineffective and expensive.** It captures a tiny fraction of CO2 emissions. **All it really does is give fossil fuel-emitting companies and jurisdictions license to continue to operate.** And given license, they do. Reduce potential deployment of renewables Wind and solar generation are actually carbon-neutral technologies, and are actually cost effective technologies. **Every MWH of wind or solar electricity eliminates the generation of a MWH of fossil fuel generation and its attendant CO2. Spending money on expensive and ineffective CCS instead of renewables is just backwards.** Create more CO2 in the atmosphere **Most of the CO2 which is sequestered is** being **used in enhanced oil recovery. That’s the process of pumping CO2 down into tapped out oil wells** to liquefy sludge and drive it to the other end of the field **so [oil]** it **can be pumped out.** When **the oil** is pumped out, it’s **burned to make more CO2. And massive oil fields where this is deployed are full of a wide variety of old oils wells and test bores, and there’s no value in sealing the holes** once enhanced oil recovery is over**. As a result, a bunch of the ‘sequestered’ CO2 is just going to leak back up.** Net result: more CO2 in the atmosphere.

### A2: Fusion

1. Deign 19- Highly unlikely any fusion technology will be available by 2050, at which point it is too late to stop disastrous climate change impacts
2. Jassby 17- fusion is way worse because it consumes more water, is ineffective in areas with drought
3. Jassby 17- nuclear fusion reactors must consume a huge portion of the energy they produce so they aren’t efficient or economical at all

[Deign 19 of GreenTechMedia](https://www.greentechmedia.com/articles/read/fusion-still-tantalizingly-far-off-despite-recent-signs-of-momentum) (YZ)

Writing in The Conversation last month, Thomas Nicholas of the Culham Centre for Fusion Energy in Oxfordshire, U.K., said: “**The world must reach net-zero greenhouse gas emissions by 2050** in order to limit future warming to 1.5 [degrees] C."

“**It’s unlikely that commercial fusion power plants will exist in time for that, and even once a first-of-its-kind** DEMO **power plant is operational, hundreds would still need to be built to seriously dent global emissions.**”

1. T: Fusion reactors would magnify all of the downsides that current fission reactors have. Fusion reactors release more radioactive waste.

[Jassby 17](https://thebulletin.org/2017/04/fusion-reactors-not-what-theyre-cracked-up-to-be/) (YZ)

But **unlike what happens in solar fusion—which uses ordinary hydrogen—Earth-bound fusion reactors that burn neutron-rich isotopes have byproducts that are anything but harmless**: Energetic neutron streams comprise 80 percent of the fusion energy output of deuterium-tritium reactions and 35 percent of deuterium-deuterium reactions.

Now, an energy source consisting of 80 percent energetic neutron streams may be the perfect neutron source, but it’s truly bizarre that it would ever be hailed as the ideal electrical energy source. In fact, **these neutron streams lead directly to four regrettable problems with nuclear energy: radiation damage to structures; radioactive waste; the need for biological shielding; and the potential for the production of weapons-grade plutonium 239—thus adding to the threat of nuclear weapons proliferation**, not lessening it, as fusion proponents would have it.

**The neutron radiation damage in the solid vessel wall** [**is expected to be worse**](https://www.sciencedirect.com/science/article/pii/S0920379605004060) **than in fission reactors because of the higher neutron energies.**

1. T/Disad: Fusion power consumes even more water than fission power.

[Jassby 17](https://thebulletin.org/2017/04/fusion-reactors-not-what-theyre-cracked-up-to-be/) (YZ)

In addition, there are the problems of coolant demands and poor water efficiency. **A fusion reactor is a thermal power plant that would place immense demands on water resources** for the secondary cooling loop that generates steam, as well as for removing heat from other reactor subsystems such as cryogenic refrigerators and pumps. Worse, the several hundred megawatts or more of thermal power that must be generated solely to satisfy the two classes of parasitic electric power drain places additional demand on water resources for cooling that is not faced by any other type of thermoelectric power plant. In fact, **a fusion reactor would have the lowest water efficiency of any type of thermal power plant, whether fossil or nuclear. With drought conditions intensifying in sundry regions of the world, many countries could not physically sustain large fusion reactors.**

1. A2 Fusion power: It’s overstated because the powerplant uses a lot of its own output electricity to run.

[Jassby 17](https://thebulletin.org/2017/04/fusion-reactors-not-what-theyre-cracked-up-to-be/) (YZ)

In addition to the problems of fueling, **fusion reactors** face another problem: they **consume a good chunk of the very power that they produce**, or what those in the electrical generating industry call “parasitic power drain,” on a scale unknown to any other source of electrical power.

In a nutshell, **below a certain size (about 1,000 MWe) parasitic power drain makes it uneconomic to run a fusion power plant.**

Worse, the **several hundred megawatts or more of thermal power that must be generated solely to satisfy the two classes of parasitic electric power drain** places additional demand on water resources for cooling that is not faced by any other type of thermoelectric power plant.

### A2: FF Tradeoff/Climate

Climate

1. **Mahajan 18**- renewables already cheaper
   1. Shahan 19- already better when subsidies accounted for
2. **Bell 20**- large scale opposition from environmentalists means around the world, ff is losing investment
   1. CarbonTracker 15 concludes FF will be gone in 15-30 years
3. **Shrader 13**- Nuclear actually generates tons of emissions when you account for the entire fuel cycle because it takes tons of energy to refine uranium, concluding its just as bad as natural gas and far worse than renewables.
4. Renewable tradeoff becomes a link turn

[Mahajan 18](https://www.forbes.com/sites/energyinnovation/2018/12/03/plunging-prices-mean-building-new-renewable-energy-is-cheaper-than-running-existing-coal/#44dd37b331f3) (AK)

This industry-disrupting trend comes down to dollars and cents, as the cost of renewable energy dips below fossil fuel generation. **Across the U.S., renewable energy is beating coal on cost**: The price to build new wind and solar has fallen below the cost of running existing coal-fired power plants in Red and Blue states. For example, Colorado’s Xcel will retire 660 megawatts (MW) of coal capacity ahead of schedule in favor of renewable sources and battery storage, and reduce costs in the process. Midwestern utility MidAmerican will be the first utility to reach 100% renewable energy by 2020 without increasing customer rates, and Indiana’s NIPSCO will replace 1.8 gigawatts (GW) of coal with wind and solar. Lazard’s annual Levelized Cost of Energy (LCOE) analysis reports **solar** photovoltaic (PV) **and wind costs have dropped an extraordinary 88%** and 69% **since 2009**, respectively. Mean**while, coal and nuclear costs have decreased by 9%** and increased by 23%, respectively. **Even without** accounting for current **subsidies, renewable energy costs can be considerably lower than** the marginal cost of **conventional energy** technologies. In other words, customers save money when utilities replace existing coal with wind or solar.

[Shahan 19](https://cleantechnica.com/2019/11/22/solar-costs-wind-costs-now-so-low-theyre-competitive-with-existing-coal-nuclear-lazard-lcoe-report/) (RK) does the comparative:

A brief decade held considerable cost-efficiency gains in **wind and solar**. These sustainable technologies **are now more** cost-effective than any other power generation technologies in general, according to[Lazard](https://twitter.com/Lazard/status/1196823993032019968). Solar and wind technologies simply make more sense. Further, this analysis excludes subsidies. Solar and wind aren’t just cost-effective when subsidized — they’re **cost-effective when not subsidized despite** more than a century of **fossil fuel subsidies.** These findings back up recent findings from Berkeley Lab’s[Tracking the Sun](https://cleantechnica.com/2019/11/17/us-solar-panel-prices-continue-dropping-solarstorage-increasing-tracking-the-sun-report/)report. Lazard’s full[Levelized Cost of Energy 13.0](https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf)report and[Levelized Cost of Storage](https://www.lazard.com/media/451087/lazards-levelized-cost-of-storage-version-50-vf.pdf)[Analysis 5.0](https://www.lazard.com/media/451087/lazards-levelized-cost-of-storage-version-50-vf.pdf)show dramatically different solar, wind, and battery storage costs in 2019 compared to 2009.

[Bell 20](https://www.atlanticcouncil.org/in-depth-research-reports/report/the-role-of-oil-and-gas-companies-in-the-energy-transition/) (AK)

As the third decade of 21st century begins, **the oil and gas industry face**s **opposition from** a public greatly concerned with the **environmental[ists]** impact of fossil fuels**,** ever-more **skeptical shareholders, and** challenges from **policy makers** seeking to simultaneously meet decarbonization goals and expected oil and gas demand. Amidst a global energy transition, the demand, financial, and social future of oil and gas companies is increasingly in question. However, even with these obstacles, oil and gas remain an important part of the energy mix, especially in developing regions. The International Energy Agency’s Sustainable Development Scenario (SDS) and the Shell Sky Scenario—both aggressive decarbonization forecasts—show an ongoing, long-term role for oil and gas, even while demand levels are reduced from where they stand today.

This suggests that what is frequently lumped together as ESG investing in fact includes a diverse range of strategies with differing implications for the role of oil and gas companies in the low carbon transition. According to data from the Global Sustainable Investment Alliance, “negative screening,” or oil and gas divestment-focused investment represents $19.7 trillion of global assets under management. **[so] Investors from both companies and countries are** also **considering divestment**; Norway’s sovereign wealth fund, for example, recently decided to divest entirely from oil and gas stocks. This broad category **in**clude **fossil fuels**—mostly coal, but also oil sands, pure play exploration, and even liquefied natural gas (LNG), depending on the fund. However, not all ESG strategies exclude fossil fuels. So-called “ESG integration” funds, representing $17.5 trillion of global assets, do not automatically preclude certain sectors, but rather focus on criteria to measure which companies have the most favorable ESG metrics

[CarbonTracker 15](https://outline.com/mC8agm)

The only change, now, is that victory is at hand. Everyone loves a winner. In conclusion, I will summarise my argument: The **fossil fuel energy** industry **is** now **entering terminal decline and will be** all but **gone within 15-30 years**. The key driver is not what most see as their greatest threat – future climate change policy. It’s that competing energy products of renewables and batteries, in a system with electric vehicles, will behave as a disruptive technology always does, delivering ever lower prices and ever higher quality in a decades’ long period of innovation and deployment, which fossil fuels can’t match.

[Shrader-Frechette](https://www.jstor.org/stable/pdf/10.2979/ethicsenviro.18.1.1.pdf?refreqid=excelsior%3A45619e676385ee5a7fcb2a9873e04d4b)

**Why do many people mistakenly believe fission is a low-carbon technology?** **Of the twenty-nine major international nuclear-emissions assessments** done since 2000—none of which were published in peer-reviewed scientific journals—**all eighteen performed/funded by the fission industry) trim data by “counting” carbon emissions from only one stage (reactor operation) of fourteen stages.** University and non-governmental organization studies, not funded by the nuclear industry, however, did not trim these data (Shrader-Frechette 2011). The fourteen nuclear-fuel-cycle stages include (1) mining uranium ore—or using hundreds of metric tons of chemicals such as sulfuric acid, nitric acid, and ammonia to leach it; (2) milling ore to extract the roughly 0.2 percent uranium oxide (U3O8); (3) converting U3O8 to gaseous uranium hexafluoride (UF6) through fluorine; (4) enriching UF6 to 3.5 percent U-235, and removing waste, enrichment tails (85 percent of the UF6); (5) fabricating fuel into ceramicpellet uranium dioxide (UO2), packing pellets into zirconium-alloy tubes, bundling tubes together to form fuel rods; (6) constructing the reactor, during an average twelve years; (7) operating the reactor; (8) reprocessing spent fuel; (9) conditioning spent fuel; (10) storing/cooling radioactive waste onsite; (11) transporting waste to a secure, permanent, storage facility; (12) storing the waste permanently, given the long half-lives of the radionuclides; (13) decommissioning the reactor; and (14) reclaiming the uranium mines, milling facilities, enrichment facilities, and so on (Fleming 2007, 4–7). **At all [nuclear] fuel-cycle stages,** except (7), **massive carbon releases occur. Yet the nuclear industry routinely calls fission an “emissions free” technology because the industry misleadingly trims greenhouse-emissions data from all but (7) of fourteen fuel-cycle stages** (NEI 2007). Stage-(2) milling, for instance, uses mainly fossil fuels and requires roughly 1,000 metric tons of uranium ore to produce one ton of U308, after grinding/leaching/processing (Argonne 2007, Diehl 2004). In stage (4) enrichment, to produce 124 tons of enriched UF6, one must process1000 metric tons UF6, create 876 tons of radioactive waste, and use 951,543 Mwh (Megawatt-hours) of electricity. At stage (4), **8 Mwh electricity (most from fossil fuels) is needed to produce one kilogram of enriched UF6** (WISE 2006). Unsurprisingly, completely independent, peer-reviewed, university analyses in professional, scientific journals throughout the world—from Oxford (UK) to Heerlen (Netherlands) to Singapore, agree about per-kilowatt-hour, carbon-equivalent, full-fuel-cycle emissions: **Once full-fuelcycle greenhouse emissions are counted, fission is five to forty times dirtier than wind, three to ten times dirtier than solar-PV), and roughly as dirty as natural gas** (Van Leeuwen 2006; Barnaby and Kemp 2007, 7–14; ShraderFrechette 2011, 35–68). **Nuclear thus contributes both to climate change, and to the massive health toll of fossil fuels—including causing up to 40 percent of all cancers** (Lashof et al. 1981, 3, 6; Shrader-Frechette, 2007, 3–38, 114–49). Although the Kyoto Protocol “counts” emissions only at the single point of electricity generation, once one includes full-fuel-cycle greenhouse emissions, university scientists agree that greenhouse-emissions ratios, among various energy technologies, are as follows: 112 coal : 49 natural gas : 49 nuclear : 4 solar : 1 wind (Sovacool 2008; Fthenakis and Kim 2007; Barnaby and Kemp 2007, 7–14; Shrader-Frechette 2011, 35–68. ; WWW, 35–68). But if so, there is no low-carbon argument to make in favor of atomic energy over renewables like wind and solar-PV.

### A2 FF Trade Off

1. *T/Johnson 19 - Cap investment for nuke and RE are similar - power lines, storage systems,*

#### 

Jeff **Johnson**, journalist, September 23, **2019**, “Can nuclear power help save us from climate change?” Chemical and Engineering News,<https://cen.acs.org/energy/nuclear-power/nuclear-power-help-save-us/97/i37> (accessed 2/5/20)

However, energy researchers at the World Resources Institute and the UCS, speaking at a recent US congressional hearing, say renewable sources will continue to expand, and major increases in energy efficiency are on the horizon. In addition, the researchers expect that as more renewable energy facilities come on line, new technologies will be developed to address the challenge of variable output from renewable energy sources, such as with solar on an overcast day. **Overreliance on nuclear might in fact stall development and installation of technologies needed for a transition to a low-carbon future**, Cleetus argues. **Her modeling shows that capital investment needed for renewable energy development—building high-voltage power lines, advanced batteries and other storage systems, and of course, renewable resources themselves—could be funneled off to build and retrofit more nuclear power plants.** And then there are those who question whether nuclear energy can even be called low carbon if greenhouse gas emissions are considered for the full energy cycle, including plant construction, uranium mining and enrichment, fuel processing, plant decommissioning, and radioactive waste deposition. Ultimately, the future of nuclear power will turn on the world’s need for energy security and how it weighs the costs of action and inaction in the face of growing impacts of climate change.

### A2: Affordable Energy

1. Frohlich 19- NH and CT have the highest energy prices in the US and predominantly use nuclear
   1. Bhardwaj 18- High construction costs mean consumers have to pay higher prices of energy since companies try to recoup costs, eg. nuclear 5x more expensive than solar
   2. Smith 19- cost of subsidies for the nuclear industry are passed onto consumers in the form of taxes
2. Renewables lower prices, tradeoff occurs

[Frohlich 19](https://www.usatoday.com/story/money/personalfinance/2019/03/01/natural-gas-coal-nuclear-power-what-electricity-costs-in-each-state/38948593/) (AK)

6. Rhode Island • Average price of electricity: 18.30 ¢/kWh • Average monthly usage: 586 kWh per customer (5th lowest) • Average monthly bill: $109 (23rd lowest) • Largest electricity source: Natural gas 5. Massachusetts • Average price of electricity: 18.92 ¢/kWh • Average monthly usage: 599 kWh per customer (8th lowest) • Average monthly bill: $114 (23rd highest) • Largest electricity source: Natural gas 4. **New Hampshire[‘s]** • **Average price of electricity [is]**: **19.22 ¢/kWh** • Average monthly usage: 604 kWh per customer (9th lowest) • Average monthly bill: $111 (24th lowest) • **[and their] Largest electricity source [is]**: **Nuclear**  3. **Connecticut[‘s]** • **Average price of electricity [is]**: **20.31 ¢/kWh** • Average monthly usage: 711 kWh per customer (15th lowest) • Average monthly bill: $142 (3rd highest) • **[and their] Largest electricity source [is]**: **Nuclear**  2. Alaska • Average price of electricity: 21.57 ¢/kWh • Average monthly usage: 590 kWh per customer (6th lowest) • Average monthly bill: $120 (16th highest) • Largest electricity source: Natural gas 1. Hawaii • Average price of electricity: 29.50 ¢/kWh • Average monthly usage: 505 kWh per customer (the lowest) • Average monthly bill: $139 (5th highest) • Largest electricity source: Petroleum liquids

This is for two reasons:

1. Nuclear energy has large construction costs which are paid for with higher electricity prices. Renewables are comparatively cheaper. South Africa proves.

[Bhardwaj 18](https://africacheck.org/reports/is-nuclear-energy-really-the-cheapest-source-of-electricity/) (AK)

Building a nuclear plant is the second most capital-intensive way to produce electricity after solar power. **The capital cost for** a solar plant is R19,250 per kilowatt of installed capacity, compared to R46,841 for nuclear energy. **Nuclear power is**, therefore, **more than double the cost of a solar plant and** nearly **three times the cost of a wind farm.** However, while nuclear energy is available 90% of the time in a 12-month cycle, solar energy is available during the daytime, approximately only 30% of the time, as energy analysts Mahmood Sonday and ZB Kotze of Top Quartile, a South Africa-based energy consulting firm, point out. Kotze says Molefe’s claim that nuclear energy is a cheaper option “once the assets have been deployed” is “misleading”. Given that the IRP cost estimates show that nuclear plants are nearly double the cost of other sources of electricity – this cost should not be overlooked. According to energy analyst Chris Yelland, any **capital cost overruns for renewable energy sources** (solar and wind) **are typically carried by the power plant owners themselves, but the cost of nuclear plants will be borne by paying consumers.** Mix of renewables and gas offer equally cheap source of electricity to nuclear. The Integrated Resource Plan also shows that the price of solar cells is expected to decrease by 44% of their current cost by 2030. For nuclear energy, the cost is expected to decrease by just 4%. By this measure, **a nuclear power plant will be nearly five times more expensive than a solar plant.** According to a recent presentation by Dr Tobias Bischof-Niemz, who heads up the Council for Scientific and Industrial Research’s Energy Centre and helped develop the IRP, producing electricity through a mix of renewable energy and natural gas will allow production of uninterrupted electricity to supply 82% of South Africa’s needs. It is also projected to cost roughly the same as nuclear energy sourced electricity for consumers, without the construction costs that a building a nuclear plant will entail. The presentation – based on an unpublished study – looked at whether a mixture of renewable energy using solar panels and wind, providing intermittent power generation, could be mixed with natural gas technology to provide 8 gigawatts of electricity on an uninterrupted basis. (The current projected output of the nuclear stations will be about 9.6 gigawatts.) Bischof-Niemz’s study concludes that the cost of energy to consumers would be R1.00 per kilowatt-hour using renewables and natural gas. In the case of nuclear energy, it would be R1.10 per kilowatt-hour. A separate calculation by Chris Yelland, using the current costs of electricity from the Koeberg nuclear plant near Cape Town, arrived at an estimated R1.52 per kilowatt-hour. According to Yelland’s calculations (based on the levelised cost of electricity), the cost of coal would be R1.19 per kilowatt-hour and for wind and solar would be R0.69 per kilowatt-hour and R0.87 kilowatt-hour respectively. Conclusion: **Nuclear is not the cheapest source of electricity**. Molefe’s office did not respond to queries requesting evidence to support his claim. Available research does not show that nuclear energy is the cheapest form of electricity. According to the IRP comparison, capital costs of building a nuclear plant are second only to centralised solar power – the cost of which is expected to decrease by 44% by 2030. In contrast, the cost of nuclear is expected to decrease by 4% during the same period. Even if a comparison is made between costs of nuclear energy once the nuclear power stations have been built, **the cost of energy to the consumer using a mix of renewable energy sources** and natural gas **is** slightly **cheaper than electricity sourced from nuclear power plants** using Bischof-Niemz’s calculations.

1. Nuclear energy requires massive subsidies which is financed through taxes

[Smith 19](https://www.ewg.org/energy/22777/federal-energy-subsidies-what-are-we-getting-our-money) (AK)

Taxpayers’ return on investment: the worsening climate crisis, dirty air that threatens public health, oil spills and toxic waste. Since the beginning of the nuclear age, federal funding just for research and development of nuclear power have topped $100 billion, says the Congressional Research Service. AWEA’s estimate for all **federal subsidies to the nuclear industry** during that period is nearly twice that much. ROI: Huge cost overruns **[have been] passed on to utility customers**; aging and crumbling reactors riskily kept running longer than they were built for; tens of thousands of tons of radioactive waste that will remain dangerous for many millennia. Federal subsidies for wind and solar projects and technology development totaled about $75 billion over the past decade, according to EWG’s analysis of data from the Treasury Department, Congress’ Joint Committee on Taxation and the Congressional Research Service.

### A2: Greentech Bad

#### A2 REMS Bad

1. Piesing 13- Synthetic rems being developed
2. Berke 18- Japan has semi-infinite supply
3. Moss 18- only inactive vents mined since otherwise equipment is damaged too much
4. Teske 16- demand for green tech isn’t high enough to warrant offshore exploration

#### A2 Intermittence

1. Plumer 13- Greentech emission reductions far outweigh any marginal increases in fuel consumption
2. Fossil fuels go away anyways due to cost
3. Hicks 20- batteries getting cheaper due to incredible innovation, will be conceivable to 100% use renewables
4. Carbontracker 18- Denmark is already able to get 50% power from renewables due to these innovations

[Plumer 13](https://www.washingtonpost.com/news/wonk/wp/2013/09/25/what-happens-if-you-add-lots-of-wind-and-solar-power-to-the-grid/) (AK)

After modeling a year's worth of electricity use (see right for an example), the NREL study found that if you add a lot of wind and solar to the grid, there will be some "cycling" of natural gas and coal plants to balance the load. That does lead to more wear and tear on power plants and increases operating costs by up to $157 million. But that's a small amount compared to the fuel savings of around $7 billion by switching to wind and solar. The same goes for pollution. "The negative impact of cycling on overall plant emissions is relatively small," the study concluded. "**The increase in plant emissions from cycling to accommodate** variable **renewables are more than offset by the overall reduction in** [other **pollutants**, such as carbon-dioxide and sulfur-dioxide]. In the **[from]** high **wind and solar** scenario, net carbon emissions were reduced by one third." As a result, the NREL team's results "disagree with some previous studies" on this score and find "that wind does not increase overall emissions and that avoided emissions from wind and solar have not been significantly overstated."

[Hicks 20](https://www.nrel.gov/news/features/2020/declining-renewable-costs-drive-focus-on-energy-storage.html) (AK)

An oft-repeated refrain—the sun doesn’t always shine, and the wind doesn’t always blow—is sometimes seen as an impediment to renewable energy. But it’s also an impetus toward discovering the best ways to store that energy until it’s needed. Declining costs in available technologies have propelled interest in energy storage forward like never before. **The price of** lithium-ion **batteries has fallen by about 80% over the past five years**, enabling the integration of storage into solar power systems. Today, nearly 18% of all electricity produced in the United States comes from renewable energy sources, such as hydropower and wind—a figure that is forecast to climb. And **as communities and entire states push toward higher percentages of power from renewables,** there’s no doubt storage will play an important role. Compared with the same period a year earlier, **the U**nited **S**tates **saw a 93% increase in the amount of storage deployed in** the third quarter of **2019**. By 2024, that number is expected to top 5.4 gigawatts, according to a forecast by market research firm Wood Mackenzie Power & Renewables. The market value is forecast to increase from $720 million today to $5.1 billion in 2024. Driving such growth is an increased focus on adding renewable energy sources to the nation’s grid. Only in the past decade has the widespread adoption of renewable energy sources become an economic possibility, said Paul Denholm, a principal energy analyst at the National Renewable Energy Laboratory (NREL). He joined NREL 15 years ago and, at the time, he and other analysts were busy plotting a path to 20% of the nation’s energy supply coming from renewable sources. Now, they’re aiming much higher. “**The declining cost of** wind and solar and now **batteries makes it conceivable to consider 100% renewables**,” he said. NREL’s Renewable Electricity Futures Study estimated that 120 gigawatts of storage would be needed across the continental United States by 2050, when the scenario imagined a future where 80% of electricity will come from renewable resources. The country currently has 22 gigawatts of storage from pumped hydropower, and another gigawatt in batteries.

[Piesing 2013 The Wire](https://www.wired.co.uk/article/race-for-rare-earth-minerals) (YZ)

In the US, **the Department of Energy is sponsoring 13 other research projects** like Laura Lewis's **to find synthetic replacements for rare-earth materials**. Professor Lewis says that because rare-earth elements were "messy to dig up and required strong, damaging acids to separate elements from the rocks the world was very happy to have it restricted to China and not in their own country" He adds that the Chinese, from their perspective, are "doing just what any other country would do". Half of Edwards' team is Chinese. "However, running alongside the desire **to substitute indium is the desire at the same time to see whether we can use it in manufacturing in a different, less energy-intensive way.** "And why shouldn't we think of this challenge at the same time?

1. A2 Chinese Monopoly: China is unable to restrict REM sales again
   1. ^ also innovation solves

[The Guardian 2015](https://www.theguardian.com/world/2015/jan/05/china-scraps-quotas-rare-earth-wto-complaint) (YZ)

**China has scrapped its export quotas for rare earths, minerals** used in mobile phones and other high- tech products, **after losing a World Trade Organisation case brought by Washington and other trading partners over controls that alarmed global technology producers.**

1. DL: We have a huge supply from Japan, no concern

[Berke of Business Insider in 2018](https://www.businessinsider.com/rare-earth-minerals-found-in-japan-2018-4?r=UK&IR=T) (YZ)

Researchers have found **a deposit of rare-earth minerals off the coast of Japan** that could supply the world for centuries,

according to a new study. The study, published in the journal Nature on Tuesday, says the deposit **contains 16 million tons of the valuable metals**. The newly discovered deposit is **enough to "supply these metals on a semi-infinite basis to the world,"** the study's authors wrote in the study. There's enough yttrium to meet the global demand for 780 years, dysprosium for 730 years, europium for 620 years, and terbium for 420 years.

1. A2 Microorganisms - DL: We only mine in dead vents that have no organisms

[Moss 18](https://knect365.com/energy/article/9c1b0a6e-e73e-4360-9485-adf5cf141b33/renewable-energys-deep-sea-mining-conundrum?utm_source=Reddit&utm_medium=Social&utm_campaign=Reddit%20-%20Social%20Referral) (EH)

Polymetallic nodules generally occur in volcanically active areas, in close proximity to hydrothermal vents (basically the underwater equivalent of geysers). Hydrothermal vents warm the surrounding ocean, leading to unique and as yet little understood communities of marine life.

But the industry claims that **only inactive vents are likely to be targeted by mining operations, as high water temperatures and low PH levels around active vents would damage mining equipment.** A much greater impact is anticipated as a result of mining for cobalt-rich crusts. These crusts occur in a thin layer (approximately 25cm thick) over a broader area of sea floor, usually around seamounts, submerged ridges and plateaus. The International Seabed Authority estimates that as much as 1.7% of the ocean floor may be covered in cobalt-rich crusts.

1. A2 Microorganisms - DL: Land supply enough

[Teske 2016](http://dscc.hifrontier.com/wp-content/uploads/2017/03/Teske_Sven_ISF-Kingston-11-July-2016.pdf,7-16-18//ALP) (NA)

**Metal demand associated with the dominant renewable technologies evaluated in this report, even assuming very aggressive growth rates under the most ambitious future energy scenarios, do not require deep-sea mining activity.**

### A2: Nuclear Exports

1. Dichristopher 19- US can’t outcompete Russia and China who already do this
   1. 3 warrants from Atlantic Council 19
      1. SOEs have more competitive pricing
      2. No domestic funding and China/Russia have a better track record
      3. US has strict non-prolif requirements, Russia/China don’t
2. Gordon 20- Super high cost to export because you need to go through complicated licensing agreements with each country you export to
3. Dichristopher 19- US needs to reach “123 Agreements” that limit use of nuclear energy before they can get exported. However, congress currently opposes them.

[Dichristopher 19](https://www.cnbc.com/2019/03/21/trump-aims-to-beat-china-and-russia-in-nuclear-energy-export-race.html) (RL)

To be sure, the Energy and Commerce departments actively facilitate U.S. nuclear cooperation with their foreign counterparts. But the State Department now intends to push the issue in talks at the highest levels of government, making it clear that Washington believes cooperation in the nuclear realm is central to its strategic relationships. But even with the State Department lending its diplomatic heft, **winning nuclear energy contracts won’t be easy. Russia and China are aggressively pursuing those deals at a time when the U.S. has struggled to build reactors at home and no longer enriches uranium** to fuel those facilities. “We have lost tremendous ground. We were once 90 percent of the market globally. We’re down to 20 [percent] if we’re lucky,” Ed McGinnis, the Department of Energy’s principal deputy assistant secretary for nuclear energy, said in an interview. “**The majority of the big 80- to 100-year nuclear power deals being made overseas are Russian and Chinese and other state-owned corporations**,” said McGinnis, who has worked in government on nuclear energy and nonproliferation issues for 27 years.

[Atlantic Council 19](https://www.atlanticcouncil.org/blogs/energysource/roadblock-for-us-nuclear-power/) (RL)

**The US commercial approach to nuclear power** (e.g., with private shareholder-owned companies) **is in trouble for two primary reasons: first, the US commercial method has difficulty competing with SOE offers; and second, the restrictive US approach to non-proliferation may limit nuclear power exports**, compared to other countries with less stringent requirements. New reactor designs from US companies are excellent, but not inherently best-in-class, compared to reactor designs offered by state-owned competitors. These nuclear SOEs work with state-owned electric utilities to develop and build new NPPs, and to develop nuclear supply chains used to support a move into the nuclear power export market. **In contrast to the American commercial market-driven approach to nuclear exports, China and Russia’s nuclear SOEs can offer very favorable prices, use nuclear power as a part of larger government-to-government (G2G) relationships, and usually offer funding for buyer countries through G2G loans with attractive terms.** China and Russia have recently expanded the powers of their nuclear enterprises, making the chasm between their efforts and those of the US even more stark. Despite China’s position as a relative newcomer to the nuclear power export scene, it has consolidated its nuclear enterprise through state financing for energy sector infrastructure and its Belt and Road Initiative (BRI) strategy both at home and abroad. In Russia, their vertically-integrated nuclear company, Rosatom, is a key player in domestic and foreign energy policy that aim to preserve and strengthen Russia’s global market share and influence. Besides building new NPPs domestically, Russia and China are also building or planning to build NPPs abroad. Russia’s ongoing and planned projects include: Bangladesh, Belarus, China, Egypt, Finland, Hungary, India, Iran, Turkey, and Uzbekistan. China has grand export plans that are built on exports to Pakistan, multiple initiatives in the United Kingdom, and a place on the Saudi Arabia nuclear vendor short list. Additionally, both countries are seeking a nuclear foothold in Europe and frontier markets such as Eurasia, the Arctic, and space. Chinese investments in developing floating NPPs and nuclear-powered icebreakers are complemented by several planned advanced reactor projects and ambitions for a nuclear-powered aircraft carrier. Russian investments are aimed at completing the first floating NPP, expanding its nuclear-powered icebreaker fleet, and growing its presence in global nuclear fuel markets, while also engaging in several advanced reactor projects. In order to compete on the world stage, the US must develop and implement a national nuclear power strategy in the US that consistently addresses technology innovation (e.g., advanced reactors), the domestic nuclear power industry (e.g., supporting new and existing NPP projects), and nuclear exports. **There are few new domestic NPP projects in the US (unlike in Russia, China, and South Korea) and the track record on these projects**, including Vogtle cost and schedule issues and the abandonment of V.C. Summer, **has not been strong. Moreover, the early retirement of existing NPPs in the US dampens credibility.** Furthermore, **the absence of project funding such as government-to-government loans or loan guarantee programs has made it nearly impossible to level the playing field with Russia and China.** The level of support that might be offered through OPIC—or the new US Development Finance Corporation (USDFC)—falls short of what SOE nuclear vendors can offer. A recent meeting between President Donald Trump and US commercial nuclear industry players highlighted several messages, including arguments that advanced reactor technology is a way for the US to regain nuclear industrial leadership and the commercial US nuclear power industry needs some government assistance in the world market. Nuclear power needs at least the same level of engagement on export promotion as the natural gas industry, for both economic and geopolitical reasons, and may need even more help. The US government should take action that is consistent with the long-term political relationships that are key factors in the sale of NPPs (and related goods and services) over a reactor operating life of sixty to eighty years. For example, the US must resolve issues in the domestic market, both to support new NPP projects and to avoid the economic retirement of existing NPPs with decades of useful life remaining. In addition to resolving the commercial issues, the US needs to rethink its approach to exporting nuclear power technology, fuel, and services, which is linked closely to imposing a US view of nonproliferation. **Increased insistence in the US for a so-called “gold standard” Section 123 agreement with Saudi Arabia, that entirely prohibits enrichment and reprocessing of nuclear fuel**, as opposed to a standard 123 agreement that only applies to enrichment and reprocessing with US nuclear technology, **may limit success in the nuclear power export market. In contrast, Russia and China do not impose the same requirements on existing and planned sales.**

[Gordon of Atlantic Council 20](https://www.atlanticcouncil.org/in-depth-research-reports/issue-brief/international-co-financing-of-nuclear-reactors-between-the-united-states-and-its-allies/) (RL)

The costs of building new LWRs are well known, and—along with increasing security and fuel efficiency—bringing down expenses is one of the many goals of new or Generation IV reactors. Although advanced reactors ultimately aim to be more cost-effective than LWRs,**there are potentially significant costs associated with demonstrating and commercializing first-of-a-kind technology.** For example, **an advanced reactor model must go through the process of licensing and permitting in each country where it seeks to build, dramatically multiplying the capital costs that it pays for upfront siting, licensing, and permitting.** However, US Nuclear Regulatory Commission (NRC) Chairman Kristine Svinicki and Canadian Nuclear Safety Commission (CNSC) President and Chief Executive Officer (CEO) Rumina Velshi recently signed a memorandum of understanding (MOU), with the aim of harmonizing the regulatory process and technical reviews, especially for advanced reactors and SMRs.32

[Dichristopher 19](https://outline.com/c5p8zc) (MM)

**The U.S. will still have to reach so-called 123 Agreements with foreign countries before American firms can sell nuclear reactors overseas.** These agreements place limits on the use of nuclear technology and must be approved by Congress. **[However] These agreements have recently drawn scrutiny from Democratic and Republican lawmakers as Westinghouse bids for nuclear power contracts in Saudi Arabia.** The Saudis have long insisted on their right to enrich uranium, something the U.S. usually opposes. The bidding also comes as tension between Riyadh and Capitol Hill has escalated after Saudi agents killed Washington Post columnist Jamal Khashoggi in October.

#### 

#### A2: Energy Poverty

1. Pratt 19- Renewables can be decentralized due to small scale grids
   1. In rural areas, there is no centralized grid because providers don’t find it profitable
2. UCS 17- Nuclear requires centralized grids

[Pratt 19](https://www.energycentral.com/c/cp/how-renewables-could-end-energy-poverty) (MM)

Enbidge informs us that the International Energy Agency on Energy Access defines energy poverty as lacking access to electricity and clean cooking areas because of a lack of modern energy and it is estimated that over a billion people worldwide suffer from this problem. **Energy poverty** might be **[is] a direct result of the situation** in developing countries **regarding** the **establishment and maintenance of a reliable electrical grid.** While it is more efficient to produce electricity from a centralized source, the fact remains that this system is less-than-perfect for developing countries that have a vast area to cover. As the volume of infrastructure required goes up, the amount of customers necessary to recoup that cost also needs to grow. However, **in places like sub-Saharan Africa, there isn't the amount of population density essential to interest centralized providers into offering their services out in rural districts. The** other **obvious alternative is the development of a distributed grid,** which has the added power of giving people back control over their electricity generation and distribution. **[which] Renewables provide** an excellent alternative **for developing nations.** As The Environmental Protection Agency mentions, centralized power generation tends to be the most economical and efficient system for providers to get the most value out of their money. However, the biggest problems with centralized generation come from their impact on the environment. Natural generation methods tend to impact the environment a lot less and could help developing countries meet their goals regarding pollution more effectively.

[Union of Concerned Scientists 17](https://www.ucsusa.org/resources/barriers-renewable-energy-technologies) (MM)

**Nuclear power**, coal, and natural gas are all **[is a] highly centralized source**s **of power,** meaning [it]they rel[ies]y on relatively few high output power plants. **Wind and solar, on the other hand, offer a decentralized model**, in which smaller generating stations, spread across a large area, work together to provide power. Decentralization offers a few key advantages (including, importantly, grid resilience), but it also presents barriers [from]: siting and transmission. Siting is the need to locate things like wind turbines and solar farms on pieces of land. Doing so requires negotiations, contracts, permits, and community relations, all of which can increase costs and delay or kill projects. Transmission refers to the power lines and infrastructure needed to move electricity from where it’s generated to where it’s consumed. Because wind and solar are relative newcomers, most of what exists today was built to serve large fossil fuel and nuclear power plants.

### A2: Generic Power Increase

### A2:Nuke Power to other countries

<https://www.power-technology.com/features/featurefear-itself-nuclear-energys-image-problem-4572770/>

First, for nuclear energy programs to be developed and managed safely and securely, it is important that states have domestic “good governance” characteristics that will encourage proper nuclear operations and management. These characteristics include low degrees of corruption (to avoid officials selling materials and technology for their own personal gain as occurred with the A.Q. Khan smuggling network in Pakistan), high degrees of political stability (defined by the World Bank as “likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism”), high governmental effectiveness scores (a World Bank aggregate measure of “the quality of the civil service and the degree of its independence from political pressures [and] the quality of policy formulation and implementation”), and a strong degree of regulatory competence. Fortunately, we have a great deal of information measuring these domestic good governance factors across the globe. **Unfortunately, the data highlight the grave security challenges that would be created if there were rampant proliferation of nuclear energy production facilities to each and every state that has expressed interest to the IAEA in acquiring nuclear power.** The World Bank publishes annual aggregate data, derived from multiple sources, on each of these good governance characteristics, and, as shown in Figure 2, the average scores of the potential new nuclear- energy states on each of these dimensions is significantly lower than the scores of states already possessing nuclear energy.

### A2: Desalination [AT: Desalination](https://docs.google.com/document/d/1bvBvX9Ip9zDBLcozLZmHXuu_r_EdvTROIMhMrsuSRSo/edit) look at me

1. **AUB Policy Institute 17 -** Solar can do it cheaper, no reason to use nuclear

[AUB Policy Institute 2017](https://www.aub.edu.lb/ifi/Documents/publications/policy_briefs/2016-2017/20170215_solar_nuclear.pdf) (DS)

**“The cheapest technology for producing potable water is reverse osmosis running on solar PV panels.”** The aim of this Policy Brief is to provide reliable data for policy-makers in the Middle East on the comparative economics of solar and nuclear desalination. Ten combinations were studied and were based on four energy sources and three desalination technologies. Of all the desalination technologies and power options studied, solar PV panels coupled with reverse osmosis technology were found to be the most economical combination. **Water cost for a plant running on reverse osmosis coupled with solar PV panels is $0.85/m3 , while a nuclear power plant coupled with the**

**same technology would have a water cost of $0.91/m3**

### A2: Global Leadership

1. Kobezkii 19- US reactors can be used to prolif
2. AP 20- Despite enormous pressure, Iran tripled its enriched uranium stockpile and isn’t cooperating on their nuclear sites
3. Global leadership is always ceded to the country that exports the most, thats China and Russia anyways (see A2 Exports)

[Kobezskii 19:](https://thebulletin.org/2019/06/will-nuclear-proliferation-challenges-limit-a-significant-expansion-of-global-nuclear-power/)

**Nuclear technologies are dual-use; that is, they can be used for both civilian and military purposes.** **The domestic development of an ostensibly peaceful nuclear power program** and the enrichment facilities needed to fuel it **can provide the means for a non-nuclear weapons state to create nuclear weapons**. Because nuclear power has significant benefits as an energy source, particularly in regard to the fight against climate change, and has a valuable role in other industries, such as nuclear medicine, it is important that the international community continue to manage proliferation risks in emerging nuclear countries. To build a nuclear weapon, one must first obtain bomb fuel—that is, uranium with its uranium 235 component enriched to 90 percent or more, or weapons-grade plutonium. **The same centrifuges that enrich natural uranium to the level suitable for use in nuclear reactors can also further enrich it to be useable in a nuclear weapon**. Similarly, the civilian reactors that produce electricity can also provide a source of weapons-grade plutonium

[AP 20:](https://www.theguardian.com/world/2020/mar/03/iran-triples-stockpile-of-enriched-uranium-in-breach-of-nuclear-deal) **Iran has nearly tripled its stockpile of enriched uranium since November in violation of its deal with world powers and is refusing to answer questions about three possible undeclared nuclear sites,** the UN atomic watchdog agency has said. The International Atomic Energy Agency made the statement in a confidential report distributed to member countries that was seen by the Associated Press.

### A2: Carbon Capture

1. **Big Think 19-** CO2 in the air is too dilute for capture tech to work, must be directly attached to fossil fuel plants
2. **Forbes 17-**Carbon capture increases emissions for 3 reasons
   1. Fossil fuel companies have an excuse to continue operations, they operate indefinitely
   2. Replaces investment in renewables which are carbon neutral
   3. Sequestered CO2 is used in enhanced oil recovery, which enables more oil to be pumped and burned. After CO2 is pumped, it leaks from the wells back into the atmosphere
3. **EES 19-** CCS only reduces CO2 by 10%
   1. Upstream emissions from extracting, transporting, and leaks mean CCS can’t work
   2. Only traps CO2, not NO2, methane, etc.
4. **Kutoba 19**- since CCS requires energy to run, it actually creates emissions itself, concluding even if it were 100% effective, society is much better off just building renewables
5. **Yeoh 19-** There’s not a ton of developed technology and investors are wary of it because it is too risky for them. Any solutions are far off in the future.

[Big Think 19](https://outline.com/nGduAD) (RL)

Here's how **CCS technology** works. There are a variety of methods, but one of the most common is to install a machine at the source of the pollution, like a coal plant, for instance, and pass the polluting gas through a liquid solution. This solution contains chemicals similar to ammonia which sticks to the CO2. Everything else bubbles through the solution, and the result is a CO2-free gas. Then, you can heat the solution up to unbind the CO2 molecules, allowing you to reuse the liquid and store the CO2 for whatever purpose you have in mind. This approach **really only works when attached to a source of CO2 like a power plant, since CO2 in the air is extremely dilute.** (Though we've started to see the first few facilities designed to scrub CO2 directly from the atmosphere!) Luckily, researchers believe that when CCS technology like this is implemented at a coal plant, for instance, it can reduce CO2 emissions by 85 to 95 percent. Or at least, that's what we've thought. New research published in the journal Energy & Environmental Science shows that this reduction may actually only amount to between 10 and 11 percent. Scrubbing 85 to 95 percent of CO2 from the gas produced by a coal plant is what CCS technology should do in theory. But in practice, the nature of CCS tech actually incurs further, additional costs that affect this rate, and researchers often ignore the upstream and downstream costs of CO2 scrubbing.

[Koerth-Baker 19](https://outline.com/c6U3XS) (RL)

All of them are pulling carbon dioxide out of the emissions from an associated factory or power plant. **Systems that pull CO2 out of the ambient air [are]**, like the ones Andrew referenced in his question, do exist. They’re just **harder and more expensive to operate because the concentration of CO2 in the air is so much lower**, Nemet said. “**At a power plant, 10 to 20 percent of what goes up the smokestack is CO2, compared to .04 percent in the air,**” he said. So generally speaking, the technology of carbon capture is ready to go. The problem with CCS is that it doesn’t really have a destination, said Dan Lashof, U.S. director of the nonprofit World Resources Institute.

[Forbes 17](https://outline.com/4wGEHt) (RL)

Delay the sunsetting of fossil fuels **Carbon capture and sequestration is highly ineffective and expensive.** It captures a tiny fraction of CO2 emissions. **All it really does is give fossil fuel-emitting companies and jurisdictions license to continue to operate.** And given license, they do. Reduce potential deployment of renewables Wind and solar generation are actually carbon-neutral technologies, and are actually cost effective technologies. **Every MWH of wind or solar electricity eliminates the generation of a MWH of fossil fuel generation and its attendant CO2. Spending money on expensive and ineffective CCS instead of renewables is just backwards.** Create more CO2 in the atmosphere **Most of the CO2 which is sequestered is** being **used in enhanced oil recovery. That’s the process of pumping CO2 down into tapped out oil wells** to liquefy sludge and drive it to the other end of the field **so [oil]** it **can be pumped out.** When **the oil** is pumped out, it’s **burned to make more CO2. And massive oil fields where this is deployed are full of a wide variety of old oils wells and test bores, and there’s no value in sealing the holes** once enhanced oil recovery is over**. As a result, a bunch of the ‘sequestered’ CO2 is just going to leak back up.** Net result: more CO2 in the atmosphere.

[Energy and Environmental Science 19](https://outline.com/nGduAD) (RL)

Or at least, that's what we've thought. New research published in the journal Energy & Environmental Science shows that this **[CO2] reduction may actually only amount to between 10 and 11 percent.** Scrubbing 85 to 95 percent of CO2 from the gas produced by a coal plant is what CCS technology should do in theory. But in practice, **the nature of CCS tech actually incurs further, additional costs that affect this rate, and researchers often ignore the upstream and downstream costs of CO2 scrubbing.** Rather than use CCS, the researchers found, it would be far more beneficial to just use renewable energy like wind or solar power in place of coal or natural gas. In coal or natural gas plants, **there are upstream emissions associated with [fossil fuel]** those **industries that can't be accounted for by CCS, such as the emissions associated with extracting and transporting fuel or fuel leaks. Furthermore,** fossil fuel plants pollute in a wide variety of ways, not just through CO2. **CCS technology is only geared towards scrubbing CO2 from gases, not carbon monoxide, nitrous oxides, mercury, or other chemicals. Then there's the fact that CCS technology also requires a significant amount of electricity to run, increasing our reliance on fossil fuels.** Then there's perhaps the most fundamental issue with CO2 capture — **there's no incentive to store [CO2]** it **long term, while there are incentives to use it for fundamentally counterproductive purposes.** Funnily enough, extracted CO2 is often sold to oil and gas companies who can use it to coax more crude oil out of depleted wells. This is actually presented as a positive thing, since it traps the CO2 underground. But it doesn't get around the fact that we're just replacing the CO2 we take out of the atmosphere with more CO2. To get around the costs associated with powering CCS technology, the researchers also analyzed the scenario where a CCS solution in a coal or natural gas plant was powered by wind turbines or solar panel array. While this did improve the CCS technology's efficiency, it still didn't account for the upstream emissions or other pollutants released by the plant.

[Kubota of Stanford 19](https://phys.org/news/2019-10-carbon-capture.html) (RL)

**Due to the high energy needs of carbon capture equipment,** Jacobson concluded that **the social cost of coal with carbon capture powered by natural gas was about 24 percent higher**, over 20 years, **than the coal without carbon capture. If the natural gas at that same plant were replaced with wind power, the social cost would still exceed that of doing nothing.** Only when wind replaced coal itself did social costs decrease. For both types of plants this suggests that, **even if carbon capture equipment is able to capture 100 percent of the carbon it is designed to offset, the cost of manufacturing and running the equipment plus the cost of the air pollution it** continues to allow or **increases makes it less efficient than** using those same resources to create **renewable energy plants** replacing coal or gas directly.

[Yeoh 19](https://www.weforum.org/agenda/2019/12/climate-change-carbon-capture-conditions/) (RL)

A 2017 Michigan study optimistically suggests that carbon removal solutions have the potential to mitigate 37 gigatons of carbon dioxide per year, where annual emissions are roughly 38 gigatons of carbon dioxide per year. However, even if this were the case, **reaching [a]** this **storage potential [of 37 gigatons per year] would require a portfolio of solutions with carbon capture costs lower than traditional storage or emissions.** Technological solutions are making progress - but **investment and time are still required to reduce carbon removal costs and to scale-up the adoption of these solutions. A Swiss-company, Climeworks, has constructed a plant which [uses]** extracts carbon dioxide directly from the air using a filter and chemical process, storing carbon dioxide as a concentrate. Technologies like these are known as **Direct Air Carbon Capture and Storage (DACCS).** Despite the novelty of this idea, **Climeworks’ plant in Italy can only capture up to 150 tons of carbon dioxide per year from the atmosphere, equivalent to taking just 32 cars off the road. Combined with high capital and carbon removal costs, solutions like these alone are not sufficient.** Reducing the market and technology risks of carbon removal solutions **Most carbon removal solutions** are still in development, and it **may take years** for them **to commercialize.** The pathway to **commercialization requires large investments into research and development without guarantees of financial return. This may not fit the risk profiles of many traditional investors or funders, limiting the available funds for the development of new solutions.**

### A2: Middle East Economy Diversification

1. Sarant 16- drop in oil prices means countries have less funding for science necessary to diversify
   1. Ahmed 17- that’s an issue because most economies in the middle east depend on oil
2. Tagliapietra 17- Middle east dismisses all attempts at diversification the moment they think prices will go back up, this is why they’re still so reliant
3. If their warrant were true, the Middle East should be diversifying because renewables undercut oil anyways
4. EIA 19- Only 1% of the US’s oil is used for electricity, rest used for things like cars

[Sarant 16 Nature](https://www.nature.com/articles/537S6a) (EH)

**Ironically, given that the long-term goal of research for the Gulf states is to free themselves from oil dependence, the drop in the oil price has reduced the amount of money available to fund science.** According to Sami Mahroum, director of the Innovation and Policy Initiative at the graduate business school INSEAD in Abu Dhabi, this tightening may be temporary.

[Ahmed 17 UPenn (EH)](https://publicpolicy.wharton.upenn.edu/live/news/1778-the-political-economy-of-oil-in-the-middle-east/for-students/blog/news.php)

Since then, **modern Arab oil-exporting economies have become heavily dependent on oil. Hydrocarbon and government activities account for the majority of total GDP in nearly every Middle Eastern country. In Libya, for instance, non-oil and non-governmental activities account for just over 0.16% of the GDP.** Likewise, **oil accounts for 80% of total exports in half of the oil-exporting economies.**

[Tagliapietra 17 Bruegel](https://bruegel.org/wp-content/uploads/2017/04/WP-2017_05.pdf) (EH)

However, it should be outlined thatthese kinds of **economic diversification plans have been part of MENA oil exporters’ rhetoric for a long time.** For instance, **Kuwait’s government was** already **discussing the need for economic diversification during the 1950s. After 60 years, oil continues to represent more than 60 percent of Kuwait’s GDP, and more than 70 percent of its fiscal revenues. MENA oil exporters** have **often set out** similar **strategies in times of low oil prices**, **and then rapidly dismissed them once prices recovered.** As Hvidt (2013) outlines, MENA rentier states easily give up their well-argued and planned policies when under pressure and fall back on established ways of doing business, namely through patronage and the predominant role of the public sector. There is, therefore, a risk that current strategies could also be quickly forgotten if/once oil prices recover from the current low levels (IEA, 2017).

[EIA 19](https://www.eia.gov/energyexplained/oil-and-petroleum-products/use-of-oil.php) (YZ)

U.S. [petroleum consumption](https://www.eia.gov/totalenergy/data/monthly/pdf/flow/petroleum.pdf) by sector and share of total in 2018

* Transportation 14.16 million barrels per day69%
* Industrial 5.13 million barrels per day25%
* Residential 0.56 million barrels per day3%
* Commercial 0.48 million barrels per day2%
* **electric power 0.11 million barrels per day 1%**

### 

### A2: Storage

[Niiler 19](https://www.wired.com/story/cheap-at-last-batteries-are-making-a-solar-dream-come-true/) (DW)

The first solar-plus-storage installations started about a decade ago on a small scale in sunny states like California, Hawaii, and Arizona. Now they’re spreading across the country, driven by falling prices of both solar panels and lithium-ion batteries the size of a shipping container imported from both China and South Korea. These countries have ramped up production efficiencies and lowered labor costs, leaving many US manufacturers in the dust. In fact, **the price of building a** comparable **solar-plus-storage generating facility is now cheaper than operating a coal-fired power plant**, industry officials say. In certain circumstances, the cost **[and] is equal to some natural gas plants**. “This is not just a California, New York, Massachusetts thing,” says Kelly Speakes-Backman, CEO of the Energy Storage Association, an industry group in Washington. She says more than 30 states have renewable storage on the grid. Utilities have proposed and states have approved 7 gigawatts to be installed by 2030. Speakes-Backman estimates the unit cost of electricity produced from a **[and] solar-plus-storage system will drop** 10 to **15 percent each year through 2024**. “If you have the option of putting out a polluting or non-polluting generating source at the same price, what are you going to pick?” says Speakes-Backman. She notes that PJM, a large Mid-Atlantic wholesale grid operator, announced it will deploy battery storage to help smooth out fluctuating power from two wind farms it operates. “When the grid fluctuates, storage can react to it quickly and can level out the supply,” she says. In the Midwest, grid-level battery storage is also being used to absorb extra wind power. Batteries hold onto the wind and put it back onto the grid when people need it. While the solar-plus-storage trend isn’t yet putting a huge dent in our fossil fuel use, according to Paul Denholm, an energy analyst at the National Renewable Energy Laboratory in Golden, Colorado, it is a good beginning and has the side effect of cutting air pollution. **By 2021, solar and other renewable energy sources will overtake coal** as a source of energy, according to a new report by the Institute for Energy Economics and Financial Analysis, a nonprofit think tank based in Cleveland.

### A2: Land/Cement

1. **Aouf 19-** Researchers found a way to manufacture cement without releasing CO2
2. Offshore wind and solar are great, no land issues
   1. **Deign 19**- companies looking to offshore wind and solar to solve land issues
   2. **Maloney 18-** offshore solar up 100x in the last 4 years and the US is picking up on the trend
   3. **Woods 19-** offshore wind will be 70 bill by 2030 and IEA 19 finds it can provide the baseload of power needed

[Aouf 19](https://www.dezeen.com/2019/10/07/mit-researchers-emissions-free-cement/) (YZ)

[Massachusetts Institute of Technology](https://www.dezeen.com/tag/mit/) (**MIT**) researchers **have demonstrated an experimental way of manufacturing** [**cement**](https://www.dezeen.com/tag/concrete/) **that releases no carbon dioxide into the atmosphere.**

A team led by MIT engineer Yet-Ming Chiang team tackled the problem of carbon dioxide emissions at the two points in the cement manufacturing process where they arise: from the burning of coal to create the necessary high heats, and from the gases released during the resulting chemical reaction.

**Tackling the first source of CO2 was simply a matter of using electricity from renewable sources** — sources that they note are increasingly the lowest-cost option.

**The second source of CO2 involved a more novel approach of using an electrolyser to convert the limestone's calcium carbonate into calcium hydroxide.**

In recent years, **materials scientists have proposed greener concrete alternatives** **made with substances including** [**desert sand**](https://www.dezeen.com/2018/03/24/desert-sand-could-offer-low-carbon-concrete-alternative/)**,** [**nano platelets**](https://www.dezeen.com/2018/08/09/carrots-concrete-stronger-lancaster-university-technology/) **and** [**human urine**](https://www.dezeen.com/2018/11/06/bio-bricks-human-urine-environmentally-friendly-university-cape-town/)**.**

[Deign 19 of GreenTechMedia](https://www.greentechmedia.com/articles/read/floating-solar-gears-up-for-the-high-seas) (YZ)

Molly Cox, a research associate at Wood Mackenzie Power & Renewables, said **offshore floating solar “may be the next frontier” as the space available for inland projects tightens in some markets.**

“The key drivers of the floating solar industry may be the lack of available land for ground-mounted arrays, high land costs and aggressive national or citywide renewable energy and greenhouse gas emissions targets,” she said.

“**These factors will help propel the floating solar market forward, for both inland and offshore applications**.”

It is taking off in the US, and solves back for lack of land space.

[Maloney 18](https://www.enr.com/articles/45983-floating-solar-farms-gain-traction-in-us) (YZ)

Mixing electricity and water is often not a good idea, but floating solar panels on water is one of the most rapidly expanding sectors in the solar-power market. **Worldwide, floating solar projects have grown more than 100-fold in less than four years**, to 1,100 MW by September 2018 from 10 MW at the end of 2014, according to an October report by the World Bank and the Solar Energy Research Institute of Singapore.

**The growth of floating solar in the United States has been slower, but that is starting to change**. Ciel & Terre says it will install about 5 MW of floating solar projects in the U.S. this year. Next year, “we could have more than 25 MW of floating solar projects,” says Chris Bartle, U.S. development manager for the French company, which also manufactures pontoons used to float solar panels. The company has focused solely on floating solar projects since 2011.

**A floating solar project is slightly more expensive, but the higher output and panel density balance out those costs and put floating solar on par with ground mounted solar**, says Lowell Dunn II, CEO and president of D3Energy. Likewise, the higher cost of floating solar equipment is offset by the fact that land does not need to be cleared nor foundations set. No heavy equipment is needed to bolt the pontoons together. All that is needed is about 100 ft of open shoreline. As a string of pontoons is bolted together, it is pushed into the water. A crew of about 10 workers can install as much as 100 kW a day, says Dunn.

Offshore wind evi - super efficient

[Woods 19 of CNBC](https://www.cnbc.com/2019/12/13/us-has-only-one-offshore-wind-farm-but-thats-about-to-change.html) (YZ)

According to the Department of Energy, **offshore wind has the potential to generate more than 2,000 GW of capacity per year, nearly double the nation’s current electricity use. Even if only 1% of that potential is captured, nearly 6.5 million homes could be powered by offshore wind energy within the next decade.**

Today states along the Eastern Seaboard, from Maine to Virginia, are poised to join a renewable-energy revolution that will not only provide clean, green electricity but also create tens of thousands of jobs, revitalize distressed port cities and spur economic growth in dozens of coastal communities.

“We are in an incredible growth period,” said Laura Morton, a senior director at the American Wind Energy Association in Washington, D.C. She cited a recent white paper from the Special Initiative for **Offshore Wind that** projects **a $70 billion business pipeline in the U.S. by 2030.**

Offshore wind can provide baseload of power and is super efficient

[IEA 19](https://www.iea.org/reports/offshore-wind-outlook-2019) (YZ)

**Offshore wind is** in **a** category of its own, as the only variable **baseload power generation technology.** New offshore wind projects have capacity factors of 40%-50%, as larger turbines and other technology improvements are helping to make the most of available wind resources.

At these levels, **offshore wind matches the capacity factors of efficient gas-fired power plants, coal-fired power plants in some regions, exceeds those of onshore wind and is about double those of solar PV.**

**Small-scale change could be implemented quickly. MIT's process**, if scaled up, **is a smaller change** that the team think could be implemented more quickly.

### A2 Direct Air Capture

1. Mikula 19- companies aren’t interested in implementing carbon capture despite tax incentives because it isn’t economically viable
2. See carbon capture

[Mikulka 19](https://www.desmogblog.com/2019/11/21/jacobson-stanford-carbon-capture-fossil-fuels-renewables) (MM)

Last year, Reuters surveyed **10 major power companies and found the vast majority have no plans to install carbon capture technology, despite the many tax incentives Congress has offered. “Carbon capture** is definitely interesting, it just **hasn’t made economic sense just yet,”** Spencer Hall, a spokesman for utility Rocky Mountain Power, explained to Reuters. At this point, **carbon capture isn’t economically viable** but remains a favorite option pushed by the fossil fuel industry. It's not unlike another policy designed to reduce carbon emissions — a carbon tax.

### A2 Desalination

1. Robbins 19- it takes 2 gallons of seawater to make 1 gallon of freshwater, the resulting brine is dumped back into the ocean which destroys sealife
2. Hydrofinity 18- sealife gets sucked into treatment plants, upsets the foodchain
   1. Webster 19- 250k fish die/day
3. Hydrofinity 18- only viable in coastal communities
4. WSA- Renewable desalination works just as well
   1. AUB Institute 17- Actually cheaper if done by solar
5. Forbes 17- 275x more expensive than current farm water, not at all practical for agriculture
6. Linnane 19 - American water infrastructure is failing. Increasing quantity does not solve for access

[AUB policy institute 17](https://www.aub.edu.lb/ifi/Documents/publications/policy_briefs/2016-2017/20170215_solar_nuclear.pdf) (YZ)

**Manufacturing costs of PV panels will drop even further as solar technology develops, bringing down capital costs** and consequently potential LCOE and water desalination costs of solar powered plants. In conclusion, **integrating solar power with desalination technology could prove more cost effective than nuclear-powered desalination plants.**

[Robbins 2019](https://www.wired.com/story/desalination-is-booming-as-cities-run-out-of-water/) (DS)

There are ecological impacts as well. **It takes two gallons of sea water to make a gallon of fresh water, which means the gallon left behind is briny. It is disposed of by returning it to the ocean and**—if not done properly by diffusing it over large areas—**can deplete the ocean of oxygen and have negative impacts on sea life. A study by the UN Institute for Water, Environment and Health published earlier this year contends that the problem of brine waste has been underestimated by 50 percent and that, when mixed with the chemicals meant to keep systems from fouling, the brine is toxic and causes serious pollution.**

[Simon 19](https://www.wired.com/story/desalination-is-booming-but-what-about-all-that-toxic-brine/) (RL)

The primary byproduct of desal is brine, which facilities pump back out to sea. The stuff sinks to the seafloor and wreaks havoc on ecosystems, cratering oxygen levels and spiking salt content. Unfortunately, scientists haven’t had a good idea of just how much brine the 16,000 operating desal facilities worldwide have been producing. Until now. Researchers report today that **global desal brine production is 50 percent higher than previous estimates, totaling 141.5 million cubic meters a day, compared to 95 million cubic meters of actual freshwater output from the facilities.** Bad news for the environment, to be sure, but things aren’t altogether dire: Desal tech is rapidly evolving, so plants are getting far more efficient, both in the brine they produce and the energy they use. Desalination facilities typically fall into one of two categories: thermal and membrane.

1. Kills fish

[Hydrofinity 2018](https://www.hydrofinity.com/blog/why-desalination-is-not-the-answer-to-the-worlds-water-issues) (DS)

There costs of desalination are not just monetary but environmental as well. **Sea life can get sucked into desalination plants, killing small ocean creatures like baby fish and plankton, upsetting the food chain.** Also, there is concern of what happens to the separated salt, which is left over as a very concentrated brine. Pumping this super salty water back into the ocean can harm local aquatic life. Reducing these impacts is possible, but it adds to the costs.

[Webster 2019](https://www.thetimes.co.uk/article/nuclear-power-plant-will-suck-fish-to-their-deaths-zm6cmj0ft) (DS)

It has been described as a giant plughole under the sea, sucking in 130,000 litres of water a second along with vast numbers of fish. The twin inlet tunnels stretching two miles out into the Severn estuary are so big that a double-decker bus could drive through them. The system will cool a new nuclear power station being built at Hinkley Point in Somerset but conservation groups say it **[one plant] will kill up to 250,000 fish a day** and must be altered or scrapped.

1. Only viable for coastal communities

[Hydrofinity 2018](https://www.hydrofinity.com/blog/why-desalination-is-not-the-answer-to-the-worlds-water-issues) (DS)

As scientists and government agencies seek answers to this crisis, desalination has been touted as the solution. But desalination is not a silver bullet. It is exorbitantly expensive, requires large amounts of energy, it is environmentally damaging plus **it is only really viable for coastal communities.**

1. DL: Doesn’t need nuclear

[Water Scarcity Atlas](https://waterscarcityatlas.org/desalination-powered-by-renewable-energy/) (DS)

How can renewable energy based desalination help overcome the current issues with SWRO desalination? Solar photovoltaic based electricity is nowadays the least cost source of electricity in most regions of the world and as the cost of renewable energy technologies and energy storage further decrease, **renewable energy powered desalination provides a cost effective alternative to fossil fuel based desalination.** To show this, we can estimate how much desalination may be required in future, and its cost of production using renewable energy and fossil fuels.

[Forbes 17](https://outline.com/4hrpz3)

In the US, the cost of electricity is about 15¢ per kWh retail, 5¢ wholesale. Farmers in California can currently buy fresh water at $4 per acre foot, if they are near the aqueduct. Putting this into a list, we get the costs of fresh water today for an acre-foot of fresh water in California:

$4 (river water from aqueduct)

$50 (desalinated water, physics limit, wholesale electricity, not yet achieved)

$150 (desalinated water, at physics limit, retail electricity, not yet achieved)

$1100 (desalinated water at Santa Barbara California, using best desalination technology available when it was built in the 1980s)

**Desalinated water is** cheaper than bottled water, but **275x more expensive than currently available farm water** in the central valley of California. It is affordable if you need water to drink and to take showers, but **not if you are using it for agriculture in a world market.** Santa Barbara installed their desalination plant during a severe drought (see link: Meyer Desalination Plant). The drought ended in the late 1980s, so they turned it off (the water was too expensive), and they have not operated it since. But they will use it if a severe drought returns.

[Linnane 2019](https://www.marketwatch.com/story/forget-the-wall-us-water-infrastructure-is-a-far-more-pressing-issue-2019-01-18)

“While it is well known that the magnitude of the water crisis in Flint was caused by lack of action to counter the threat of corrosion, the case spotlights how **financial avoidance influences the ongoing infrastructure crisis in the U.S. water sector**,” said the report.

**There are more than 151,000 drinking-water systems in the U.S., delivered through millions of miles of pipes. These systems experience roughly 240,000 leaks and breaks every year mostly due to third-party damage or corrosion, leading to the waste of more than 2 trillion gallons of drinking water,** the report found.

### A2 SMRs

1. Brown 18- not large enough market
2. McMahon 12- can’t compete with natural gas even with government support
3. UCS 13- can’t compete with larger nuclear reactors because they aren’t as efficient at producing energy
4. Ramana 14- Cost of SMRs isn’t sustainable
   1. Even if upfront costs cheaper, the operation costs aren’t competitive with other forms
   2. Requires weapons-grade uranium, causes major fears of prolif
   3. Lower fuel burnup means fueling costs are higher
5. Green 19- Model of SMRs means there’s no way to conduct good safety inspections and there are explosion and fire hazards

[Brown 18](https://climatenewsnetwork.net/small-modular-reactors-have-little-appeal/) (MM)

A number of companies in the UK and North America are developing SMRs, and prototypes are expected to be up and running as early as 2025. However, the next big step is getting investment in a factory to build them, which will mean getting enough advance orders to justify the cost. **A group of pro-nuclear US scientists,** who believe that nuclear technology is vital to fight climate change, have **concluded that there is not a large enough market to make SMRS work.** Their report, published in the Proceedings of the National Academy of Sciences, says that large reactors will be phased out on economic grounds, and that **the market for SMRs is too small to be viable.** **On a market for the possible export of the hundreds of SMRs needed to reach viability, they say none large enough exists.**

[Union of Concerned Scientists 13](https://www.ucsusa.org/resources/small-modular-reactors) (MM)

However, there's a catch: **“affordable” doesn’t necessarily mean “cost-effective.”** Economies of scale dictate that, all other things being equal, **larger reactors will generate cheaper power.** SMR proponents suggest that mass production of modular reactors could offset economies of scale, but a 2011 **study concluded that SMRs would still be more expensive than current reactors.**

[McMahon 12](https://www.forbes.com/sites/jeffmcmahon/2012/05/23/small-modular-reactors-by-2022-but-no-market-for-them/#533115a23e64) (MM)

**The Department of Energy will spend $452 million**—with a match from industry—over the next five years **to guide two small modular reactor designs through the nuclear regulatory process by 2022. But cheap natural gas could freeze even small nuclear plants out of the energy market well beyond that date.** The same summary **records doubt that SMRs can compete in a market increasingly dominated by cheap natural gas.** Nuclear Consultant Philip Moor told Senate staff that **SMRs can compete if natural gas costs $7 to $8 per million BTU—gas currently costs only $2 per MBTU**—or if carbon taxes are implemented, a scenario political experts deem unlikely.

[Ramana 14](https://www.wiseinternational.org/nuclear-monitor/790/too-much-ask-why-small-modular-reactors-may-not-be-able-solve-problems?__cf_chl_jschl_tk__=e8703912e71cb63034b315f0b2d98431d76771b2-1583264446-0-AVkFzis9FnKMhS6u0Kyhg7VXfgvnGOiMvzvR6RzvOV0JpmxKGr3BUFgpZxtTSMqwjh7jb8LSOB_C5x0p2Bvc53L9Oa2-4rXwlkuB_zetUTiu2DtqPc0XmhjUnGY4Zj6r1od4KodOLa6hl6msFIMEA-QLh0mOwKyabLZfqd_sPFmv_3bjnIbFviDeoiEglOwio1EpBPRKF8_WyufWsKZYcJmim3UwFbxhGK4IaAwRfdg502dMPbml1pFq-rW8ujG44K6OV0x1Cgx6DXeaeakUPFDcPKtsczSbNiRJx0JKQPoiKZm50f6_OmpJHjNBSfzZSmMKepIMhSlz5rVfZaCl1vzUSaBmQAxx0zy2xG4hIofYeQqpQzQR9_uLDMk7E2kli5pRu0jYTRW6RQKXpdzetBo) (RL)

Evaluating all the different SMR designs, even when they are organized in families, against the desired criteria of costs, safety, waste, and proliferation is not straightforward. Each of these criteria has several dimensions, and multiple technical characteristics are needed to effectively implement each criterion. **The economics of nuclear power, for example, is a challenge both because of the high cost of constructing each facility and the high cost of generating each unit of electrical energy relative to other options for meeting the same demand**. The two are related but distinct. **Even if SMRs might ameliorate the first challenge to some extent, they might make the latter challenge even harder to meet.**Conversely, a large energy project might produce lower cost electricity relative to a small power plant but might have difficulty getting off the ground because of the high initial expenditures. **Proliferation resistance is another characteristic that imposes sometimes contradictory requirements.** One way to lower the risk of diversion of fuel from nuclear reactors is to minimize the frequency of refueling because these are the periods when the fuel is out of the reactor and most vulnerable to diversion, and so **many SMR designers seek longer periods between refueling. However, in order for the reactor to maintain reactivity for the longer period between refuelings, it would require starting with fresh fuel with higher uranium enrichment** or mixing in plutonium. Some designs even call for going to an enrichment level**beyond 20 percent uranium-235, the threshold used by the International Atomic Energy for classifying material as being of "direct use" for making a weapon.** All else being equal, the use of fuel with higher levels of uranium enrichment or plutonium would be a greater proliferation risk, and is the reason why so much international attention has been given to highly enriched uranium fueled research reactors and converting them to low enriched uranium fuel or shutting them down. Moreover, an SMR design relying on highly enriched uranium fuel creates new proliferation risks – the need for production of fresh highly enriched uranium and the possibility of diversion at the enrichment plant and during transport. Any reduction of proliferation risk at the reactor site by reducing refueling frequency, it turns out, may be accompanied by an increase in the proliferation risk elsewhere. Technical characteristics and consequences The multitude of SMR designs that are being developed make it hard to make general statements with wide applicability about how well SMRs as such could meet the requirements for cost, safety waste and proliferation resistance. At the same time, the different designs do have some shared technical characteristics, and these characteristics affect how these reactors might score on different desirable criteria. The table uses the idea of SMR families to summarize some of the broadly shared technical characteristics and their impacts: SMR family Technical characteristic Cost Safety Waste volume Proliferation risk iPWR Smaller size, lower fuel burnup Higher Increased Larger Increased HTGR Lower power density and higher enrichment level Higher Increased Mixed impact Mixed impact Fast reactors Higher power density and higher fissile content, molten metal coolants Higher Decreased Smaller Increased The smaller power capacity of SMRs has a largely negative effect on costs. **Designers hope that this negative effect possibly could be offset somewhat through economies of mass manufacture or by regulatory authorities relaxing licensing rules. But most experts conclude that it seems unlikely that any such offsets in cost would be sufficient to make these reactors economical. In addition, there are specific features of each of these SMR types that would tend to increase costs. For example, the lower fuel burnup in iPWRs means that fueling costs would be higher** whereas the special materials used to coat the fuel particles in high temperature reactors and non-conventional manufacturing techniques also lead to higher fueling costs.

[*Green 19*](https://wiseinternational.org/nuclear-monitor/872-873/smr-safety-issues?__cf_chl_jschl_tk__=83ee80a539ac743ed1a37004b912132cc95f6f35-1583382661-0-AeiL8vMfC2Ef4M_0Bae8qiPgvwcYNxcS9Ds-uCnonOWviS5MQcp8207s2QYsyg3R_WZTizNs51F_Vg_rtX2Hzv3RFBAWIMWq3RZuHMG8ETyv0ODT9yT43vghlH1SL8oHcJoGnhJbaFqwrWhvXoOjQS2w4JhuSNqLRwF8j3GTEsE1v3Jbvn9qJpmw0JEzx6tewDzWbSHvG4IEqYLkxspFrVeJm5kySLbBh7GMXTixZehEJ_-39oaUeINwlvkJ_vY5Xjcx6sFyomIjCNAAj-FpcpY5D7jfrJmgQZfTuDzjjeQBBz1M1gMuYakZG_rCEu8mNb5zCHypS7MAxnNJTNztb8A)

"Many of the safety concerns described in the UCS report have now been validated by a Powerpoint presentation that was recently included, perhaps inadvertently, in the many thousands of pages of documents that the NRC has released under a Freedom of Information Act request for documents related to the Fukushima accident. The Powerpoint presentation, entitled "Center for Nuclear Waste Regulatory Analyses: Support to the U.S. Nuclear Regulatory Commission Office of New Reactors"4 (p. 479-529) and dated March 24, 2011, describes safety issues for SMRs such as

Potential fire and explosion hazards: below-grade facilities present unique challenges, such as smoke/fire behavior; life safety; design and operation of the HVAC system and removal of waste water. Potential flooding hazards: below-grade reactors and subsystems raise concerns with regard to hurricane storm surges, tsunami run-up and water infiltration into structures. **Limited access for conducting inspections of pressure vessels and components that are crucial for containing radiation, such as welds, steam generators, bolted connections and valves.**

# A2: Neg

### A2 Nuke Terror

1. Link Defense: US nuclear power plants are extremely well protected. Mcfarlane (Conversation) 2016: US Nuclear power plants are some of the most well-guarded facilities in the world. After 9/11, the sites were required to add multiple layers of protection. NRC regulations require plants to hold regular drills in which well-trained military units attack the plants. The exercises are evaluated, and severe punishments are imposed on facility owners who fail.
2. Link Defense: Nuclear plants don’t provide the material needed to make a weapon. Shellenberger (Forbes) 18: Neither the fuel nor the waste are enriched enough to make an actual weapon. That’s why he concludes that a nuclear plant might be the worst place imaginable to get the materials to make a bomb.
3. Link Defense: Even if terrorists obtain nuclear material, they aren’t able to actually construct a bomb. Ward 18 (RAND): There is currently no evidence that terrorist groups could build a nuclear weapon, its too difficult. Wood (Atlantic) 17: ISIS has access to radioactive material but no dirty bomb has ever been used. They refrain from weaponizing their cobalt-60 because they doubt their ability to experiment with it without killing themselves.
4. Link Defense on Planes: Shellenberger (Forbes) 18: There is zero evidence that any terrorist anywhere has planned an attack on a nuclear plants because a) flights would be impossible because of restricted airspace around nuclear sites, making them fearful that any plane would be shot down before impact and b) attacking a nuclear site would undermine terrorists’ main goal of propaganda because plants are low-lying and often not visible from publicly accessible areas.
5. TURN: Increased US production of Nuclear Energy would put us in a position of power and influence, which would enable us to promote better regulation of other countries’ plants. Gordon 2020: If the US fails to make their nuclear energy competitive, they will likely cede the mantle of global leadership in that area to China and Russia, where nuclear companies are already exploring emerging markets for nuclear exports. Cardwell (NYT) 2017: The US could lose considerable influence over standards governing safety and waste management and as a result, the world may show less willingness to move toward potentially safer designs.
   1. Outweighs because it means that across the world, regulations are better and the chance of nuclear terror is decreased.
6. TURN: US production of Nuclear Energy is safer than that of developing countries. Exporting our energy/co-financing projects is the best way to prevent insecure plants which have a higher risk for nuclear terror.

### A2 Cyber

1. Link Defense: Cyber attacks are only able to impact the business and administrative side of things, not the actual plant operation. Conca (Forbes) 2018: Nuclear power plants cant be hacked into. Nuclear plants are, on purpose, mostly analog and are not connected to the internet, functioning as operational islands wholly disconnected from the internet, with no chance of being hacked into.
2. Link Defense: If any potential disturbance is encountered, the plants shutdown to avoid risk. NEI 2016: Should there be a disturbance on the electrical grid, power plants are designed to shut down safely until the threat has passed.
3. Link Defense on Thumb Drives: In the rare case a thumb drive is used, its vigorously scrubbed to ensure its safe. Conca (Forbes) 2018: Outside laptops and thumb drives cannot be used without scrubbing, if at all.

### A2 Waste/Pollution/Radiation

1. Link mitigation: Center for Science and Tech Information: All of the nuclear waste generated in every nuclear plant in the last 50 years would only fill a football field to a depth of less than 10 meters, and 96% of this can be recycled to make new fuel.
2. Impact Defense: Rhodes 18: Nuclear waste disposal is no longer a continuing problem in the US. 96% of the fuel can be recycled, and that that isn’t is stored in impenetrable casks on the grounds of operating reactors. One single waste disposal site can accommodate the entire world’s nuclear waste for the next thousand years.
3. Impact mitigation: Center for Science and Tech Information: Only .005% of the average American’s yearly radiation dose comes from nuclear power, 100x less than we get from coal. Rhodes 18: Nuclear power releases less radiation into the environment than any other major energy source.
4. Impact mitigation on leaks: Biello 2014: At the Illinois leak, if the water exposed to the leak was consumed for an entire year, the radiation dose would be 0.3 millirem. For comparison, one chest x-ray produces four millirem, over 13x as much.

### A2 Cost - fix

1. If we are moving towards a low carbon future, Nuclear is needed to keep costs down. Dahl 2018: The exclusion of nuclear energy from low-carbon scenarios could cause the average cost of electricity to rise drastically. MIT: This is because, among other things, Nuclear provides a reliable and cost efficient way to back up intermittent renewables.
2. Nuclear is cheaper than renewable alternatives.
   1. Reilly:
3. Check the conca stuff in a2 time

### A2 Prolif

1. Empirically, there isn’t a link between power plants and nuclear proliferation. Dartmouth 17: Most countries had already begun seeking nuclear weapons before they had started their nuclear energy programs. Countries who pursue energy first face obstacles to proliferation because foreign intelligence agencies and the International Atomic Energy Agency often monitor and regulate use of this energy.
2. CACN- Uranium tech available widespread on the international market, cheaper to buy it than to make your own enrichment systems

### A2 Time

1. Modern plants don’t take long to build. Wang 08: Modern nuclear plants are planned for construction in 4 years or less as opposed to over a decade for old plants. Mearns 16: 374/441 reactors were built in under 10 years and multiple were completed in under just 3. The mean construction time for all of these plants was only 7.5 years.
2. Small Modular Reactors (SMR’s) take a fraction of the time that full reactors have taken in the past. Gellerman: A smaller design eliminates 2/3 of the system components you find in a large plant. Office of Nuclear Energy 19: Micro reactors can be set up in days, not years, to provide reliable heat and power to a host of places.

### A2 Emissions

1. Lenzen 15: Taking into account the entire fuel cycle, Nuclear produces the same amount of emissions as wind, and much less than natural gas or coal.
2. IL is fossil fuels, this changes if renewables and nuclear do take over. Shrader Frechette: Each stage of production only releases emissions because the energy to complete the stage comes from fossil fuels
3. Shrader Frechette cites calculations from Sovacool, exact same source says that 81% of the studies are outdated or had flaws in methodology
4. Kugelmass 2020: Net zero emissions through green tech does not solve because there is already carbon in the atmosphere to heat us up. Only solution is direct air capture to remove carbon and nuclear is the only energy source powerful enough.

[Kugelmass 2020](https://www.usatoday.com/story/opinion/2020/01/22/climate-change-solution-nuclear-energy-our-best-hope-column/2821183001/)

Here’s the crux: Since it takes energy to remove carbon and carbon is released in making energy, being "low-carbon" isn’t good enough! The energy source used needs to have such an extremely low carbon footprint that it can effectively power the capture and transformation of carbon dioxide. Regardless of cost and considering only the carbon math, the only possible energy source capable of powering atmospheric carbon dioxide removal — true negative emissions — is nuclear energy. This becomes obvious considering that any power source’s carbon footprint is a function of materials required to produce this energy. Using nuclear forces (the energy inside an atom), instead of chemical forces (the energy between atoms), we produce 3 million times as much power for the same amount of material.

### A2 Desalination Bad

1. Link Defense: Nuclear isn’t needed, Solar power can desalinate water too…and for a cheaper price. AUB Policy Insti: The cheapest tech for producing portable water is reverse osmosis running on solar panels, 6 cents cheaper than if you used Nuclear.
2. Link TURN: Nuclear plants use a bunch of water for cooling systems.

### A2 Cement

1. Don’t need a lot. Wang 2007: Building 1,000 Nuclear plants would use less than 10% of the worlds annual concrete and steel.
2. Rhodes 18: Nuclear power plants release greenhouse gases during construction just about the same as solar, which is 4-5% as much as a natural gas plant.
3. Aouf 19: MIT has demonstrated way of manufacturing cement that releases no carbon dioxide. Alternative ingredients have been found, including desert sand, nano platelets, and human urine.
4. Renewables 15x

### A2 Kills Fish

1. Only existing plants. NBC 2008: Technology has reduced the fish kill by 90% or more. Cooling towers allow the plant to recycle the water rather than continuously pump it. New plants are required to use this technology. Rabin 2013: Closed-cycle cooling reduces water use and fish kills by more than 95%. NBC: New plants in New Jersey use treated waste water from sewage plants so they don’t have to worry about killing fish at all.

### A2 Uses Water

1. New plants use less water. EIA 2014: Power plants have shiften to recirculating systems, where water is kept in a closed circuit loop and recirculated. Recently, plants have even shiften to dry cooling, where fans and air are used to cool the plant as opposed to water.
2. Seawater not freshwater. WNA 2019: There is no reason to place plants away from the coast, where they can use saltwater cooling.
3. A2 Green River Plant/200k evi: Blue Castle Project: By using less than 1% of total water consumption in Utah, the project increases electricity production by 50%.
4. Microreactors solve. Steinmeyer: With air-cooling, micro reactors don’t need to be situated near an ocean, river, or lake. Hyperallergetic: Don’t require water

### A2 Uranium

1. DL: Already have enough uranium. Conca (Forbes) 2019: We have more uranium than we need for hundreds of years of nuclear power
2. Only have to mine a tiny amount of uranium. Conca (Forbes):Its important to know how little U is needed to produce power in a nuclear reactor. A single U pellet the size of a fingertip contains as much energy as 17,000 cubic feet of natural gas, 1,780 pounds of coal, or 149 gallons of oil.
3. DL: Don’t have time mine, new tech means we can extract from the ocean. Conca (Forbes) 2019: New tech has made removing uranium from seawater within economic reach. This new process makes nuclear power completely renewable and the uranium in seawater now would fuel a thousand plants for 100 thousand years.
   1. Berger 18/only cost 200 per kg, which is cost competitive
4. Lots of safer regulations since 1990’s. Scissons 2013: Over the last few decades uranium mining and milling has been done safely in many places around the world including in the United States. The poor mining practices of the past were undertaken with no regulatory controls or protection of people and the environment. Those terrible impacts continued even into the early 1980’s when “the modern era” of uranium mining began. Today, in Canada and around the world, the modern uranium mining industry is very different.

#### A2 Dev Nation Mining

1. TURN: Kazakhstan benefits greatly from uranium exports. OECD 18: Extraction industry makes up a quarter of GDP and as demand is falling, growth is falling.
2. Lenzen: Avg radiological exposures less than 1/10 dose received by people living in locations with naturally high concentrations of radioactive elements in the soil

<https://www.newsdeeply.com/oceans/articles/2018/06/28/the-nuclear-option-technology-to-extract-uranium-from-the-sea-advances>

Right now, Gill said, one of the early analyses of the DOE program’s work was that it would cost a little over $1,000 to get a 1kg (2.2lb) of **uranium out of seawater**. Now, he says, he estimates it as a little over $**200 per kilogram** ($440 per pound).

But even if costs have fallen, to extract uranium from seawater “on a commercial scale you would have to demonstrate that the cost would be competitive with land-based sources,” said Edwin Lyman, a senior scientist at the Union of Concerned Scientists who works for the nonprofit’s global security program. **A 2017 study published in the journal Progress in Nuclear Energy found that extraction of uranium from seawater would reach an economical “tipping point” when uranium prices are consistently $175–$250 per pound.**

### A2: Set Col / indigenous ppl

1. There’s two reasons why their advocacy entrenches colonialism in a pre-fiat manner
   1. [Sachs 96] Assertion that nuclear plants are bad for natives, even though the natives agreed to host the plants, undermines the decision making of native groups and extends racism
   2. [Collins 93] The neg’s authors put natives into one group, assuming that they all do not want these nuclear reactors. This entrenches their subordinate stereotype. Authors assume they know what is best for natives, and this stereotype clouds any good policy-making over nuclear facilities.
2. [Gover 92] The reason that some groups should be allowed the choice to accept nuclear reactors is because they are some of the only sources of economic development. It is imperative to give each tribe the option to choose for themselves, the aff does this
   1. Also functions as a turn to the neg on case

Cards in here

<https://docs.google.com/document/d/18MYbW2_1dMRCZBNLlsM-bRp_6escH9LgQQEnJU_spro/edit?usp=sharing>

### A2: Meltdowns (generic)

Overall

1. Lose all investments - sunk cost
2. WNA 19 - US requirements are that chance of meltdown has to be at minimum 1 in 100k
3. Permanent and sweeping regulations were introduced since the last accident, which will prevent any future problems. Dalton 2009: the Three Mile Island incident led to sweeping and permanent changes in how plants are regulated in the US.
   1. EIA 15 - multiple redundancies
      1. Safety systems
      2. Operator Training
      3. Frequent testing/maintenance
      4. Regulatory requirement of the NRC
      5. **Containment structure/vessels to contain accidental release of radiation**
   2. Lee 11: An entire program and a set of new regulations have been put in place in order to prevent human involvement and the potential for human error.
   3. The average number of significant reactor events over the past 20 years has dropped to zero.
   4. The number of times safety systems have even needed to be activated is about 1/10 of what it was 22 years ago.
   5. **Also functions as a turn**
      1. Wallace 18/US leadership and involvement in the global nuclear marketplace increases nuclear security. w/out US, risk of catastrophic failure is immensely increased
      2. Kane/Russian built reactors in the Middle East have critical safety flaws and no regulations: they’re more likely than most other reactors to melt down
4. NEI 15- The US’s NRC conducts thousands of hours of inspections on these power plants and if they are found to not meet the regulations, they can get fined or even shut down, concluding security is the industry’s highest priority.
5. World Nuclear 19: Small Modular Reactors (SMR’s) physically can’t meltdown due to an ultra safe design that doesn’t require pumps, cooling water, or human intervention.
6. Extremely low probability. Humber 14: In the US, a typical nuclear station has cut its probability of meltdown to once in 20,000 years of operation. In 2/3 meltdowns, there wouldn’t even be any deaths.

**Impact Level/Specific events**

1. Overall:
   1. Rhodes 18 - the worst nuclear accidents still far better than industrial accidents in other nrg sectors
   2. Safety is a inteer
2. Katie Tubb 19 [Heritage] - Noone died from radiation exposure from Three Mile Island and Fukushima
   1. Three Mile Island was U.S’s worst nuclear accident - less radiation than a dental xray
   2. Chernobyl was only 43 deaths
   3. Nick Stockton 16 [Wired] - 7500 die in the US per yr bc particulate matter from coal power
3. **Fukushima**: Stockton 16: New plants rely on gravity to pull water from elevated storage tanks, preventing the problem at Fukushima, where there was now power to use the pumps.
4. **Chernobyl**: Chernobyl has a completely different design than US plants. Kramer (BI) 2016: Chernobyl’s design put graphite, a material that promotes fission at the end of its control rods, not a material that slows down reactions. This caused a huge power surge which overpowered the system. Not a single US reactor uses graphite. There’s absolutely no way the accident at Chernobyl could have happened at any US reactor.

#### Generic

1. **turn**
   1. Wallace 18/US leadership and involvement in the global nuclear marketplace increases nuclear security. w/out US, risk of catastrophic failure is immensely increased
   2. Kane/Russian built reactors in the Middle East have critical safety flaws and no regulations: they’re more likely than most other reactors to melt down
2. NEI 15- The US’s NRC conducts thousands of hours of inspections on these power plants and if they are found to not meet the regulations, they can get fined or even shut down, concluding security is the industry’s highest priority.
3. WNA 19 - US requirements are that chance of meltdown has to be at minimum 1 in 100k - chance low

#### Nat disaster

1. NRC 19/Regulations to deal with nat disasters in squo
   1. Keep reactors cool and maintain containment barrier for indefinite amount of time in case of emergency
   2. Inspections verified that all US nuclear plants have this capability
2. NRC 19/After Fukishimi, NRC ordered all nuclear plants to identify hazards from natl disasters
   1. These evaluations were used to modify plants and find strategies to stop future harm
3. (Even if leaks happen) Eia 15/U.S. reactors have containment vessels that are designed to withstand extreme weather events and earthquakes.

#### Skilled workers

1. Turn - they defend the squo
   1. Power Mag 19/The reason theres a lack of skilled workers in the squo is cus nuclear is seen as a dead indistry - theres no hope for their career future
   2. Only by reviving the industry do you encourage people to go down those career paths
   3. Doesn't even take time since they can hire from other energy areas
2. Dep o nrg 19 - inc in # of degrees in nuke engineering from 2017 to 2018, 58% higher than 2009

#### Trump Regs

#### Old Tech

1. Old tech is a problem right now - only the aff solves
   1. Lochbaum 16 - the way to fix the problem is to increases resources and regulations towards the problem
   2. that only happens when the industry grows and faces greater scrutiny + has more resources

#### New Tech

1. t/WNA 19/
   1. New plants have 1 in 10 million chance of meltdown - new better
   2. Listening rules for new plants require that effects of meltdown must be contained to plant, w/out the need to evacuate nearby residents

Jan 24, 2019 19, 1-24-2019, "Global Report Warns of Looming Skills Shortages in Power, Nuclear, Renewables Sectors," POWER Magazine, https://www.powermag.com/global-report-warns-of-looming-skills-shortages-in-power-nuclear-renewables-sectors/

Ultimately, the nuclear sector will need to focus on creativity and resourcefulness to address its workforce challenges, the report concludes. “**This means two things: hiring more professionals without nuclear experience, and showcasing the sector’s technological development. The more that companies can convey the sector’s vitality, innovation and growth, the more that individuals will see their potential.”**

**“Nuclear professionals want to know that their careers will progress and that the sector will continue to evolve,” said Peet. “Having a clear roadmap into the future should be a priority for companies.”**

<https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/safety-of-nuclear-power-reactors.aspx>

June 2019

**Licensing approval for new plants today requires that the effects of any core-melt accident must be confined to the plant itself, without the need to evacuate nearby residents.**

A mandated safety indicator is the calculated probable frequency of degraded core or core melt accidents. The US Nuclear Regulatory Commission (NRC) specifies that reactor designs must meet a 1 in 10,000 year core damage frequency, but modern designs exceed this**. US utility requirements are 1 in 100,000 years,** the best currently operating plants are about 1 in 1 million and **those likely to be built in the next decade are almost 1 in 10 million**. While this calculated core damage frequency has been one of the main metrics to assess reactor safety, European safety authorities prefer a deterministic approach, focusing on actual provision of back-up hardware, though they also undertake probabilistic safety analysis (PSA) for core damage frequency, and require a 1 in 1 million core damage frequency for new designs.

<https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/safety-of-nuclear-power-reactors.aspx>

The use of nuclear energy for electricity generation can be considered extremely safe. **Every year several thousand people die in coal mines to provide this widely used fuel for electricity. There are also significant health and environmental effects arising from fossil fuel use. To date, even the Fukushima accident has caused no deaths**, and the **IAEA** reported in June 2011: "to date, no health effects have been reported in any person as a result of radiation exposure." Subsequent **WHO** and **UNSCEAR** reports have supported this.

The decades-long test and analysis program showed that less radioactivity escapes from molten fuel than initially assumed, and that **most of this radioactive material is not readily mobilized beyond the immediate internal structure**. Thus, **even if the containment structure that surrounds all modern nuclear plants were ruptured, as it has been with at least one of the Fukushima reactors, it is still very effective in preventing escape of most radioactivity.**

David Lochbaum 16, 2-24-2016, "Nuclear power in the future: risks of a lifetime," Bulletin of the Atomic Scientists, https://thebulletin.org/2016/02/nuclear-power-in-the-future-risks-of-a-lifetime/

In theory, refurbishing or replacing parts can safely extend the lives of nuclear reactors well beyond their originally envisioned life spans—perhaps even doubling longevity to 80 years. But in practice, refurbishment and replacement may merely swap wear-out failures for break-in failures. T**he nuclear industry and its regulator must devote more resources to this issue, especially as aging US nuclear reactors require more and more upkeep.** To balance the risks of operating reactors for 60 years or longer, the NRC’s license renewal process must include substantive risk-reduction measures.

[Department](https://www.energy.gov/articles/orise-report-shows-number-nuclear-engineering-doctoral-degrees-spike-highest-level-52-years) of Energy 19- According to the report, 623 students received bachelor’s degrees in nuclear engineering in 2018—a 1 percent increase over 2017. Still, the number of bachelor’s degrees in 2018 remains significantly above the numbers reported in the previous decade and is 58 percent higher than the number reported in 2009.

<https://www.nrc.gov/reactors/operating/ops-experience/post-fukushima-safety-enhancements/flooding-and-seismic-defense.html>

**In light of the Fukushima plant damage from the extreme earthquake and tsunami, the NRC requested U.S. nuclear power plants operators to perform detailed "walkdown" inspections of their installed seismic and flooding protection features.** The operators ensured the features met current requirements, and identified, corrected, and reported any degraded conditions. NRC inspectors performed follow-up reviews.

Based on advances in the knowledge and understanding of seismic and flooding hazards and given the severity of the event at Fukushima Dai-ichi, the NRC requested the licensees of operating reactors to reanalyze potential flooding and seismic effects. **These reevaluations used updated information and methodologies to inform plant operators of potential impacts to their sites. As a result, several nuclear power plant owners modified the protection of certain plant structures, systems, and components, or they identified alternative strategies to maintain the safety of the reactors in the event of a flooding or seismic event.**

[**https://www.nrc.gov/reactors/operating/ops-experience/post-fukushima-safety-enhancements/mitigation-strategies.html**](https://www.nrc.gov/reactors/operating/ops-experience/post-fukushima-safety-enhancements/mitigation-strategies.html)

Jan 2019

**In order to maintain key safety functions, the NRC ordered every U.S. commercial reactor operator to have strategies for dealing with the long-term loss of standard safety systems**. Instead of speculating on which events might happen, the **order focused on improving plant flexibility and diversity in responding to extreme natural phenomena, such as severe flooding and earthquakes**. The goal is to **keep the reactor core cool, preserve the containment barrier** that prevents or controls radiation releases, and cool the spent fuel pool, **all for an indefinite period of time**. Plants with multiple reactors should be able to implement these measures at all reactors simultaneously. Each plant installed new emergency response equipment, stored onsite and protected from natural hazards. **NRC inspectors have verified that the strategies are in place at all U.S. nuclear power plants.** Additional equipment and resources are stored at two National Response Centers, ready to be deployed to a plant during an emergency.

<https://www.nrc.gov/reactors/operating/ops-experience/post-fukushima-safety-enhancements.html>

On March 11, 2011, a 9.0-magnitude earthquake, followed by a 45-foot tsunami, heavily damaged the nuclear power reactors at Japan's Fukushima Dai-ichi facility. **Following this accident, the NRC required significant enhancements to U.S. commercial nuclear power plants.1**

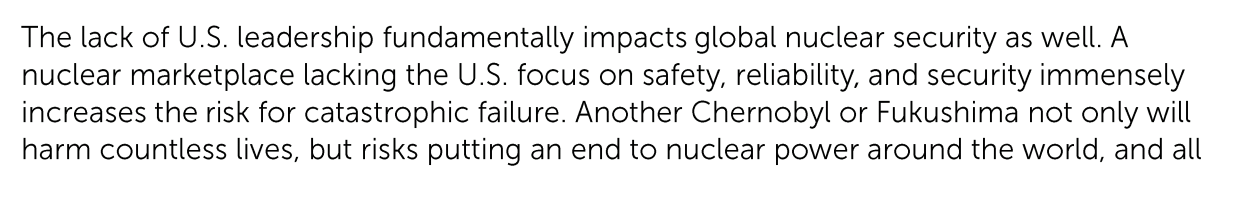
The enhancements included: **adding capabilities to maintain key plant safety functions following a large-scale natural disaster**; updating evaluations on the potential impact from seismic and flooding events; **new equipment to better handle potential reactor core damage events**; and **strengthening emergency preparedness capabilities**. Combined, these actions ensure that the nuclear industry and the NRC are prepared for the unexpected.

[Yale RHODES • JULY 19, 2018](https://e360.yale.edu/features/why-nuclear-power-must-be-part-of-the-energy-solution-environmentalists-climate) (SL)

they indicate that **even the worst possible accident at a nuclear power plant — the complete meltdown and burnup of its radioactive fuel — was yet far less destructive than other major industrial accidents across the past century**. To name only two: Bhopal, in India, where at least [3,800 people died immediately](https://www.theatlantic.com/photo/2014/12/bhopal-the-worlds-worst-industrial-disaster-30-years-later/100864/) and many thousands more were sickened when 40 tons of methyl isocyanate gas leaked from a pesticide plant; and Henan Province, in China, where at least [26,000 people drowned](http://en.people.cn/200510/01/eng20051001_211892.html) following the failure of a major hydroelectric dam in a typhoon. “Measured as early deaths per electricity units produced by the Chernobyl facility (9 years of operation, total electricity production of 36 GWe-years, 31 early deaths) yields 0.86 death/GWe-year),” [concludes](http://ecolo.org/documents/documents_in_english/cherno-zbigniew_fear-06.htm) Zbigniew Jaworowski, a physician and former UNSCEAR chairman active during the Chernobyl accident. “This rate is lower than the average fatalities from [accidents involving] a majority of other energy sources. For example, the Chernobyl rate is nine times lower than the death rate from liquefied gas… and 47 times lower than from hydroelectric stations.”

**Kane 15** [Chen Kane, Miles A. Pomper, “Russia Becomes the Middle East’s Preferred but Flawed Nuclear Partner,” World Politics Review, April 23, 2015, <http://www.worldpoliticsreview.com/articles/15598/russia-becomes-the-middle-east-s-preferred-but-flawed-nuclear-partner>] JW

Nuclear technology on the cheap, however, has its own unique risks and disadvantages, which nuclear newcomers with little to no expertise and experience would be wise to take into account when relying on Russian nuclear technology. The BOO model, in particular, raises the question of how well host governments can regulate Russian-operated plants, given Russia’s poor reputation as a supplier of safe nuclear technology. Recent reports of serious operational damage at an old Chernobyl-type Russian nuclear plant near the Finnish border are reviving old concerns of Russia’s lax safety record. The new and untested nuclear regulatory bodies in many Middle Eastern countries may find it difficult to challenge more experienced Russian operators about safety and security violations—especially when Russia holds all of the financial cards. That in turn opens up a bigger issue: One of the lessons learned after Fukushima nuclear disaster was the importance of strong, independent nuclear regulatory bodies. Without a separation between agencies regulating and agencies promoting nuclear power, both the government where the reactor is built and the company behind it have an interest in finishing construction as soon and as cheaply as possible. When the regulatory body is part of the promoting agency, which is the case in many new Middle Eastern markets, it is discouraged from raising safety and security questions that inevitably increase costs and extend construction time. Turkey is a case in point. After having rejected construction of the Akkuyu plant three times on environmental grounds, Turkey’s Ministry of Environment and Urban Planning suddenly approved what many viewed as a deficient environmental impact report hours before Russian President Vladimir Putin arrived in Ankara last December, paving the way for construction to start. Several Turkish organizations contend the report does not address nuclear waste management, emergency plans and responsibility in case of accident, earthquake risk evaluation and environmental effects on marine ecosystems.

Michael Wallace 2018 Pg 34. <https://csis-prod.s3.amazonaws.com/s3fs-public/publication/180714_Wallace_BackFromtheBrink_Web.pdf?XcEEhWkM1msyhBiDvIiTijfpiekw5oBm>****

[NEI 15](https://www.nei.org/resources/fact-sheets/safety-nuclear-energy-industry-highest-priority)

The nuclear energy industry is one of the most heavily regulated commercial enterprises. The principal responsibility for government oversight lies with the NRC, which issues the federal licenses to construct and operate nuclear power plants. **The NRC’s mission is to protect public health and safety by ensuring that plants comply with the terms of their licenses as well as all of the technical and administrative requirements imposed by the agency.**

**The NRC enforces its regulations with increased inspections, requirements for corrective action and fines—and can even order the shutdown of a plant. At least two NRC resident inspectors are assigned to every U.S. nuclear energy plant, where they conduct more than 2,000 hours of baseline inspections each year. Additional direct inspection is based on plant performance.**

<https://www.eia.gov/energyexplained/nuclear/nuclear-power-and-the-environment.php>

, “Nuclear Power and the Environment”, US Energy Information Administration, 12 Nov 2015

An uncontrolled nuclear reaction in a nuclear reactor can potentially result in widespread contamination of air and water. The risk of this happening at nuclear power plants in the United States is considered to be **small because of the diverse and redundant barriers** and many safety systems in place at nuclear power plants, the training and skills of the reactor operators, testing and maintenance activities, and the regulatory requirements and oversight of the U.S. Nuclear Regulatory Commission. A **large area** surrounding nuclear power plants is restricted and guarded by armed security teams. **U.S. reactors have containment vessels that are designed to withstand extreme weather events and earthquakes..**

Nuclear reactors in the United States may have large concrete domes covering the reactor.**A containment structure is required to contain accidental releases of radiation**. Not all nuclear power plants have cooling towers. Some nuclear power plants use water from lakes, rivers, or the ocean for cooling.

Katie Tubb, 9-17-2019, "Nuclear Could Be the Clean Energy Source the World Needs," Heritage Foundation, https://www.heritage.org/nuclear-energy/commentary/nuclear-could-be-the-clean-energy-source-the-world-needs

**Perhaps first among people's concerns are the infamous accidents at Chernobyl, Three Mile Island and Fukushima. It may be hard to believe, but no one has died from radiation exposure from the latter two. In the case of America's worst nuclear accident at Three Mile Island in 1979, actual radiation exposure for the 2 million people living closest to the reactor amounted to less than a dental x-ray.** For decades, state and federal agencies and private companies tested agricultural, health and environmental factors, finding nothing of concern.

**Less a commentary on nuclear technology than on authoritarian government, the accident at Chernobyl in 1986 resulted from an egregious, unethical Soviet experiment. The Chernobyl reactor also lacked important safety features, like containment domes, common to all US reactors. So far, the UN has confirmed 43 deaths from radiation at Chernobyl, considered the worst nuclear accident in history.**

**Stockton’ 16** Stockton, Nick (Freelance Journalist specializing in science, transportation, and infrastructure). "Nuclear Power Is Too Safe to Save the World From Climate Change." Wired, 3 April 2016, <https://www.wired.com/2016/04/nuclear-power-safe-save-world-climate-change/>. [Premier]

In terms of full blown nuclear disaster, there is really only one data point: Chernobyl. Which was horrifying. But in terms of real risk? The World Health Organization estimates the disaster will claim 4,000 lives, a figure that includes everything from direct victims to people born with genetic mutations well after the meltdown in 1986. By comparison, **particulate matter from coal power plants kills about 7,500 people in the US every year**. Radiation is the shark attack of environmental danger: An awful way to go, but far less likely than, say, a car wreck.

### A2: Greentech tradeoff

**Weighing**

1. **U of Melbourne 10 -** over the entire lifecycle of their Nuclear Plant including Uranium mining, milling, enrichment, plant construction, operating, decommissioning and waste disposal, the total amount CO2 emitted is 3.3 grams per KW-Hr of produced power. Nuclear Plants to emit less CO2 than any of its other energy production mechanisms including Hydro, Wind, Solar and Biomass

**Delinks**

1. Doesn’t happen in the first place (funding link)
   1. **Wesoff 19-** Greentech is taking funding from incubators and corporate investors
   2. **Kempfer 19-** nuclear attracts primarily VC
      1. This is bc nuclear is inherently riskier than greentech
2. Gov support means no tradeoff
   1. **Kempfer 19-** gov substantially supports and invests in development of nuclear technology, we’d contend there’s no tradeoff in private investment
      1. Probable since there’s bipartisan support and occurring to a small degree in the squo
3. **Ellsmoor 19** - unsubsidized renewable still cheapest form of nrg - always an incentive
   1. **Shahan 19** - solar/wind cheaper than nuclear power
4. **Lenzen 15 -** Complete literature review of studies that take into account the entire fuel cycle finds nuclear same as wind in terms of emissions
5. [Budinger 19] 100k sq mi needed for solar to meet US consumption, 6x that for wind (Louisiana is 50k)
   1. Land costs gradually become more expensive + NIMBY = not affordable

**OR turns**

1. [Davies 16 NPR] Inability to maintain constant output + lack of large-scale storage means that renewables requires alt energy source, usually ff, to balance out - emissions still exist
   1. [Budinger 19] Bc of ^, even tho German RE can sometimes provide 100% of nrg, over a year it only supplied 29% of nrg
      1. [Davies] rest was coal
   2. [Budinger 19] use of ff as backup is why ff companies are investing in RE - they see it as a way of ensuring the use of ff in the long term
      1. Lock in ff in the long term (nuclear no emissions?)
   3. [Budinger 19] Just ends up making things more expensive w/out reducing emissions - Germany/Cali prove
      1. Turn about energy pov or smth
2. Empirically, Nuclear trades off with fossil fuels.
   1. Plumer 16: When reactors shut down, its awful news for climate change. In California, plant shutdowns have been replaced by natural gas generation, which increased C02 emissions.
      1. Warrant is probably that ff is a stable source of nrg, RE isnt (explained in first turn)
   2. Sommer 16: As a result of the closure, natural gas use in California could rise by around 34%. Overall, closing 7 plants would increase total US emissions by 2 percent – like putting an extra 10 million cars on the road. This is because fossil fuels still dominate the grid, and renewables only provide 33% of all energy, a number that has remained static for many years. “If we get to the point where we are choosing between Nuclear and renewables, that’s a good position to be in, but we’re not there yet”.
   3. More of the same: Nuclear encourages renewables. Rhodes: Nuclear plants produce energy 92.3% of the time as opposed to renewables, which are all around 30%. As a result, Shellenberger 18: Solar and wind lock in fossil fuels for decades because you need backup capacity for when solar and wind aren’t producing. Even the best batteries on the market, can’t store enough energy to negate this effect.

#### A2 Offshore Wind

1. Link Defense: Because the US isn’t a part of UNCLOS, large scale offshore wind is unable to start up. Dwyer: Without UNCLOS, there is no protection for these farms in international law, which prohibits developers from taking up such projects.
2. Link Defense: Offshore wind is too expensive. Roberts 2018: The price of offshore wind is $0.132/kWh, well over the onshore wind price of $.06/kWh

#### A2: off-grid

1. **Senate Committee on Energy 19** - new reactor tech can make it be off-grid

**Physicists from the School of Physics at the University of Melbourne in Australia 10**

This website was developed by a group of **Physicists from the School of Physics at the University of Melbourne in Australia**. The aim is to provide authoritative information about Nuclear Power. **The group has no particular vested interest in Nuclear Power other than to ensure that people fully understand the risks and benefits of both employing or not employing Nuclear Power for energy generation**. The information has been obtained with quantitative analysis and has been subject to peer-review following the Scientific Method. **To this end Scientists and Professionals from different fields were invited to review the site**. We have strived to make our conclusions as transparent as possible and have made sure that readers can obtain the source materials and can repeat the calculations that underlie our text. This site is under continuous revision and is updated as more information becomes available.

<http://nuclearinfo.net/Nuclearpower>

There is world-wide concern over the prospect of Global Warming primarily caused by the emission of Carbon Dioxide gas (CO2) from the burning of fossil fuels. Although the processes of running a Nuclear Power plant generates no CO2, some CO2 emissions arise from the construction of the plant, the mining of the Uranium, the enrichment of the Uranium, its conversion into Nuclear Fuel, its final disposal and the final plant decommissioning. The amount of CO2 generated by these secondary processes primarily depends on the method used to enrich the Uranium (the gaseous diffusion enrichment process uses about 50 times more electricity than the gaseous centrifuge method) and the source of electricity used for the enrichment process. It has been the subject of some controversy. To estimate the total CO2 emissions from Nuclear Power we take the work of the Swedish Energy Utility, Vattenfall, which produces electricity via Nuclear, Hydro, Coal, Gas, Solar Cell, Peat and Wind energy sources and has produced credited Environment Product Declarations for all these processes.

**Vattenfall finds that averaged over the entire lifecycle of their Nuclear Plant including Uranium mining, milling, enrichment, plant construction, operating, decommissioning and waste disposal, the total amount CO2 emitted per KW-Hr of electricity produced is 3.3 grams per KW-Hr of produced power**. Vattenfall measures its CO2 output from Natural Gas to be 400 grams per KW-Hr and from coal to be 700 grams per KW-Hr. Thus nuclear power generated by Vattenfall, which may constitute World's best practice, emits less than one hundredth the CO2 of Fossil-Fuel based generation. In fact **Vattenfall finds its Nuclear Plants to emit less CO2 than any of its other energy production mechanisms including Hydro, Wind, Solar and Biomass** although all of these processes emit much less than fossil fuel generation of electricity.

[Roberts 2018 of Vox](https://www.vox.com/energy-and-environment/2018/5/25/17393156/offshore-wind-us-massachusetts-rhode-island-zinke) (DL)

**In 2017, Maryland commissioned two offshore-wind projects** (together 368 MW) **at a price of $0.132/kWh,** just over half. **That’s still well over onshore wind’s high-end price of $0.06/kWh**, but headed in the rig

No Author, 3-27-2019, "Murkowski, Booker, and 13 Colleagues Reintroduce the Nuclear Energy Leadership Act," No Publication, https://www.energy.**senate**.gov/public/index.cfm/2019/3/murkowski-booker-and-13-colleagues-reintroduce

“Developing advanced nuclear technologies to meet our energy needs will not only expand our sources of reliable and affordable energy but will also [and] reduce our carbon footprint,” Portman said. “This legislation helps break down the barriers to advanced nuclear development, ensuring that the U.S. is the leader on nuclear technology and innovation. I have long supported policies that grow the economy and create jobs while reducing emissions, and I look forward to working with my colleagues on this legislation.”

**Advanced** reactors are the next generation of breakthrough **nuclear technologies** that will **offer significant advantages** for power generation. **Some are smaller than today’s commercial reactors and can provide increased reliability and resilience to the grid, as well as off-grid power.** Others will utilize exotic fuels, materials, and coolants to decrease the cost of delivered power or provide high-temperature process heat for industrial manufacturing.

[Lenzen](https://theconversation.com/is-nuclear-power-zero-emission-no-but-it-isnt-high-emission-either-41615) 15 (AY)- Quantifying all these emissions is a complicated prospect, but we can attempt to do it using a method called “life-cycle assessment”. The result of one such estimate (with which I agree) is quoted in **the Intergovernmental Panel on Climate Change**’s [Special Report on Renewable Energy Sources and Climate Change Mitigation](http://srren.ipcc-wg3.de/report/IPCC_SRREN_Ch09.pdf) (see pages 731-2). This **shows that despite the long list of stages at which greenhouse gases are emitted**, and based on what researchers have been able to take into account so far, **the overall life-cycle emissions for nuclear power are likely to be lower than for fossil fuels**. [**My review of various estimates**](http://www.sciencedirect.com/science/article/pii/S0196890408000575) **suggests** that **the greenhouse emissions from nuclear power vary** from 10 to 130 grams of CO2 per kilowatt hour of power, **with an average of 65 g per kWh – or roughly the same as wind power.** For comparison, coal power has emissions of about 900 g per kWh, and gas-fired power about 450 g per kWh. About 15-25% of nuclear’s greenhouse emissions come from building, maintaining and decommissioning the nuclear power plant.

[Ellsmoor 19](https://www.forbes.com/sites/jamesellsmoor/2019/06/15/renewable-energy-is-now-the-cheapest-option-even-without-subsidies/#621b1dea5a6b) (MM)

In recent years, the world has marched towards renewable energy. According to a new report by the International Renewable Energy Agency (IRENA), **unsubsidized renewable energy is now** most frequently **the cheapest source of energy generation .** The report finds that the cost of installation and maintenance of renewables, which was an important stumbling block to mass adoption, continues on a downward trajectory.

[Shahan 19](https://cleantechnica.com/2019/11/22/solar-costs-wind-costs-now-so-low-theyre-competitive-with-existing-coal-nuclear-lazard-lcoe-report/) (MM)

**Solar and wind** became cheaper than competing new-build power plants years ago. What the latest report shows is that they **have** actually **gotten so cheap that they are** now competing with existing coal and nuclear power plants. In other words, new wind and solar farms can be **cheaper than continuing to get power from existing coal and nuclear power plants.** Here are some LCOE ranges for different technologies:

[Wesoff 19](https://www.greentechmedia.com/articles/read/how-do-cleantech-startups-get-funded-in-2019)

Bill Gurley of Benchmark, a successful VC investor, recently wrote [in a tweet](http://twitter.com/bgurley) that the “vast majority of entrepreneurs should NOT take venture capital,” because it’s “a binary ‘swing for the fences’ exercise. Bootstrapping is more likely to lead to individual financial success.”

**And as this roundup illustrates, cleantech entrepreneurs are taking that advice and finding capital and resources at incubators, accelerators, foundations and corporate investors — not with traditional VCs.**

[**Kempfer 19**](https://www.thirdway.org/memo/raising-the-next-generation-of-nuclear-a-road-map-for-deployment)

**More than $1.3 billion in private capital from a variety of venture capital firms,** companies like Fluor, and big-name funders like Bill Gates and Nathan Myhrvold, has been invested in advanced nuclear startups and projects by established companies.3 **Support for the industry is growing in Washington as well. The Obama Administration launched the Gateway for Accelerated Innovation in Nuclear initiative (GAIN), which continues to provide needed coordination and leadership for innovators working with the National Labs. The Department of Energy has issued more than $100 million in grants for private innovators to work with the labs on research to move advanced reactors closer to commercialization.4 Overwhelmingly bipartisan majorities in congress passed, and President Trump signed into law, the Nuclear Energy Innovation and Modernization Act (NEIMA) and the Nuclear Energy Innovation Capabilities Act (NEICA).5 These proposals were the highest priorities for advanced nuclear innovators and will accelerate the modernization of the Nuclear Regulatory Commission (NRC), provide needed financial support and resources towards the development of advanced reactor fuel, and increase opportunities for developers to collaborate with universities and the national labs. Five companies are already working with the NRC to prepare for licensing, and NuScale just completed the third phase of the first ever, small modular reactor-design-certification application process.6 Even before Congress passed legislation to mandate it, substantial efforts were in progress at the NRC to modernize its structure and processes to better accommodate advanced reactor developers.7**

**Budinger 19** William [Budinger](https://democracyjournal.org/arguments/a-very-inconvenient-truth/) [William Budinger served for 33 years as founder, CEO and Chairman of Rodel, Inc. A physicist, he holds over three dozen patents. Rodel, a private company now part of DuPont, invented breakthroughs in semiconductor manufacturing technology and built plants around the world which manufactured products for the electronics industry], 5-10-2019, "A Very Inconvenient Truth," Democracy Journal, <https://democracyjournal.org/arguments/a-very-inconvenient-truth/> // ash

Hydro is terrific but, unfortunately, most of the U.S. hydro potential is already on the grid. Hydro is also dependent on long-term weather cycles.

That leaves massive deployment of wind and solar as our primary hope for renewable energy to replace fossil fuels. Can wind and solar, by themselves, really do all or most of that job?

Answering that question requires knowing how much electricity needs to be generated. Decarbonizing is not only about replacing existing power plants. Electricity generation represents less than 40 percent of the energy America uses, 25 percent of the world’s energy. In order to fully decarbonize any economy, it will be necessary to electrify transportation, heating, and more. Even meeting America’s present electricity demand requires over 8,000 large power plants. Decarbonizing through universal electrification means the United States will need to more than double that generating capacity. Some experts believe that world-wide electricity generation would have to increase by as much as eight times. Could wind and solar alone get us there?

**Sadly, it is becoming clear that although they will certainly make a valuable contribution, to do the whole job, wind and solar will need a lot of help. Here are the dominant reasons:**

**Intermittency.** All of the excitement over the plunging cost of solar panels and wind turbines rarely allows for the much larger system costs necessary to power a society primarily with unpredictable intermittent energy sources. **Absent super-cheap and massive battery storage** (for **which we are not yet even close to having the technology**), **wind and solar must be backed up by a reliable 24/7 power source capable of taking the entire load.** Although it might seem that stretching powerlines across large geographies could relieve much of the problem, the data say that doing so does not help as much as we’d hoped.**In Germany, even though on some days last year wind and solar provided substantially more than 100 percent of the country’s power, for the full year they supplied barely 29 percent.** For a society that demands light anytime the switch is flipped, intermittent electricity is not an option.

**Land**. The current experience with solar is very misleading. In spite of significant solar buildouts, in 2018, all of America’s solar installations supplied barely 1.6 percent of U.S. electricity. That means that minimal land has been required so far and it’s been, therefore, inexpensive. But **enough solar panels to power a fully electrified United States would require between 50 and 100 thousand square miles** (254,000 km2) **of land** (a little perspective: Louisiana is about 50,000 square miles, Germany 357,000 km2). And **that land could be used for nothing else. Wind requires two to six times as much land as solar**, although wind land can usually be multi-purposed. **In both cases, however, once the best and cheapest sites are gone, additional land becomes progressively more expensive. And that’s without factoring in NIMBY problems** or the huge amounts of land necessary to mine the rare and often toxic minerals needed to produce wind and solar equipment.

**Wind and solar do not eliminate the need for traditional power plants**. This is the most disappointing problem of all. **Because of intermittency, a backup system must always be on standby, ready to seamlessly take over the full load the instant the wind stops or the sun sets**. **The dominant source of that backup in some countries is natural gas** (methane)—an improvement over coal but still **a carbon-generating fossil fuel.** Understanding this is perhaps why so many fossil fuel companies strongly support renewables without fear of losing market. ExxonMobil and other fossil companies are budgeting billions over the next decade to expand their fossil fuel production. They seem to believe that wind and solar are, far from being a threat, a way to ensure a continuing need for their fossil fuels.

**Cost**. A small amount of wind and solar can be extremely cheap, cheaper even than natural gas. But **as soon as wind and solar constitute a significant percentage of generation, the systems cost—compensating for intermittency, running a standby fossil system, land costs—rises dramatically above any other form of generation.**

Real-life experience demonstrates the problem. Fifteen years ago, Germany committed to transition to 100 percent renewables, even building enough to replace its nuclear plants. **After spending almost €300 billion on their renewables program, they have seen little commensurate reduction in carbon emissions.** And Germany now has the highest electricity costs in Europe. Similarly, as the state of California has expanded renewables and closed its nuclear plants, its emissions have gone up and so have its electricity costs. Indeed, in places where emissions have declined, it has been mostly the result of conversions from coal to gas. Yes, wind and solar generate carbon-free electricity. But because they require backup, they lock in fossil fuel power plants as an essential part of the electricity system.

**Davies and Bakke ’16** (Dave Davies [co-host of *Fresh Air*] and Gretchen Bakke [author of *The Grid*]. “Aging And Unstable, The Nation's Electrical Grid Is 'The Weakest Link.'” August 22, 2016. <https://www.npr.org/2016/08/22/490932307/aging-and-unstable-the-nations-electrical-grid-is-the-weakest-link>) CVHS AB

BAKKE: So the grid is a system that embodies the way we make power, the way we transmit power, so the wires, which is what we often think of, and the way we use power. So all of the machines that we have hooked into this electricity system, they're all a part of the grid. And anytime you change anything on one piece of that system, whether or not it's a lot of people using a lot more electricity at a certain moment in time or making that electricity differently or in different places, you change actually the grid itself. And so what renewables do is that they shift this longstanding relationship between a very steady, controlled power made at the source. Which is to say **with fossil fuels**, with nuclear, even with hydro and biomass, **you can control how much electricity is going into the grid by controlling the fuel source. And what happens with wind is that you can't control the fuel source and the same thing with solar.** So if the wind blows strongly, there's more electricity going into the grid. There's some adjustments now you can do to the wind turbines to try to even it out. Bu**t essentially, it's up to the wind. And with solar, it's even worse, actually, because for one thing, the sun goes down at night, so there's no solar electricity except for during the daytime.** And then every time - especially with rooftop solar, **every time a little cloud goes by, all of the panels that are covered by that cloud dip in the amount of electricity that they're producin**g. And often, people who don't have solar systems on their houses don't realize that people with solar panels on their roof, they aren't making electricity for themselves. All of that electricity is going into the grid. And so - and then they're - the electricity those people use is also coming out of the grid again. So every time a little cloud comes over Phoenix, for example, there's just a whole neighborhoods that the output of their electrical panels goes down. And that system has to really struggle to keep up with that. DAVIES: Explain why that is. I mean, you have an electrical grid. You have a utility that's getting power from its nuclear plant or whatever plant. And then it's got - it's hooked up to wind turbines and solar panels. And when there's a drop in their production, why is that a problem for the utility? BAKKE: Well, it's a problem for the utility because **we don't actually have a good way yet to store electricity, not on a large scale**. We have little - we have our little batteries in our telephones, for example. And so we think that we have electricity storage. But in fact for the grid, we don't. And there's a lot of people working on this. This is, again, a part of that, like, excited moment in the grid is like, how can we store it? How can we store it? And there's crazy great ideas out there, crazy not great ideas out there. But a lot of mind power going into the problem. But for right now, effectively, we can't store - to a degree that's sufficient to be useful to the grid, we can't store electricity. DAVIES: You make the point in the book that electricity - and there's a technical explanation for it. But essentially, **the grid needs to** have - to **be producing exactly what is consumed all the time**, right? I mean, so if there's a big variation of either supply or demand, it's a problem. And you describe being in a control room somewhere - I don't remember where - but where some technician is literally watching a gust of wind through weather charts move toward some wind turbines. Describe what he was seeing and what that meant. BAKKE: So he was talking about sometimes you have a gust of wind come over the Rockies. And from the Rockies toward the Pacific Ocean, there are all of these wind farms. And he could see the spike and production as that wind hit farm after farm after farm after farm after farm. So we could actually watch the wind on his screen. And all of that power then needs to be absorbed by somebody using it somewhere. So part of his job is to figure out - to talk to the people to figure out how to ask, usually industry, to please use some more electric power 'cause you can see it coming. DAVIES: You literally have to say, look, we have electricity coming in. We have to use it or it's going to do - what? - fry the wires? BAKKE: Yeah, exactly. Too much electricity will destroy the wires. Normally what they do is shut off self-protectively. So they have basically a circuit breaker like you have at home that when things get too out of whack, they turn themselves off. BAKKE: But what that means is that then there's - all that electricity is still on the other side of that - like, the wires have protected themselves. The electricity hasn't gone anywhere. It's just bumping around breaking things. So we do have to - we do absolutely have to use it. DAVIES: So then when there's a surge of electricity, they have to - quickly have to find a way to find a user for it. What happens **when there's a drop in electricity, when the wind stops blowing or the sun sets or clouds pass and the solar panels stop generating them**? I've got a system. I was getting your electricity from these renewables, suddenly I don't. What does the utility do then? BAKKE: Well, **they have to** - for the moment, what we do is we **balance generation with generation**. So we're getting a bunch of solar power, starts to get - be 5 p.m. **The amount of solar power diminishes slowly and then stops from rooftop panels, and fossil fuel burners for the moment come on. So California especially, they balance solar with natural gas. In Germany, they balance wind with coal. And this leads to this very ironic situation where the places with the highest penetration of renewables also have greenhouse gas emissions which are going up**. DAVIES: And this is a fascinating thing that you describe where a utility will literally have an old plant running on fossil fuels - coal or diesel - and it sits idle until there's a decline in some other energy source. And then they fire up this expensive, antiquated, polluting equipment? BAKKE: Exactly. Yeah, either a dip in another energy source or a big surge in use. So we usually use - they're called peakers, and we usually use them, for example, on a very hot August day when everyone turns up their air conditioning. So that's another case where the plants that are making electricity aren't making enough. And so these plants have to get turned on.

### A2: Exporting ff

1. **Nakano 19** - countries already aware of impact of coal on their local environment
   1. **Bertaliago 19** - Developing countries have overtaken developed ones in terms of renewable technology - no warrant for why’d they would take US fossil fuels
2. t/Some energy better than none - let them escape poverty
   1. **Indrawati 15 -** lack of energy traps people in pov
   2. (uncarded) Development lets people adapt to cc - no harm

#### 

#### A2 Gas

1. NU. Clemente 17: 2018 was a record breaking year for the US natural gas export business. Exports hit a record high, a jump of 35% from the year before. Cadwell: Within 5 years, the US will surpass Australia and Qatar to become the worlds largest exporter of natural gas.
2. TURN: Natural gas reduces emissions when compared to other alternatives. Times of India 18: To produce the same amount of heat, Natural gas emits 30% less Co2 than burning oil and 45% less C02 than burning coal.

[Indrawati 15](https://blogs.worldbank.org/voices/what-you-need-know-about-energy-and-poverty) (RK):

We find that [energy](http://www.worldbank.org/en/topic/energy) poverty means two things: **Poor people are** the least likely to have access to power. And they are **more likely to remain poor if they stay unconnected**. Around one in seven, or 1.1 billion people, don’t have access to electricity, and almost 3 billion still cook with polluting fuels like kerosene, wood, charcoal, and dung. In [Africa](http://www.worldbank.org/en/region/afr), the electricity challenge remains daunting. In [Liberia](http://www.worldbank.org/en/country/liberia), for example, just 2% of the population has regular access to electricity. Even countries with access often have highly unreliable service. One in three developing countries experiences at least 20 hours of power outages a month. When power is available, it can be expensive: In many countries in Sub-Saharan Africa, consumers pay as much as 20-50 cents per kilowatt-hour against a global average close to 10 cents. Inclusive economic growth is the single most effective means of reducing poverty and boosting prosperity. Yet most **economic activity is impossible without adequate, reliable and competitively priced modern energy**. This is why access to energy is so important in the fight against poverty.

[Bertaliago 19](https://www.enelgreenpower.com/stories/a/2019/01/developing-countries-and-renewable-energy-for-a-sustainable-future?fbclid=IwAR3GioEJdeesuDrb3CAr3Rx1okRTNrNHupqeZxRX7K8dTm-2uwZpcuk2rus) (RK) :

100 countries were scrutinized by the BNEF, revealing how emerging countries have overtaken first world countries in renewable installed capacity. Renewable energy production in developing countries has now surpassed the capacity generated by fossil sources. This landmark was revealed by the annual Climatescope report from Bloomberg New Energy Finance (BNEF), outlining how 2017 saw an unprecedented global rise in demand for renewable energy. Other **factors like a steady growth in demand for electricity**, the implementation of innovative energy policies, **abundant investments and lower technology costs** all combined to **ensure for the first time ever that developing countries snatched the primacy in renewable capacity from industrialized nations: something considered like science fiction only a few years ago.**

[Nakano of the CSIS 2019](https://www.csis.org/analysis/greening-or-greenwashing-belt-and-road-initiative) (RK):

In its seventh year, however, the BRI finds itself under a heightened pressure to address the emissions implications of its energy projects. In 2018, over [40 percent of the BRI lending for the power sector was still in coal projects](https://www.chinadialogue.net/article/show/single/en/11212--Green-Belt-and-Road-in-the-spotlight). Also, some BRI recipient **countries are beginning to voice concern over** Chinese **coal projects for their impact on the local environment** as well as the potential of crowding out lower carbon power generation alternatives in the future. In [Kenya](https://www.businessdailyafrica.com/news/counties/4003142-4789624-format-xhtml-g6o6j9z/index.html), the construction of a Chinese financed coal power project has been halted per judicial order issued in September 2018 amid local environmental activists warning the environmental and public health effects of burning coal. In December 2018, Pakistan decided to [suspend](https://en.dailypakistan.com.pk/headline/pakistan-finally-shelves-coal-power-project-under-cpec/) a 1,300-megawatt coal project that had been planned under the auspices of the China-Pakistan Economic Corridor, a flagship BRI project, as the Pakistani government had determined that “[surplus generation capacity had already been contracted and more contracts would lead the country to a capacity trap](https://www.dawn.com/news/1457449).”

# 