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Neither Climate nor Jobs:
Nuclear Myths about the Just Transition

Dr. Neil Overy

The author

Dr Neil Overy is an environmental researcher, writer, and photographer. He has worked in the non-profit sector for more than 20 years and is particularly interested in the intersection between environmental and social justice issues. He has written extensively about nuclear power in the media, for non-profit organisations and academically.

Neither Climate nor Jobs: Nuclear Myths about the Just Transition by Dr Neil Overy

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For queries, please write to: info@za.boell.org
W www.za.boell.org

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INTRODUCTION

In 2007, author Naomi Klein published the 'Shock Doctrine' in which she argues that disasters are exploited by corporations and politicians to push through controversial or unpopular policies designed to further entrench neo-liberal economic and social policies.[1]

Her 'disaster capitalism' thesis appeared to play out almost perfectly in Texas in February 2021. In the grip of climate-induced extreme weather, which saw temperatures plunge to previously unrecorded lows, energy supplies failed, leaving millions of Texans without power. Under this pretext, numerous politicians and commentators blamed the crisis on renewable energy – particularly wind power. Texas Governor Greg Abbott, for example, argued that the crisis showed 'how the Green New Deal would be a deadly deal for the United States of America.'[2] On Fox News, Tucker Carlson stated that 'the windmills froze, so the power grid failed.'[3] These, and numerous other commentators, then proceeded to promote fossil fuels as the solution to the crisis. The *Wall Street Journal*, for example, stated in an editorial that 'power shortages show the folly of eliminating natural gas—and coal.'[4]

Evidence has since shown that in fact, the loss of wind power was hardly the primary cause of the crisis. The loss of 4000MW of wind power was minor when compared to the 29000MW lost from gas, coal and nuclear power installations. Gas, which provides 46% of the state's energy needs, was the main culprit as it froze at wellheads and in pipelines.[5] Coal fired power stations, such as the 1800MW Limestone Electric Generating Station failed, while the 1300MW South Texas Project-1 nuclear reactor went off-line for two days – because frozen water prevented pumps from operating.[6]

While it is hardly surprising that Republicans and sympathetic right-wing commentators used the crisis to push fossil fuels, less predictable was that some progressive forces would also use the opportunity to promote nuclear power as a carbon-free and reliable alternative to renewables. Writing in February in *Jacobin,* a *'leading voice of the American left'*[7], Fred Stafford stated, without providing any evidence, that nuclear power was 'a sign of hope' because it provided both reliable and clean energy, and 'many high-paying union jobs.'[8]

It is the intention of this publication to counter such claims, and offer a comprehensive account of why nuclear power offers little by way of viable energy solutions to the climate emergency – and even less for how the massive socio-economic transformations our society must undertake in response to it – can be just.

MYTH 1: Nuclear power reliability will not be impacted by climatic events [*yes, it will*]

The reliability of a particular power source relates to how much it can generate over a specific period, compared to the maximum theoretical amount of power that could be created during that same period (the 'capacity factor'). Because of maintenance and the need to refuel reactors, nuclear power stations have a capacity factor of around 80%.[9] While this does compare favourably with other power sources, numerous incidents demonstrate that this capacity factor will continue to fall due to climatic events linked to global heating.

The Texas power crisis is a case in point. The South Texas Project-1 nuclear reactor failed due to extremely cold weather. Winter storms such as the one that caused the widespread power outages have become more frequent in regions of the United States that have not experienced such conditions before. It is, however, not only freezing temperatures that impact nuclear power reliability. As the 2021 World Nuclear Industry Status Report points out, cooling based thermal power plants like nuclear will be particularly affected by climate change 'due to reduced streamflow, and warming ambient and streamflow temperatures.'[10]

Cooling based thermal power plants like nuclear, which depend on water, will be particularly affected by climate change due to reduced river flows and warming ambient and water temperatures in fresh and sea water sources.

Examples from the past century abound. In 2018, nuclear power stations in Finland, Sweden and Germany had to reduce their power output due to a heatwave which caused ocean water temperatures to rise, compromising reactor cooling systems.[11] A year later, another heatwave forced nuclear power stations in Germany and France closed, shutting down 8% of the France's nuclear power capacity, as reactors had to be switched off due to high river temperatures and decreased river flows.[12] In 2020, the French nuclear power plant in Chooz was shut down for a month due to the low level of the Meuse River.[13] Alongside frequent power outages caused by the declining performance of plant cooling systems[14], research shows that temperature rises caused by global heating will also reduce nuclear power efficiency. [15]

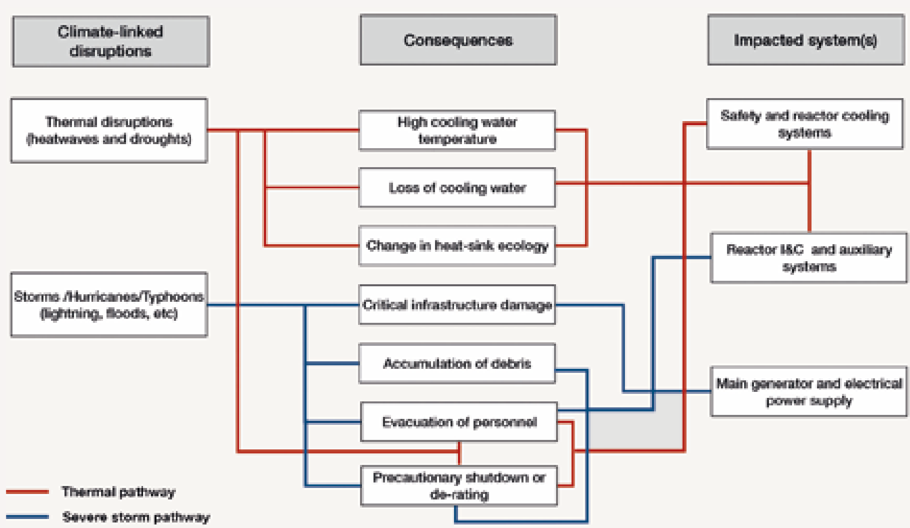
Besides temperature variability, increases in other extreme weather events such as storms pose significant challenges to nuclear power reliability. In France, inland flooding in 1999 forced the Le Blayais nuclear power station to go off-line. In 2003, several reactors had to be shut down when storms and flooding caused river water used for cooling to become contaminated with mud and plant matter. In the United

Noting that 'water emerges as a key component of climate change interactions with nuclear power plants', researchers conclude that 'nuclear power is not and will not be a suitable mitigation measure' , and is unlikely to be resilient in the context of a changing climate.

States, hurricanes have prompted nuclear power stations to go off-line. As they erode sea defences, sea-level rises caused by global heating will also threaten nuclear power reliability. Evidence from the United States shows that predicted sea-level rises, accompanied by storm surges, threaten the viability of current and future coastal locations for nuclear power stations.[16] The frequency and severity of droughts is also likely to increase as the impacts of the climate emergency deepen, threatening the viability of using rivers as a source of cooling.

Given these examples, what guarantee is there that similar, or worse weather events, will not force nuclear power stations to go off-line for extended periods of time? Noting that 'water emerges as a key component of climate change interactions with nuclear power plants,' researchers conclude that 'nuclear power is not and will not be a suitable mitigation measure'[17], and is unlikely to be resilient in the context of a changing climate.

Figure 1: The numerous ways Nuclear Power could be disrupted by climate events



Source: Ali Ahmad, Nature Energy, July 2021. As featured in World Nuclear Industry Report, 2021. Figure 59.
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Neither Climate nor Jobs: Nuclear Myths about the Just Transition

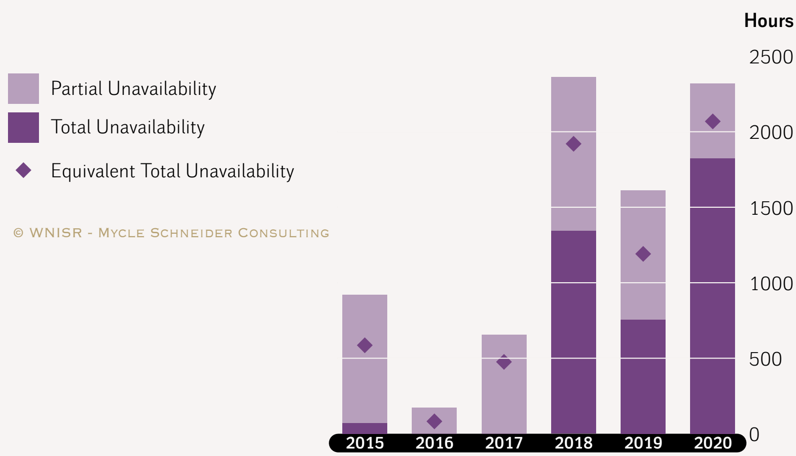
A further challenge to nuclear power reliability is its centralised nature. Nuclear stations centrally produce high volumes of power, which is then dispatched via extensive national grid systems to scores of consumers. When things go wrong, therefore, the impact is significant. When the South Texas Project-1 nuclear reactor went off-line during the February 2021 storm, for example, 270 000 homes lost their power, just as they needed it most.[18]

The alternative to this centralised energy system is a distributed one, based on smaller-scale local power generation and localised power grids. These types of systems, where power is primarily provided by multiple renewable sources located closer to energy users (reducing transmission losses), offer greater flexibility. If a problem occurs in one plant, its capacity can be replaced by another. Decentralised energy systems also have the ability to service rural areas, which often cannot be connected to centralised national grid systems.

A last point about the reliability of nuclear power is that research suggests that the uranium supplies, on which it depends, are dwindling. Some researchers argue that supplies have already peaked and the metal is increasingly scarce.[19] Others predict that the peak will be reached by 2050. What is certain is that supplies are diminishing, and those left are less accessible and of lower quality.[20] Resulting uranium price increases could lead to 'involuntary and perhaps chaotic nuclear phase-outs.'[21]

Figure 2: Climate Related Disruptions of French Nuclear Power Plants, 2015-2020

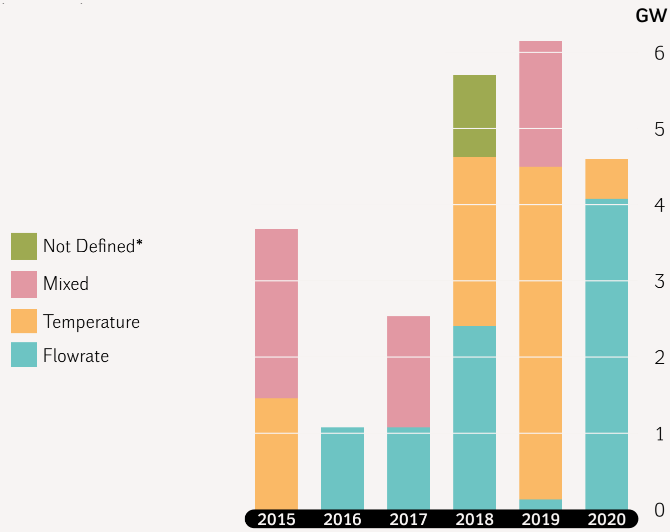
Type and duration of unavailability



Source: REMIT, compiled by Callendar, 2021, as featured in World Nuclear Industry Report, 2021. © WNISR – Mycle Schneider Consulting

Figure 3: Climate Related Disruptions of French Nuclear Power Plants, 2015-2020

in GW per Year per Cause



Source: REMIT, compiled by Callendar, 2021, as featured in World Nuclear Industry Report, 2021. © WNISR – Mycle Schneider Consulting

MYTH 2: Nuclear power is necessary for baseload [*no, it's not*]

It is frequently argued that nuclear power is necessary because it provides essential 'baseload power'[22] – the ability of a power plant to continually provide the minimum amount of power demanded.[23] In any large grid system, there will always be demand for a minimum level of electricity to power ongoing industrial processes like smelting, or domestic appliances like fridges. Historically, baseload power for this 'round-the-clock demand' has been provided by large, centralised coal and nuclear power plants which are 'always on'. Conventionally, when baseload demand is breached during normal and predictable fluctuations throughout the day, it can be supplemented by 'intermediate' and 'peaking power' plants, typically fuelled by gas or oil.

It is argued that renewable energy sources cannot meet baseload power demand because the power they generate is intermittent – i.e. determined by the availability of wind and sun, and thus not as predictable as that generated by nuclear power plants. There is, however, a fundamental problem with this argument relating to the very concept of baseload power, and for 'round-the-clock' supply from a single source.[24] Simply put, as grid technology advances, increasing capabilities for the analysis of supply and demand in real time mean that grid operators can match demand accurately and rapidly, with power generated by a variety of complementary sources. Baseload power, therefore, as well as the belief that it must be provided by large scale, centralised installations, are rapidly becoming irrelevant and anachronistic to 21st century 'smart grid' energy systems.

Evidence from South Africa shows that the rapid expansion of renewables is the 'least cost' energy option for South Africa between now and 2050 **despite** grid upgrading costs. This finding is supported by research from elsewhere that shows that while there are grid costs associated with significantly expanding renewables, they are more than compensated for by the reduced generation costs that come from renewables.

Additionally, even in contexts where baseload power will remain a necessity in the short to medium-term, ample evidence exists that a mix of renewable energy can provide the minimum supply and reliability necessary for a grid operator to maintain constant supply. For example, research from Australia indicates that a mix of geographically dispersed wind, solar PV and concentrated solar thermal with storage could provide between 85% – 100% of the country's energy needs, with hydro and gas as backup for the remaining 15%.[25] As battery storage prices have dramatically declined since this research was undertaken, batteries are fast becoming more competitive than gas.[26]

Proponents of baseload nuclear power argue that grid upgrading costs associated with these developments make renewable energy too expensive.[27] This claim, however, does not stand up to scrutiny. For example, evidence from South Africa shows that the rapid expansion of renewables is the 'least cost' energy option for South Africa between now and 2050 despite grid upgrading costs.[28] This finding is supported by research from elsewhere that shows that while there are grid costs associated with significantly expanding renewables, they are more than compensated for by the reduced generation costs that come from renewables.[29]

MYTH 3: Nuclear phase-outs inevitably lead to Greenhouse Gas emission increases [*not really*]

Between 2011 and 2017, as part of its 'Energiewende' (Energy turnaround or transition), Germany shut down 11 GW of nuclear power. Because the power 'lost' through this process was replaced with coal generated power, greenhouse gas (GHG) emissions from the energy sector increased over this period by an average of 36 Mt per year[30]. Supporters of nuclear power cite this as evidence demonstrating that nuclear phase-outs inevitably lead to emissions increases. However, such a simple causal relationship is far from true. A host of other issues within and outside of the energy sector need to be considered to properly account for the emissions increase. While it is beyond the scope of this paper to explore these in detail, a brief analysis follows.

> Earlier political decisions to properly manage the transition away from coal and create enabling conditions for the expansion of renewables (such as earlier grid upgrading, higher carbon prices, etc.), would have removed the need and/or incentive to replace nuclear with coal. To suggest that the link between nuclear phase-outs and emissions increases is causal therefore, is entirely spurious.

Between 2009 to 2017, the question of nuclear power in Germany's 'Energiewende' was characterised by a great deal of uncertainty. Initially agreed to in 2002, the phase-out was to see the last nuclear power station close in 2022. However, in 2009, a new coalition government pushed back the deadline, extending the life of Germany's remaining 17 nuclear power stations by between 8 and 14 years. In 2011, however, following the Fukushima nuclear disaster, the original phase-out date of 2022 was reinstated.[31] It is within this political milieu that Germany's commitment to the large scale roll-out of renewable energy also slowed, as forces both within and outside of government looked to appease and even bolster the politically powerful coal lobby, while managing the political and economic fallout of transition job losses in the coal sector.[32] The turn to coal as replacement to the nuclear power phase-out must also be seen within broader policy frameworks, such as the low carbon tax prices used within the European Emissions Trading System, making coal power economically attractive.[33] In fact, it was so attractive, that Germany increased its energy exports from coal burning power stations throughout the period, thus contributing to the increase in emissions.[34] The rollout of renewables, however, slowed down from the mid-2010s onwards, as the German grid operator struggled to upgrade the grid as swiftly as demanded by the rapid expansion of renewables.[35]

Earlier political decisions to properly manage the transition away from coal and create enabling conditions for the expansion of renewables (such as earlier grid upgrading, higher carbon prices, etc.), would have removed the need and/or incentive to replace nuclear with coal. To suggest that the link between nuclear phase-outs and emissions increases is causal therefore, is entirely spurious.

Ultimately, what is important to note is the complexity and political nature of energy transitions. History shows that transitioning from one source of power to another is not a simple technocratic process. Rather, it is one which pits entrenched political and economic interests against new political and economic forces intent on upsetting the status-quo. It is also a process – rather than an event – in which competing technologies reshape the employment landscape.[36] This complexity means that decisions around energy are as political as they are technical, can inhibit or accelerate transitions, and most importantly, determine their nature, and how just their outcomes are.

MYTH 4: Nuclear power is carbon neutral [*no, it's not*]

The claim that nuclear power is 'carbon neutral' is not supported by evidence. While it is true that during day-to-day operations, nuclear power plants emit very limited amounts of GHGs, it is necessary to consider the entire life of a station to properly assess its carbon footprint. A 'life cycle assessment' quantifies the amount of carbon dioxide produced by an energy plant during all the stages of the life cycle – from construction to decommissioning and waste disposal.

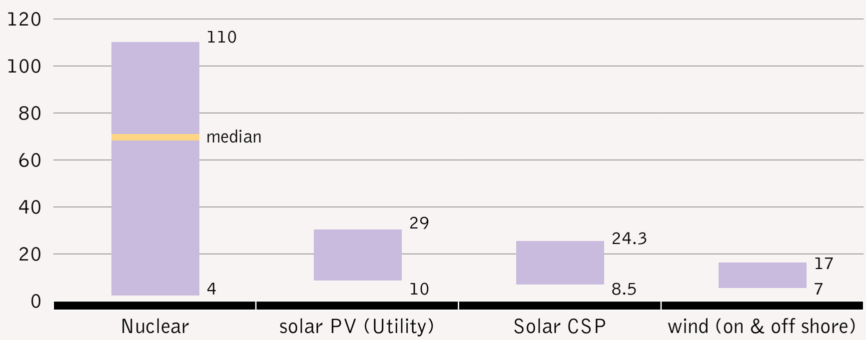
Meta-analyses of the life cycles of 103 nuclear power stations conclude that they emit a mean value of 66g CO2e/kWh, or 66 grams of greenhouse gas-equivalent emissions for every kilowatt hour of energy that they produce.[37] Nuclear power stations generate most of these emissions during upstream (uranium fuel production) and downstream (decommissioning and nuclear waste storage) phases. During the former, uranium must be mined, milled, converted, enriched, fabricated into fuel for nuclear reactors and then transported – all processes which demand fossil fuels. For example, one ton of mined rock contains an average only 1-5g of uranium, while South Africa's enriched uranium for its nuclear power station comes from Russia.[38] Downstream, the enormous task of decommissioning highly contaminated nuclear power stations is something which takes decades, and around which little certainty exists. Nuclear waste storage is another problem. Over their lifetimes nuclear reactors produce thousands of tons of dangerous nuclear waste, all of which needs to be transported, often over long distances, to waste sites. In addition, high-level waste such as plutonium needs to go through expensive and carbon-intensive vitrification processes before it can be stored.

Because the uncertainty surrounding decommissioning and long-term nuclear waste storage make it impossible to properly quantify the life cycle emissions of nuclear power stations, it is very likely that greenhouse gas-equivalent emissions from nuclear power stations are underestimated.

However, because the uncertainty surrounding decommissioning and long-term nuclear waste storage make it impossible to properly quantify the life cycle emissions of nuclear power stations, it is very likely that greenhouse gas-equivalent emissions from nuclear power stations are underestimated.[39] Even by these current (under) estimates, however, nuclear power emissions are far from zero, and much higher on average than for renewables.

Figure 4: Lifecycle emissions of different technologies: CO2 emissions (grams) per kWh.

Bars indicate range



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MYTH 5: Nuclear power generates 'many high paying union jobs' [*not as many as renewables*]

In the Jacobin[42] article, Stafford provides no evidence for the contention that nuclear power provides 'many high-paying union jobs', compared to 'scarcely staffed solar and wind farms'. When available evidence is considered, this claim appears to be spurious. While estimating the impact on employment by specific energy sources is not an exact science, in recent years a great deal of research has gone into assessing the impacts on employment of transitioning away from traditional sources of energy like coal and nuclear towards renewables.

Job creation is generally assessed in three ways: direct jobs are those created by the core industry itself; indirect jobs are those created by supporting or supply chain industries; while induced jobs are those created by increases in demand for goods and services created by an industry. In addition, some researchers refer to the number of job-years created; thus, one job year would be one job for one year.

While the figures differ slightly across different research, a range of research provides unequivocal evidence that renewables create more jobs than nuclear power, on any measure.

While the figures differ slightly across different research, a range of research provides unequivocal evidence that renewables create more jobs than nuclear power, on any measure. Recent research from the United Kingdom shows that for every 1 gigawatt hour, renewables generate 4.7 short-term and 3.5 long-term jobs, while nuclear equivalents are 0.8 and 0.5, leading the researchers to conclude that 'the employment effect of nuclear electricity is not only much smaller in absolute terms than that of renewables but also less sustainable'.[43] Despite having an active nuclear power construction and export industry, research from South Korea came to a similar conclusion, finding that renewables have a greater positive economic effect, creating more jobs than nuclear power.[44] Similarly, as shown by the figures below, meta-analyses of average employment (over the lifetime of different energy sources) have also consistently yielded better results for renewables than nuclear. Despite measuring direct job creation, in Barros et. al (2017) again nuclear fared particularly badly, with researchers noting that 95% of the time, nuclear created less than 0.4 job-years/GWh.[45]

Figure 5: Evidence from the UK Direct job creation from renewable vs. nuclear energy

Source: Arvanitopoulos et.al, 2020.

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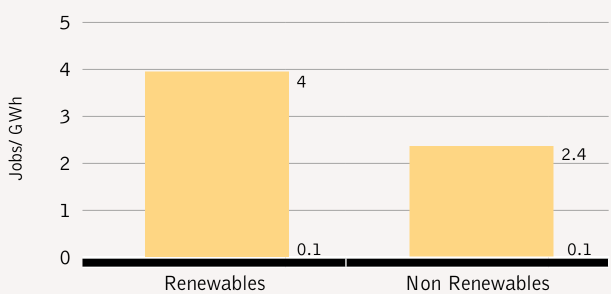
Figure 6: Meta-analysis of direct job creation per energy type



Source: Barros et al., 2017

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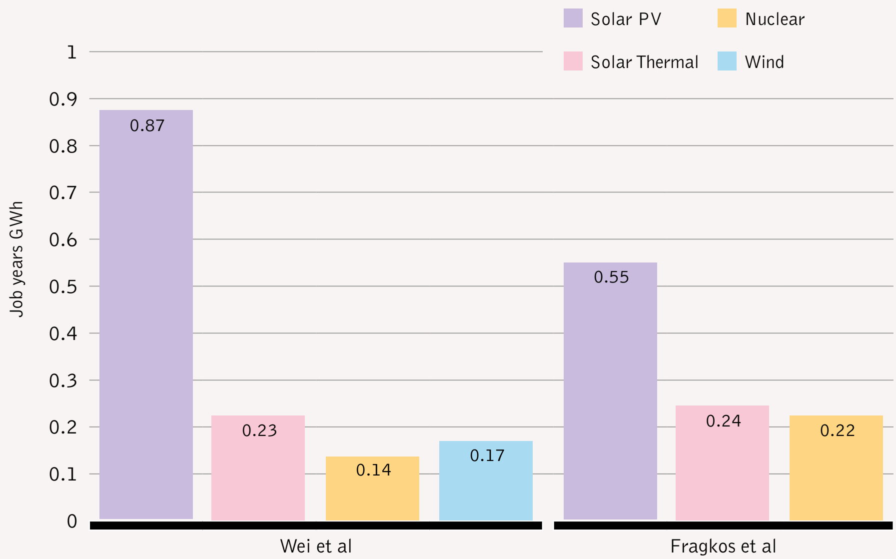
Moreover, the jobs created by renewables tend to be more generalised and semi-skilled, as opposed to the fewer highly-skilled jobs offered by nuclear. Jobs in renewable energy thus fit national qualification and work profiles more readily in most countries, and are less likely to exacerbate inequality[48]. As renewable energy sources are decentralised, so are the jobs they offer, meaning that jobs can be created in areas where they are most needed. They can thus more readily address important

Figure 7: Job years per Gigawatt hour/ different technologies: meta analysis findings:



Source: Wei et al., 2010; Fragkos et al., 2018

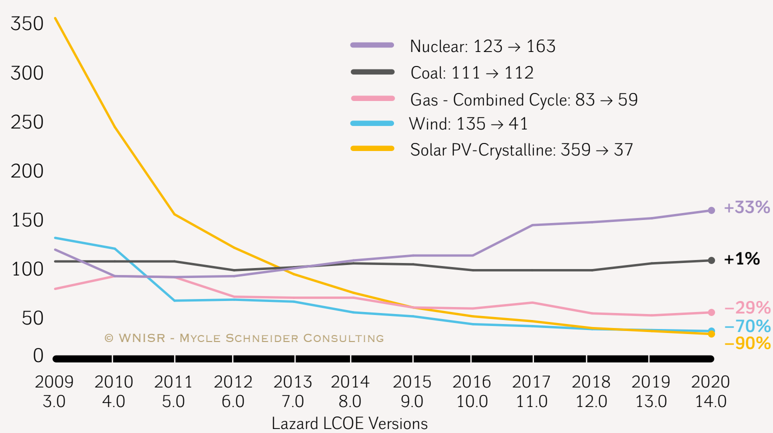
issues of equity and poverty alleviation.[49] These critical insights should be considered within the context of the global transition away from fossil fuels. If this transition is to be just, then it is critical that not only are job numbers maximised, but also that they are distributed geographically, and broadly accessible to the population, particularly those who will lose their jobs in the transition away from fossil fuels. Experts thus agree that a Just Transition to a post-carbon world requires decentralised renewable energy systems, preferably community-owned.[50] There is, therefore, no place for centralised nuclear power in a Just Transition.

MYTH 6: Nuclear power is affordable [*actually it's fantastically expensive and will most likely delay a Just Transition*]

The dramatic decline in the price of renewables over the past decade means that nuclear is now four times as expensive as solar or wind. The most accurate way to compare the costs of electricity sources is via the 'levelized costs of energy' (LCOE) – the average cost of electricity generated by a utility-scale power plant over its lifetime and is expressed by indicating how many US dollars it costs to produce one megawatt of energy for one hour ($/MWh). In the 2021 World Nuclear Industry Status Report (as based on the highly respected Lazard Estimates), the LCOE of nuclear power was $163/MWh, while solar had dropped to $37/MWh and wind to $41/MWh. It is worth noting, as indicated by Figure 8, that while renewables have become cheaper, nuclear has become more expensive due to increased spending on safety.

Figure 8: The Declining Costs of Renewables vs. Traditional Power Sources

Selected Historical Mean Costs by Technology
LCOE values in US$/MWh



* Reflects total decrease in mean LCOE since Lazard's LCOE VERSION 3.0 in 2009.

Source: Lazard Estimates, 2020, as featured in World Nuclear Industry Report, 2021. © WNISR – Mycle Schneider Consulting

While the International Energy Agency projects that the prices of renewables will continue to dramatically decline, no significant changes are anticipated to nuclear costs.[51] This is not surprising. Nuclear power stations are costly due to several interrelated factors. These begin with the enormity and complexity of their construction, the massive amount of resources these projects consume, as well as the technical skills sets they require. Nuclear build cost and time overruns are considered by researchers to be a 'near certainty'.[52] Research illustrates that the mean cost overrun for nuclear power station construction is 117%, compared to 8% for wind farms, and 1% for solar farms.[53] Other cost drivers include waste disposal, extended decommissioning requirements, and the resulting costs of debt financing. These will be discussed below.

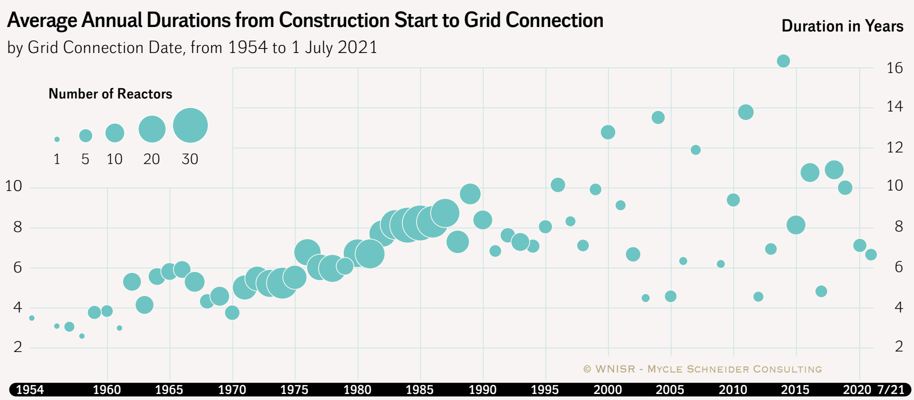
Build time and delays

As noted, a major driver of the costs of nuclear power is the time it takes to build. Since 2010, 63 new reactors have been connected to grids, with construction times ranging from 4 to 43 years. 2021 figures indicate that average construction times are close to a decade (7.2 years). This excludes the time required for complex planning and licensing processes. Of the 20 new reactors that started up in 2018-20, only two were on time, with the rest taking about twice as long as predicted.[54]

Extended timeframes aren't only a cost driver, they are also a key reason for ruling out nuclear as a response to the climate crisis. If the Paris Accord climate commitments are to be met, action to reduce GHG emissions needs to be taken urgently. Whereas nuclear takes about a decade [55] to complete, utility-scale solar and wind are completed on average in just over three years.[56] For example, in South Africa, it took on average less than two years to connect each of the 71 utility-scale renewable energy plants to the grid since the end of 2013.[57]

Figure 9: Average Annual Construction Times in the World

(from Construction Start to Grid Connection)



Source: WNISR, with IAEA-PRIS, 2021 as featured in World Nuclear Industry Report, 2021. © WNISR – Mycle Schneider Consulting

Decommissioning

An additional cost driver is the need to decommission nuclear power stations at the end of their lives. This is another hugely complex and expensive operation that must be undertaken, given that many parts of nuclear stations are highly radioactive.

Decommissioning takes decades to complete.[58] Estimated costs for decommissioning vary wildly between countries. Germany has set aside US$45 billion to decommission 17 reactors, France $27 billion for 58 reactors, while the United Kingdom is to set aside between $130 – $298 billion for 17 reactors.[59] Given the level of complexity and costs, most countries are doing little to decommission nuclear power stations, preferring to simply pass the problem onto future generations by deferring the task by as much as 80 years. By the end of 2019, out of 181 reactors that had been shut down, only 19 had been decommissioned.[60]

> To cover nuclear's extraordinary costs, many countries take on significant debts from nuclear power station vendors. These debts are generally tied to long-term electricity supply contracts, resulting in inflated electricity costs for consumers. In the UK the government's Public Accounts Committee recently estimated that British electricity consumers will pay the vendor of Hinkley Point C nuclear power station $40 billion more over its 35-year power supply contract than if electricity had been sourced from renewables like offshore wind

Moreover, nuclear power stations also generate large quantities of extremely dangerous nuclear waste that needs to be disposed of. Some of this waste, called high-level waste (HLW) remains lethally radioactive for many thousands of years. Yet, viable solutions to the safe management of this waste have still not been found. Attempts to safely store it either have failed, or their outcome still uncertain. They have also been fantastically expensive.

As a temporary solution, Germany buried hundreds of tonnes of radioactive waste in the 1960s and 1970s in salt mines. Just fifty years later this waste is being dug up at great cost because storing it this way is now deemed 'unsafe'.[61] Between 1983 and 2009, the United States spent $15 billion on the Yucca Mountain repository for its HLW, before abandoning it because of safety concerns.[62] France has already spent over $7 billion on a pilot waste disposal site at Bure. If the pilot is successful, the French government has estimated the total cost of the completed site will be in the region of $42 billion.[63] Finland is currently building a repository deep underground at Onkalo for its HLW at an estimated cost of $4 billion.[64] It is supposed to keep the waste secure for at least 100 000 years (the pyramids in Egypt are approximately 4000 years old), but nobody can possibly know if this is even feasible, let alone likely. Therefore, no one can predict with any certainty that the waste will remain isolated from the environment.

Until a safe and long-lasting solution to the problem of HLW can be found, it accumulates at nuclear power stations throughout the world, posing an additional risk to citizens in the case of serious accidents. As with decommissioning, this is an intergenerational environmental justice matter.

Debt and financing

To cover these extraordinary costs, many countries take on significant debts from nuclear power station vendors. These debts are generally tied to long-term electricity supply contracts from vendors, resulting in inflated electricity costs for consumers. For example, in the United Kingdom the government's Public Accounts Committee recently estimated that British electricity consumers will pay the vendor of Hinkley Point C nuclear power station $40 billion more over its 35-year power supply contract than if electricity had been sourced from renewables like offshore wind.[65] Similarly, controversial deals which will result in hugely inflated electricity costs for consumers have also recently been signed in Turkey and Egypt between nuclear vendors and host governments.[66] In this manner, profits gained from nuclear power stations are privatized, while the considerable risks that they pose are entirely socialised.

Corruption

The last issue that needs to be seriously considered when evaluating the costs of nuclear power is corruption. A 2013 survey of corruption in the nuclear industry found that it was 'widespread and often deep', and that the capture of state regulatory functions was commonplace.[67] The research found that both national and international nuclear regulatory regimes were 'virtually completely ineffective' in addressing these, and drew particular attention to wider problems, such as the limited and toothless regulatory powers of the International Atomic Energy Agency.[68]

In recent years, the industry has been rocked by several corruption scandals in South Korea, Brazil, Canada and the United States.[69] The construction and ongoing maintenance of nuclear power stations are particularly susceptible to corruption for two specific reasons. Firstly, because they are megaprojects, they are massively complicated enterprises that involve potentially thousands of contractors and sub-contractors, creating fertile conditions for corruption. These conditions are then exacerbated by the secrecy that surrounds nuclear power. While this secrecy supposedly limits the spread of nuclear technology or the capture of nuclear materials for a 'dirty bomb', it fosters an environment that is shielded from scrutiny and public oversight. As Prof. Donna Goldstein notes, 'corruption thrives under the cover of nuclearity and in large-scale construction projects relevant to national security.'[70]

The implications for Just Transitions

The consequences of the massive expenditure required by nuclear power is not only less money for public spending on key services like health and education, but also the crowding out of spending on renewables.

> Because nuclear energy is now four times as expensive as solar and wind, it is a deeply regressive policy choice. Not only is each Euro or Dollar unnecessarily spent on nuclear a resource diverted from public services like health or education, it also crowds out the investment required for a Just Transition – skills development, industrial programmes, and a stronger social safety net.

Nuclear proponents argue that both nuclear and renewable energies can be pursued. However, research has shown that the development of renewable energies and nuclear power are mutually exclusive as 'each creates lock-ins or path dependencies that crowds out the other.'[71] Evidence from Europe shows that in most countries which have a developed nuclear power sector, the rollout of renewable energy has been delayed. Both Norway and France, for example, have been slow to develop renewable energy sources because of ongoing commitments to their nuclear power sectors.[72] This situation is exacerbated by the decision of operators to extend the lives of their nuclear power stations beyond their original decommissioning dates. For example, France recently decided to extend the lives of 32 nuclear power stations, while 58 other nuclear power stations in Europe are being considered for lifetime extension.[73] This is despite the absence of evidence suggesting that implementing lifetime extensions at nuclear power plants is more cost-effective than building new utility-scale renewable energy plants.[74]

Moreover, the fantastic cost of nuclear power also has a profound impact on government budgets. As noted above, nuclear is now at least twice – and in some cases three times – as expensive as solar or wind. Each Euro or Dollar unnecessarily spent on nuclear power is one that cannot be spent on other important projects. In South Africa, for example, the National Treasury stated in 2015 that if the country pursued its nuclear ambitions, critical social development spending would need to be curtailed. The National Treasury indicated that plans by the government to introduce a public health system would have to be abandoned, as would post-school education innovations and social security reforms, while public sector wage increases would be threatened.[75] The impact of this budgetary crowding-out is obviously most felt by those already economically and socially marginalised. Spending on nuclear power is thus deeply regressive and anti-poor – when far cheaper alternatives are available.

The consequences of such anti-poor spending decisions are adverse for the viability of Just Transitions. Because energy transitions reshape the employment landscape, ensuring that no one is left behind requires investment in re-skilling and ensuring that stronger social safety nets are in place. They also require investment in local capacities for research and innovation, the localisation of upstream and downstream opportunities, and frameworks, including subsidies, that support small businesses and collectives to benefit from such opportunities.
Moreover, massive investments will be required to ensure that the climate emergency does not drive thousands more into poverty and hunger. The costs of rebuilding homes that have been destroyed by extreme climate events, retrofitting existing homes to new climatic conditions or recovering from climate driven economic, health or environmental shocks, simply cannot be shouldered by the majority of households on their own. Alongside support to households, it will be essential to invest in re-inventing food systems and basic infrastructure so they are resilient in the face of new and unstable climates. In these conditions, we simply cannot afford the ‘luxury’ of paying two or three times more per MW for electricity than necessary. This is especially the case when the ‘luxury’ being purchased is one that also poses significant health and safety risks.

MYTH 7: Nuclear power is safe [*not based on what we know, and even less based on what we don't know*]

A great deal of controversy and differing scientific and medical opinion characterises the debate about whether nuclear power is dangerous to human health under normal operating conditions. Although chances of accidents are considered to be very low (one meltdown per 10,000 reactor years), in the past 70 years three major meltdowns, involving five reactors, have occurred. (Three Mile Island 2, USA 1979; Chernobyl 4, Soviet Union 1986; Fukushima 1,2,3 Japan 2011)[76]. Risks are exacerbated by the many plant lifetime extensions happening worldwide, which raise grave concerns as they cannot be adequately retrofitted to the latest safety standards, and will therefore operate beyond the limits of their original designs. The International Nuclear Risk Assessment Group recently stated that 'the ageing of nuclear power plants leads to a significantly increased risk of severe accidents and radioactive releases'.[77]

> Although chances of accidents are considered to be very low (one meltdown per 10,000 reactor years), in the past 70 years three major meltdowns, involving five reactors, have occurred.

While it is beyond the scope of this brief article to interrogate the debates regarding health and safety in detail, it is worth reflecting on the health impacts, both physical and mental, of the Chernobyl and Fukushima nuclear accidents. Proponents of nuclear power claim that less than 100 people died because of the 1986 Chernobyl disaster. This figure is, however, considered by many to be a gross underestimate. The Russian Academy of Sciences puts the figure closer to 200 000.[78] The Ukrainian government still pays compensation to 35 000 spouses of those who died from Chernobyl-related illnesses, while the Union of Concerned Scientists estimates 27 000 deaths.[79]

The reality is that we will never know the true fatality total because there has never been a comprehensive, longitudinal examination of the health impacts of the disaster. This means that deaths from cancer in Ukraine, Belarus and Russia or elsewhere in Europe are simply recorded as such, and are not linked to Chernobyl. For the same reasons we will also never know how many people have, or will, die from the Fukushima accident. This speaks to the problem of simply recording or estimating death rates as this tends to hide nuclear accident-related chronic illnesses, suffering caused by illnesses, and the negative impacts on mental health. In Fukushima, for example, nearly 600 people died after they were evacuated due to what has been described as 'evacuation stress'.[80] Clearly, the stress of forcing thousands of people to abandon their homes, most permanently, is very significant. 160 000 people were forced to evacuate their homes in Japan, and 350 000 in the Ukraine.[81]

Moreover, while rare, serious nuclear accidents are staggeringly expensive to try and manage. A meta-analysis of costs associated with the Chernobyl nuclear disaster carried out by the University of Southern California in 2016 estimated that direct and indirect costs total $700 billion.[82] The Japan Centre for Economic Research recently estimated the costs of the Fukushima accident to be between $322 – 758 billion.[83]

Lastly, nuclear power stations are an ongoing threat to safety and security not only because of the possibility of a serious accident, but also because of their relationship to nuclear weapons. The historic link between nuclear weapons and nuclear power is well documented as nuclear reactors are needed to produce the key ingredients in nuclear weapons (highly enriched uranium or weapons-grade plutonium).[84] All nuclear power stations can be repurposed to produce weapons-grade plutonium. In addition, under normal operating conditions they produce different forms of highly toxic radioactive wastes that in theory could be used to produce 'dirty bombs'.[85]

Nuclear power stations are thus a security risk in two ways. Firstly, states could use them to build nuclear weapons, and secondly, they can become targets for terrorist attacks. Attacks could take the form of direct attacks on nuclear power plants themselves, or via the theft of waste products. The latter makes the entire management of waste, including processing, transportation, and storage, vulnerable to attack. The current global push by nuclear vendors to promote small modular reactors therefore poses a significant security risk as it promises the profusion of nuclear technology and its attendant safety and security risks.[86]

CONCLUSION: Neither climate nor Jobs

Nuclear is punted as the solution to the climate emergency because it is carbon neutral, reliable, produces 'on-demand' energy to power economies, and creates 'quality jobs'. The preceding analysis shows that none of these claims hold up. In fact, a continuing reliance on nuclear will be detrimental to our ability to mitigate emissions, secure energy supply in a time of changing climate, and facilitate a just transition.

First, as nuclear power's reliance on water makes it particularly vulnerable to the impacts of climate change, it will not be able to provide a reliable source of power. In the face of an unstable climate, decentralisation and diversification is the only path to energy resilience.

Second, even in the unlikely case that nuclear power stations are located in sites that will not be impacted by temperature changes, storms, sea level rise or water scarcity, the lengthy time lag between planning to operation of new plants (almost a decade) means that new nuclear will be of little help in mitigating emissions in the crucial decade leading up to 2030. In comparison, utility-scale solar and wind are completed on average in around half the time – three years from planning to operation.

Third, even as a technology that could potentially reduce GHG emissions after 2030, nuclear costs are prohibitively expensive and make for anti-poor policies. Even before accounting for the nuclear waste management expenses, a new nuclear power plant cost is around four times that of renewable utilities. Not only does such fantastic expense divert resources from public services like health and education – it also crowds out the investment required for a Just Transition – skills development, industrial programmes, and a stronger social safety net – precisely when these will be needed most. Despite its enormous expense, the economic stimulus nuclear creates is less than that created by renewables.

Fourth, all evidence shows that renewables create more jobs than nuclear. Depending on the technology and the job measurement – up to six times more. Moreover, not only do renewables create more jobs – they also create a wider variety of jobs, across more flexible locations. This means that job profiles are accessible to a wider array of people, and can be located where they are needed most.

The above two points suggest that nuclear is spectacularly unfit to power a Just Transition: while the jobs it creates are few and for largely for highly skilled elites, its economic stimuli impacts are lesser, and its costs are likely to result in austerity policies.

Fifth, even if we ignore all of the above – cost, time, jobs, economic impact, supply reliability risks – nuclear still provides inferior environmental outcomes. The median carbon footprint of nuclear power is at least two to four times more that of renewables – and that is still an underestimate. It also creates an intergenerational toxic waste crisis.

Finally, history shows us that the social and economic consequences of a serious accident occurring at a nuclear power station are devastating to both workers and society at large. Such outcomes can hardly be justified by the few jobs nuclear creates.

All this leads to the conclusion that nuclear power is not, has never been, nor will ever become, a viable means to generate electricity, especially within the context of the worsening climate emergency. It is obvious via any metric, that renewable energy is a far better option if we are to avert a climate catastrophe, and do so while safeguarding decent livelihoods and rolling back inequality.

There is an urgent need to abandon disaster capitalism along with nuclear power in favour of renewables and more sustainable and equitable development paths. Renewables must take precedence, and crowd out once and for all the toxic legacy of nuclear power.

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Neither Climate nor Jobs

Nuclear Myths about the Just Transition

Dr Neil Overy

In February 2021, in the grip of climate-induced extreme weather, energy infrastructure in Texas failed, leaving millions without power. Drawing on the 'disaster capitalism' playbook, many have attempted to use this incident to argue that our energy futures cannot depend on renewable sources, and that a transition to low emissions society would require nuclear power. This brief publication revisits the evidence to demonstrate that on any metric – reliability, emission reductions, costs, jobs and economic impact – nuclear is inferior to renewables. The evidence shows, moreover, that a continuing insistence on nuclear will be detrimental to our ability to power a Just Transition: while the few jobs it creates are primarily for the highly skilled, its enormous costs will likely result in austerity policies.

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