C1) Thermal pollution to water

Derek Abbott, University of Adelaide, "Why nuclear power will never supply the world's energy needs", 5/11/2011, https://phys.org/news/2011-05-nuclear-power-world-energy.html

Of course, not many nuclear advocates are calling for a complete nuclear utopia, in which nuclear power supplies the entire world's energy needs. But many nuclear advocates suggest that we should produce 1 TW of power from nuclear energy, which may be feasible, at least in the short term. However, if one divides Abbott's figures by 15, one still finds that 1 TW is barely feasible. Therefore, Abbott argues that, if this technology cannot be fundamentally scaled further than 1 TW, perhaps the same investment would be better spent on a fully scalable technology. "Due to the cost, complexity, resource requirements, and tremendous problems that hang over nuclear power, our investment dollars would be more wisely placed elsewhere," Abbott said. "**Every dollar that goes into nuclear power is dollar that has been diverted from assisting the rapid uptake of a safe and scalable solution such as solar thermal**." Solar thermal devices harness the Sun's energy to produce heat that creates steam that turns a turbine to generate electricity. Solar thermal technology avoids many of the scalability problems facing nuclear technology. For instance, although a solar thermal farm requires a little more land area than the equivalent nuclear power infrastructure, it can be located in unused desert areas. It also uses safer, more abundant materials. Most importantly, solar thermal can be scaled to produce not just 15 TW, but hundreds of TW if it would ever be required.

C2) Tradeoff

Travis Miller, Morningstar, "The Renewable Future | Morningstar", 11/18/2019, https://www.morningstar.com/articles/956808/the-renewable-future

Renewable energy is still a small player in the U.S. energy ecosystem, accounting for just 10% of U.S. electricity sales and 7% of U.S. energy consumption, excluding hydropower. Oil, natural gas, nuclear, and even coal will keep us comfortable, charged, and on the go well into the next decade. But we think renewable energy will grow faster than consensus forecasts. We expect U.S. renewable energy-- mostly wind and solar--to climb 8% annually during the next decade, reaching 22% of total electricity generation. Tech, consumer, and even oil and gas firms are rushing into renewable energy to establish sustainability cred, and politicians are greening up their resumes. Utilities that can harness this renewable energy growth will win big for investors; those that lack public support and struggle to execute will be left behind. Renewable energy is also shifting the U.S. energy landscape. Natural gas is at risk. Coal and nuclear generation are reaching bottom, and energy demand is stagnant, creating a zero-sum game between renewable energy and gas. Gas has a near-term advantage, but renewable energy is gaining strength. Texas, California, and New England will be early battlegrounds. Morningstar's 2030 U.S. Renewable Energy Forecast We forecast that U.S. renewable energy will surpass 1,000 terawatt-hours by 2030, or 22% of U.S. electricity generation, excluding hydro. The ramp-down in solar and wind tax credits during the next five years won't slow growth as much as others assume. State renewable energy portfolio standards and corporate purchases will fill the growth gaps. Our 8% compound annual growth rate for 2018-30 is higher than global growth rate forecasts and higher than the 5.6% forecast CAGR from the U.S. Energy Information Administration, which has a history of underestimating renewable energy growth.Brian Mann, NPR,

"Unable To Compete On Price, Nuclear Power On The Decline In The U.S. : NPR", 2016, https://www.npr.org/2016/04/07/473379564/unable-to-compete-on-price-nuclear-power-on-the-decline-in-the-u-s

Renewable energy and new technologies that are making low-carbon power more reliable are growing rapidly in the U.S. Renewables are so cheap in some parts of the country that they're undercutting the price of older sources of electricity such as nuclear power. The impact has been significant on the nuclear industry, and a growing number of unprofitable reactors are shutting down. When the first nuclear power plants went online 60 years ago, nuclear energy seemed like the next big thing. There are 100 commercial nuclear reactors licensed to operate. Link to a full list. U.S. Nuclear Regulatory Commission In many ways, it lived up to that promise. It turned out to be remarkably safe and reliable and clean. It's carbon-free and is the source of about 20 percent of the country's electricity. But right from the start, people in the nuclear industry struggled with a big problem: cost. Making nuclear power cheap was the Holy Grail. It never panned out. **Nuclear plants keep coming in over-budget. And after the Fukushima disaster in Japan in 2011 — when three nuclear reactors melted down after an earthquake and tsunami hit — companies were forced to spend millions of dollars more on safety equipment to keep older plants operating. "It would be very difficult for any company to make a decision to try to build a new nuclear plant,"** says Mike Twomey, a spokesman for Entergy Nuclear, which runs nuclear power plants. Entergy has already taken one unprofitable reactor offline in Vermont and plans to close two more plants that are losing money in upstate New York and Massachusetts. In all, 19 nuclear reactors are undergoing decommissioning, of which five have been shut down in the past decade, according to the U.S. Nuclear Regulatory Commission. The Nuclear Regulatory Commission is overseeing the decommissioning of 19 nuclear power reactors. Link to the full list. U.S. Nuclear Regulatory Commission The main reason behind the wave of closures is a new generation of cheap, gas-fired power plants that has pushed the wholesale price of electricity into the basement. But Mycle Schneider, a nuclear industry analyst, says nuclear also faces growing price pressure from wind and solar. Renewable energy is so cheap in some parts of the U.S. that it's even undercutting coal and natural gas. "We are seeing really a radical shift in the competitive markets which leave nuclear power pretty much out in the rain," Schneider says. Over the past decade, no new nuclear power plants have begun commercial operations in the U.S.; the last reactor to start up in the U.S. was in Tennessee in 1996 (another unit at the same plant is expected to come online sometime later this year). There are a handful of new nuclear reactors under construction in the South, where energy markets are still highly regulated. Big power authorities there don't face the kind of head-to-head competition that has revolutionized energy markets in other parts of the country. ALL TECH CONSIDERED Solar And Wind Energy May Be Nice, But How Can We Store It? ENERGY Coal, Gas, Nuclear, Hydro? How Your State Generates Power THE TWO-WAY U.S. Government Will Back Loans For Nuclear Power ENVIRONMENT How President Obama Wants To Shrink The Government's Carbon Footprint ENERGY Fight Over Nuclear Plant Draws N.Y. Political Heavies But even within the nuclear industry itself, a growing number of experts agree that the U.S. has reached a pivot point, where new nuclear power plants are just too expensive.

Travis Miller, Morningstar, "The Renewable Future | Morningstar", 11/18/2019, https://www.morningstar.com/articles/956808/the-renewable-future

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Renewable energy is also shifting the U.S. energy landscape. Natural gas is at risk. Coal and nuclear generation are reaching bottom, and energy demand is stagnant, creating a zero-sum game between renewable energy and gas. Gas has a near-term advantage, but renewable energy is gaining strength. Texas, California, and New England will be early battlegrounds.

Morningstar's 2030 U.S. Renewable Energy Forecast We forecast that U.S. renewable energy will surpass 1,000 terawatt-hours by 2030, or 22% of U.S. electricity generation, excluding hydro. The ramp-down in solar and wind tax credits during the next five years won't slow growth as much as others assume. State renewable energy portfolio standards and corporate purchases will fill the growth gaps. Our 8% compound annual growth rate for 2018-30 is higher than global growth rate forecasts and higher than the 5.6% forecast CAGR from the U.S. Energy Information Administration, which has a history of underestimating renewable energy growth.

W1) Tax Incentives

Brad Plumer, Vox, "Nuclear power is dying. Can radical innovation save it? - Vox", 3/27/2017, https://www.vox.com/energy-and-environment/2017/3/27/15043522/nuclear-power-future-innovation

We can learn from the Koreans," writes Michael Shellenberger in a long recent essay on Toshiba/Westinghouse's woes. **To revive nuclear, countries and industry would need to likewise settle on a proven light-water reactor [small modular reactors] design and build it again and again to drive down costs — as opposed to the current situation, where countries like the United Kingdom are pursuing a welter of new designs.** Only once a global supply chain is reestablished will it be time to experiment with incremental new models. "Nations must work together to develop a long-term plan for new nuclear plant construction to achieve economies of scale," Shellenberger writes. "Such a plan would allow for certainty, learning-by-doing, cost declines and lower financing costs." It's a forceful call to action. Yet it's also clear that this would require sweeping policy and political shifts in many countries**. The US, for example, doesn't have a single state-owned utility like South Korea does — it has balkanized state electricity markets and deregulated utilities, which has made standardization and coordination on nuclear power far more difficult. This vision would also likely require significant government investment in nuclear, at least early on.**

France's nuclear build-out, remember, was guided by the heavy hand of the state. Just as importantly, such a build-out would likely require changing public opinion about nuclear power in the United States, Europe, Japan, and elsewhere — overcoming long-standing (but often

unfounded) concerns around radiation and waste. It would require persuading regulators that existing light-water reactor technology is already safe enough and shouldn't be bogged down by shifting requirements that drive up costs. It'd take too long to delve into all those issues here, and I won't hazard a guess as to whether these changes are feasible. But they're certainly daunting, which is why many nuclear advocates now think radical innovation is a better way forward…

Kari Lydersen , EnergyNews, "Why the nuclear industry targets renewables instead of gas | Energy News Network", 2/6/2015, https://energynews.us/2015/02/06/midwest/why-the-nuclear-industry-targets-renewables-instead-of-gas/

Cheap natural gas has upended the nation's energy landscape and made aging nuclear power plants increasingly uncompetitive. **Yet the nuclear industry, which generates almost a fifth of the nation's energy, has declared war not on gas but on wind and solar, which represent about 4 and 0.2 percent of our energy mix, respectively. Nuclear generators have successfully fought against renewable and energy efficiency standards on the state level, and lobbied against tax incentives for wind and solar on the federal level.** They're in the process of securing changes in regional capacity markets that would benefit nuclear and harm solar and wind. And as states develop their Clean Power Plans to fulfill the federal mandate to reduce carbon emissions, nuclear is often pitted against renewables. In deregulated states like Illinois, Ohio, Michigan and Pennsylvania, nuclear generators have found it increasingly difficult to sell their power at a profit on open markets, because of competition primarily from gas but also from wind. Meanwhile, energy efficiency and distributed solar generation have reduced demand for electricity and are part of a fundamental shift which could significantly shrink the role of large, centralized power plants.

Tim Judson, NIRS, "Killing the Competition The Nuclear Power Agenda to Block Climate Action, Stop Renewable Energy, and Subsidize Old Reactors", September 2014

These reforms would have far-reaching impacts on the U.S.'s energy future. Rigging the markets for baseload power plants would boost nuclear, coal, and natural gas, and enable fossil fuel generators to afford the emissions credits they would buy from nuclear to comply with carbon regulations. In total, nuclear would create multiple new and increased revenue streams, throw a regulatory lifeline to coal and natural gas, and block the growth potential of renewables. In such a market, energy efficiency could even become a benefit to nuclear, coal, and gas by limiting the need for new generation sources. **The last time such sweeping energy policy changes were made—the move to utility deregulation in the 1990s—the public was largely kept in the dark about the implications. That move sustained nuclear and coal generation and ushered in a massive increase in use of natural gas to generate electricity. It also delayed the development and growth of renewable energy for well over a decade after the Kyoto Treaty made climate action a recognized global priority.** The truth is, we can address climate change and meet our energy needs, affordably and sustainably, but we can't do it simply by paying more to prop up the same energy sources that have created the problem. The sustainable energy technologies we need to build a carbon-free energy system have arrived, and they are cost-effective. But we do need to make a choice. Doing so would give us the opportunity not just to address climate change, but also to revitalize our

economy and create millions of jobs in new industries. That is what the nuclear industry is afraid of: that America will realize how little nuclear has to offer, and decide to move in a new direction.

Josh Siegel, Washington Examiner, "Daily on Energy: The case for cutting renewable subsidies to save nuclear", 7/11/2019,
https://www.washingtonexaminer.com/policy/energy/daily-on-energy-the-case-for-cutting-renewable-subsidies-to-save-nuclear

xA new report on nuclear energy could ignite debate on Capitol Hill over whether to allow renewable energy subsidies to sunset, or renew them as Democrats are seeking to do. **The free-market Manhattan Institute's latest report on nuclear energy says the best thing Congress can do to help nuclear energy is to eliminate both subsidies for wind and solar.** The July 10 study, now being circulated on Capitol Hill, concludes that renewables subsidies have hurt the market for nuclear power by making it harder for nuclear power plants to bid into the wholesale electricity markets to sell their power. Tax credits for solar are slated to decrease in value at the end of the year toward phaseout, but Democrats have been mulling extensions to renew the subsidies. Here's the problem for nuclear: The subsidies create negative prices, which give renewable energy an advantage, given market rules that favor the lowest-cost form of generation. Large nuclear utilities like Exelon have argued against wind subsidies for years, blaming them for some of the financial difficulties power plants have been experiencing.

Institute for Energy Research, "Green Technologies Cannot Survive in the Marketplace without Subsidies - IER", 6/14/2017,
https://www.instituteforenergyresearch.org/uncategorized/green-technologies-cannot-survive-marketplace-without-subsidies/

Green technologies (e.g., wind, solar and electric vehicles) cannot compete in the marketplace without subsidies or other favorable government policies. In Nevada, for example, when the government modified its policy to pay customers less for excess power produced by rooftop solar systems, solar installers left the state for others providing more favorable net metering policies. With its solar installations down, Nevada's legislature recently passed a net metering bill, which the Governor is expected to sign, that brings back net metering at a slightly discounted rate. The reason the state removed net metering was that solar rooftop customers received free transmission access, forcing non-rooftop solar customers to pay for the transmission services of the solar customers. Net metering is a regressive policy because most rooftop solar customers are higher income households. Nevada's electric utility company, NV Energy, indicated that restoring net metering under an earlier version of the revised policy would be expensive—over $63 million each year, or about $1.3 billion over two decades.[i] Besides net metering, many states have renewable portfolio standards that require a certain percentage of their generation to come from renewable energy by a specified date. **These state measures—along with federal government subsidies such as the production tax credit for wind, the investment tax credit for solar and the tax credit for purchasing electric vehicles—provide lasting incentives that are pushing green technologies into the U.S. marketplace. These technologies would not have grown to today's levels without these incentives.**

W2)

Jason Deign, Greentech Media, "Interest in Small Modular Nuclear Reactors Is Growing. So Are Fears They Aren't Viable | Greentech Media", 3/14/2018,
https://www.greentechmedia.com/articles/read/interest-in-small-modular-nuclear-grows

SMRs are the future of nuclear. Will they always be the future? slow-moving small modular reactor (SMR) market saw some positive activity in recent weeks, even as one expert predicted the technology would never achieve commercialization. Earlier this month, the World Nuclear Association reported that Ukraine had signed a memorandum of understanding with SMR developer Holtec International, aiming to turn the Eastern European nation into a manufacturing hub for Holtec's SMR-160 reactors. The Association said Holtec is planning a Ukrainian manufacturing plant to allow for partial localization of its 160-megawatt SMRs, so Ukraine's nuclear operator Energoatom can use the design to replace two aging Russian VVER-440 reactors at its Rivne nuclear power plant. The news came a week after the government of Canada announced a road-mapping exercise to explore the potential of SMRs in the country. TOP ARTICLES MOST POPULAR MOST COMMENTS NextEra's FP&L Wins Approval for Massive... General Motors Aims for 'Reinvention' With New Modular EV... David Energy Raises $1.5M to Turn New York's Buildings... WHITE PAPERS U.S. Solar Market Update DOWNLOAD > Utility Security: Exceeding Mandates to Mitigate Risk DOWNLOAD > U.S. Solar Market Insight DOWNLOAD NOW > Webinar - An accelerated view of the energy transition WATCH NOW > "The road map will be an important step in positioning Canada to advance next-generation technologies and become a global leader in the emerging SMR market," said Natural Resources Canada, a federal institution. This was welcome news for a technology that has been slow to achieve commercialization -- and which some believe might never take off. In the December 2017 edition of the National University of Singapore's Energy Studies Institute Bulletin, for example, Canadian academic Professor M.V. Ramana provided a detailed argument for why SMRs could never be a viable technology. Nuclear plants in general require high levels of capital, he noted, and high construction costs mean the electricity they provide ends up being more expensive than coal, gas and, more recently, wind and solar. SMRs may be able to overcome the first problem, said Ramana, who is a professor at the University of British Columbia's School of Public Policy and Global Affairs.

David Thompson, NB Media, "Small modular nuclear reactors threaten renewable energy transition in NB – NB Media Co-op", 12/1/2019,
https://nbmediacoop.org/2019/12/01/small-modular-nuclear-reactors-threaten-renewable-energy-transition-in-nb/

If non-renewable energy projects such as these small modular nuclear reactors have any realistic economic merit, they can and will be funded by private investors. High profile and speculative non-renewable energy projects that require large amounts of public funding threaten the progress of transitioning to a renewable energy future. They divert investment away from renewables and conservation. The benefits of renewable energy are obvious. The fuels for renewable energy (sunshine and light from the sun, wind, moving water, and thermal heat from the earth) are all free and inflation-proof into the future. Renewable energy production produces no toxic waste materials, C02 or air pollution. Many renewable energy generation projects can be constructed and be producing a stream of cash and clean electricity in less than five years. Currently, wind power is the cheapest form of electricity generation at about 3.5 cents per kw hour, and the cost continues to drop with greater efficiency

and new technological developments. In most cases, wind projects can be up and running in less than three years, producing both electricity and cash. Our government needs to expand, build and improve on energy conservation and efficiency programs to assist homeowners, particularly those on lower incomes, to upgrade their homes, reduce their cost of living and improve their communities. Expanded and improved energy conservation and efficiency programs are also required for small businesses, public facilities and rental housing. Energy efficiency and conservation programs have huge potential to create employment in many building trades and economic activity in communities.

Jack Trevors, NCBI, "Is Nuclear Energy the Solution?", 2010, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2773373/

On October 29th, 2009, one of us, (MHS) attended a lecture on “Nuclear Responsibility” on the University of California, San Diego campus. The speaker was Rochelle Becker, Executive Director of the Alliance for Nuclear Responsibility. The information presented was both revealing and upsetting and is documented extensively in a pamphlet entitled: “Why a Future for the Nuclear Industry Is Risky.” These sources emphasized the problems that exist, especially in the USA. This editorial is based on these sources. We should all know that: first, investments in nuclear power are risky as indicated by the fact that Wall Street has chosen to stay clear; second, nuclear power plants are stated terrorist targets and carry serious risks of their own; third, nuclear power will not reduce our dependencies on foreign energy as is sometimes claimed; fourth, nuclear-generated electricity does not compare favorably with electricity derived from either the combustion of fossil fuels or renewable sources such as wind, solar, geothermal, wave, and tide, and finally, there is currently no good means of nuclear waste disposal, hence more environmental pollution. Promises of improved safety and performance are coupled with billions of dollars of subsidies. Nevertheless, claims that **nuclear power is a necessary energy source for displacing greenhouse gases has not convinced investors. Wall Street is flat out not investing in new nuclear power plants because they do not believe that they will be safe profitable investments. In fact, as things stand, new nuclear power plants will not be cost competitive with other electricity-generating alternatives. For example, wind power and other renewable technologies, combined with energy efficiency and conservation can be more cost effective and can be deployed much sooner than new nuclear power plants. Building expensive nuclear plants will divert private and public investment from the cheaper and readily available renewable and energy efficiency options** needed to protect our climate and humanity.

…

Wind power and other renewables, such as solar and bio-energy, coupled with energy efficiency, and conservation are proving to be much more cost effective. Moreover, they can be deployed much faster. Building new nuclear power plants will divert private and public investment from the cheaper, readily available options needed to protect our global climate. **Each dollar invested in electric efficiency in the USA displaces nearly seven times as much carbon dioxide as a dollar invested in nuclear power, and nuclear power saves as little as half as much carbon per dollar as wind power. R**ecent studies analyzing the

potential of nuclear power to combat global warming have concluded that between 1,000 and 2,000 new nuclear reactors would have to be built around the globe to achieve a meaningful impact on carbon dioxide emissions. These projections point to an infeasible schedule as new reactors would have to be completed every few weeks.

Grace Hilliard, Liberty University, "A New Day for Nuclear The Impact of Nuclear Energy and Its Effects", Spring 2014, https://digitalcommons.liberty.edu/cgi/viewcontent.cgi?article=1478&context=honors

Verbruggen, an Energy and Environmental Economics professor at the University of Antwerp (2008), highlights five reasons that nuclear power and renewables are incompatible. The first is that nuclear "is architect of the business-as-usual that has to be changed urgently and drastically" (p. 4046). This means that nuclear would not allow for a radical shift from fossil fuels which is necessary for the expansion of renewable energy. Verbruggen argues that renewable energy needs an immediate expansion that would be thwarted by nuclear power. Next is that renewables and nuclear yield very different results when they are added to fossil-fuelled power plants. To convert a fossil-fuelled plant into one with a different energy source, the nuclear add-on would be bulky and cumbersome while the renewable add-on would be flexible (Verbruggen). T**he third incompatibility is with the power grids that are connecting millions of power sources. Nuclear would need a new type of grid in order to make its output functional.** Fourth, Verbruggen states that the risks for nuclear power make it unsustainable while renewable energy is believed to be safer and have fewer risks associated with implementing it. The final aspect is that nuclear and renewables are not the only ones fighting for funding (Verbruggen). Renewables and nuclear would not be able to co-exist because of the extraordinary amount of money that is involved in funding both of these technologies. Renewables need a flexible source of energy to complement them. Ac

Philip Murphy, Environmental Progress, "New Jersey Letter — Environmental Progress", 3/15/2018, http://environmentalprogress.org/new-jersey-letter

Nuclear plants around the country are at risk of being replaced by fossil fuels because they are excluded from state and federal clean energy subsidies and mandates. In 2016, renewables used for electricity production received $6.6 billion, or 33 times more, in federal tax preferences than nuclear. **Therefore, considering nuclear's larger share of clean electricity generation, federal subsidies for renewable electricity averaged 94 times more than subsidies for nuclear.** New Jersey further subsidizes clean energy while excluding nuclear. Solar provides less than four percent of the state's electricity at a cost of six hundred million dollars per year. Since nuclear provides more than eleven times this amount of electricity each year, the same New Jersey solar subsidy rate for nuclear energy would have cost seven billion dollars last year alone. Proposals to save New Jersey's nuclear plants would cost about $10 per megawatt-hour while avoiding increased prices from importing more natural gas of at least that amount. Current proposals wisely build in consumer protections, making sure that the nuclear plants need the help before providing it; other clean energy subsidies in New Jersey have not, and do not, include such consumer protections.

Aviel Verbruggen , University of Antwerp, "Sci-Hub | Positioning Nuclear Power in the Low-Carbon Electricity Transition. Sustainability, 9(1), 163 | 10.3390/su9010163", 12/4/2016, https://sci-hub.tw/https://doi.org/10.3390/su9010163

Nuclear power and variable renewable supplies are incompatible in the future green transition in terms of five different aspects [35]. First, nuclear power offers no new qualitative progressive policy shift but is a blast from the past resonating since the 1950s. Notwithstanding massive financial and political support for

the development of the technology and its civil applications (since Atoms for Peace was launched in 1953), nuclear power did not deliver on the announced energy transitions: the all-electric, nuclear supplies (1950–1960s); significant weakening of the position of petroleum as energy market kingmaker (1970–1980s); and solving the problems of waste and safety for obeying sustainability imperatives (1950–2016). Second, nuclear power requires different ways to balance the power supply than renewable power. **Third, the two powers need different types of electricity grids to transmit their outputs—a bulky, centralized top-down type for nuclear outputs and broad dispersed, multilateral network setups for the various and numerous renewable energy suppliers. The disparity is most obvious for supplies outside densely urbanized areas of advanced economies**. Fourth, risks and externalities of nuclear power production and permanency of nuclear waste problems highlight the unsustainability of nuclear power [36]. Fifth, nuclear power survival and renewable technology inventions, innovations and development depend both on state support and funding for Sustainability 2017, 9, 163 7 of 14 R&D. The public budgets are limited, college curricula are competitive, scientists and engineers can be productively used for either nuclear survival or renewable technology inventions and innovations, not both at the same time. The EU has choked its own leadership in renewable energy by changing the state aid guidelines in 2014, fencing in support for distributed renewable projects, while allowing the UK's high price

UGC Research Program, "2.7 Projected Deaths and Illness from Temperature Exposure | Climate and Health Assessment", 2016, https://health2016.globalchange.gov/temperature-related-death-and-illness/content/projected-deaths-and-illness-temperature-exposure

Climate change will increase the frequency and severity of future extreme heat events while also resulting in generally warmer summers and milder winters, with implications for human health. Absent further adaptation, these changes are expected to lead to an increase in illness and death from increases in heat, and reductions in illness and death resulting from decreases in cold, due to changes in outcomes such as heat stroke, cardiovascular disease, respiratory disease, cerebrovascular disease, and kidney disorders.,3 **A warmer future is projected to lead to increases in future mortality on the order of thousands to tens of thousands of additional premature deaths per year across the United States by the end of this century.,,,,,8**,,, Studies differ in which regions of the United States are examined and in how they account for factors such as adaptation, mortality displacement, demographic changes, definitions of heat waves and extreme cold, and air quality factors, and some studies examine only extreme events while others take into account the health effects of smaller deviations from average seasonal temperatures. Despite these differences there is reasonable agreement on the magnitude of the projected changes. Additionally, studies have projected an increase in premature deaths due to increases in temperature for Chicago, IL,,13 Dallas, TX,14 the Northeast corridor cities of Boston, MA, New York, NY, and Philadelphia, PA,14,,, Washington State,, California, or a group of cities including Portland, OR; Minneapolis and St. Paul, MN; Chicago, IL; Detroit, MI; Toledo, Cleveland, Columbus, and Cincinnati, OH; Pittsburgh and Philadelphia, PA; and Washington, DC. However, these regional projections use a variety of modeling strategies and therefore show more variability in mortality estimates than studies that are national in scope.

Mark Jacobson, Stanford University, "Evaluation of Nuclear Power as a Proposed Solution to Global Warming, Air Pollution, and Energy Security", 12/22/2019, https://web.stanford.edu/group/efmh/jacobson/Articles/I/NuclearVsWWS.pdf

In evaluating solutions to global warming, air pollution, and energy security, two important questions arise are (1) should new nuclear plants be built to help solve these problems, and (2) should existing, aged nuclear plants be kept open as long as possible to help solve these problems? To answer these questions, the main risks associated with nuclear power are examined. The risks associated with nuclear power can be broken down into two categories: (1) risks affecting its ability to reduce global warming and air pollution and (2) risks affecting its ability to provide energy and environmental (aside from climate and air pollution) security. Risks in the former category include delays between planning and operation, emissions contributing to global warming and outdoor air pollution, and costs. Risks in the latter category include weapons proliferation risk, reactor meltdown risk, radioactive waste risk, and mining cancer and land despoilment risks. These risks are discussed, in this section. Here are additional specific findings: • **New nuclear power plants cost 2.3 to 7.4 times those of onshore wind or utility solar PV per kWh, take 5 to 17 years longer between planning and operation, and produce 9 to 37 times the emissions per kWh as wind. • As such, a fixed amount of money spent on a new nuclear plant means much less power generation, a much longer wait for power, and a much greater emission rate than the same money spent on WWS technologies. •** There is no such thing as a zero- or close-to-zero emission nuclear power plant. **Even existing plants emit due to the continuous mining and refining of uranium needed for the plan**t. **However, all plants also emit 4.4 g-CO2e/kWh from the water vapor and heat they release**. This contrasts with solar panels and wind turbines, which reduce heat or water vapor fluxes to the air by about 2.2 g-CO2e/kWh for a net difference from this factor alone of 6.6 g-CO2e/kWh. • On top of that, because all nuclear reactors take 10-19 years or more between planning and operation vs. 2-5 year for utility solar or wind, nuclear causes another 64-102 g-CO2/kWh over 100 years to be emitted from the background grid while consumers wait for it to come online or be refurbished, relative to wind or solar. • Overall, emissions from new nuclear are 78 to 178 g-CO2/kWh, not close to 0. • C**hina's investment in nuclear plants that take so long between planning and operation instead of wind or solar resulted in China's CO2 emissions increasing 1.3 percent from 2016 to 2017 rather than declining by an estimated average of 3 percent. The resulting difference in air pollution emissions may have caused 82,000 additional air pollution deaths in China in 2016 alone, with additional deaths in years prior and since**

Manola Secaira, Business Insider, "Wind and solar energy are saving lives - Business Insider", 2017, https://www.businessinsider.com/wind-and-solar-energy-are-saving-lives-2017-8?IR=T

The increasing presence of wind and solar in the United States helped prevent the premature deaths of up to 12,700 people between 2007 and 2015, according to a new study from Nature Energy. How's that? Well, with the rise of clean energy, there's a reduced risk of exposure to harmful emissions from fossil fuel–burning power plants, like the class of sooty airborne particulate known as PM2.5 (which has been found to damage lungs). ut wind and solar can't take all the credit — increased regulations and shifting markets helped, too. The study authors report that sulphur dioxide emissions fell from almost 10 million tons in 2007 to 2.7 million tons in 2015 after coal plants were required to complete retrofits to meet air-quality standards. So that's one more piece of evidence that wind and solar really do save the day.

guarantees for new nuclear stations [33]

Miklos Antal, University of Leeds, "How the regime hampered a transition to renewable electricity in Hungary - ScienceDirect", 1/5/2018, https://www.sciencedirect.com/science/article/pii/S2210422418300029

The other main objective was to better understand why the regime wanted to block wind and solar. Which interests of the nuclear lobby or the government, ideas of the regime, or institutional factors might have been responsible for this? The answer for the industrial part of the regime is more or less clear: their main aspirations have likely been profitability and long-term dominance, also influenced by an ideologically hostile relationship with supporters of renewables. Motivations of the government are more difficult to reveal, especially in an illiberal system. As energy strategy documents are not followed, most experts are excluded from the policy process, pre-decision public discussions are missing, and post-decision justifications by the government are short and dubious, only speculation is possible. Suspected interest-based explanations include a perceived clash with political marketing strategies such as utility cost reduction, the potentially lower capacity utilization of state-owned power plants, and private interests that might profit most from large, centralized projects. Possible idea-based reasons include the disbelief in market-based approaches to energy supply, a preference to serve the interests of capital-in-general, low awareness of rapid global changes in electricity supply, attributing high importance to domestic supply chains, the personal aversion of the prime minister towards renewables, and preference for more centralized solutions as opposed to energy democracy. Institutions rarely constrained the actions of the illiberal government, but renewables could suffer due to the comfortable position of the regime that would have been disrupted by institutional changes or because the government put renewables on hold to let incumbents or others prepare for the takeover of these new markets. The diversity of these explanations reveals an analytical challenge that complicates the understanding of illiberal systems: while the balance of power is shifted towards the political regime in comparison with liberal democracies, explaining the motivations behind political decisions that drive or hamper change becomes increasingly difficult. From a climate perspective, a nuclear phase-out in Hungary might still look risky. **Nevertheless, rushing towards a new NPP was hasty and blocking the breakthrough of renewables put the country on a higher emission path than necessary. Both the socialist and the right wing government have responsibility in this, not least because both excluded experts and the public from key decisions. Before 2009, conditions that could have helped the spread of renewables–such as demand growth, ageing infrastructure, and growing imports–had a negative effect on wind and solar energy by triggering the project of nuclear expansion. After 2010, anti-renewables policies pushed the country to the bottom of renewable energy lists in Europe**. Whether the future will be different will be decisive for a low-carbon, affordable and secure supply of electricity based on domestic sources, because such scenarios are difficult to imagine without a significant development of wind and solar energy.’

RE World, "Renewables vs. Nuclear: Do We Need More Nuclear Power? - Renewable Energy World", 4/28/2015, https://www.renewableenergyworld.com/2015/04/28/renewables-vs-nuclear-do-we-need-more-nuclear-power/#gref

In the next 10 years, renewables will add well over 100 nuclear reactors-worth of electricity. The above output numbers for renewables assume no advances in wind or solar efficiency and no grid storage. Both assumptions will become completely false, so the 131 GW number should be considered a minimum number. Capacity factor numbers used were 40 percent wind, 25 percent utility solar, 20 percent rooftop PV, 85 percent biomass/biogas, 80 percent geothermal. Note that some of the utility solar added to the grid was solar thermal with molten storage, with an 80 percent capacity factor, so 25 percent capacity factor number was used to encompass all utility solar. Obviously, we can not use EIA's capacity factor numbers for renewables, as they only have renewable generation data for the last four months of 2014. That means no summer months for solar and a few missed windy months for wind. The additional nuclear power output of 5.1 GW will come from 5 under construction plants that are behind schedule and billions over budget. They include Watts Bar, Summer and Vogtle. Even favorable policies and new plant approvals won't change nuclear's contribution — nuclear is expensive and takes too long to build. The next 10 years = five reactors = 5.1 GW output. The 10 year projection for renewables is highly conservative. We excluded EIA's projections due to flawed data (more on that here, here and here), but I've considered Exxon's really low projections and ACORE's really high projections. The estimate of 131 GW for renewable generation is about half of the optimistic generation estimate of 254 GW, although even that estimate is obtainable with favorable policies. So, here is the big question: why are renewables growing faster than nuclear, even in places like China where they are building the most reactors? In places like the U.S., Japan and Europe, is it because of nutty environmentalists and anti nuclear groups? Isn't that what happened with Vermont Yankee? Actually, no – Vermont Yankee really closed because the O&M costs became too high. The real answers: risk, cost and time to build.

Grant SMith, Environmental Working Group, "The Economic Viability of Nuclear Power Is Only Going Down | EWG Next Level Energy", 1/8/2019, https://www.ewg.org/energy/22388/economic-viability-nuclear-power-only-going-down/

Nuclear advocates' claims that nuclear power is required to fight climate change falls short. California met its climate goal of reducing greenhouse gas emissions to 1990 levels by 2020 four years early by turning off its nuclear plants and setting policies that prioritize renewables, energy efficiency and energy storage investments over natural gas plant additions. An argument advanced in the Energy Department report is that, to ensure that power can be delivered 24/7, large coal and nuclear power plants designed to run day and night – also known as baseload plants – need to be replaced by small nuclear units that run day and night. However, mounting, real-world evidence refutes this assertion. Recent studies from New York and California show that it is cheaper to invest in renewables, energy efficiency and energy storage in order to replace aging nuclear plants than it is to keep the existing plants running. Savings range from hundreds of millions to billions of dollars – achieved without any impact on electric system reliability. Nuclear power belongs in a museum. We shouldn't continue to squander public dollars on a technology that will never make economic sense. We should divert resources into improving and deploying wind, solar, energy efficiency and energy storage technology that we know will keep the lights on, effectively reduce carbon emissions and cost what we can afford to pay.

Keeping the Lights on: Nuclear, Renewables and Climate Change; Sixth Report ..., House of Commerce, "Keeping the Lights on: Nuclear, Renewables and Climate Change; Sixth Report ... - Great Britain: Parliament: House of Commons: Environmental Audit Committee - Google Books", https://books.google.com/books?id=7ijsy52C1_QC&pg=PA9&lpg=PA9&dq=private+investment+nuclear+production+divert+renewables&source=bl&ots=ZDpG7sO8I8&sig=ACfU3U112w3gU91yNiedY3AhF-iLChkLDQ&hl=en&sa=X&ved=2ahUKEwiv0-zy5oHoAhVEpZ4KHTDwD2E4ChDoATAGegQIChAB#v=onepage&q=private%20investment%20nuclear%20production%20divert%20renewables&f=false

renewable energy?

At the moment, as far as WWF-UK is aware, there is no realistic prospect of private investors putting money into nuclear power. Despite the many theoretical statements by the pro-nuclear lobbyists that the nuclear industry is economically viable, so far investor confidence in the industry has remained low.

It is argued that financial investors regard nuclear power plants sceptically and cautiously because of the extremely long planning, construction and radioactive waste management times. When Sizewell B nuclear plant was planned, for example, the ensuing public enquiry took almost four years.

Financial institutions also see risks because most of the national power utilities which are highly reliant on nuclear power receive either direct or indirect subsidies from the state governments eg British Energy in the UK[16], EdF in France, and state-owned nuclear reactors in Russia.

No new nuclear reactors (except one in Finland) are presently planned or under construction in any of the industrialised countries until 2010. This is largely a result of huge financial costs and associated risks. Helm (2003) concluded that the UK nuclear programme had proved to be ". . . probably one of the biggest investment mistakes since the Second World War . . . Not once since the first White Paper in 1955 had the nuclear option delivered what was promised."[17]

Financial investors are putting significant money in offshore and onshore windfarms, but inadequate government spend, policies and short-term target setting as well as prohibitive planning processes are stifling industry confidence in the market and preventing the large-scale investment needed. Much more funding and long-term market certainty is urgently needed for these new types of renewables in order to give confidence to investors.

— *How much Government financial support would be required to facilitate private sector investment in nuclear new build? How would such support be provided? How compatible is such support with liberalised energy markets?*

WWF-UK relies on the expertise of the private sector to provide the information needed to answer this question on level of financial support, however WWF-UK fundamentally opposes any government funding to be diverted away from existing safe and reliable renewable and energy efficiency technologies which are currently under-supported, into unsustainable and highly risky technologies such as nuclear power.

— *What impact would a major programme of investment in nuclear have on investment in renewables and energy efficiency?*

In short, new nuclear build and its associated huge financial costs would have a negative impact on the level of investment available for alternative clean, zero-carbon options, such as renewables and energy efficiency.

Nuclear power in the UK warrants vast sums of money in the order of £billions over the next 30–40 years. This will effectively divert the increased funding available and political interest away from the much needed renewables and energy efficiency measures.

Craig Morris, Energy Transition, "Renewables replace nuclear and lower emissions simultaneously | Energy Transition", November 20 2019, https://energytransition.org/2019/11/renewables-replace-nuclear-and-lower-emissions-simultaneously/

t's not just trolls: Cambridge professors are saying it, and top US journalists are saying it, and a US presidential candidate told it to the New York Times: "Germany initially set out to close all of its nuclear reactors by 2022, but as a result, they are now likely to miss their emissions reduction targets. And France is now considering options to extend the life of many of its older

nuclear power plants." — US presidential candidate Marianne Williamson in the New York Times What's worse, US policymakers are saying it. Five US states now subsidize nuclear to keep reactors from closing, and it's possible that all of them have done so based on this incorrect assumption. It happened years ago in New York State with explicit reference to German emissions allegedly rising because of the phase-out, it then happened in Illinois, and as one press report from Ohio put it this year when the new nuclear subsidy was announced: The experience of Germany was repeatedly used as an example of what might happen in Ohio. Germany decommissioned its nuclear plants in favor of an all-renewable strategy. Electricity prices spiked and carbon pollution spiked, in part because of the ramping up of fossil-fuel plants to compensate for when wind and solar faltered. "If the studies are correct, the Germans must not know how to do this," Mr. Randazzo [chairman of the Public Utilities Commission of Ohio] said. "If the studies are correct" indeed: So do Germany and France show that climate change requires nuclear, as Williamson says? Let's start with France. The second objection is generally: "Germany would have lowered emissions even more if it had phased out coal, not nuclear." That's a fine thing to discuss, but it only moves us from a falsehood ("German phaseout raised emissions") to revisionist history – not to facts. The revisionist historians act as though renewables would have been built anyway if nuclear remained online. As I wrote in my 50-page paper entitled Can reactors react (2018), the Germans argued a decade ago that renewables were unlikely to be built if nuclear stayed online. What do the French and German cases show about how much renewable energy gets added when nuclear stays online? The French are also failing to add new nuclear as quickly as its own power company closes old reactors it wishes to keep on. From 2010-2018, wind and solar grew by 27.4 TWh in France, while nuclear shrank by 14.7 TWh (and demand stayed flat). During the same timeframe in Germany, nuclear shrank by 64.6 TWh – but solar and wind alone grew by 91.8 TWh. The current French situation suggests that, if you remain committed to nuclear, nuclear power nonetheless shrinks; to make matters worse, the growth of renewables struggles to close the gap. **Germany suggests that, if you stick with renewables and phase out nuclear, renewables growth outstrips the drop in nuclear nearly twofold, and you reduce emissions by 2 percentage points annually in the power sector.**