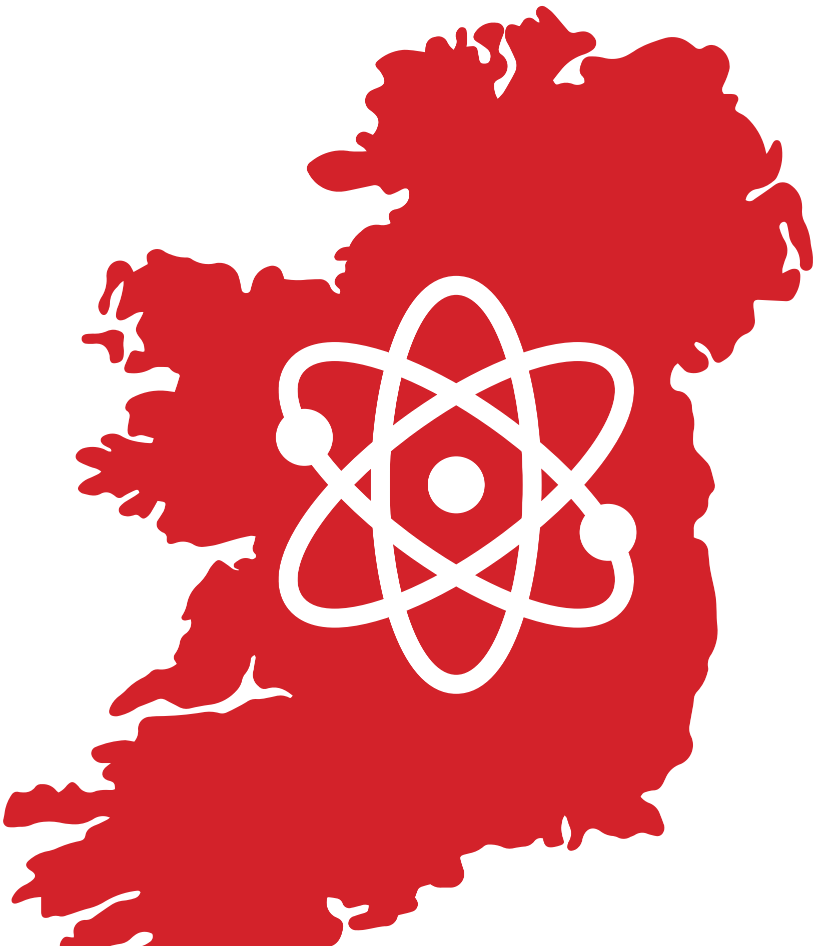
Let's Get Real



A Plan For Nuclear Power In Ireland

THE WORKERS' PARTY

Executive Summary

The failed promise of decarbonisation

Despite 30 years of government pledges on climate action on both sides of the border, including two periods with the Green Party in government in the south, there is one thing we have never seen in Ireland: a clearly stated plan for how we can achieve a zero-carbon economy through renewable energy alone.

This is not an accident. No government has been willing to confront the real technical and economic leaps which must be made in order to make such a plan a reality. Instead, a consensus has emerged here and among Western governments around a two-pronged policy. First, this policy promotes transition away from fossil fuels and nuclear power, and towards variable renewable energy (VRE) sources such as solar and wind power. Second, the policy demands a significant reduction in energy use to be delivered primarily through price hikes for consumers.

The Workers' Party believes this approach to be both scientifically and economically misguided, and likely to inflict unnecessary poverty and pain on the working class, while failing in its stated aim of decarbonising our economy.

From a purely technical point of view, we see the renewables only approach as unlikely to succeed. Plans to produce 100% VRE energy grids, such as that proposed by the Irish Green Party, have never been attempted in practice, and assume the existence of yet-to-be-invented energy storage technology. This pessimism is not mere speculation. In spite of an estimated €580 billion investment in renewable energy by 2025, the result of Germany's move away from nuclear power since 2011 has been a marked increase in the use of fossil fuels, including the reopening of coal-powered electricity generation stations[1].

Meanwhile, to reduce energy use, capitalist governments inevitably rely on tools which penalise workers for essential energy usage, without providing alternatives.

Nuclear energy is the alternative

Put simply, absent the use of nuclear energy, we believe it will prove impossible to completely decarbonise the Irish energy grid within the foreseeable future, whilst attempts to do so penalise ordinary workers to little benefit.

The Workers' Party proposes that an ambitious programme of nuclear development, begun now, can completely decarbonise our electricity grid within 30 years, while significantly increasing energy supply and guaranteeing reliable and affordable energy for both workers and industry.

Though nuclear power is still distrusted by many Irish people, fears related to nuclear safety have proven to be unfounded, and in many cases are based on deliberate misinformation promoted by the fossil fuel industry. In fact, evidence shows that nuclear energy is responsible for fewer deaths even than wind power, and is the safest large-scale energy technology[2]. As it is significantly more predictable and reliable than any other low-carbon technology available, nuclear energy can be scaled up to meet increasing electricity demand, meaning that we can grow our energy supply while simultaneously eliminating carbon emissions and allowing for

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[1] https://www.dw.com/en/germany-reactivates-coal-fired-power-plant-to-save-gas/a-62893497
https://www.cleanenergywire.org/news/2022-emissions-reduction-too-little-put-germany-track-2030-target

[2] https://ourworldindata.org/safest-sources-of-energy

development of our industrial economy. Furthermore, nuclear energy has the smallest ecological footprint of any energy source, helping to mitigate environmental harm and tackle the growing biodiversity crisis.

In this policy document we will summarise the case for nuclear energy in Ireland, outlining the technical, economic and ecological benefits, assessing the economic and environmental risks, and estimating the costs and infrastructural requirements of an ambitious but achievable programme.

How could nuclear energy work in Ireland?

The Workers' Party believes that, over 30 years, Ireland can develop a fleet of nuclear power stations at a scale broadly comparable to programmes in similar-sized European countries, including Finland and Slovakia. By 2055 Ireland can potentially construct up to six nuclear reactors across two or three sites, sufficient to completely replace current fossil fuel capacity and potentially doubling our reliable energy supply compared with 2022 levels, with an added capacity of 6-10 Gigawatts (GW). The first reactor could be online as early as 2030.

For reasons of practicality and economy of scale, such a programme would use established, commercially available, advanced Pressurised Water Reactors (PWR) with a proven safety record, with preference given to designs which are already in operation or under construction in multiple countries. Numerous such reactors are currently under construction in 15 countries worldwide. Sites for reactors would be chosen to reuse, wherever possible, the infrastructure of existing large power generation plants such as the coal-burning plant at Moneypoint, Co. Clare. Further preference would be given to sites close to large population centres to allow for construction of Combined Heat and Power district heating systems[3].

In order to make greatest use of current expertise and to ensure an efficient process, it is proposed that Ireland's nuclear power plants would be owned in cross-border partnership between the ESB Group (as majority owner) and Eirgrid-SONI in its role as the all-island network operator, along with an overseas manufacturer which would initially construct the reactors and train local operators. Preference would be given to state-owned energy companies with international experience in constructing nuclear reactors, such as EDF (France) and KEPCO (S. Korea). In this regard, our programme will take advantage of lessons learned by comparable countries such as Finland, Slovakia and the UAE which have successfully developed nuclear power programmes in recent years through similar partnerships.

How much would nuclear energy cost?

We estimate that an ambitious programme of this type could be completed for a total capital cost in the range of €40-60 billion in 2022 values over 30 years. This estimate includes necessary upgrades to Ireland's grid infrastructure and interconnection capacity[4]. Costs for construction of initial reactors would be part-funded through general taxation and partly through a special purpose bond issue, designed to take advantage of future, promised EU green finance schemes. As of 2022 nuclear investment is part of EU green taxonomy until at least 2030. This provides the opportunity to raise capital at favourable rates, with significant long-term benefits in terms of Levelised Cost Of Energy[5] (LCOE). Costs of subsequent reactors would be part-funded through operating revenue from energy sales and export.

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[3] A district heating system provides heat for homes using the waste heat produced as a result of, for example, energy production or waste incineration. Potential for district heating is already in place in Ringsend as part of the waste incinerator project.

[4] This estimate is based on construction costs of recently completed reactors in comparator countries, using EPR (Finland), VVER (Slovakia) and APR1400 (UAE) designs, as well as the ongoing Celtic Interconnector project.

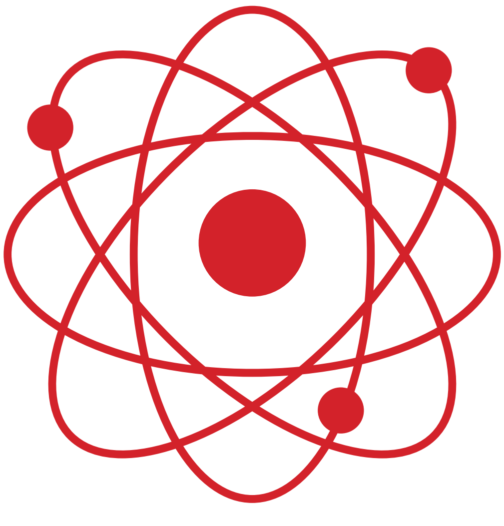
[5] LCOE is a mechanism which is used in order to compare the cost efficiency of various energy types, factoring in varying lifetimes, upfront cost, long-term upkeep and depreciation

There is the potential for €0.5-1 billion in additional export revenue annually from the moment a first nuclear reactor is online. The design life of reactors is a minimum of 60 years. Over this timescale LCOE is favourable compared to offshore wind, provided initial capital is raised at reasonable interest rates[6]. This means that the project will pay for itself over the longer term.

Ireland's energy future

While Ireland has made significant progress in renewable energy in the last decade, the fact remains that over 80% of our total energy use is still derived from fossil fuels[7]. If we are to significantly reduce this fossil fuel dependence in the next 30 years, an ambitious and transformative programme is required to not only decarbonise our current electricity grid, but to provide dependable power to allow electrification of transport, home heating and industry.

Under the proposed programme, the construction of nuclear energy facilities would be accompanied by an immediate total phase-out of remaining coal, oil and peat generation upon commissioning of Ireland's first two reactors, which would immediately result in a significant drop in carbon emissions. During the development of the nuclear fleet, the country would initially retain up to 5GW of reserve gas turbine generation capacity for redundancy and to meet short-lasting peaks in energy demand. Onshore wind and solar farms, which have a very large ecological impact while delivering relatively little energy, would be gradually phased out, with land to be designated for reforestation or bog restoration. Offshore wind power and rooftop solar generation would continue to be developed in tandem with nuclear power. Under this programme we believe that by 2050 Ireland could be deriving 95% of our electricity from low-carbon sources, with sufficient capacity to have eliminated fossil fuels from our transport and heating systems.



[6] The International Energy Agency estimates that in the long term nuclear power is the cheapest available energy option if interest rates are less than 7%. Even with current rising interest rates, bond rates are well below this level and could not be anticipated to rise above it.: https://www.iea.org/reports/projected-costs-of-generating-electricity-2020

[7] SEAI Energy in Ireland report 2022 https://www.seai.ie/publications/Energy-in-Ireland-2022.pdf

Introduction

The failed promise of decarbonisation

At its 2019 Ard Fheis, a motion for the Workers' Party to become the first party in Ireland to support nuclear energy was deferred without conclusion following heated debate. Two years later, the motion was proposed again, and passed by a large majority. So what changed?

During the intervening period, through a series of debates and discussion papers, members assessed the country's energy demand, both present and future, the available technologies, and the resources and land use required by the various energy generation options. Party members looked at the implications for security and reliability of supply, the cost of each option, and the impact of climate and energy policies on the lives of ordinary workers.

In the end, the Party came to a near unanimous conclusion: if we are serious about moving to a zero-carbon economy, and we are also committed to improving the lives and conditions of working people, then adopting nuclear energy is our only viable option. Wind and solar power can take us some way towards decarbonisation. But these technologies alone will not be enough to replace fossil fuels. Those who claim that this is possible are not being honest about the technical barriers and the social implications in terms of chronic shortages, unreliability of supply, and spiralling domestic energy and transport costs, which will inevitably be borne disproportionately by the working class.

For a party of committed environmentalists, many with links to historically anti-nuclear groups such as CND, this was a difficult and much-debated shift. Some members were themselves present - often in leading positions - at the protests which ultimately prevented the construction of a nuclear energy plant at Carnsore Point.

If Ireland is to succeed in decarbonising its economy, a comparable debate and transformation will be essential across all of Irish society, most particularly amongst those committed to environmentalism. There is already much scepticism regarding the potential for large-scale wind and solar power, and growing awareness of the environmental cost of both of these energy types.

There is, additionally, acute awareness of the precarity of Ireland's energy system, the potential for electricity shortages in the near future, and the rising cost of energy for working households. Current state policy relies heavily on the use of "demand management" techniques and punitive pricing mechanisms to reduce demand and thus avert shortages, by raising the cost of energy. As always, such austerity policies primarily affect those on lower incomes, with significant negative effects on living standards.

There is, therefore, growing recognition of the failure to date of the Irish state to set forward a workable plan for decarbonisation. Additionally, there is considerable awareness that the only real plans being put forward by the FF-FG-Green government rely on extracting money from working class households in a futile attempt to prevent the collapse of our electricity system.

In light of this, this paper puts forward the case for nuclear power as a clean, safe and affordable way of decarbonising our energy system. The Workers' Party believes that nuclear power represents Ireland's best chance at a clean, prosperous and socialist future. We propose that by initiating an ambitious programme of nuclear development now, we can completely decarbonise our electricity grid within 30 years, while significantly increasing energy supply and guaranteeing reliable and affordable energy for both workers and industry.

1. Renewable energy: 30 years of catastrophic failure

1.1 Renewables alone aren't enough

Wind and solar energy have made enormous strides over the last 20 years, but their inherent unreliability means they cannot form the basis of a stable energy system, while their material and environmental costs are routinely underestimated.

Ireland is considered a world leader in the use of wind power for electricity generation. The most recent figures from the Sustainable Energy Authority of Ireland (SEAI) show that in 2021, 36% of electricity supply in the south came from renewable sources, primarily wind, and this is expected to increase significantly over the next 10 to 20 years. However, while these figures sound impressive, they refer only to electricity supply, which accounts for around 20% of total energy use. But over 70% of Irish energy supply goes towards transport and heating, and comes overwhelmingly from fossil fuels. In fact, world leading though Ireland may be, we currently derive only 7% of our total energy demand from wind, and 12% in total from all renewable sources, including hydroelectricity, solar power and the burning of biomass.

In 2021 the Irish government committed to a carbon budget requiring an average 5% reduction in carbon emissions each year from 2021-2025, and an average 8% reduction each year from 2026-2030. In reality, energy-related carbon emissions increased by 5% during 2021, and are projected to have increased by a further 6% in 2022[8]. In the electricity sector, an average annual decrease of 12% in emissions from 2021-2025 is required to meet the carbon budget, while in reality electricity-related emissions increased by 5% in 2021. What's more, while an absolute increase in emissions may be attributable to a rebound in demand following Covid-19, the carbon intensity of Irish electricity (carbon emitted per unit of electricity produced) increased by 12.5% in 2021. In its report, the SEAI attributed this increase to "a low wind year", highlighting the reality that, contrary to claims by wind energy proponents, periods of low wind production are a major problem, and do not balance out in the medium term.

Over the last 20 years Ireland has seen a significant decarbonisation of its energy grid, with carbon intensity in the South falling from over 800 gCO2/kWh in 2001 to a record low of 309 gCO2/kWh during Covid-hit 2020. The largest contributor to this drop is the displacement of coal and peat by cleaner natural gas in fossil-fuel burning plants, but significant investment in wind energy has also played a large role. However, despite continued year-on-year increases in wind capacity, this progress has stalled, and carbon intensity in 2021 is in fact significantly increased compared to the last pre-Covid year (2019).

This stalling of progress in wind generation is not confined to Ireland, but rather a feature of all energy grids which include a large proportion of variable renewable energy. Perhaps the most lauded renewable energy transition of all is Germany's Energiewende, a programme of mass investment in renewables to replace fossil fuels and nuclear power, which was begun at the turn of the century and was officially codified in 2013. In the last nine years Germany has spent approximately €500 billion[9] in public funds on this programme, equivalent to 15% of Germany's GDP. In Irish terms this would correspond to public investment of €55 billion over 10 years (a figure that is comparable to the upper estimate of the cost of the 30-year nuclear programme proposed in this document). Despite this unprecedented level of investment, and some initial rapid progress, Germany's

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[8] SEAI Energy in Ireland report 2022 https://www.seai.ie/publications/Energy-in-Ireland-2022.pdf

[9] https://energsustainsoc.biomedcentral.com/articles/10.1186/s13705-017-0141-0

reduction in carbon emissions has stalled and reversed in the last five years, while the recent shift away from natural gas burning towards coal has further worsened Germany's emissions problem. Since 2020 Germany has seen a large number of previously-closed, fossil fuel burning plants reopened, as a result of unreliability in wind generation. As a direct consequence of closing its nuclear plants, and its decision to rely on wind for primary supply, Germany still has the highest carbon intensity of major countries in Europe, and is the EU's largest carbon emitter by a significant margin[10]. It is instructive to note that the countries with the current highest carbon intensity in Europe, Poland and Estonia, have recently announced plans to build new nuclear reactors to decarbonise their energy grids after efforts to decarbonise through renewables failed to make significant progress.

1.2 But doesn't Denmark get all its power from wind?

It is important to consider certain physical realities when comparing Ireland's energy grid to other countries. While certain countries such as Norway and Iceland achieve close to 100% of their electricity from renewable sources, this comes almost entirely from hydroelectricity and geothermal power, neither of which is a viable option for Ireland due to our geography. Denmark is often cited as a better example of a nation which derives most of its electricity from wind energy. However a closer look reveals that this comparison is also not very useful for Ireland. While Denmark's headline figures for renewable energy generation suggest that up to 80% of its electricity comes from renewables, this in fact refers to electricity generation, rather than consumption. In fact, 50% of electricity consumed in Denmark is imported from neighbouring countries to account for the shortfall of wind production on low-wind days[11]. This is balanced by a significant amount of export during windier periods, meaning that net imports can be reported as only 10% of total consumption. Denmark also retains significant fossil fuel capacity to provide firm supply during periods of Europe-wide shortage.

What makes this possible is the fact that Denmark's grid is directly integrated into the Nordic grid - which depends primarily on nuclear and hydroelectric capacity - and has a high level of interconnection with the continental European grid. As a result Denmark can import electricity from countries with more reliable supply at a far higher scale than is feasible in Ireland, and is entirely dependent on imports to maintain stable supply.

Denmark currently has an interconnector capacity of approximately 7 GW, with works underway on additional interconnectors to increase this capacity to 8.5 GW by 2024. By contrast Ireland's total interconnector capacity to other countries consists of two 500 MW connections to Britain, with plans to add a 700 MW connection to France bringing total future capacity to 1.7 GW by 2026. Given our geographic remoteness from mainland Europe, and the critical importance of maintaining a secure energy supply, it is likely that Ireland will rely on local generation for the vast majority of energy use for the foreseeable future.

What is more, despite its status as world leader in wind energy, the leaders of Denmark's energy industry have recently admitted that the country will not fully decarbonise without nuclear energy. The chairman of the country's largest investment fund and the CEO of its largest energy company, which is also the world's largest wind farm developer, have recently stated that Denmark must consider developing nuclear energy to eliminate fossil fuels[12].

The reality is that any country which cannot reliably meet its own electricity demand with a firm, controllable supply, is critically reliant on imports to fill the gaps. Indeed, while Green Ministers may talk of Ireland as the

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[10] Emissions Database for Global Atmospheric Research https://edgar.jrc.ec.europa.eu/report_2022

[11] Danish Energy Agency https://ens.dk/sites/ens.dk/files/Statistik/energy_in_denmark_2021.pdf

[12] https://www.datacenter-forum.com/datacenter-forum/top-ceos-open-nuclear-energy-debate-in-denmark

"Saudi Arabia of wind power", Tánaiste Micheál Martin has recently acknowledged that plans to meet our energy demand through local wind and solar are unrealistic, stating that a hypothetical European "Supergrid", connecting Northern European energy grids to solar and wind farms in the Mediterranean and North Africa is "the only way to go" to secure our energy supply.

We would suggest that, rather than rely completely on an as-yet non-existent supergrid to prop up an inherently unreliable system, Ireland should focus on developing a secure, clean, local electricity supply, while also improving our interconnector capacity to allow for future energy exports

1.3 The limits of variable renewable energy

In order to decarbonise our economy, it is absolutely essential not just to phase out fossil fuels from our current electricity grid, but to greatly increase our dependable electricity supply. At present renewable sources supply just 12% of Ireland's total energy demand[13]. While electrification of carbon intensive transport and heating may significantly improve energy efficiency, it is utterly unrealistic to expect that decarbonisation can be achieved without a several-fold increase in low-carbon generation capacity. In fact, committing to a zero carbon economy in earnest will require three to five times our current non-fossil fuel capacity, just to maintain our current output.

Roughly 1-2% of Ireland's land area is now occupied by wind farms. If increased by a factor of five, this would represent the equivalent of several entire counties devoted to turbines. In theory, solar farms and roof-mounted solar panels score somewhat better in terms of land use, but this is countered by the obvious disadvantage of our weather. Even in the southeast, which has by far the best conditions for solar energy, solar panels on average produce around 10% of their rated potential output due to lack of sunshine. For the rest of the country, that proportion is even lower. Offshore wind farms represent much better value, and don't have the same disadvantages in terms of land use. As the technical challenges to large-scale offshore wind are overcome, it will likely provide the majority of renewable energy in Ireland, but like onshore wind and solar still suffers from the biggest problem of all when it comes to renewables: unreliability.

Ireland doesn't enjoy the advantages of countries like Norway, Sweden or Iceland, where geography and geology provide abundant renewable power through hydro or geothermal sources. Here, we are entirely at the mercy of the weather. But the wind doesn't always blow, and in these parts the sun rarely shines. Moreover, the demand for electricity peaks and dips throughout the day and over the course of the year. In order to reliably keep the lights on, we need a mechanism to match the peaks and troughs in supply with the massive swings in demand. In a nuclear or fossil fuel-based system this is easy: the oil- and gas-fired power stations which currently supply the majority of our power can scale up their output within minutes to meet surges in demand or fill the gaps when renewable supply drops off, and can be powered down again when demand drops or the wind picks up. Nuclear stations, while less rapid in their response than gas turbines, can also ramp supply up and down to match demand over the course of the day, or can simply be run at full capacity at all times, with any excess produced made available for export or for industrial purposes.
But what happens when our gas-powered plants are phased out? Ireland regularly experiences lulls of 2-3 days during which effectively no wind power is produced, either on- or offshore, and lulls of up to 5 days are not uncommon. This means that to shift to an entirely renewable supply, we need the capacity to either store or import enough energy to meet our entire demand for up to 5 days at a time.

Interconnectors can help to some extent. Currently, two north-south interconnectors and undersea high-tension cables connect the Republic of Ireland's grid to that of the UK, allowing the potential to export or import up to 1 GW of power at any given time. The Celtic Interconnector currently under development may soon provide a connection to the French grid, with its reliable supply of nuclear energy, and increase this total capacity to 1.7

[13] EAI Energy in Ireland report 2022 https://www.seai.ie/publications/Energy-in-Ireland-2022.pdf

"GW. But, as valuable as these connections are, they cannot possibly meet our total demand, which in the past year has reached a new all-island record level of 7GW at peak times. Moreover, the Atlantic weather systems which determine our weather are very large, often covering the entire continent, meaning that when it's windless or overcast in Ireland, it's often windless and overcast over the UK and much of Europe. Even if we had the connection capacity to meet our entire demand through electricity imports, it is highly unlikely that the supply would be available when needed. Indeed, the only countries in Europe with the capacity to consistently export electricity in times of low wind output are those, like France, which rely primarily on nuclear power.

If imports aren't going to solve the problem, then the remaining option is storage, and here the scale of the problem we face is once again overwhelming. There are three potential systems for large scale storage of clean energy, two of which are largely untested. Perhaps the least realistic option is battery storage. Rechargeable batteries are extremely expensive, difficult to maintain, have a severely limited lifespan and require large amounts of scarce and non-renewable resources to produce. Battery storage on anything near the scale required to fulfil our full energy demand has never been attempted, and to do so would place an enormous demand on the already scarce supplies of rare metals such as cobalt and lithium. Indeed lithium has already begun to replace oil as the driver of a new era of resource wars, as demonstrated by the recent US-backed attempts to overthrow the government of Bolivia, which holds the world's largest lithium deposits.

Green hydrogen storage is theoretically a more sustainable proposition than battery storage, although it too is largely untested. In this scenario excess renewable electricity is used to produce hydrogen gas through electrolysis, which must then be stored in underground salt caverns and can later be burned to release zero-carbon energy. Green hydrogen has the potential to replace natural gas in providing domestic heating, particularly in homes where installation of electric heat pumps is not possible, and may play an important role in decarbonising certain industrial applications. As a large-scale storage solution however, hydrogen remains completely unproven, and there are significant doubts over the technical feasibility of large-scale, long-term hydrogen storage. Ireland does not yet have any capacity for hydrogen storage, even in prototype, nor is it clear that suitable sites of the size required exist in this country. These problems may well be overcome in future, but the real problem with hydrogen storage is the efficiency of the process, which is less than 40%. This means that for every kWh of electrical energy supplied to the end user, at least 2.5kWh must be produced from renewable sources. Production of hydrogen for use in heating and industrial processes suffers from related inefficiencies, meaning that the transition of these applications from fossil fuels to hydrogen would require an increase rather than a reduction in energy use. None of these challenges mean that hydrogen will not be an important component in our energy system in years to come, but the combination of inherent inefficiency, and the fact that the required infrastructure does not yet exist, and in many cases has not yet been invented, makes it extremely unlikely that hydrogen will be used at scale in the next 20 years.

At present the only proven system for electrical energy storage on these scales is pump storage. When excess power is available, it is used to pump water uphill from a low-lying reservoir into a higher reservoir. When the supply dips, the water flows back down through a hydroelectric turbine to produce power. Pumped storage is used extensively in alpine countries where geography allows the creation of large mountain reservoirs. Ireland currently has only one pump storage station, at Turlough Hill in Co. Wicklow, which can supply 300 MW of power for up to 6 hours at a time. To cover our total electricity demand during a 5-day lull in wind generation we would require 500 Turlough hills. So, say goodbye to the mountains of Wicklow, Kerry, Connemara and Donegal, they have been turned into power stations in the name of environmentalism.

2. The case for nuclear power

2.1 Nuclear power and Ireland's energy security

Recent events in Europe have placed renewed emphasis on the critical importance of energy security for any country which hopes to control its own economic and foreign policy. For socialists, who envision a break with the dominant neo-liberal economic order, it has long been clear that any state attempting to implement an independent economic policy must be prepared to resist external economic pressure.
Ireland is a very small country, geographically isolated from its main trading partners, with limited natural resources and a small and historically underdeveloped industrial economy. As a result Ireland is extremely sensitive to such economic pressure. This was amply demonstrated in 2018 when British Home Secretary Priti Patel suggested that the UK should use the threat of food shortages in Ireland to gain concessions in Brexit negotiations. More recently, the effects of relying heavily on imported natural gas were felt by consumers as gas and electricity prices doubled in 2022 following the war in Ukraine. It is worth noting that at the present time, 100% of Irish gas and electricity imports come through connections to the UK.

Under Ireland's current energy policy, it is likely that in the near future Ireland will become critically dependent on energy imports from the UK to maintain supply at times of peak demand, while we already import over 70% of our natural gas from the UK. Any potential interruption of either gas or electricity imports to Ireland can be expected to have immediate effects on energy supply, which may be felt by consumers within hours or days. As a result, the stability of our energy supply depends on maintaining good relationships with both foreign governments and the private owners of the gas and electricity interconnectors.

Nuclear energy offers significant strategic advantages in this area due to its reliability, and the ability to easily stockpile fuel. Unlike fossil-fuel plants, which require a constant fuel supply, nuclear reactors are typically refuelled only once every two years, while sufficient fuel for many years' operation is routinely stored on site. As a result, countries whose grids are based on nuclear energy are protected against short-term economic pressures due to energy shortages, and can guarantee stable energy prices to their population.

With nuclear as a baseload power, and wind power to top it up, Ireland could be completely self-sufficient and even be a consistent exporter of power abroad. Even more importantly, it could do so with effectively zero carbon emissions in the process of power generation.

2.2 Nuclear is safe

Nuclear power evokes fear in the hearts and minds of many. But is this fear well-founded or is this danger little more than a myth? When we compare nuclear power to other energy sources, the safety of nuclear power becomes apparent. ExternE is a comprehensive European Union survey of externalities of power production by source and location[14]. This survey concluded that of the power systems used in Europe, the cost in human life per unit of energy was lower for nuclear than for any other power system save hydroelectric, a power source unavailable in significant quantities in Ireland due to geology. This is not an isolated study. Another by Markandya, A., & Wilkinson,[15] published in the Lancet journal, found effectively the same result, showing that nuclear energy was in fact safer than wind or solar power. In all cases, these studies find that both nuclear and renewables are orders of magnitude safer than fossil fuels, which are responsible for tens of thousands of deaths each year, primarily through air pollution.

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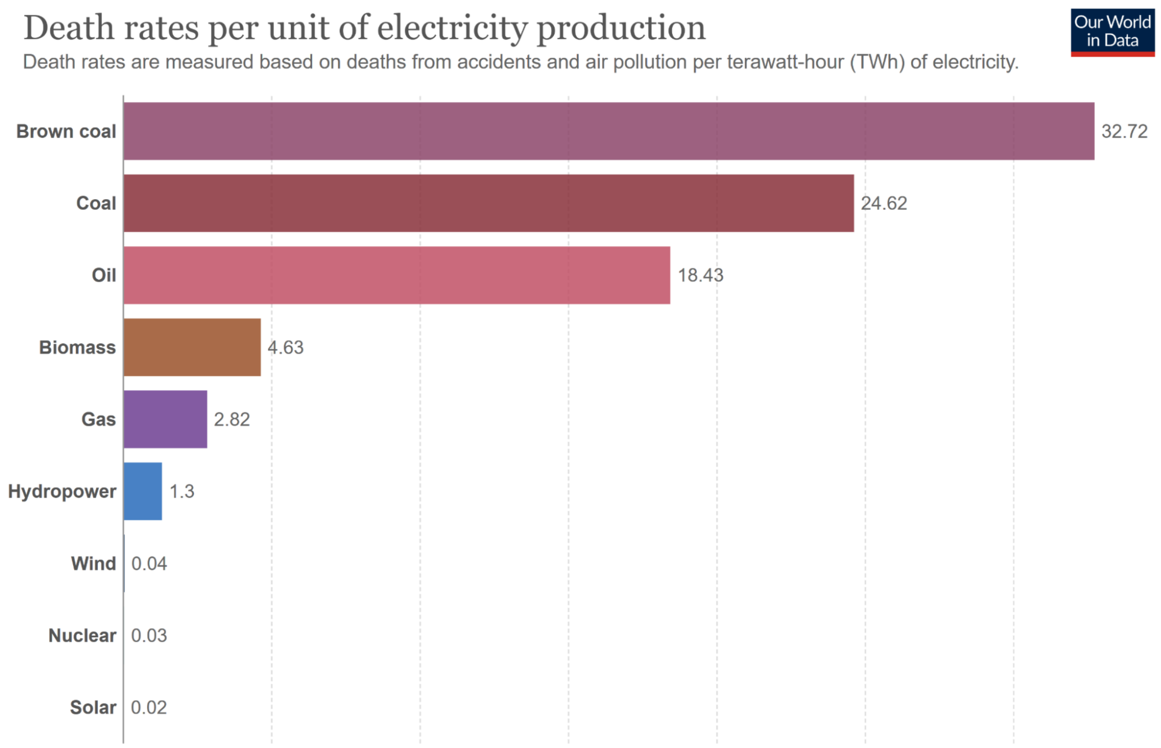
[14] Electricity Generation - Taking into Account Health and Environmental Effects. Nils Starfelt Carl-Erik Wikdahl, ExternE

[15] Markandya, A., & Wilkinson, P. (2007). Electricity generation and health. The Lancet, 370(9591), 979–990. doi:10.1016/s0140-6736(07)61253-7



While the finding that wind and solar cause more deaths than nuclear energy seems very surprising, this can be understood by reflecting on the difference in the amount of power generated. While there have not been any major disasters involving wind or solar energy, there are nonetheless risks associated with any energy source, including in the mining of raw materials and the production and installation of turbines and solar panels, which do cause some deaths. Importantly, since these technologies produce so little energy compared to the amount of infrastructure required, these few deaths still result in a higher rate of fatalities per unit of energy produced than does nuclear, which produces energy at a far higher scale, and requires far fewer raw materials and other inputs.

How could nuclear possibly be the safest option if the general public believes that it is so dangerous? Firstly, while accidents are extremely rare, those few that have occurred have been dramatic, and have received extensive media coverage, while deaths related to other energy sources are rarely reported. Nuclear accidents have been much more heavily covered in the media than other energy-related disasters and may provoke unwarranted panic.

The Fukushima incident in 2011 is a useful example to consider. While this incident was widely covered in the media, according to the WHO, there was only one death attributed to radiation[16] from the accident, while 20,000 deaths were caused by the earthquake and tsunami which damaged the plant. During the same earthquake, a natural gas plant exploded and five people were instantly incinerated. These fossil-fuel-related deaths provoked little concern from the public.

The wide-scale displacement of people in Fukushima did result in deaths from stress, panic and lower living conditions. Approximately 2,000 people are expected to have died from the evacuation, largely the elderly. In retrospect, this displacement should never have occurred.[17]

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[16] Health risk assessment from the nuclear accident after the 2011 Great East Japan earthquake and tsunami, based on a preliminary dose estimation; WHO

[17] Was the Risk from Nursing-Home Evacuation after the Fukushima Accident Higher than the Radiation Risk? PlosOne; Shuhei Nomura, Stuart Gilmour, Masaharu Tsubokura, Daisuke Yoneoka, Amina Sugimoto, Tomoyoshi Oikawa, Masahiro Kami, Kenji Shibuya

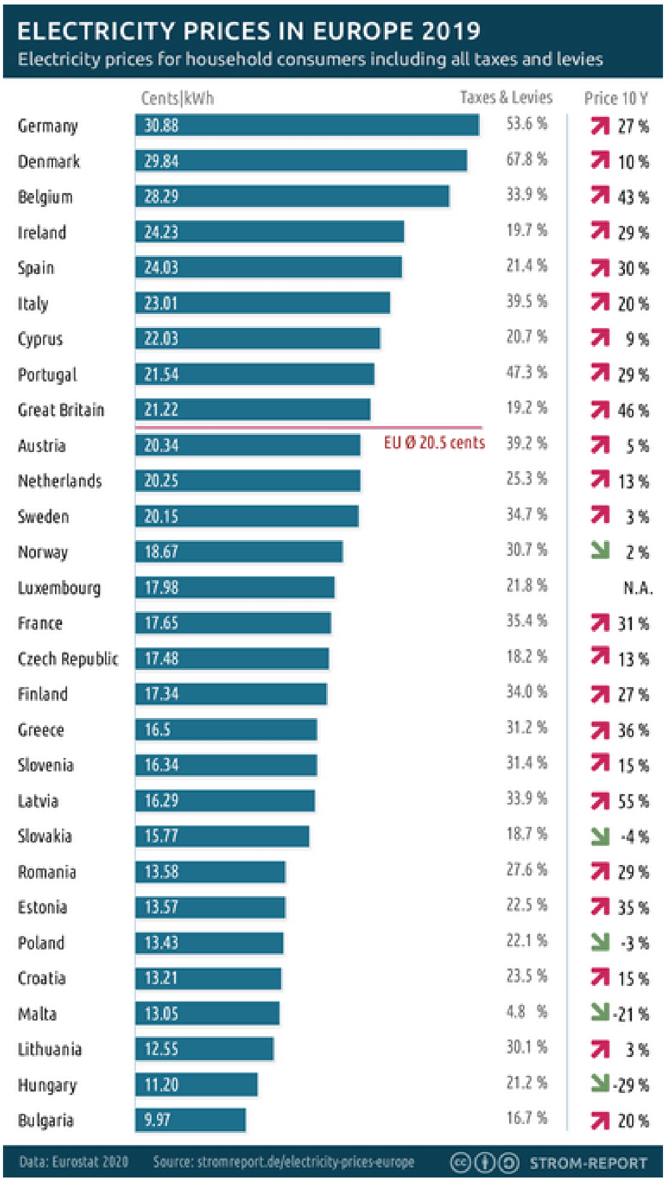
Assessment of radiological impact shows that having no evacuation would have had a much lower cost of life excepting only for the zone immediately adjacent to the reactor facility. To make matters worse, the response of shutting down other functioning nuclear power plants during the alarm surrounding Fukushima led to increases in energy prices such that the mortality from energy poverty is higher than the accident itself.[18]

The only disaster in history with an unavoidable and large death toll due to radiation has been the RBMK reactor at Chernobyl. This reactor was built using incorrectly designed control rods and no containment structure allowing wide radiological release. All remaining RBMK reactors have been retrofitted to remove these defects, and no other nuclear power plants exist without suitable containment structures. Russia no longer builds RBMK reactors, preferring to replace its fleet with the newer VVER pressurised water reactor. This type of disaster will never happen again.

2.3 Nuclear is cheap

When evaluating power solutions, price should not be the only factor considered. There are all sorts of other concerns which we must also weigh against including safety and sustainability. However, price should also be part of the story. If a solution is too expensive to feasibly deploy or so expensive that we have to radically reduce our power use, then it can not really be considered an effective solution.

When evaluated in isolation, nuclear power's low price is not always obvious. There are several reasons that this is the case. First, the up-front capital costs of nuclear power are quite large. Nuclear power plants are large high-tech construction operations. Obtaining the upfront capital for such a large undertaking often requires a state investment.



However, the operating costs of nuclear power, including upgrades and retrofitting, are low and highly predictable. The cost of fuel is generally below 5% of operating costs. This has the added benefit that the operating costs are resilient to changes in fuel supply costs. And importantly, the operational life of the plant is very long, allowing us to spread the capital costs over extremely long time frames. In fact, nuclear plants are so cheap to operate that they are competitive with coal and gas when they have been operating for over a decade.

However, many countries (rightly) require all waste management to be provided for by a nuclear power plant. This often means that the costs of waste management must be put into some sort of escrow account which guarantees proper disposal or caretaking. This is in sharp distinction to every other type of energy production - including solar and wind - in which the costs of disposal are not considered.

In addition to this, the costs of the overall grid management and storage are often not considered are often not considered when people compare power produced from wind or solar energy, and that produced from nuclear energy. Nuclear reactors produce regular, constant and reliable power. This makes for simple, reliable and cheap

[18] Be Cautious with the Precautionary Principle: Evidence from Fukushima Daiichi Nuclear Accident; Matthew J. Neidell, Shinsuke Uchida, Marcella Veronesi, NBER Working Paper No. 26395

grid technology. The fluctuations, load balancing and complexity of more diffuse power generation require much more extensive and expensive grid management. In addition, spreading of fluctuations requires energy storage which is expensive or replacement with power generation which can be ramped up quickly, such as natural gas which produces CO_2.

In the final analysis, the numbers speak most clearly. If we look at prices prior to the disruptions of the Covid crisis and the Ukraine war, the cost to the consumer for electricity in 2019 for Germany was 30.88 cents/kWh (0% domestic nuclear), while in France it was 17.65 cents/kWh (75% domestic nuclear). That is, relying primarily on nuclear power turned out to be half as expensive to consumers as attempting to rely on a mix of gas, coal, wind and solar. Similarly, we can compare the prices for Denmark at 29.84 cents/kWh (0% domestic) and Sweden at 20.15 cents/kWh (40% domestic nuclear). Clearly it is not only the CO_2 profile which is better, but the price of nuclear is better as well.

2.4 Nuclear waste: A manageable issue

Perhaps the greatest worry that remains for those who accept the relative safety of nuclear power generation is nuclear waste. However the scale of this problem is generally grossly over-exaggerated. Well over 90% of what is termed nuclear waste from power plants is "low-level" waste, consisting of lightly contaminated items such as tools or protective clothing. This waste may only need to be stored on site for days or months before it is no longer radioactive, and can be safely disposed of as with any other industrial waste.

A small proportion of the waste produced by plants is "high-level" waste, which can remain highly radioactive for tens to thousands of years. This waste, which largely consists of used fuel rods, is indeed highly dangerous, and must be stored safely to avoid potentially harmful radiation exposure.
While storage of this waste is an important matter which must be addressed in the planning stage of any nuclear programme, it is in fact an easily tractable problem with well established and highly successful protocols, meaning that these fears are largely unfounded.

In reality, in the 70 years since the first nuclear reactors were commissioned, there has never been a single fatality or severe injury caused by waste from a commercial reactor.

Three important points must be made regarding nuclear waste from power plants:

1. The quantities of waste produced by modern reactors are extremely small.
A typical household's lifetime power use would require approximately 2kg of uranium fuel using current light-water reactor technologies. This means that a typical Irish family who derived all their electricity from nuclear energy over their entire lifetimes would generate a quantity of waste which can fit easily into a pint glass. To put this another way, if Ireland were to build six 1.4GW nuclear reactors, as proposed in this policy, they would produce approximately 20 cubic metres of high-level waste per year. At this rate, if Ireland were to generate all of its electricity solely from nuclear energy, it would take several thousand years to produce enough high-level waste to fill an Amazon warehouse.

2. There is no "green goo."
Spent fuel rods are compact, practically indestructible and very easily stored. The vast majority of "high-level" radioactive waste from nuclear plants comes from spent fuel rods, which are typically removed from the reactor after several years of use, and must then be stored. Contrary to popular belief, this fuel is not a difficult-to-store liquid, nor does it take a form which can easily be moved, vaporised, or otherwise dispersed. Rather it consists of extremely dense metallic rods, each weighing several tonnes, which are stored in purpose-built facilities on the reactor site after use. Typically, a light water reactor facility will leave the spent fuel rods to cool for some period of time, after which they are moved to dry cask storage. These large reinforced concrete casks are shielded and

armoured making them extremely safe, and are designed to be resistant to impacts and explosions. In fact there has never been a single recorded case of a radiation leak from a dry waste cask.

Workers, evaluating temperature readings on the outside of dry waste casks. Workers do not need to wear any protective clothing since radiation levels are negligible.

3. Not waste, but future fuel

Spent fuel material is not actually waste. In a typical commercial light-water reactor, up to 95% of the Uranium in the fuel rods remains unused when the rods are removed. Fuel rods are replaced, not because the fuel is exhausted, but because of the build-up of fission by-products in the reactor over time. As a result, the vast majority of "waste" removed from reactors can potentially be re-processed and used again as nuclear fuel, leaving only 3% as unusable waste. Spent fuel can be recycled to provide new mixed oxide fuel for light water reactors by reprocessing. This is the approach used by France, which says it has reduced mining requirements significantly. However, an even better solution exists. Fast Breeder Reactors, of which several prototypes are currently in operation in Russia, India and Japan, can reuse up to 97% of the waste from standard reactors, leaving only small quantities of waste with significantly shorter lifespan for storage. Under this scenario the spent fuel already stored in countries such as France and the US could potentially fuel future reactors for thousands of years.

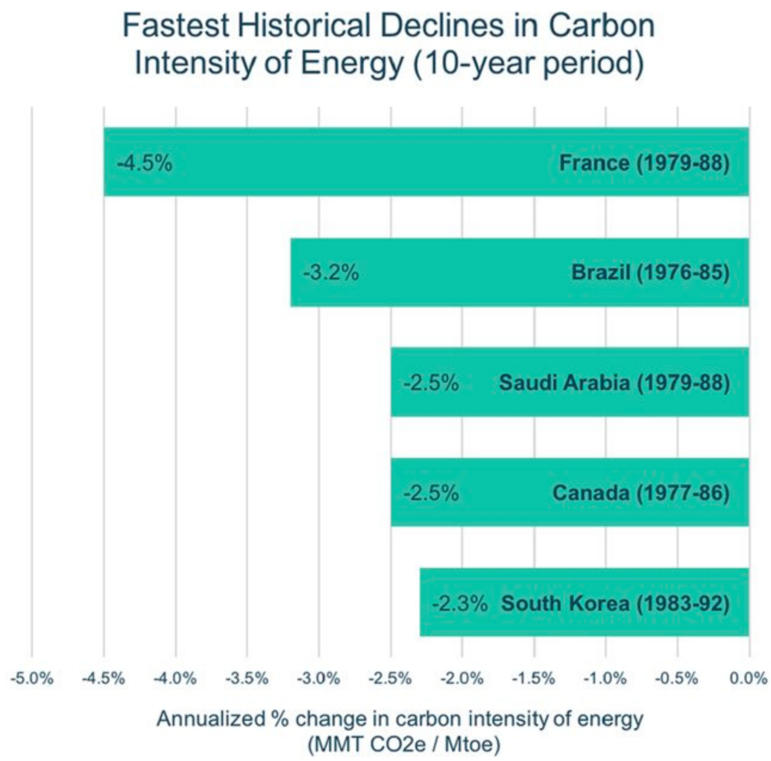
2.5 Nuclear is near-zero emission

All but the most backward have accepted that CO2 emissions must be reduced or we will suffer severe consequences. Yet deciding the means of achieving these reductions is more difficult than a mere acknowledgement of the problem.

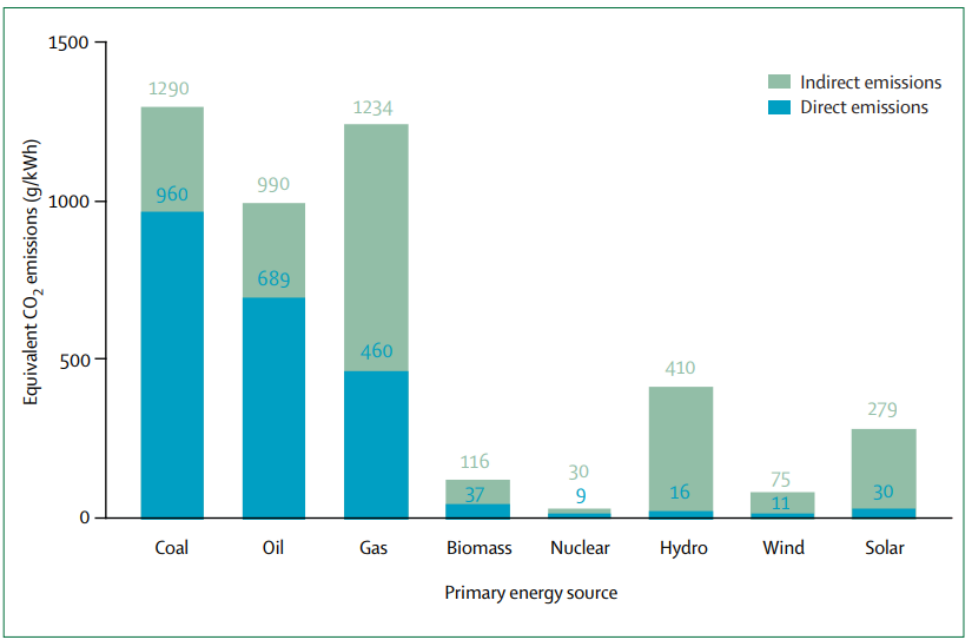
The German Energiewende provides a useful case study. Germany embarked on a very ambitious plan to reduce carbon emissions which has thus far incurred costs of over €500 billion. This involved a radical expansion in wind and solar energy capacity. At the same time, the German government decided to shut down their existing nuclear plants.

The result has been that German CO2 emissions have remained almost completely stagnant over this period despite this massive expansion in renewable energy, and in 2021 and 2022 energy-related CO2 emissions significantly increased as a result of the shut-down of Germany's last nuclear plants,and the re-opening of coal fired plants.

Nuclear power puts more power into the grid faster than any low-CO2 emissions alternative available. [19] As a result, when looking at countries which have achieved rapid reductions in carbon intensity of electricity, the leading examples all come from nuclear programmes.



Beyond this, nuclear produces almost no direct CO2 emissions, but there are emissions associated with building nuclear power plants, maintenance, mining and transport. Yet this also holds for solar, wind and hydro alternatives. As it turns out, when all is accounted for, CO2 emissions associated with nuclear power are significantly lower than the alternatives: half as much as wind, and a tenth as much as solar.



[19] Potential for Worldwide Displacement of Fossil-Fuel Electricity by Nuclear Energy in Three Decades Based on Extrapolation of Regional Deployment Data Staffan A. Qvist, Barry W. Brook; PLOSOne

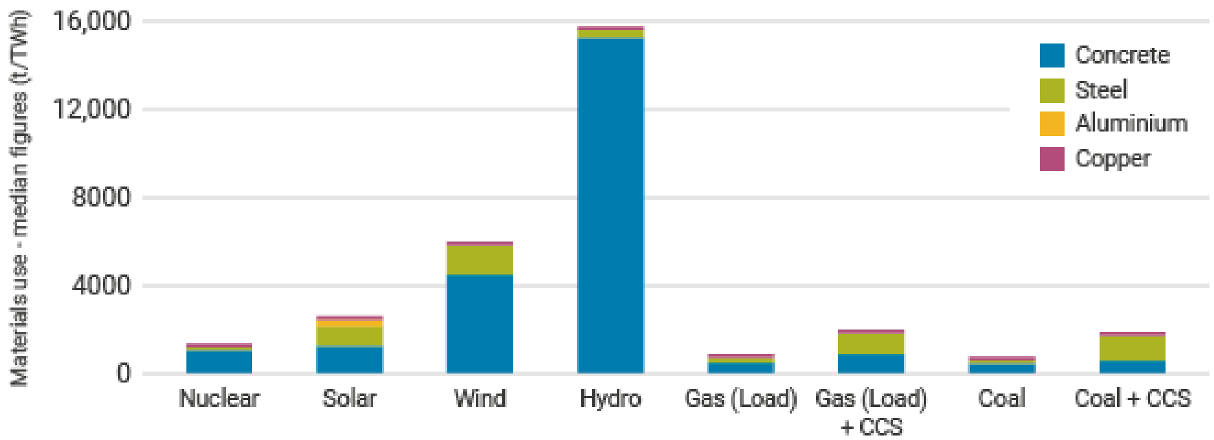
2.6 The ecological merits of nuclear power

The modern green movement is increasingly motivated more by an aesthetic distaste for industrialisation and the "crass consumerism" of the masses than by rational analysis of climate or environmental problems. This often results in a preference for developments which enjoy an eco-friendly image, over those which objectively minimise environmental harm. This tendency shows itself for example in a preference for land-intensive and inefficient organic farming practices over more efficient scientific methods, as well as a preference for expensive, inefficient "green" energy technologies over options, such as nuclear power, which entail significantly less resource use and environmental damage by every known measure.

Wind and solar energy, though far cleaner than fossil fuels, still entail major ecological impact both in their manufacture and operation.

All of these technologies require significant material and energy inputs in their manufacture, which results in a not insignificant carbon footprint. While estimates vary, manufacturers of solar PV panels often advertise that panels will be in operation for three years before they have produced enough energy to offset the carbon released in production. In Ireland, where solar performance is particularly poor due to weather, this can be expected to take significantly longer. In fact, some research has even estimated that when all energy inputs are accounted for, solar panels in Northern Europe may in fact produce less energy over their lifetime than is required to manufacture and install them. [20]

Despite concerns about over-use of critical resources, many environmentalists who express concerns about overconsumption of resources also favour the use of inefficient solar and wind-energy over nuclear, despite their significantly larger resource use. When considering the raw materials which must be mined, refined and processed to manufacture nuclear plants, solar panels or wind turbines, nuclear requires by far the lowest inputs per unit of energy produced. The result is that the environmental impacts of mining steel, copper and rare-earth elements, are greatly reduced by employing nuclear energy.



Resource use of different electricity generation types.

However the most obvious ecological impact of renewable energy is in land use. A typical 1GW nuclear plant occupies a land area of 2-3 square kilometres.[21] In Ireland, to achieve the same output a solar farm would need to occupy over 100 times as much land, while a wind farm would require well over 200 times as much, up to 900 square kilometres. The choice to devote such large tracts of land to energy generation is not without environmental harms. . A significant proportion of wind farms in Ireland are located on blanket bogs, a delicate and easily degraded ecosystem which also acts as a major carbon store, while many others are located in areas suitable for reforestation.[22]

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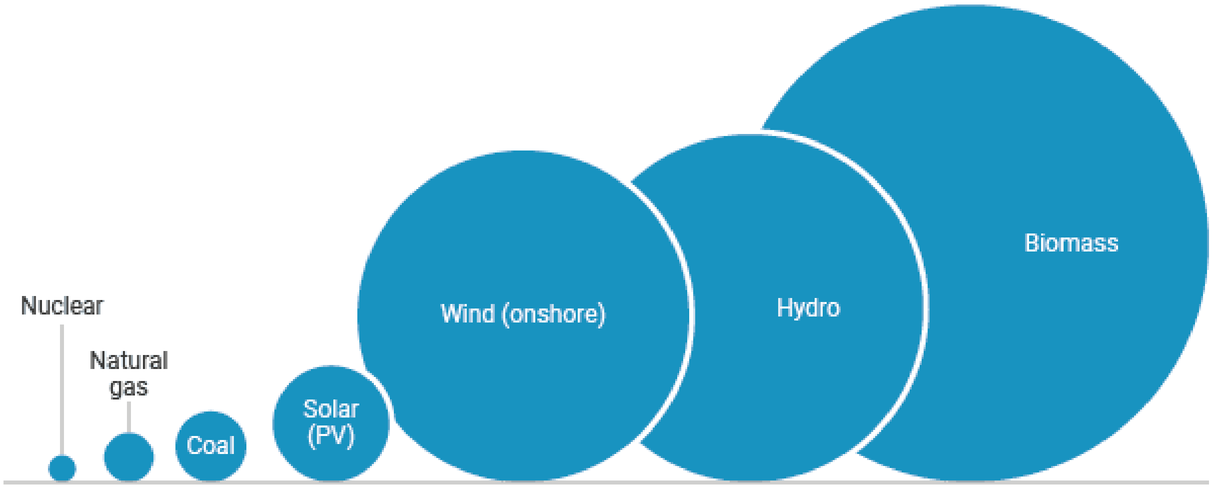
[20] https://www.sciencedirect.com/science/article/pii/S0301421517302914

[21] https://medium.com/@alkidel/the-land-footprint-of-solar-and-nuclear-and-wind-power-b4a8b2c42ba9

[22] https://www.nature.com/articles/s41598-023-30752-3/tables/2



Land use of different electricity generation modes per unit capacity.

3. Against energy austerity: Nuclear power and the workers' economy

3.1 Energy austerity: The carrot for the rich, the stick for the poor

Given the challenges of building a 100% renewable grid outlined above, and the fact that our political class is united in opposition to nuclear energy, it is no surprise that the primary focus of climate policy in Ireland is on reduction of energy use. As long as our governing parties refuse to consider technologies which could provide a reliable clean supply, it is the politics of energy austerity which will dominate Irish climate action for the next 20 years. State policy currently includes a target 20% reduction in total energy use between 2020 and 2030[23], which will be achieved primarily through price mechanisms to penalise energy use.

In Ireland we have already seen the introduction of a regressive regime of carbon taxation, aimed at increasing the cost of transport and home heating, allied with some limited grants and subsidies for home retrofitting and electric vehicles. As is often the case under neo-liberal governments, the punitive measures primarily target workers on low and middle incomes, for whom these increased costs represent a significant proportion of disposable income, while the subsidies primarily benefit wealthy property owners.

A recent report commissioned by Dublin and Cork City councils projected that only 15% of new households in these cities will be able to buy rather than rent, while the ESRI estimates that half of 25-34 year-olds in Ireland will never own a home[24]. In the absence of a mass social housing programme, the future of the next generation of Irish people lies in the unregulated private rental market, where tenants have no ability to upgrade or retrofit their homes, and landlords have no incentive to do so. As a result, despite much publicised home retro-fitting schemes, the vast majority of Irish workers will continue to live in poorly insulated, energy inefficient homes for decades to come. CSO data shows that 16% of those living in rented accommodation are in arrears on utility bills, and are more than 5 times more likely to experience fuel poverty than homeowners[25]. Under current state policy, these workers will see continuing increases in the price of heating and electricity over the next two decades.

What's more, CSO figures show that in Ireland new homes with the best energy efficiency ratings have the highest total energy use, in both gas and electricity consumption, while those living in the lowest rated homes already have the lowest energy consumption despite having the highest need[26]. These figures confirm that the low-income households targeted by carbon taxes are already extremely constrained in their energy use, and have little scope to reduce it further. Attempts to further reduce energy consumption through price increases or tax-based incentives will have only negative effects on such households, who are likely to be pushed further into fuel poverty while gaining no benefit from subsidies targeted at homeowners.

Much the same can be said regarding transport. Though electric vehicles have become cheaper in recent years, they remain unaffordable for the majority of the working class, while electric charging infrastructure is non-existent in most low-income areas. Decades of car-based development policy as well as unaffordable housing in cities and town centres has resulted in the majority of Irish workers living in areas which are remote from their place of work, and usually poorly served by public transport. Recent initiatives by some local governments

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[23] https://www.seai.ie/about/irelands-energy-targets/

[24] https://www.esri.ie/system/files/publications/RS143.pdf

[25] https://www.cso.ie/en/releasesandpublications/ep/p-silc/surveyonincomeandlivingconditionssilc2021/povertyanddeprivation/

[26] https://www.cso.ie/en/releasesandpublications/ep/p-hecber/householdelectricityconsumptionbybuildingenergyratings2021/

to discourage car use while providing no additional public transport capacity have already had predictable negative effects on workers. One such scheme recently implemented in the Liffey Valley shopping centre outside Dublin has seen workers, many on minimum wage, being charged €600 per year for parking, despite most having no practical means of getting to work without a car.

The Workers' Party believes that this policy of constricting energy supply to working people will ultimately fail to significantly reduce carbon emissions, but not without causing a great deal of unnecessary suffering. Rather than attempt to constrain energy demand to meet the supply of an inherently unreliable and inefficient VRE grid, we should instead focus on expanding our developing a stable and abundant supply of zero-carbon energy, to provide clean, cheap electricity to the Irish people, and power the industrial transformation needed to tackle the climate crisis.

3.2 Continuing industrial development

Since the 1980s, the Western countries have seen a continuous trend towards de-industrialisation of their economies, with a steady decline in the proportion of industrial and manufacturing employment, and a corresponding growth in the service economy. Following the lead of Thatcher and Reagan, the majority of European nations have allowed their industrial and manufacturing sectors to shrink in the belief that they no longer need to foster large technical, industrial or manufacturing sectors to provide jobs for the working class. Employment in these sectors has been allowed to relocate or decline, to be replaced with a reliance on financial services, legal and management consultancy and other "high-value" services, the wealth from which will supposedly trickle down to the majority of the population who provide lower value services to the high-value elite. The nominally higher productivity and greater profitability of services, and in particular financial services, has allowed these nations to maintain generally high levels of economic growth throughout this process.

The results of this misguided policy are increasingly clear to most observers, especially in the English-speaking world. After 40 years in which GDP and nominal economic productivity have massively increased, living standards, working conditions and real-term wages for the majority of workers in these countries have fallen below the levels of the 1970s, while the massive inequalities of the financialised economy have seen a small capitalist class obtain unprecedented levels of wealth. This is compounded by the weakening of trade unions, both as a result of a wave of anti-union legislation passed by most Western governments during the 1990s, and due to the atomisation of much of the workforce in casualised and often de-centralised service jobs, which have replaced the traditional industries in which the union movement had its base.

Due to the short-lived boom in high-tech industries in the 1990s and early 2000s, Ireland had a significant number of highly skilled workers in fields such as pharmaceutical manufacturing, micro-electronics and semiconductor manufacturing, food processing, medical devices and other areas which continue to provide stable well-paid employment, representing 13% of the workforce in the South and 11% in the North. The Workers' party believes that the continued development of locally owned technical industry in these fields, and the rebalancing of our economy towards employment in industry and high-value manufacturing is essential to maintaining or improving living standards for working people. Crucially, these industries are critically reliant on secure low-cost energy supplies. In its survey of manufacturing businesses in Ireland in 2022, IBEC reported that rising energy costs and insecure energy supply were the largest concerns for senior management in the manufacturing sector, and represent a significant risk in terms of potential job losses or relocation of industry.

3.3 Against 'degrowth' and for socialist economic development

The Workers' Party is a Marxist organisation. We are materialists. Our social and economic policy is grounded in the understanding that economic development is the ultimate driver of historical change, and makes possible the liberation of working people and the improvement of their living conditions.

It is important to reaffirm this belief in the context of the climate crisis, since it is one which is not shared by much of the environmentalist movement, and is increasingly disavowed by many of those who consider themselves socialists.

The decline and collapse of the Soviet Union in the late 1980s had the effect of causing much of the Western left to lose faith in the economic principles of socialism. Many centrist and social democratic groups, including the Irish and UK Labour parties, embraced market-liberal economic policies. Other socialist groups remain nominally Marxist but, lacking confidence in their ability to win economic arguments, increasingly focus on moral condemnation, critiquing the social ills of the capitalist economy, but rarely engaging in real economic analysis or policy making of their own.

As a result, the majority of the left in Ireland and other Western countries have either abandoned economic arguments entirely or have given up real economic analysis, in favour of a focus on the moral failings of consumerist society. The result is the abandonment of materialism, and the development of a mode of critique which sees economic analysis, and indeed "the economy" itself, solely as tools of the capitalist class, where economic development is to be seen in opposition with social development and liberation. In this mode of thinking, socialism reduces to mere anti-capitalism, which offers no positive vision for the working class.

This long-running tendency has recently found new life in the form of "degrowth" anti-capitalism. Degrowth, which in part developed from the "overpopulation" panic of the late 20th century, is based on the belief that the human population and human consumption have exceeded the natural limits of the planet. For climate catastrophe to be avoided there must be a significant decline in consumption of all resources, most notably energy. While few would dispute that current fossil fuel use and carbon emissions are far beyond safe limits, and must be eliminated, the degrowth movement goes further in demanding that consumption of all material resources is radically reduced in absolute terms. In the view of degrowthers, pursuit of economic growth has driven capitalist economies beyond the natural boundaries of what is sustainable for the planet. To prevent catastrophe, "growth" must end.

Many prominent intellectual leaders of the degrowth movement, such as economist Kate Raworth, anthropologist Jason Hickel and journalists such as Naomi Klein, present degrowth in terms which are highly appealing to socialists. They argue that current global production and consumption levels, if evenly distributed, would be sufficient to provide a high standard of living for everyone on earth, and present degrowth as an opportunity for radical redistribution of global wealth, and an end to colonialist exploitation of resource-rich countries. In this view, the drive towards economic growth is a purely capitalist one, unrelated to human need, and dangerously out-of-sync with what might be called the balance of nature. We believe that these arguments, though well intended, are mistaken in material terms, and underestimate the importance of continued economic development in both tackling climate change and making socialism possible.

Indeed, much of what is espoused recently as "degrowth" would be more familiar to Marxists under the now unfashionable label of economic planning, and remains central to our vision. Our objection to degrowth is not to these elements, but rather to the lack of materialist analysis underpinning its central tenets, or a viable theory of how the envisioned economic transformation is to be achieved.

The argument that current global economic output is sufficient to provide universal prosperity without growth in energy and resource use seems empirically false. If distributed evenly, and even accounting for differences in prices, current global income levels would provide each person on earth with a purchasing power equivalent to $18 USD per day at US prices[27], which is more than 50% below the US federal poverty threshold of $40[28]. Despite the extreme hoarding of wealth by the capitalist class, redistribution alone will not provide a decent quality of life and liberation from poverty for everyone on earth. It is both unrealistic and unjustifiable to expect the working class of developing nations to place this limitation on their further development.

What's more, it is through continued industrial and technological development that we will acquire the tools to tackle climate change, rather than an unrealistic goal of retreating from industrial society. Increased agricultural productivity to reduce land use and restore biodiversity; synthetic protein production to reduce the consumption of meat; the development of clean transport and heating technology; new low-carbon processes to produce steel and concrete; new packaging materials to eliminate plastic waste. All of these technological developments will be essential in reducing environmental impacts, and yet will require industrial growth. Likewise, the adaptations that must be made to cope with the climate change already being experienced, such as the mass desalination of seawater for consumption, will require increased energy supply.

If socialism and the improvement of working people's living conditions remains our goal, then we must remain committed to developing our economic and industrial capacity, and strive for technological developments which can increase productivity while reducing the environmental and ecological impact of industrial production. Nuclear energy is just such a technology.

While we have significant disagreements with left-wing proponents of degrowth, we do share their vision of a radically more equal global economy. The real danger in degrowth ideology, however, lies in its co-option by neoliberal elements who share no such vision, but rather would use the degrowth movement to oppose the development of socialism.

This tendency can be clearly seen in the Irish and many European Green parties, who oppose any economic developments which might significantly increase energy consumption among the working class, regardless of whether or not they raise carbon emissions. In 1999, when speaking in favour of a bill banning the development of nuclear energy in Ireland, future Green party leader Trevor Sargent specifically identified the danger that nuclear energy would result in electricity being produced "more cheaply and on a larger scale", which would de-incentivise reductions in energy use. Anti-populist, committed to technocratic, market-led policies, yet at the same time disdainful of the wasteful consumption which is endemic to market economies, the Greens' great fear is of the working class achieving a level of consumption equal to that enjoyed by themselves and the professional upper-middle class from which they are drawn. The co-option of "degrowth" arguments by these elements is 'green-washing' at its most pernicious, and must be resisted by those committed to real environmental transformation.

[27] https://ourworldindata.org/grapher/daily-mean-income
[28] https://www.healthcare.gov/glossary/federal-poverty-level-fpl/

4. A nuclear energy policy for Ireland

The Workers' Party proposes that Ireland should immediately begin development of a nuclear energy programme with the aim of adding enough conventional nuclear capacity to the Irish grid over the next 30 years to both replace current fossil-fuel generation, and significantly increase total dispatchable supply. This programme will partner with state-owned energy companies in countries which already have significant nuclear programmes to take advantage of existing knowledge and economies of scale, and utilise proven reactor designs already in operation in partner countries.

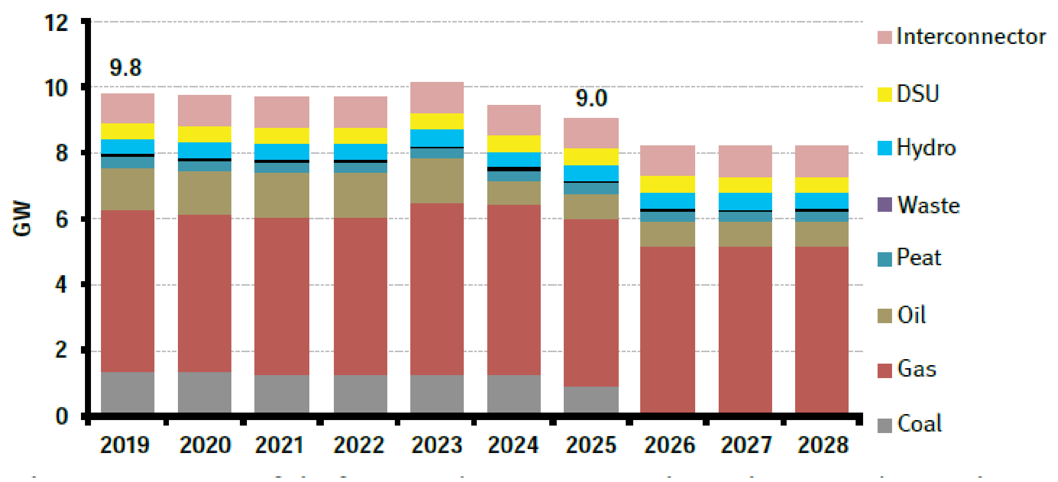
We believe this development will be essential to allow Ireland to decarbonise while maintaining a stable abundant energy supply and allowing for ongoing development of our industrial economy. An essential first step in this process will be the removal of statutory barriers to nuclear development enacted in the 1990s.

4.1 Current and future energy demand in Ireland

At present, on an all-island basis, Ireland has a total despatchable (on-demand) generating capacity of 8.5GW, coming primarily from fossil-fuel burning plants, as well as up to 1GW in potential import capacity. In recent years the average availability of this generating capacity has declined to around 80%, meaning that on average there is only 7GW of on-demand capacity available. This capacity is expected to further decline by 1GW over the coming decade as coal burning is eliminated[29].

Total installed wind generation capacity in Ireland is currently 5.6GW, however the capacity factor (CF) of Irish wind is typically less than 30%, meaning that average available wind power is only 1.8GW and frequently less than 0.5GW for extended periods.

In December 2022 all-Ireland peak energy demand exceeded 7GW for the first time. This implies that Ireland will very soon face the possibility of having a peak energy demand which cannot be met without reliance on renewable sources or imports[30]. Notably, on the day when this record demand was set, wind energy supplied less than 10% of demand, while solar output was effectively zero.



All-Ireland current and projected despatchable generation capacity. Source: Eirgrid

[29] Eirgrid All-Island generation capacity statement 2019-2028

[30] https://www.thejournal.ie/lights-out-part3-capacity-market-5944608-Dec2022/

Current government plans aim for the installation of 7GW of offshore wind capacity over the next 10-20 years, alongside 5GW of rooftop solar power. However, while capacity factors of offshore wind farms are generally higher than onshore, they still average less than 40%, while Irish solar installations have CFs well under 10%. By comparison, nuclear generation typically achieves capacity factors of 90-95%, with non-availability primarily due to planned maintenance or refuelling.

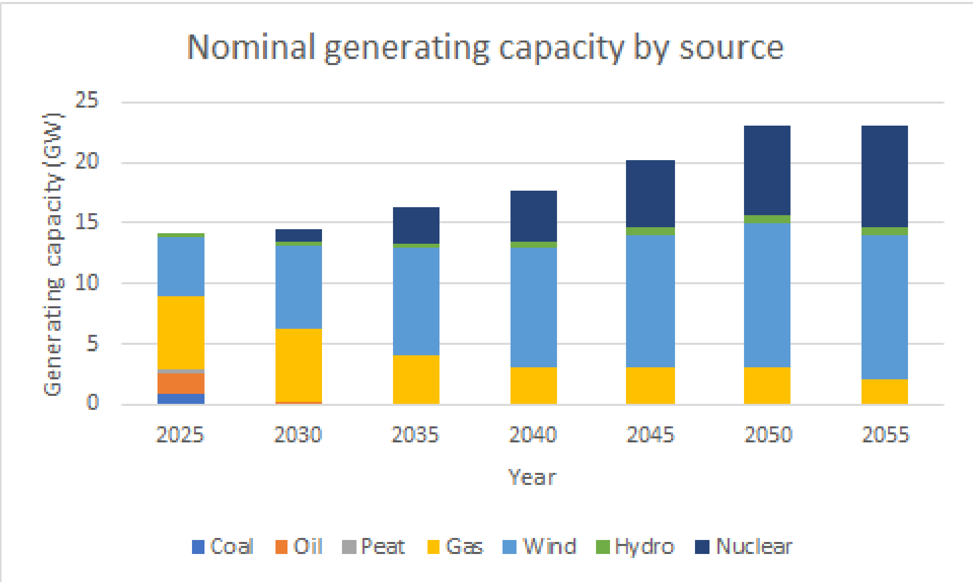
As a result, even without the problems of intermittency, these proposed installations cannot replace current fossil-fuel capacity unless accompanied by an approximately 50% reduction in energy demand.

The Workers' Party proposes that, rather than attempt to enforce this unrealistic reduction in energy use, the state should instead replace its dispatchable fossil-fuel capacity with up to 10GW in reliable nuclear power, generated at two or three principal sites which will replace current large scale thermal generation facilities. This nuclear capacity will be complemented by offshore wind generation and increased interconnector capacity, and backed-up where necessary by reserve combined-cycle gas turbines to provide dispatchable supply during unforeseen outages. This plan allows us to project a 90-95% reduction in electricity related carbon emissions over 20 years, while simultaneously increasing total energy supply to allow for electrification of transport and heating, and industrial development.

4.2 Generating capacity and carbon emissions

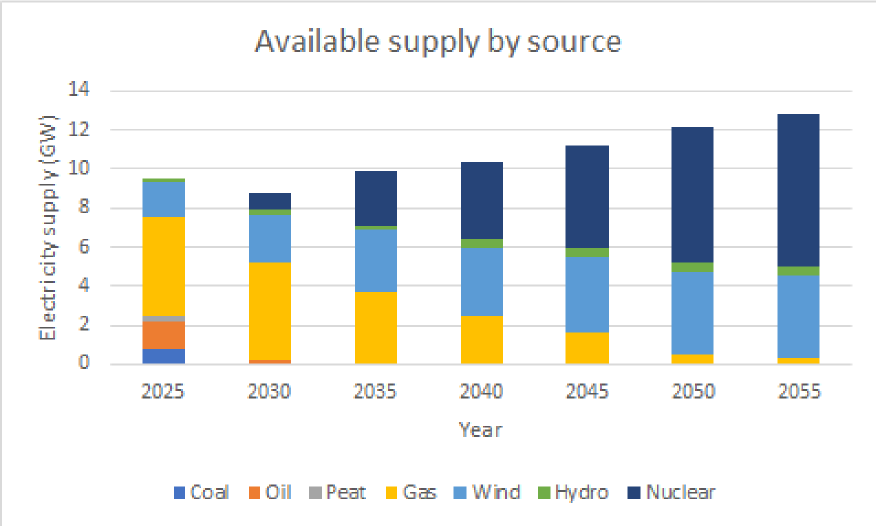
We present an example scenario in which six 1.4GW nuclear reactors are built in two plants over a 30-year period, with construction beginning between 2025 and 2030, and the first reactor commissioned between 2030 and 2035. Subsequent reactors are commissioned at a rate of two every ten years, one at each site. This is comparable to the planned programme in Poland, which envisions six reactors with a total capacity of 8.5GW being constructed over a 20-year period.

In this scenario, the current planned development of offshore wind capacity would be continued, while onshore wind farm construction would be halted. Coal and peat burning are to be phased out immediately upon commissioning of the first reactor, while oil burning is eliminated after the commissioning of the second unit. Significant gas turbine capacity is maintained, though actual use is continually reduced as nuclear capacity is added. The total despatchable energy supply is approximately doubled over a 30-year period, while average supplied power increases by over 50%.



Projected generating capacity by source

Under such a plan, we envision that by 2050 94% of energy will be generated from low-carbon sources, while energy related CO_2 emissions will be reduced by approximately 97%.



Projected generation by source

4.3 Locations and composition of nuclear plants

We propose the construction of up to six nuclear reactors, to be sited in two or three multi-reactor sites. The co-location of reactors on a single site has multiple benefits including reduction of build cost and efficiency of operation.

There are several factors to consider when choosing suitable sites for the construction of nuclear plants, most importantly their physical requirements in terms of infrastructure and access to large supply of water, their environmental impact, and their acceptability to local residents. Furthermore ancillary benefits such as potential for district heating make certain sites highly valuable for nuclear generation. Each of these requires careful consideration, and a full assessment of the suitability of specific locations is beyond the scope of this policy. Nonetheless it is worthwhile to outline these requirements and identify the general attributes which are desirable in potential sites.

4.3.1 Size and impact

Despite the depiction of nuclear plants in popular culture as excessively large, sinister structures which loom over their surroundings, nuclear plants are in fact very compact, and in general have a land footprint which is smaller than other thermal generation plants of comparable output, and several orders of magnitude smaller than the footprint of VRE sources like wind turbines. A typical 1GW nuclear plant requires a land area of 2-3 square kilometres, similar in area to current thermal plants in Moneypoint, Poolbeg and Great Island. The siting of multiple reactors together in a single site can greatly reduce this footprint, since multiple reactors can share supporting infrastructure and generating equipment. Perhaps the largest environmental impact of a nuclear plant is in its water demand, which varies depending on specific design, but in general is significantly larger than other thermal generation plants. For this reason, it is highly desirable to site such plants beside considerable bodies of water. In the Irish context, where there are few large inland bodies of water, it seems clear that nuclear plants should preferably be sited on the coast or on tidal estuaries, as is already the case with large coal and oil plants.

4.3.2 Repurposing of existing plants

Given their comparable size to existing coal- and oil-fired plants, there has been much interest internationally in the re-purposing of these plants to host nuclear reactors. This has several benefits in terms of reuse of infrastructure and in the reduction of environmental harm associated with building on green-field sites. Furthermore, given that all such infrastructure projects are likely to attract a degree of opposition from local residents, the potential for such opposition can be reduced by citing the benefits for local population of replacing existing coal or oil plants with nuclear, including improved air and water quality and the retention of skilled employment which would otherwise be lost when such carbon-intensive plants are decommissioned.

However the largest benefit to locating nuclear plants on existing thermal generation sites is from the availability of high-tension transmission lines. Nuclear plants generally have higher and more sustained power output than all but the largest oil or gas plants. As a result, nuclear plants require significant investment in high-tension lines to distribute this energy, adding to the cost of development. Large coal-powered plants often have capacities similar to a nuclear plant, and as a result have existing high-tension connections which can be reused or upgraded as necessary, reducing costs and reducing the need for construction of pylons, which typically attract opposition.

4.3.3 District heating

Thirdly, there are significant potential benefits to siting nuclear plants in or near large urban areas, both to reduce the need for long-distance transmission lines, and also to take advantage of the potential for district heating. Many large European cities make use of district heating through Combined Heat & Power (CHP) systems, in which the waste heat from thermal generation plants is used to provide hot water to homes in the surrounding area.

4.3.4 Potentially suitable sites

Based on these criteria it is possible to identify a number of existing generation sites which have high-value for conversion to nuclear power. These include:

- Poolbeg, Co. Dublin

Advantages: Existing district heating infrastructure. Coastal, Multiple medium/high-tension connections, minimal environmental impact.

- Moneypoint, Co. Clare

Advantages: Coastal, Highest capacity existing site, multiple high-tension connections, minimal environmental impact

- Great Island, Co. Wexford

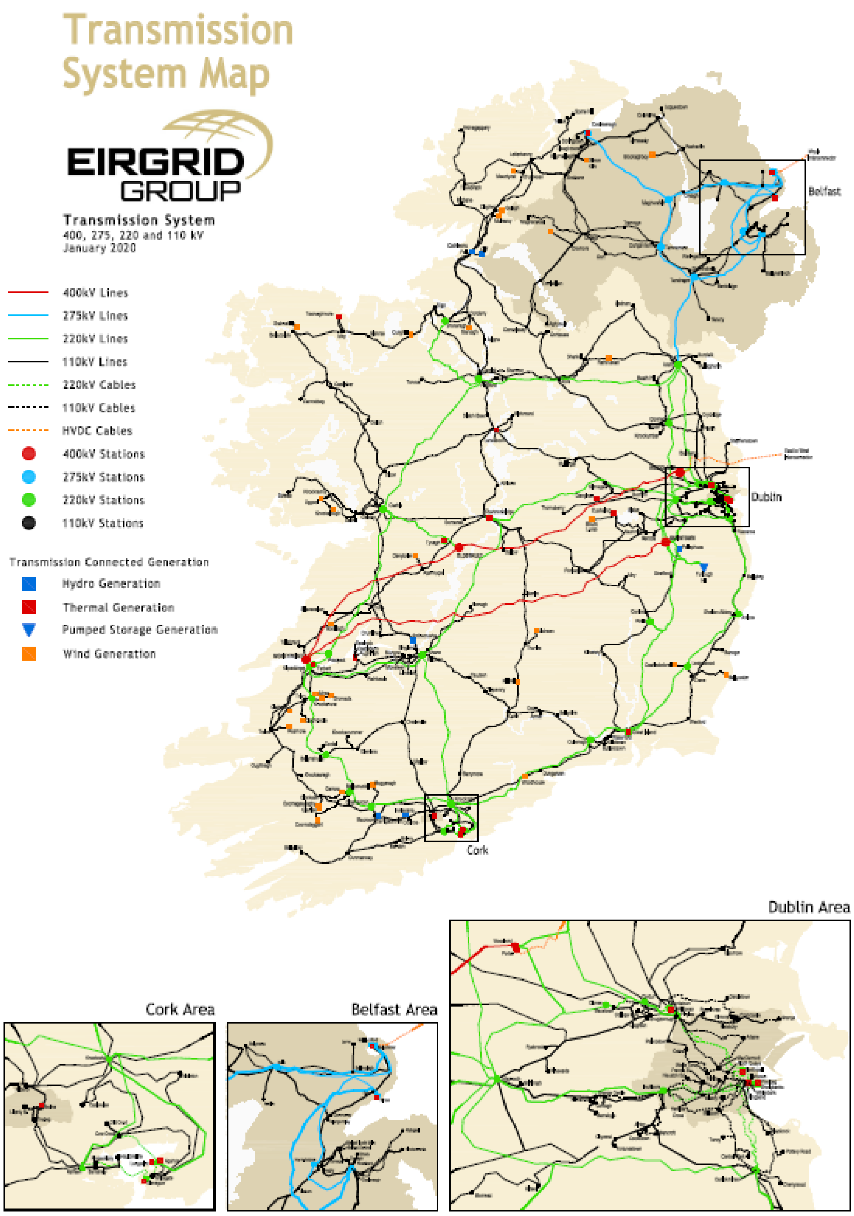
Advantages: District heating potential, Coastal, Multiple medium-tension connections

- Whitegate Co. Cork

Advantages: District heating potential, Coastal, Multiple medium-tension connections

- Ballylumford Co. Antrim

Advantages: District heating potential, Coastal, Multiple medium-tension connections

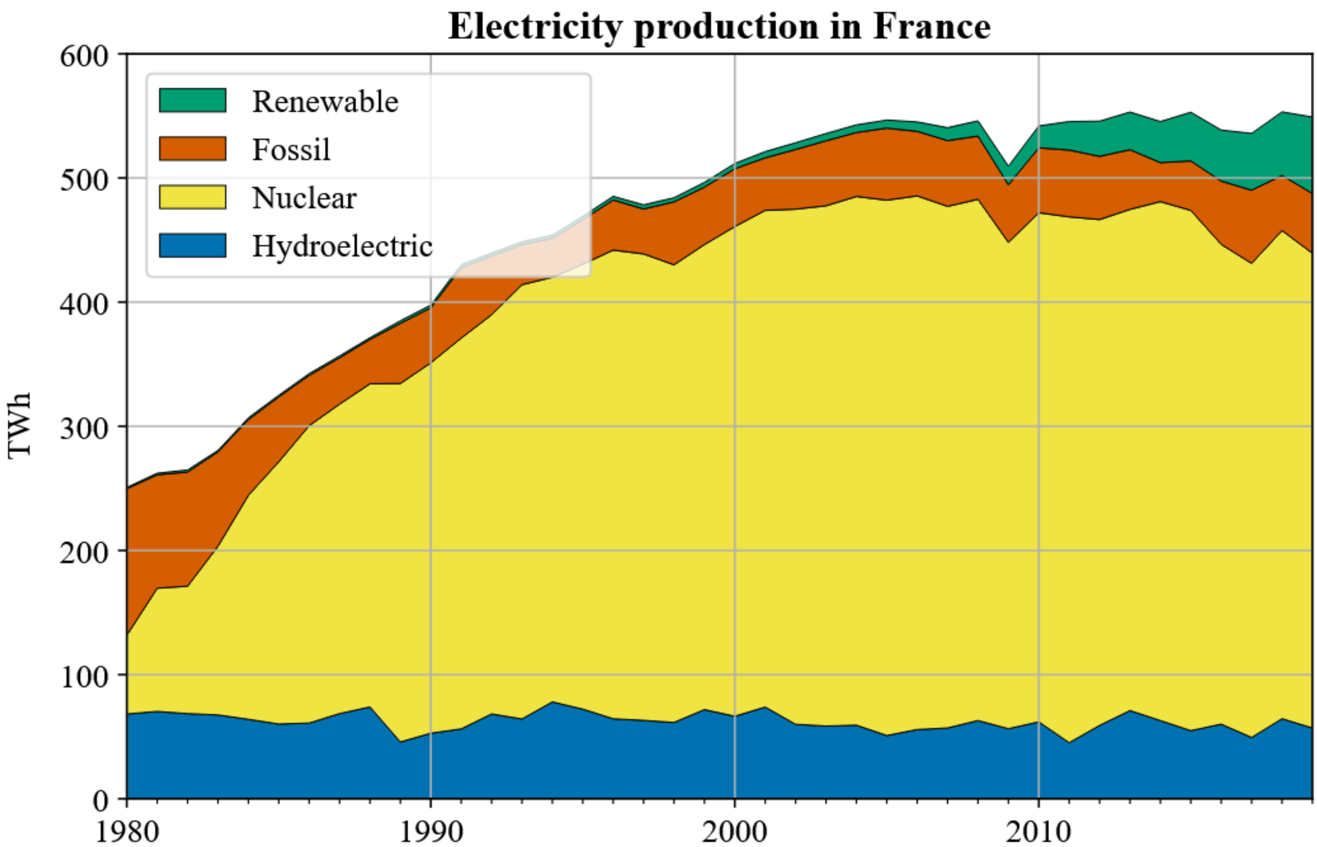


4.4 Development timescale

When concerns over safety, affordability and storage of waste have been dealt with, the principle argument still deployed against the use of nuclear energy is that a nuclear programme can not take effect quickly enough to achieve rapid decarbonisation. However, again this is largely a misconception, and in fact nuclear development has been shown in numerous studies to achieve decarbonisation at a faster rate than any other technology.

Typical construction times for new nuclear plants are in the range of 6-8 years per reactor, which would appear to compare badly with the 6-month construction time often cited for a typical 50MW wind farm. However this must be balanced by considering the difference in scale of power output. A typical 1GW nuclear reactor can be expected to produce on average 50 times more energy per year than a 50MW wind development, while also having a much longer useful lifespan. Furthermore, the average development time for nuclear plants appears large due to significant delays often associated with the construction of novel reactor designs. Experience from countries with long-term nuclear programmes has shown that the use of established proven reactor designs can greatly reduce construction times, often to as little as four years.

Under the Messmer Plan, announced in the late 1970s, France constructed 58 nuclear reactors over a period of 25 years, resulting in the most rapid reduction in carbon emissions ever achieved by a major country. Between 1979 and 1989 France added 40GW of nuclear capacity to its energy grid, resulting in a grid with over 90% zero-carbon power. In the space of just 10 years France reduced its electricity related CO2 emissions by 70%, and total greenhouse gas emissions by 30%. Importantly, these plants were completed in an average construction time of less than 5 years.



Similarly, South Korea's 25 nuclear reactors were built in an average construction time of 4.6 years, while Canada's 19 CANDU reactors had an average construction time of 6 years. More recently, between 2012 and 2023 the UAE constructed four new reactors at its Barakah plant, achieving a 25% reduction in electricity related carbon emissions in just 10 years.

The key to the rapid development of nuclear programmes in these countries has been the construction of several reactors using a single proven and established design, overseen by a single state-owned company, and preferably sited in multi-reactor plants, which allow for greater economy of scale.

Given these factors, we believe that under the programme proposed here, in which Irish reactors would use a single, established design, to be constructed in cooperation with an existing nuclear programme in a partner country, an 8-year construction time for an initial reactor is entirely feasible, with significant reductions in construction time for each subsequent reactor built.

Construction time of nuclear reactors vs. the year that construction started

Includes all of the world's reactors that came into operation by 2023. Construction times are measured in months from the start date of building, not planning.

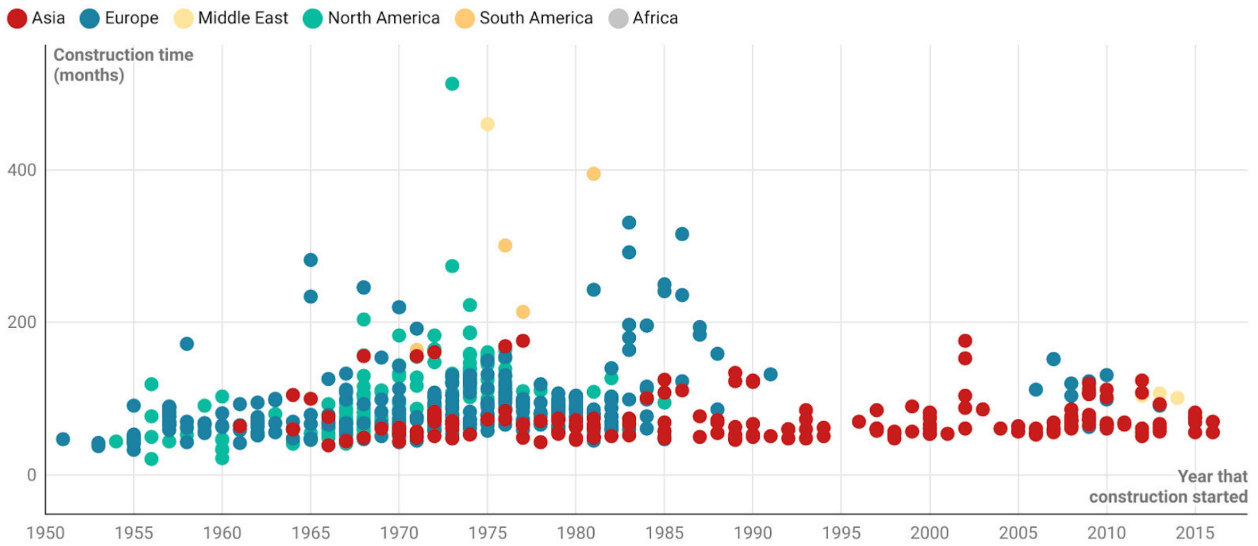


Chart: Hannah Ritchie • Source: IAEA Power Reactor Information System (PRIS) and Wikipedia • Created with Datawrapper

4.5 Reactor design: currently available options

Much recent attention has focused on recent developments in new reactor designs including small modular reactors (SMRs), which are significantly smaller than conventional reactors, and can potentially be mass produced off-site, greatly reducing the construction costs for nuclear energy.

While these developments show great promise, it is likely to be several decades before SMRs are in widespread use. What's more, given Ireland's need to rapidly replace our fossil fuel fleet, we do not believe that Ireland can afford to wait for the development of new technology before implementing a radical decarbonisation plan. Given the projected need for up to 10GW of additional capacity over the next 10-20 years, we propose that Ireland should partner with a major producer of conventional pressurised water reactors to begin development using existing established and well-tested designs.
Due to the lack of an existing native nuclear industry, initial development will rely on a partnership between an Irish State-owned operator (preferably the ESB-group, which already operates power plants and maintains the electricity grid on both sides of border) with a single main overseas partner which will build plants and provide training of staff.

At present, several countries with large state-owned energy companies are engaged in or planning new nuclear programmes. These include France, which has announced plans for 14 new reactors using Électricité de France's (EDF) EPR design; South Korea, which produces the APR1400 reactor through its state owned Korea Hydro & Nuclear Power (KHNP) and has announced plans to recommence reactor construction; and Poland, which has recently announced plans to build 6 nuclear reactors, likely using either the Korean APR1400 or the American AP1000 design. Other countries currently engaged in commercial production of reactors for export include Russia, whose state-owned Rosatom provides reactors to several European countries, and China, which is currently constructing 12 reactors using the Hualong-1 design, and has announced intentions to build up to 150 reactors in the next 20 years.

Commercial Reactor designs currently in production worldwide:

Design Model	Type	Principal manufacturer	Capacity (MWe)	# under construction
VVER-1200	PWR	Rosatom (Russia)	1200	12 (5 countries)
Hualong 1	PWR	CGN (China)	1200	12 (2 Countries)
VVER-1000	PWR	Rosatom (Russia)	1000	5 (2 countries)
APR1400	PWR	KEPCO (S. Korea)	1400	4 (2 countries)
EPR	PWR	EDF (France)	1650	3 (2 countries)
AP1000	PWR	Westinghouse (USA)	1250	2 (1 country)
VVER-440	PWR	Rosatom (Russia)	470	2 (1 country)

Commercial Reactor designs currently planned or under construction in EU & UK:

Design Model	Type	Principal manufacturer	Capacity (MWe)	Countries
VVER-1200	PWR	Rosatom (Russia)	1200	Hungary, Finland*
VVER-440	PWR	Rosatom (Russia)	470	Slovakia
EPR	PWR	EDF (France)	1650	France, UK
AP1000	PWR	Westingthouse (USA)	1250	Poland
APR1400	PWR	KEPCO/KHNP (Korea)	1350	Poland

*Development in Finland is currently suspended for political reasons related to the Ukraine-Russia conflict. For a complete list of nuclear reactors currently under construction see Appendix A.

4.6 Fuel sources and availability

Reliable fuel supply is of course essential in our aim of ensuring energy security. A significant advantage of nuclear power is that nuclear fuel may be easily stockpiled and stored for many years, meaning that it is possible to store sufficient fuel supply for many years of operation of the proposed power plants, greatly reducing Ireland's exposure to fuel supply stocks.

At present Ireland has no ability to mine or purify uranium, meaning that, at least initially, an Irish nuclear programme will require importation of fuel. Uranium for nuclear fuel is currently mined in 15 countries worldwide, including major trading partners of Ireland such as Canada and Australia.

Rank	Country	Uranium production (Tonnes/Year)	Share
1	Kazakhstan	21,819	45.14%
2	Namibia	5,753	11.90%
3	Canada	4,693	9.1%
4	Australia	4,192	8.67%
5	Uzbekistan	3,500 (est.)	7.24%
6	Russia	2,635	5.45%
7	Niger	2,248	4.65%
8	China	1,885 (est.)	3.90%
9	India	615 (est.)	1.27%
10	Ukraine	455	0.94%
11	South Africa	385 (est.)	0.80%
12	Iran	71 (est.)	0.15%
13	Pakistan	45 (est.)	0.09%
14	Brazil	29	0.06%
15	United States	8	0.02%

List of Uranium producing countries.

Raw uranium is processed into reactor fuel by a number of companies, generally closely linked to major manufacturers of nuclear reactors. Areva (France), Tenex (Russia), Urenco (UK, Netherlands), Cameco (Canada) among others produce nuclear fuel assemblies and export them to partner countries. As part of the proposed programme, Ireland and the ESB group should develop links with one or more of these fuel suppliers as part of the long-term development plan.

In addition, geological surveys indicate that Ireland may have significant local reserves of uranium, leading to the possibility of developing an indigenous fuel supply. As part of this programme we propose to begin detailed exploratory studies to investigate the feasibility of supplying Irish reactors with locally produced fuel.

4.7 Costs Estimates

While the costs of any nuclear programme will depend heavily on the specifics of the plan, including reactor design, location, and number of co-located units, we provide estimates here based on known or projected costs of recent and ongoing nuclear construction projects in comparator countries.

4.7.1 Comparator programmes

- Finland (Population 5.6M)
    - As of 2023 Finland has 5 operating nuclear reactors located at two sites, with a total nuclear capacity of 4.4GW, providing approximately 50% of Finland's electricity supply.
    - The most recently completed reactor was the Olkiluoto-3 reactor, commissioned in 2022. This was the first reactor of its kind built in Europe, and currently the largest single nuclear reactor in the world, with a capacity of 1.6GW.
    - Total construction cost for Olkiluoto-3: €11Bn (€6.8Bn/GW).

- Slovakia (Population 5.4M)
    - As of 2023 Slovakia has 5 operating reactors in two sites, with a 6th reactor under construction. This 6th reactor is expected to be commissioned in 2025.
    - The Mochovce 3 reactor was commissioned in 2023, while it's sister reactor, Mochovce 4 remains under construction. These reactors provide 880 MW (0.88GW) of generating capacity at an estimated total cost of €6Bn (€6.8Bn/GW).

- United Arab Emirates (Population 10.2M)
    - UAE has 3 operating reactors, with a fourth completed but not yet commissioned. These reactors were built on a single site between 20212 and 2023.
    - Construction of the 4-reactor Barakah Nuclear power plant was begun in 2012 and completed in 2023. The site contains four APR1400 1.35GW units constructed by the Korean state-owned KEPCO.
    - Total cost estimate for four reactors: €22.5Bn (€4.2Bn/GW).

- Poland (Population 38M).
    - Poland has announced a programme to build its first nuclear reactors, with plans to construct 6 units with capacity of 8.5GW.
    - Several international companies have bid for contracts with total estimates in the range of €30-40Bn (i.e. approximately €3-5Bn/GW).

These programmes, though differing widely in their detail and in the chosen technology, indicate current construction costs for new nuclear programmes in developed countries in the range of €4.5-6.8Bn per GW, including infrastructural costs involved in grid upgrades. Based on a programme to develop 7GW of capacity in 5-6 units, this corresponds to costs in the range of approx €32-48Bn.

In addition, development of significant additional interconnection capacity to allow export of surplus generation is allowed for. Based on the €1.6Bn costs of the planned Celtic interconnector, we estimate €2-4Bn in costs for the development of an additional 2GW export capacity. Finally, we include an allowance for required upgrades to the high-voltage distribution network required to handle the increased generating capacity. While these costs are dependent on the location of chosen sites, we have allowed for construction of between 500 and 2,000 kilometres of high-tension lines, at a cost of approximately €1M per kilometre, giving upgrade costs in the range of €0.5-2Bn.

Sample cost estimates for construction of 6 reactors with total capacity 8GW:

	Lowest-cost scenario (€Billion)	Median-cost scenario (€Billion)	Highest-cost scenario (€Billion)
Reactor Construction	24.5	45	54
Network upgrade costs	0.5	1	2
Interconnector construction	2	3	5
Total	€27 Billion	€49 Billion	€61 Billion

4.9 Funding

Nuclear energy is characterised by large initial capital costs, and very low running costs per unit of output. For example, fuel costs typically represent less than 1% of the retail cost of energy. Since the price of nuclear energy is determined principally on the construction cost and associated financing, the long-term cost-effectiveness of nuclear energy depends critically on the interest rate, or discount rate, at which funding is acquired. The OECD Nuclear Energy Agency estimates that at a 3% discount rate, nuclear is the most cost-effective option for all countries, while at a discount rate of 7-10% nuclear becomes approximately equally expensive as gas generation.

Given the large upfront capital costs, funding is perhaps the most significant challenge to developing a nuclear programme. However, given the scale of the commitments already made by both states towards decarbonisation, nuclear development will likely prove the most cost-effective route to meeting these goals. Based on the most likely of the scenarios outlined above, we estimate that this programme can be implemented for a total capital cost of circa €50 Billion in 2022 values. This represents approximately 10% of nominal GDP. By comparison the German Energiewende has thus far entailed costs of approximately 15% of GDP over only 10 years, with negligible benefit. In 2022 Irish national debt was approximately €226 billion, or 45% of GDP. Forecasted annual debt repayments for the next 10 years are in the range of €5-10 billion annually. It is therefore reasonable to estimate that annual borrowing at a rate of €2 billion / year over a 25 year period could be easily financed without significant negative effect on debt ratios[31].

Furthermore, we forecast that revenue generated through increased energy exports following the completion of the first plants can fund further development. Under our proposed plan we estimate that net exports can increase by 2-4TWh (Terawatt-hours) upon commissioning of the first completed reactor, while simultaneously eliminating oli and peat burning. At mean European wholesale prices this would represent €0.5-1 Billion in additional export revenue per annum, to be offset against ongoing construction costs of approximately €2Bn per annum.

[31] Annual report on public debt in ireland 2022 https://assets.gov.ie/246331/b98ab4b2-9a62-4cb8-9ce7-7d35840715f3.pdf

4.10 Ownership

Given the capital costs involved, the strategic importance of the assets, and the highly centralised nature of the generating system, any nuclear programme of this type must necessarily be primarily owned and controlled by the state.

In the case of Ireland the natural choice of owner operators are the ESB group and the network operator Eirgrid/SONI. Both companies currently operate cross border, and run grid operations and energy generation in both jurisdictions. Despite the deliberate degradation of its capacities, ESB Networks retains significant experience in large infrastructure projects, and is the obvious choice to run the proposed system.

As is the case with comparable programmes in other similar countries, this programme should be undertaken by a consortium including state and overseas partners with appropriate expertise. International experience suggests that faster completion times are achieved in projects with a large state role, and fewer overseas companies involved. Since Ireland has no native nuclear industry or expertise, it will necessarily rely on an overseas manufacturer. As much as possible the state should aim to create a long-term partnership with a state-owned manufacturer in an established nuclear state, e.g. EDF (France) or KEPCO (South Korea).

4.11 Implications for other technologies

Despite the weaknesses of variable renewable energy systems discussed here, we do not oppose the continued development of these technologies. However development should be focused on cases which provide the most reliable energy supply, and minimise ecological and environmental costs. For this reason we propose to continue large scale development of offshore wind energy, while discontinuing onshore wind farm construction. Onshore wind-farms, many of which are constructed in mountainous areas and on blanket bogs, have a significant degrading effect on local ecosystems, while also being less reliable than offshore wind. We propose that current onshore wind installations should be removed and not replaced as they reach the end of their lifespan, with land currently used for wind farms re-designated for bog restoration and reforestation or rewilding projects.

Similarly, given the poor energy generation performance of large-scale solar farms in Ireland, their very large material requirements in terms of mining and manufacturing costs, and the high land-use requirements, we propose the discontinuation of large-scale solar farms. Rooftop solar generation, where cost-effective, should be continued.

Appendix

Nuclear reactors in development worldwide

Planned completion	Country	Name	Design	Capacity
2022	Belarus, BNPP	Ostrovets 2	VVER-1200	1194
2022	China, CGN	Fangchenggang 3	Hualong One	1180
2022	Russia, Rosenergoatom	Kursk II-1	VVER-TOI	1255
2022	Slovakia, SE	Mochovce 3	VVER-440	471
2023	Bangladesh	Rooppur 1	VVER-1200	1200
2023	China, CGN	Fangchenggang 4	Hualong One	1180
2023	China, CNNC	Xiapu 1	CFR600	600
2023	France, EDF	Flamanville 3	EPR	1650
2023	India, NPCIL	Kakrapar 4	PHWR-700	700
2023	India, NPCIL	Kalpakkam PFBR	FBR	500
2023	India, NPCIL	Kudankulam 3	VVER-1000	1000
2023	India, NPCIL	Kudankulam 4	VVER-1000	1000
2023	India, NPCIL	Rajasthan 7	PHWR-700	700
2023	India, NPCIL	Rajasthan 8	PHWR-700	700
2023	Korea, KHNP	Shin Hanul 2	APR1400	1400
2023	Korea, KHNP	Shin Kori 5	APR1400	1400
2023	Russia, Rosenergoatom	Kursk II-2	VVER-TOI	1255
2023	Slovakia, SE	Mochovce 4	VVER-440	471
2023	Turkey	Akkuyu 1	VVER-1200	1200
2023	UAE, ENEC	Barakah 4	APR1400	1400
2023	USA, Southern	Vogtle 3	AP1000	1250
2023	USA, Southern	Vogtle 4	AP1000	1250
2024	Bangladesh	Rooppur 2	VVER-1200	1200
2024	China, SPIC & Huaneng	Shidaowan 1	CAP1400	1500
2024	China, Guodian & CNNC	Zhangzhou 1	Hualong One	1212
2024	Iran	Bushehr 2	VVER-1000	1057
2024	Korea, KHNP	Shin Kori 6	APR1400	1400
2024	Turkey	Akkuyu 2	VVER-1200	1200
2025	China, SPIC & Huaneng	Shidaowan 2	CAP1400	1500
2025	China, CGN	Taipingling 1	Hualong One	1200
2025	China, Guodian & CNNC	Zhangzhou 2	Hualong One	1212
2025	Turkey	Akkuyu 3	VVER-1200	1200
2026	China, CGN	Cangnan/San'ao 1	Hualong One	1150
2026	China, Huaneng & CNNC	Changjiang 3	Hualong One	1200
2026	China, CNNC	Changjiang SMR 1	ACP100	125

2026	China, CGN	Taipingling 2	Hualong One	1202
2026	China, CNNC	Tianwan 7	VVER-1200	1200
2026	China, CNNC	Xiapu 2	CFR600	600
2026	India, NPCIL	Kudankulam 5	VVER-1000	1000
2026	Russia, Rosatom	BREST-OD-300	BREST-300	300
2026	Turkey	Akkuyu 4	VVER-1200	1200
2027	Argentina, CNEA	Carem	Carem25	29
2027	China, CGN	Cangnan/San'ao 2	Hualong One	1150
2027	China, CNNC	Sanmen 3	CAP1000	1250
2027	China, CNNC	Tianwan 8	VVER-1200	1200
2027	China, CNNC & Datang	Xudabao 3	VVER-1200	1200
2027	China, Huaneng & CNNC	Changjiang 4	Hualong One	1200
2027	India, NPCIL	Kudankulam 6	VVER-1000	1000
2027	UK, EDF	Hinkley Point C1	EPR	1720
2028	Brazil, Eletrobrás	Angra 3	Pre-Konvoi	1405
2028	China, CGN	Lufeng 5	Hualong One	1200
2028	China, CNNC & Datang	Xudabao 4	VVER-1200	1200
2028	Egypt, NPPA	El Dabaa 1	VVER-1200	1200
2028	UK, EDF	Hinkley Point C2	EPR	1720
2030	Egypt, NPPA	El Dabaa 2	VVER-1200	1200

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