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Nuclear in Australia would increase household power bills

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Key Findings

Typical Australian households could see electricity bills rise by AUD665/year on average under the opposition Coalition's plans to introduce nuclear to the country's energy mix.

IEEFA analysed six scenarios based on relevant international examples of nuclear power construction projects; in every scenario, bills increased by hundreds of dollars.

For households that use more electricity, bills could rise more – for a four-person household, the bill rise was found to be AUD972/year on average across nuclear scenarios and regions.

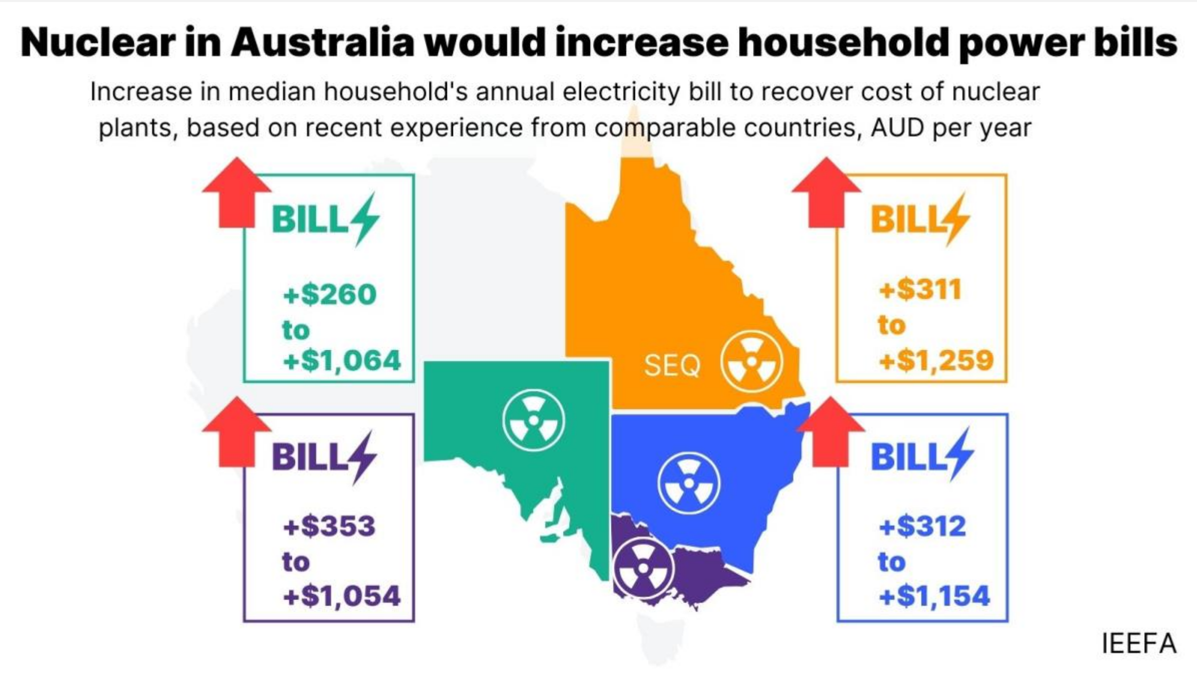
The cost of electricity generated from nuclear plants would likely be 1.5 to 3.8 times the current cost of electricity generation in eastern Australia.

Key results on one page

Under the Coalition's nuclear plan, IEEFA found median household electricity bills could rise by AUD665 per year on average across regions. This is based on the costs of six recent nuclear projects in countries comparable to Australia.

The bill increase for households consuming a median amount of electricity was as low as AUD260 based on the anticipated cost of a new nuclear plant in the Czech Republic, and up to AUD1,259 based on the costs of Hinkley Point C in the UK, currently under construction.

The report looks at the impact across different sizes of households and across four regions: New South Wales (NSW), South Australia, South East Queensland (SEQ), and Victoria.



The bill impact would be more acute for larger households, given their higher electricity consumption. For example, for a four-person household the bill impact would be AUD972/year on average across nuclear scenarios and regions, and for a five-plus-person household that figure would be AUD1,182/year.

Executive Summary

Australia's main federal opposition, the Liberal-National Coalition, has proposed building seven nuclear power plants across the country, including both large-scale reactors and small modular reactors (SMRs). This report seeks to detail the likely impact on household consumers' electricity bills from such a plan, based on recent real-world experience from construction costs for nuclear power plants around the world.

Rather than use theoretical projected costs, we have calculated the potential electricity bill impact for a range of nuclear cost recovery scenarios, based on the following real-world examples:

- **Finland:** Olkiluoto Unit 3.
- **France:** Flamanville Unit 3.
- **UK:** Hinkley Point C.
- **US:** Vogtle Units 3 and 4.
- **US SMR:** NuScale SMR.
- **Czech Republic:** Dukovany proposed plant expansion.

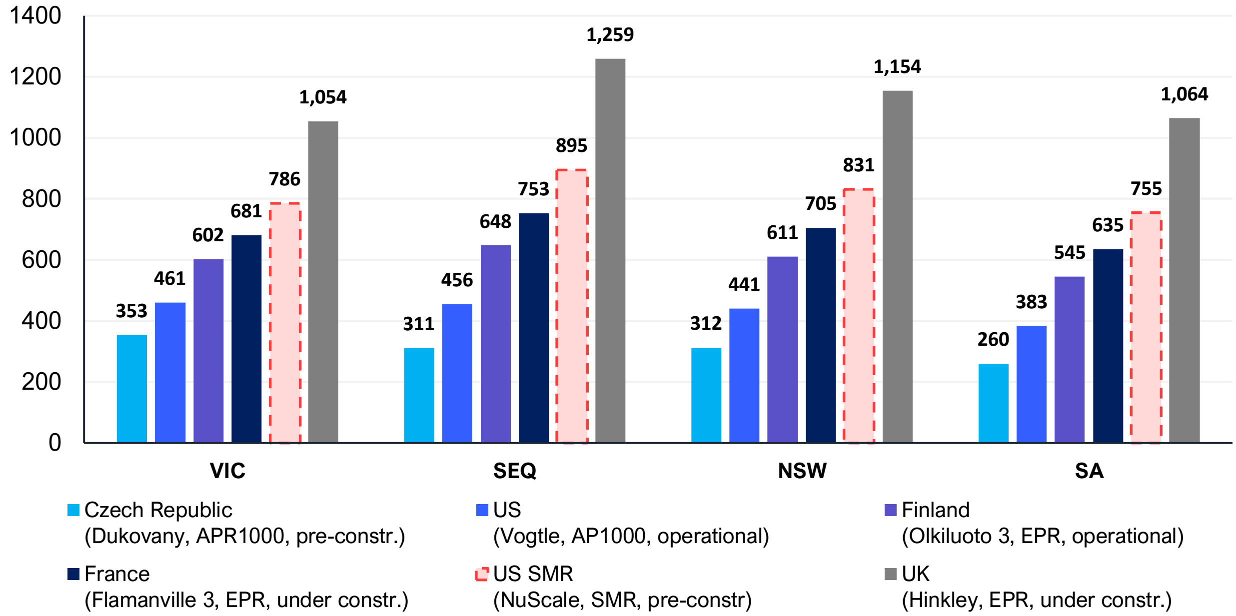
The first four scenarios are based on actual, recent nuclear power plant construction costs and timeframes for countries in liberal democracies where costs are transparent. Commenting on nuclear construction cost estimates, electricity market economist Professor Paul Joskow states: "The best estimates are drawn from actual experience rather than engineering cost models."

In the case of SMRs, no plants have been successfully completed in a democratic country, so we instead used the one example of a binding contract offer to build such a plant in the US, the now-cancelled NuScale project. We also used this approach for assessing the costs for a proposal to build South Korean APR technology (a design that the Coalition has cited for potential implementation in Australia) in a separate democratic country with laws protecting labour rights, outside of its country of origin – the Czech Republic.

Household electricity bills impact

We found that electricity bills would need to rise in order for nuclear costs to be recovered. The chart below illustrates the resulting increase in typical household power bills if nuclear power plants with similar costs and characteristics to the international examples were built in Australia. The average bill increase was AUD665/year across states and nuclear scenarios for households with a median level of electricity consumption. The lowest impact is equivalent to bill increases of AUD260-AUD353 per year, linked to estimated costs for the pre-construction project Dukovany, which is highly likely to underestimate final costs. The lowest impact from a nuclear plant successfully completed (Vogtle) is AUD383-AUD461 per year for an average household. Meanwhile, the UK experience with Hinkley Point C indicates electricity bill rises of more than AUD1,000 per year are possible.

Figure 1: Increase in typical household electricity bill to recover cost of nuclear plants based on different countries' experience (AUD/year)



Source: Various sources (see Appendix) and IEEFA calculations. Note: Bill increases are for a household with median electricity consumption levels.

The range of costs is wide due to the significant cost differentials for large-scale nuclear in different countries, and the significant cost uncertainty for SMR technology, which is still under development. The impact in each state can vary due to differing typical electricity consumption levels in each state, and different electricity bill cost structures.

For households using more electricity than the median level, the bill increases from nuclear would be higher. For example, for a four-person household the bill impact would be AUD972/year on average across nuclear scenarios and states, and for a five-plus-person household AUD1,182/year.

How nuclear costs are reflected on electricity bills

These results might come as surprising to some, because large-scale nuclear is a mature technology currently in use across a wide range of countries. In addition, misinterpreted data on retail electricity prices (which also include the costs of powerlines and taxes, not just generators and so is misleading) can show some cases of nations that use nuclear who have lower retail prices than Australia.

However, in almost all cases around the world, the cost of nuclear power plant construction and financing is not fully reflected in market prices for power. This is because either nuclear power plants are very old and their costs are largely depreciated, or governments have acted to recover the costs either through taxpayers, or via levies which are independent of electricity markets – for example in

France, the UK and Ontario, Canada. In other jurisdictions, such as a number of US states including Georgia where the Vogtle power plant is located, there isn't actually an electricity market in operation, with consumers instead served by a regulated monopoly without any competitive choice.

The Coalition has outlined something different, ruling out taxpayer subsidies and stating that any government investments in nuclear plants would receive a commercial return. This implies that the Coalition expect that wholesale electricity market prices will be sufficient for nuclear power plants in each state to recover their construction costs plus a commercial level of return. The Coalition has also outlined that these nuclear power plants would operate at full capacity almost all of the time. Therefore, power prices would need to average out at the level a nuclear plant needs to be commercially viable – to recover their costs – almost all of the time.

High costs of recent nuclear projects

The reason bills increased in this study is because recent large-scale nuclear projects across Europe and North America involved very high costs. The European Pressured Reactor (EPR) program had promised to deliver more efficient, safer nuclear power. However, the three recent projects (Olkiluoto 3, Flamanville 3 and Hinkley Point C), which have either just been completed or are under construction, have all faced construction challenges, delays and cost-blowouts. If plants with similar costs and characteristics were built in Australia, they would require a levelised cost of electricity (LCOE) between AUD250 per megawatt-hour (MWh) and AUD346/MWh to recover their costs.

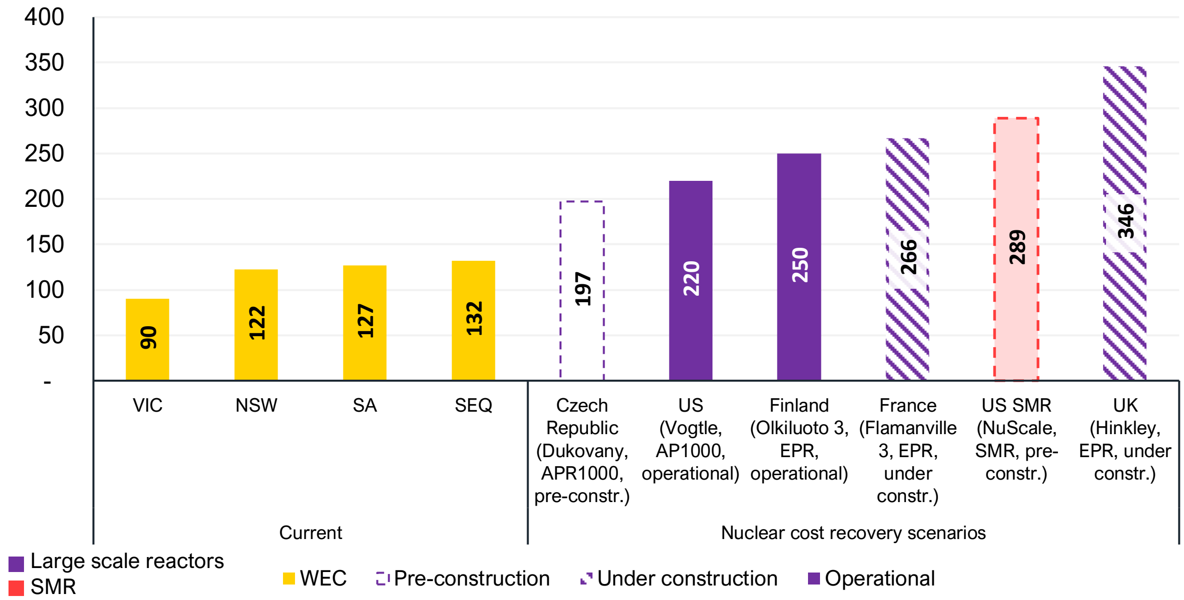
A few other types of reactors are being built or considered internationally of a similar design to what the Coalition indicates might be built in Australia: the South Korean APR1000 design proposed at Dukovany in the Czech Republic; and a Westinghouse AP1000 design recently completed at Vogtle in the US. The Vogtle plant experienced seven years of delays and actual capital costs (excluding financing costs) 1.7 times the original estimates. Those plants present LCOEs of between AUD197 and AUD220 per MWh in an Australian context – noting the Dukovany costs are only initial pre-construction estimates and could rise.

Based on NuScale, we estimate that the LCOE of nuclear SMR in an Australian context would be AUD289/MWh – but could be far higher if construction extends beyond the 3.25 years used in this study – as financing costs increase as construction timelines extend.

Capital costs (excluding financing costs) of recent nuclear power builds have tended to blow out by a factor of between 1.7 and 3.4, leading to financial difficulties for companies involved. All conventional nuclear projects built in recent years in the US and Europe – Vogtle, Olkiluoto 3, Hinkley Point C and Flamanville 3 – have contributed to financial difficulties for companies involved. Westinghouse, which was the technology provider for Vogtle, filed for bankruptcy protection in 2017. France's AREVA, who was the original technology provider for Olkiluoto 3, Flamanville 3 and Hinkley Point C, came close to bankruptcy over 2015, which required a French Government-sponsored bail-out.

The chart below details the wholesale market prices required for each of the recently constructed or quoted nuclear plants to be commercially viable, relative to the current wholesale electricity costs being passed through in household electricity bills in the regions of Victoria, NSW, South East Queensland (SEQ) and South Australia (SA).

Figure 2: Current wholesale energy cost (WEC) component of current household bills compared to commercial price to recover nuclear plant costs in Australian context (AUD/MWh)



Source: Various – see Appendix. SEQ: South East Queensland. Current wholesale energy cost is based on market rates, the DMO and the VDO. Current WEC excludes GST, losses, ancillary services, RERT, directions cost, prudential costs and fees. Nuclear LCOEs represent the cost of these projects translated to an Australian context with specific assumptions taken.

Australia would likely face even higher large-scale nuclear costs than these recent international examples, due to the country's limited nuclear capability and the small size of any potential Australian nuclear build-out program. With seven nuclear power stations proposed (two of them SMR-only), all at separate sites, there will be limited scope to achieve learning-based cost reductions like those seen in a large continuous build program, for example the build program in South Korea on which CSIRO's GenCost costings are based. South Korea has built 26 reactors since the 1970s. Further, the assumptions in this report have provided an optimistic levelised cost of electricity for nuclear, for example using a 60-year economic lifetime, 93% capacity factor, and a low discount rate.

Our analysis suggests household power bills would need to rise significantly for nuclear power plants to become a commercially viable investment in the absence of substantial, taxpayer-funded government subsidies. In IEEFA's opinion, any plan to introduce nuclear energy in Australia – such as that proposed by the Coalition – should be examined thoroughly, with particular focus on the potential impact on electricity system costs and household bills, and with detailed analysis of alternative technologies such as renewables and firming.

Introduction

There are currently no nuclear power stations in Australia and there are laws prohibiting their installation. Recently the Liberal-National Coalition, Australia's main federal opposition, proposed the construction of nuclear power stations as part of its energy policy should it win government. Its media release states:[1]

"A Federal Coalition Government will initially develop two establishment projects using either small modular reactors [SMRs] or modern larger plants such as the AP1000 or APR1400. They will start producing electricity by 2035 (with small modular reactors) or 2037 (if modern larger plants are found to be the best option).

"The Australian Government will own these assets, but form partnerships with experienced nuclear companies to build and operate them."

The Coalition has proposed seven locations where it intends to build nuclear power plants, located at the sites of coal-fired power stations that have closed or are scheduled to close. Each of these sites could host more than one reactor.[2] The proposed sites are:

- Liddell Power Station, New South Wales (NSW).
- Mount Piper Power Station, NSW.
- Loy Yang Power Stations, Victoria.
- Tarong Power Station, Queensland.
- Callide Power Station, Queensland.
- Northern Power Station, South Australia (SMR only).
- Muja Power Station, Western Australia (SMR only).

News reports outline that five of the sites could host either large-scale nuclear reactors or SMRs, but the WA and SA sites are only expected to host SMRs.[3]

The Coalition has repeatedly ruled out taxpayer subsidies for these proposals, stating that any government investments in nuclear plants would receive a commercial return. For example, at the National Press Club in May, Shadow Treasurer Angus Taylor stated: *"The key for me as someone who really believes that we should make sure that we have affordable, reliable power, and I don't want to commit subsidies that aren't necessary, is to make sure that it's [nuclear power] commercially viable, and we think it can be. … If it's commercially viable, it's not going to be subsidies. It's as simple as that."*[4]

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[1] Liberal Party of Australia. Australia's Energy Future. 19 June 2024.
[2] Sky News Australia. Shadow energy minister Ted O'Brien reveals multiple reactors could be built at each nuclear site to keep costs down. 23 June 2024.
[3] ABC. Why has the Coalition gone nuclear? The facts you need to navigate the energy debate. 19 June 2024.
[4] Angus Taylor. National Press Club Q & A - Wednesday 22 May 2024. 27 May 2024.

This implies that the Coalition expects that wholesale electricity prices will be sufficient for nuclear power plants in each state to recover their construction costs plus a commercial level of return. Moreover, Shadow Energy Minister Ted O'Brien has outlined that these nuclear power plants would operate as an "always on 24/7 baseload power source" at very high capacity factors.[5] Therefore, power prices would logically need to average out at the level a nuclear plant needs to be commercially viable almost all of the time.

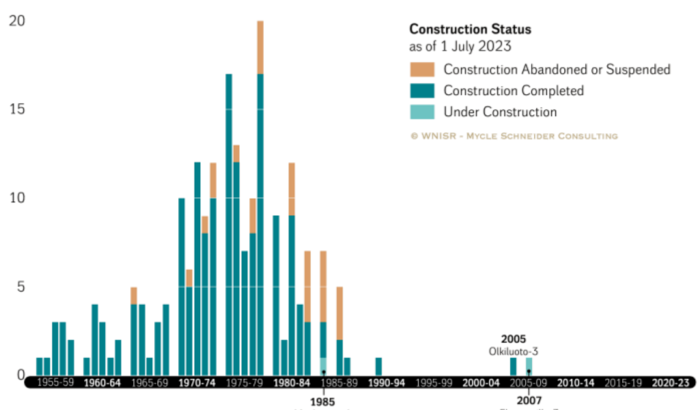
This study takes these propositions from the Coalition as given, and then examines what this would mean for household power bills. The Coalition has stated that nuclear power will reduce electricity bills.[6] In this paper, we examine the international evidence on nuclear costs and translate this into the Australian context to estimate the impact of nuclear power on bills.

Nuclear costs

Conventional large-scale nuclear reactors are an established technology that harnesses energy released from splitting atoms – also known as fission. The energy released in the fission reaction is harnessed as heat, which is used to produce steam. This steam is used to drive turbines that produce electricity. A nuclear power station may have one or multiple reactor units.[7]

There was an extensive international build out of large-scale nuclear reactors from the 1950s to the 1980s. Since then, a limited number of new nuclear power plants have been built, and safety regulations have tightened.

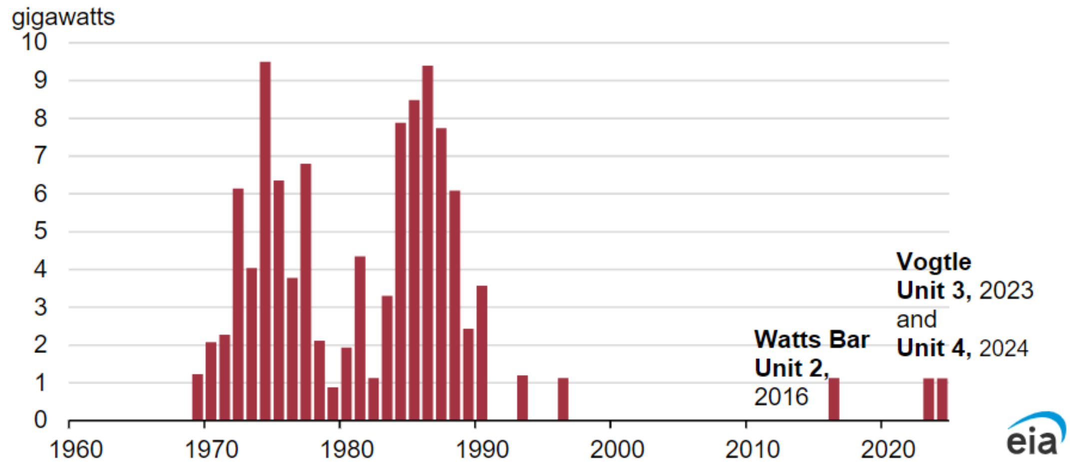
Figure 3: Construction starts of nuclear reactors in the European Union EU27 (in units, from 1955 to 1 July 2023)



Source: World Nuclear Industry Status Report 2023.[8]

[5] Sky News. Ted O'Brien requests CSIRO re-run nuclear costs modelling after damning report forecasts inflated energy prices. 28 May 2024.
[6] The Guardian. Peter Dutton announces Coalition's nuclear power plan – video. 19 June 2024.
[7] World Nuclear Association. Nuclear Power Reactors. Updated 27 August 2024.
[8] World Nuclear Industry Status Report. World Nuclear Industry Status Report 2023. December 2023.Page 465.

Figure 4: Annual US nuclear power capacity additions, by year of initial operation (1960-2024)



Source: Energy Information Administration (EIA).[9] Note that Watts Bar Unit 2 received construction permit in 1973, construction was halted in 1985, in 2007 construction restarted[10] so it does not meet the criteria of 'proceeded to construction within the past 20 years' and is a Generation II design so is excluded from this report.

We can examine recent international experience to understand the potential costs of building nuclear energy infrastructure in Australia. In determining what would be realistic examples of nuclear build costs in Australia, IEEFA considers that the following criteria should be met for the international example to be relevant in the current Australian context:

1. **Projects need to have proceeded to construction within the past 20 years** – Nuclear reactor designs and regulatory processes have advanced over the decades to address safety concerns in response to events such as the Three Mile Island, Chernobyl and Fukushima nuclear disasters, as well the September 11 terrorist attacks. While changing regulations may have led to some safety improvements, it appears they may have also made nuclear reactors more complicated and expensive to construct.[11,12] For that reason, we have only considered reactor construction projects commenced within the past 20 years. We have not considered plants that commenced construction but were then subsequently cancelled or halted.[13]

2. **The technology must be considered safe and secure by Australian allies** – Given the community concern around reactor meltdown risks and our national security interests, and the fact that Russia and China are not members of the Organisation for Economic Co-operation and Development (OECD) Nuclear Energy Agency (which facilitates cooperation

[9] EIA. Plant Vogtle Unit 4 begins commercial operation. 1 May 2024.
[10] EIA. History of Watts Bar Unit 2 Reactivation. 24 March 2021.
[11] Institute for Progress. Why Does Nuclear Power Plant Construction Cost so Much? 1 May 2023.
[12] Washington Post. I oversaw the U.S. nuclear power industry. Now I think it should be banned. 17 May 2019.
[13] In the US, one plant – Virgil C Summer – an AP 1000 design was cancelled part way through construction after cost blow-outs became unmanageable. In Japan construction was halted on two plants – Ohma and Shimane 3 – in the wake of safety concerns after the Fukushima reactor explosion.

and standards on nuclear),[14] [15] Australia is unlikely to consider Russian or Chinese nuclear technology as acceptable. Instead, Australia will almost certainly be limited to using modern third- or fourth-generation designs certified by as safe by European or North American regulators. This is consistent with the Coalition's policy, which references the Westinghouse AP1000 and the Korean APR1400 technology.[16]

3. **Labour market conditions** – Australia is a high wage country, where labour have legally protected rights to organise and to strike as part of the bargaining process. This is particularly pertinent to large construction project sites, such as a nuclear power plant, which tend to have high rates of unionisation and high wages (relative to skill qualifications) even by Australian labour market standards.

4. **Form of government** – Australia is a liberal democracy with a free press, independent judiciary and rule of law, and enshrined rights for peaceful community protest. Where there is significant controversy or community opposition, major construction projects in this country face a range of hurdles and prospects for delay, including legal challenges. Even where these projects have significant government support, governments' ability to ignore or override community opposition is constrained by both the legal and democratic systems. A democratic system with free press is also likely to heighten the level of scrutiny regulators apply to the safety of the reactor build.

5. **Cost transparency** – Part of the challenge of evaluating nuclear build costs is that there is an absence of such builds taking place without extensive government involvement and support. In many cases this government support takes forms that obscure the financial value of the assistance. We looked for cases where these costs were likely to be kept transparent thanks to either transparent economic regulatory filings (such as in the US) or competition law requirements (which operate in the European Union to constrain the use of state aid), or financial market disclosure rules governing publicly listed entities.

6. **Scale of nuclear build program** –The Coalition's plan for a nuclear project build-out involves a small number of power plant sites in total (seven sites, two of which would be SMR only).[17] Each site is likely to host just one or possibly two reactors, due to the scale of the existing coal plant capacity at the sites proposed, and the scale of AP1000 and APR1400 nuclear technology the Coalition has referenced.[18]

   Also, given the need to replace retiring coal plants on a timely basis (and minimise the use of expensive gas), as well as the Coalition's target date for nuclear plant start-up of 2035 for

[14] ATSE. Small modular reactors. July 2024. Page 5.
[15] OECD Nuclear Energy Agency. Member Countries.
[16] Liberal Party of Australia. Australia's Energy Future. 19 June 2024.
[17] Liberal Party of Australia. Australia's Energy Future. 19 June 2024.
[18] Ibid. Note that transmission constraints, electricity demand, water cooling requirements of the power plants, etc. would need to be considered in making decisions around the size and quantity of any proposed reactors. Loy Yang site may have additional capacity if both Loy Yang A and Loy Yang B capacity are utilised.

SMR or 2037 for large-scale, it appears likely that the large-scale reactors across Queensland, NSW and Victoria will almost certainly need to be built at least partly in parallel, rather than consecutively.

This provides little scope for a construction team to build up learning and experience and share construction equipment and infrastructure across multiple reactors, where the learnings from the first reactor can then be incorporated into subsequent reactors to achieve greater speed, efficiency and improved quality in the construction process. Therefore, nuclear build programs involving just one or two reactors at a single site and a relatively small number of projects in total for a country are likely to be the most comparable to what the Coalition has proposed.

Applying this criteria led to selection of the following projects:

- Finland’s Olkiluoto Unit 3.
- France’s Flamanville Unit 3.
- The US’s Vogtle Units 3 and 4.
- The UK's Hinkley Point C.

In addition, IEEFA also included consideration of the Czech Republic’s Dukovany Project, which has just concluded its tender process, even though the plant is yet to commence construction. Given historical experience with nuclear plant construction, the budgeted cost of a project at the tender award stage is highly likely to be an underestimate.[19] Nonetheless, its inclusion was deemed warranted as it is the first deployment of the Korean APR technology (which the Coalition nuclear policy references[20]) in a democratic, developed nation outside of its country of origin.

Also, because there is no experience at all with the construction of a commercial-scale SMRs in a liberal democracy (only Russia and China have built what is said to be SMRs), we have made use of the Utah Associated Municipal Power Systems (UAMPS)’s experience in contract negotiations with NuScale. This project was ultimately cancelled before construction commitment as members of the UAMPS consortia ended up withdrawing due to a blow-out in budgeted costs. Nonetheless, it represents the only example of a SMR design that received US regulatory certification that has managed to reach the stage of providing a firm contract price for construction (noting that its licence was later cancelled by NuScale after design changes[21]). It therefore represents the closest example we could find to a cost somewhat representative of an actual construction cost for an SMR, rather than a hypothesised, designer estimate.

[19] Flyvberg and Gardner. How Big Things Get Done. 2023.
[20] Liberal Party of Australia. Australia's Energy Future. 19 June 2024
[21] The licence was cancelled by NuScale in 2023 as it decided to pursue a larger reactor size. Source: ATSE. Small Modular Reactors. July 2024.

IEEFA notes that South Korea and the United Arab Emirates (UAE) are often used as cost references for nuclear. See the Appendix for a discussion on their lack of applicability to the Australian context given the five factors above.

Large-scale nuclear capital costs

The European Pressured Reactor (EPR) programme was launched in 1992 to revive Europe's nuclear industry following the Chernobyl disaster of 1986. The EPR design intends to offer more efficient, safer nuclear power.[22] However, this next-generation nuclear design has suffered major cost overruns and schedule delays, as detailed in a prior IEEFA report.[23] There have been three EPRs built or under construction in OECD countries in recent years. The costs of these reactors can serve as examples of modern-day nuclear build costs – though it should be noted that not all final cost information is available on these plants, so some capital costs are estimations based on the best sources available. The Coalition proposal suggests that various modern larger nuclear reactor types are under investigation for the initial projects, so it does not seem to be off the table for EPR reactors to be installed.[24]

- **Olkiluoto 3** was a "first of a kind" EPR reactor of 1,600 megawatts (MW).[25] Construction commenced in 2005.[26] It was originally due to start up in 2009. However, commercial operations began in 2023 (representing 18 years construction time).[27,28] This was 14 years behind schedule – due to technical delays, legal disputes and cost overruns. Its price tag rose from EUR3 billion in 2003 to an estimated EUR14.7billion (EUR9.2 per watt for a 1,600MW plant in 2023 euros).[29,30,31] This corresponds to AUD24.3 billion overnight cost (2024 AUD, excluding financing costs).

- **Flamanville 3** is the first nuclear reactor being built in France after its pause in nuclear build since 1999.[32] The first concrete was poured to begin construction of the 1,630MW plant in Dec 2007.[33,34] Flamanville 3 has been plagued by challenges including engineering and design changes, changing safety requirements, poor planning and coordination, damaged fuel rods, and issues with penetration welds on the reactor building.[35] It was originally estimated to cost EUR3.3 billion (overnight cost in 2005 euros), but the construction cost has

[22] Euractiv. French nuclear safety authority greenlights commissioning of Flamanville power plant. 13 May 2024.
[23] IEEFA. European Pressurized Reactors (EPRs). 2 February 2023.
[24] Liberal Party of Australia. Australia's Energy Future. 19 June 2024.
[25] Euro News. Finland's new nuclear reactor: What does it mean for climate goals and energy security? 17 April 2023.
[26] Power Technology. Olkiluoto 3 Nuclear Power Plant, Finland. 8 March 2024.
[27] Power Technology. Olkiluoto 3 Nuclear Power Plant, Finland. 8 March 2024.
[28] International Atomic Energy Agency (IAEA). Olkiluoto 3. Accessed August 2024.
[29] World Nuclear Industry Status Report. The World Nuclear Industry Status Report 2019. September 2019. Page 66.
[30] Montel News. Finland's OL3 to start operation on Mon, 14 years late. 14 April 2023.
[31] 9.2 Euros/Watt in 2023 currency, for a 1,600MW net plant. Rystad. Kjernekraft i Norge. 27 November 2023.
[32] IEEFA. France's nuclear buildout plan must not jeopardise renewables growth. 18 April 2024.
[33] The Guardian. Flamanville: France's beleaguered forerunner to Hinkley Point C. 27 July 2016.
[34] IAEA. FLAMANVILLE-3. Last updated 9 September 2024.
[35] IEEFA. European Pressurized Reactors (EPRs). 2 February 2023.

now blown out to EUR13.2 billion (2015 euros).[36,37] This equates to AUD27.6 billion overnight cost (2024 AUD, excluding financing costs). It is expected by EDF to have first connection before November 2024,[38] and then commercial operation could still be quite some time afterward. The most optimistic scenario would therefore be 17 years construction time (2007 to 2024), but this will likely be slightly longer.

- **Hinkley Point C** is the first nuclear power plant to be built in the UK since 1995.[39] It is being built by French company EDF with support from the UK government, and is made up of two reactors with total net capacity of 3,260MW.[40] In 2007 the then CEO of EDF UK promised the Hinkley project would be "cooking Christmas turkeys" in England by 2017, at a cost of GBP9 billion.[41,42,43] It is now expected by EDF to open in 2030 in a base case scenario, with a cost of completion (excluding interim interest) of up to GBP46.5bn in current value.[44] This equates to AUD89.7 billion. Construction began in 2018 for the first reactor and 2019 for the second reactor, so minimum construction length would be around 11 years.[45]

There are a few other types of reactors recently installed or to be installed in economies comparable to Australia that are the same or a similar design to the design that the Coalition has suggested it might initially select: "A Federal Coalition Government will initially develop two establishment projects using either small modular reactors or modern larger plants such as the AP1000 or APR1400".[46]

- At the **Vogtle** plant in Georgia in the US, two additional AP1000 nuclear reactor units were built at an existing nuclear power plant site – the first new nuclear units to be constructed in the US in more than 30 years.[47] Construction began in 2013 on both units.[48] The two new reactors were originally expected to cost around USD9.7 billion (overnight cost, in 2009) and be in service by 2017.[49,50] However the final overnight cost of the two reactors was estimated by MIT to be USD11,000 per kilowatt (kW).[51] IEEFA calculates this to equal USD24.6 billion in 2024 dollars (AUD37 billion) – though financing costs of Vogtle have pushed the project cost

[36] World Nuclear Association. Nuclear Power in France. 21 May 2024.
[37] EDF. Update on the Flamanville EPR. 16 December 2022.
[38] EDF. Update on the Flamanville EPR: launch of reactor divergence operations. 2 September 2024.
[39] UK Government. Nuclear capacity in the UK.
[40] EDF. Hinkley Point C – Building Britain's low-carbon future . July 2016. Page 2.
[41] University of Sussex. Will we ever be cooking Christmas turkeys from Hinkley C? 20 November 2014.
[42] Beyond Nuclear International. What a turkey. 31 January 2024.
[43] RenewEconomy. French nuclear giant scraps SMR plans due to soaring costs, will start over. 2 July 2024. Note: IEEFA assumes the cost quoted is in 2007 GBP.
[44] EDF. 2024 Half Year Results. July 2024. Values quoted are for the base case scenario (scenario ii).
[45] IAEA. Hinkley Point C-1. Accessed August 2024. *Hinkley point C1 started construction December 2018*. | IAEA. Hinkley Point C-2. Accessed August 2024. *Hinkley point C2 started construction December 2019*.
[46] Liberal Party of Australia . Australia's Energy Future. 19 June 2024.
[47] Georgia Power. Vogtle Fun Facts. Accessed 21 August 2024.
[48] World Nuclear News. Vogtle 4 start-up moved to 2024. 9 October 2023. | IAEA. Vogtle-3. Accessed August 2024. *Vogtle 3: construction start 2013 and commercial operation 2023*. | IAEA. Vogtle-4. Accessed August 2024. *Vogtle 4: construction start 2013 and commercial operation 2024.*
[49] IEEFA. Southern Company's Troubled Vogtle Nuclear Project. 1 January 2022.
[50] GPB. A second new nuclear reactor is completed in Georgia. The carbon-free power comes at a high price. 29 April 2024.
[51] MIT. 2024 Total Cost Projection of Next AP1000. July 2024. Page 11.

up to around USD35 billion.[52] Commercial operation of each Vogtle unit was achieved by 2023 and 2024 – around seven years later than expected.[53] This means the construction time for the fastest reactor unit was 10 years.

Of note is that there were another two AP1000 reactors which commenced construction in South Carolina around a similar time at the Virgil C Summer site. However, after major budget blow outs and the bankruptcy of Westinghouse, construction was ultimately abandoned by its owner on the basis that completing the plants would be "prohibitively expensive."[54]

- At **Dukovany** in the Czech Republic, a nuclear power plant expansion is planned at an existing nuclear power station site. The Czech Republic government has selected the preferred bidder for the project build – Korea Hydro & Nuclear Power Company (KHNP).[55] KHNP's reactor design that will be installed is the APR1000.[56] The project will likely consist of two new reactor units, constructed in one location (Dukovany) at the same time, and currently KHNP's bid for the project is CZK200 billion per unit.[57,58] Owners cost would be on top of this, which IEEFA has estimated at 14% based on MIT research.[59] This gives a total overnight cost of AUD29.8 billion (excluding financing costs) however cost increases could occur as this project is still in very early stages. A building permit is expected to be secured by 2029, with trial operation to start in 2036, followed by commercial operation in 2038 (this gives expected construction time of about nine years).[60] The Czech Republic Minister of Industry and Trade stated: "The option of building two units on one site will also ensure that much of the work will not have to be done twice and will allow economies of scale to be exploited, leading to significant cost reductions. Specifically, about 20 percent per unit."[61]

It should be noted that this section explored the overnight costs of nuclear power plants which exclude financing costs incurred throughout construction. All-in costs, which include financing costs, are much higher particularly if construction schedules are long. For all-in costs estimated in the Australian context, see the Appendix.

[52] MIT. 2024 Total Cost Projection of Next AP1000. July 2024. Page 11.
[53] GPB. A second new nuclear reactor is completed in Georgia. The carbon-free power comes at a high price. 29 April 2024.
[54] Washington Post. S.C. utilities halt work on new nuclear reactors, dimming the prospects for a nuclear energy revival. 2017.
[55] DW. Surprise as Czechia picks S. Korea to power nuclear drive. 23 July 2024.
[56] World Nuclear News. KHNP selected to supply new Czech nuclear units. 17 July 2024.
[57] AP. Korea's KHNP selected to build at least 2 new nuclear reactors in Czech Republic. 17 July 2024.
[58] Government of the Czech Republic. The Government Has Decided on a Preferred Supplier for the New Nuclear Power Source at Dukovany. 17 July 2024.
[59] MIT. 2024 Total Cost Projection of Next AP1000. July 2024.
[60] Government of the Czech Republic. The Government Has Decided on a Preferred Supplier for the New Nuclear Power Source at Dukovany. 17 July 2024.
[61] Government of the Czech Republic. The Government Has Decided on a Preferred Supplier for the New Nuclear Power Source at Dukovany. 17 July 2024.

SMR capital costs

Small modular reactors (SMRs) are a newer type of nuclear power generation technology. SMR designs have a power capacity up to 300MW per unit – around a third of the size of a traditional nuclear power reactor unit. The nuclear industry is aiming for a modular design so that SMRs can be assembled offsite at factories and transported onsite for installation. The reactors in these designs use nuclear fission to generate heat to produce electricity, like conventional large-scale nuclear reactors.[62] SMRs could be scaled down conventional uranium-fuelled-water-moderated reactors (e.g. Russia's floating plant), or any number of alternative designs with different fuels, moderators and coolants (e.g. China's high-temperature gas-cooled reactor, HTGR).

Currently there are no licensed designs, or constructed or operating SMRs in Australia or in any OECD countries, according to the Australian Academy of Technological Sciences & Engineering (ATSE). "OECD SMR developers have not yet built and operated a full-scale prototype SMR."[63] As SMRs are currently unproven, estimating SMR costs is fraught with uncertainty. Any cost estimations, including those in this report, need to be taken with a large grain of salt.

There are only three so-called SMRs in operation around the world, to IEEFA's knowledge. There are two floating SMR units on a ship in Russia, and one operating HTGR in Shidao Bay in China.[64] However, there is very little technical design or cost information available about these projects. Further, Russian and Chinese reactor designs cannot be commercialised in an OECD setting as Russia and China are not members of the OECD Nuclear Energy Agency, which facilitates cooperation and standards on nuclear.[65] These reactors also don't meet the six criteria outlined above. Thus, these examples have been excluded from this nuclear cost analysis.

There are a number of proposed SMRs worldwide, including the TerraPower Natrium reactor and the X-energy SMR, both in the US, and the GE Hitachi SMR, proposed in Canada.[66,67,68] The costs of these projects are anticipated to be high, but they remain uncertain as the projects are in early stages, so they have not been included in this report to indicate potential SMR costs in Australia. There is also a pilot SMR project called CAREM25 in Argentina that is under construction. However this has also not been used to indicate SMR costs in Australia as it is a very small pilot project of only 25MW, so costs would likely not be indicative of a ~300MW reactor. See the Appendix for further information on these SMRs.

The SMR that was furthest progressed in an OECD country, having got to the contract pricing stage, and therefore for which the capital cost data is most reliable, is the NuScale SMR reactor that was

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[62] IAEA. What are Small Modular Reactors (SMRs)? 13 September 2023.
[63] ATSE. Small modular reactors. July 2024. Page 9.
[64] IEEFA. Small Modular Reactors: Still Too Expensive, Too Slow and Too Risky. 29 May 2024.
[65] ATSE. Small modular reactors. July 2024. Page 5.
[66] AP. In Wyoming, Bill Gates moves ahead with nuclear project aimed at revolutionizing power generation. 16 August 2024.
[67] X Energy. Small Modular Nuclear Reactor: Xe-100. Accessed 21 August 2024.
[68] Pipeline Online. Four reactors could cost Saskatchewan $12 to $20 billion. The feds just gave us $74 million. 21 August 2023.

proposed in Idaho, US. The anticipated cost of this now cancelled SMR can indicate potential nuclear SMR costs in Australia.

- The **NuScale** 462MW reactor proposed to be built in Idaho, US, was in development since 2000 and was cancelled in 2023.[69,70] It should be noted that the term "small" is relative against large-scale nuclear: the NuScale SMR was anticipated to weigh 700 tonnes.[71] This is about 100 times heavier than an elephant.[72] The construction cost of the project blew out. In 2022, IEEFA reported that: "In 2016, the company's chief commercial officer, Mike McGough, said NuScale's SMR could be built for $5,078/kW (in 2014 [US] dollars)."[73] In 2024 Australian dollars, this equates to AUD10,167 /kW for the original reactor size of 720MW. The latest estimate of the project reported was around three times this: CSIRO have documented the cost at AUD28,581/kW (2023 AUD, which IEEFA converts to 2024 AUD to give AUD28,881/kW).[74] NuScale has announced it expected a construction time of 3.25 years.[75] It should be noted that this is much faster than the Russian and Chinese so-called SMRs which took 12-13 years to construct.[76]

Capital cost discussion

It is clear that the capital cost of nuclear is high from the examples examined. The overnight capital cost ranges from AUD14,901/kW (Dukovany) to AUD27,500/kW (Hinkley Point C) for large-scale nuclear, and is sitting at AUD28,881/kW for SMR.

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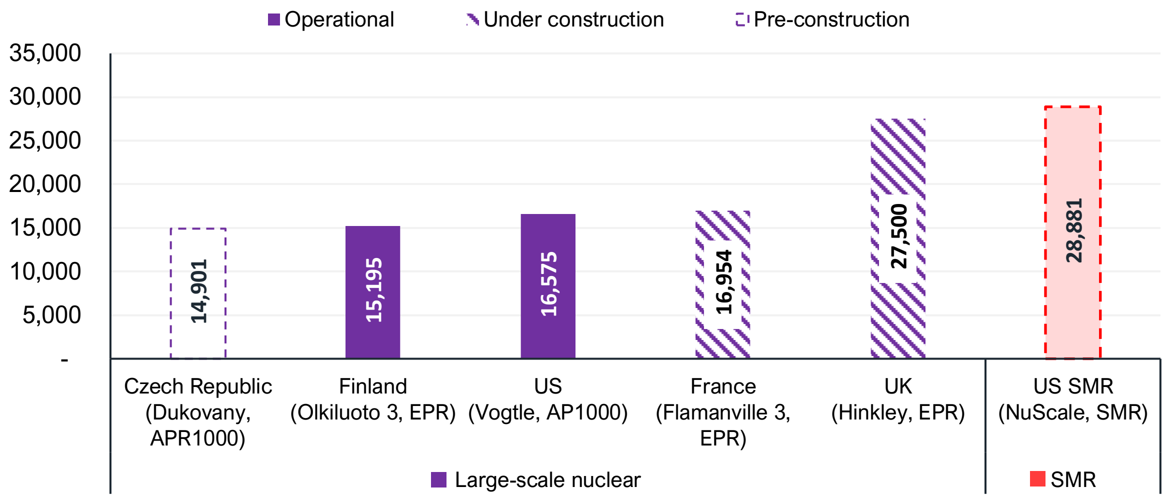
[69] IEEFA. NuScale's small modular reactor. 1 February 2022.
[70] TheChemicalEngineer. NuScale cancels first planned SMR nuclear project due to lack of interest. 21 November 2023.
[71] ATSE. Small modular reactors. July 2024.
[72] The Measure of Things. How heavy is 700 tons?. Accessed 21 August 2024.
[73] IEEFA. NuScale's Small Modular Reactor. 1 February 2022.
[74] CSIRO. GenCost 2023-24. May 2024. Note: CSIRO's GenCost has found that this cost does include some interest expenses from the pre-construction phase of the project, so CSIRO removes USD1,588/kW from the capital cost. CSIRO also removes AUD100/kW of transmission costs, which might also be included. IEEFA adopts this same approach, using CSIRO's capital cost of AUD28,581/kW (2023 AUD, which IEEFA converts to 2024 AUD to give AUD28,881/kW).
[75] NuScale. Small Modular Reactor. Accessed August 2024.
[76] IEEFA. SMRs: Still Too Expensive, Too Slow and Too Risky. May 2024.

Figure 5: Capital cost of selected international nuclear projects (2024 AUD/kW – overnight cost, excludes financing costs)



Source: IEEFA calculations and various sources as indicated throughout this report. Note: NuScale project was cancelled before construction start.

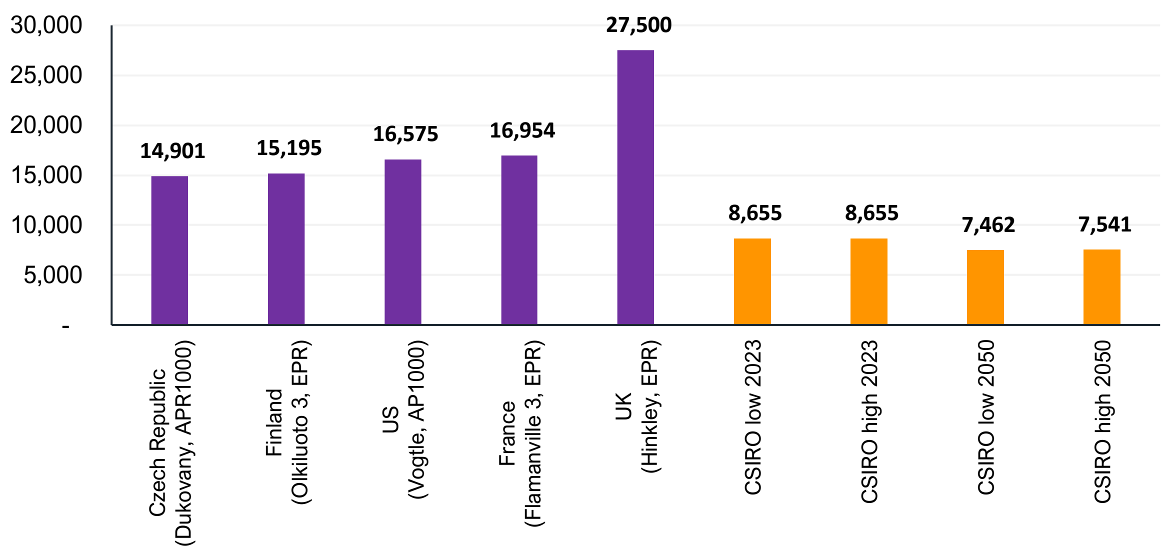
An assumption of declining costs over time is quite commonly embedded within economic modelling of the future cost of nuclear power, where the model attempts to estimate what is expected to happen to future cost after experience is gained from building several reactors. This is often termed the "nth-of-a-kind" (or NOAK) cost, as in the cost after a certain, often vaguely defined, number (denoted as "N") of reactors have been built. The problem with this theory is that it isn't well supported by historical evidence for most western democratic countries. It's also highly uncertain just how many reactors of a particular design need to be built at a global and a local level before you could reliably get to the nth-of-a-kind cost.

In terms of the French EPR design, construction costs rose from Olkiluoto 3 to Flamanville 3 then to Hinkley Point C which arrives at four reactors in total across Europe (Hinkley has two reactors). If you include the ultimately abandoned Virgil C Summer's two reactors, the US is up to its fourth AP1000 reactor, yet costs remain very high. Note this is for regions with significant capability and experience in nuclear which Australia lacks. The Coalition is proposing a maximum of five large-scale nuclear power plants in Australia and has not clarified what this means in terms of the number of reactors. If these plants involve just one reactor each then the prospects for learning based cost reductions appears small.

Yet this history of rising costs over time in nuclear build extends back even further than the EPR and AP1000 designs. The historical evidence shows that in the US, France, Germany and Japan, nuclear costs trended up over time.[77,78,79] Only in South Korea have construction costs seemed to steadily decrease.[80]

This nth-of-a-kind theoretical costing approach is part of the reason why CSIRO's GenCost estimates of nuclear costs are out of alignment with recent, real-world international experience detailed in this report (see chart below). In spite of the fact that South Korea is an outlier, and evidence from the recent Czech Republic tender indicating they are unable to replicate home country build costs in other developed nations, they were used in the CSIRO GenCost report as the indicator for what nuclear power might cost in Australia.

Figure 6: Overnight capital cost of international plants compared with CSIRO GenCost (AUD/kW)



Source: CSIRO GenCost, IEEFA calculations and various sources as indicated throughout this report.

According to the CSIRO, South Korea was selected because it was best indicative of a continuous build program that might realise NOAK costs. CSIRO states: "South Korea's nuclear plant costs can therefore be considered as an example of NOAK costs, which Australia may achieve if between 5 to 10 units are built on a continuous basis (US DOE 2023)."[81] Evidence suggests South Korea, unlike most other nations, has certainly been able to capture cost reductions by learning effects and other efficiencies through the replication of multiple reactor units. Yet the question is could these be replicated in Australia? Since the 1970s the Koreans have built 26 reactors, all concentrated within just four locations. [82] The Coalition's plan meanwhile might be just five reactors of the same type

[77] Hultman, Koomey, Kammen. What history can teach us about the future costs of US nuclear power. 1 April 2007.
[78] Grubler.The costs of the French nuclear scale-up: A case of negative learning by doing. September 2010.
[79] IFP. Why Does Nuclear Power Plant Construction Cost So Much? 1 May 2023.
[80] IFP. Why Does Nuclear Power Plant Construction Cost So Much? 1 May 2023.
[81] CSIRO. GenCost 2023-24. May 2024. Page 32.
[82] World Nuclear Association. Nuclear Power in South Korea. 3 May 2024.

dispersed over five locations plus two SMRs. Further discussion on the replicability of Korean experience in Australia is provided within the Appendix.

Levelised cost of electricity

The capital costs of various nuclear power plant projects can be converted into a levelised cost of electricity (LCOE) – the cost of electricity generated on a per-MWh basis – which includes capital cost, ongoing operations and maintenance (O&M), and fuel cost.

To do this, IEEFA used the National Renewable Energy Laboratory (NREL) 2024 Annual Technology Baseline to determine the all-in costs for Australian nuclear, which includes financing costs during construction (using a discount rate of 6% aligning with CSIRO's GenCost).[83] Financing costs are sensitive to construction timelines – longer construction timelines increase the all-in cost of nuclear projects significantly. The best available information has been used on construction times.[84]

Then IEEFA used CSIRO's LCOE calculator to calculate the LCOE using the all-in costs and the following assumptions. See the Appendix for the full assumption list.

- O&M costs, fuel costs, efficiency and discount rates: used CSIRO LCOE assumptions.[85]
- Economic lifetime: An economic lifetime of 60 years was used rather than CSIRO's assumption of 30 years.[86] We note the Coalition asked CSIRO to model 80 years economic life.[87] We do not see evidence for 80 years technical lifetime from the relevant nuclear reactor manufacturers' datasheets and media reports, though a number of manufacturers state that the technical lifetime of certain nuclear reactors is 60 years. The International Atomic Energy Agency (IAEA) states "the operating life of a nuclear power plant is typically 40 years in the USA, 12 years in India, and in Brazil it started with 20 years but this has now been extended to 30 years."[88] IEEFA expects beyond the 20-, 30- or 40-year mark, costly refurbishments would be required, so using an economic lifetime of 60 years as we have in this study is likely to understate nuclear LCOE. However, we have attempted to replicate within technically reasonable bounds the Coalition's proposal.
- Capacity factor: IEEFA assumed that nuclear in Australia would achieve a capacity factor of 92.7% reflecting the Coalition's expectation (based on the performance of plants in the US).[89] IEEFA notes that the EIA reports this 92.7% average annual capacity factor in the US for

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[83] NREL. 2024 Annual Technology Baseline (ATB) Excel Workbook. 25 June 2024.
[84] See prior section on capital costs of large-scale nuclear and SMR for assumptions on construction times.
[85] CSIRO. GenCost project data: GenCost2023-24FinalApxTables_20240522.xlsx. 21 May 2024.
[86] KHNP. APR1000 – Advanced Power Reactor 1000. 2019. | Power Technology. Olkiluoto 3 Nuclear Power Plant, Finland. 8 March 2024. | BBC. Hinkley C: UK nuclear plant price tag could rocket by a third. 24 January 2024. | Power Technology. Flamanville 3 Nuclear Power Plant, Normandy. 7 August 2017. | IAEA. Status report 81 - Advanced Passive PWR (AP 1000). | The Breakthrough Institute. Can NuScale's SMR Compete With Natural Gas? 8 September 2020.
[87] The Guardian. CSIRO stands by nuclear power costings that contradict Coalition claims. 29 May 2024.
[88] IAEA. Economic Performance Indicators for Nuclear Power Plants. 2006. Page 8.
[89] The Guardian. CSIRO stands by nuclear power costings that contradict Coalition claims. 29 May 2024.

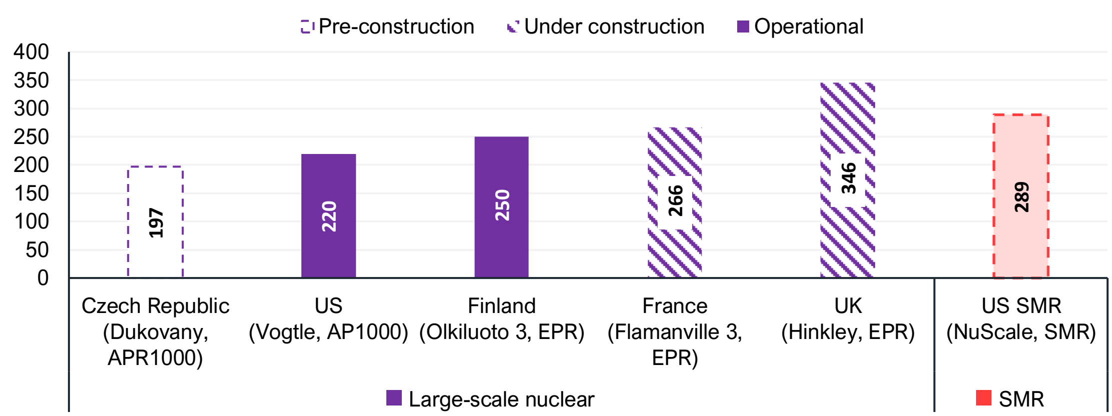
2021.[90] However, this data is out of date, and IEEFA theorises that the nuclear capacity factor would likely decline over time as renewables penetration increases – as is being seen with coal power in Australia.[91] The World Nuclear Association reports that in 2023 the global average capacity factor was 81.5% in 2023 and 80.4% in 2022.[92] Therefore, IEEFA's assumption on capacity factor may underestimate nuclear costs – but once again, this study attempts to model the energy bill impact of the Coalition's proposal.

It should be noted that the LCOEs presented in this report do not reflect the real-world LCOE of these reactors internationally, but rather the LCOE in the Australian context if we use international capital costs and construction times, potential technical design lifetime as economic life, and Australian CSIRO/AEMO assumptions on efficiency, O&M costs, fuel costs and discount rate. Further, the LCOE costs do not include provisions for decommissioning, in line with CSIRO's GenCost methodology.

The levelised cost of nuclear power consists mainly of the capital cost. Operation, maintenance and fuel costs are comparatively small. The economics of nuclear power are therefore sensitive to longer construction timelines, capital cost increases and interest rates. See the Appendix for the breakdown of assumptions and cost components of LCOE.

The graph below shows the LCOE for our range of nuclear cost recovery scenarios if plants with similar costs and characteristics were built in Australia. They would require a LCOE from AUD197/MWh to AUD346/MWh. The three EPRs (Olkiluoto 3, Flamanville 3 and Hinkley Point C) in the Australian context would see an LCOE between AUD250/MWh to AUD346/MWh. The recently completed Vogtle plant implies an LCOE of 220/MWh in the Australian context and the announced Dukovany project shows the lowest indicative LCOE of AUD197/MWh.

Figure 7: LCOE of various nuclear power plants in Australian context (AUD/MWh)



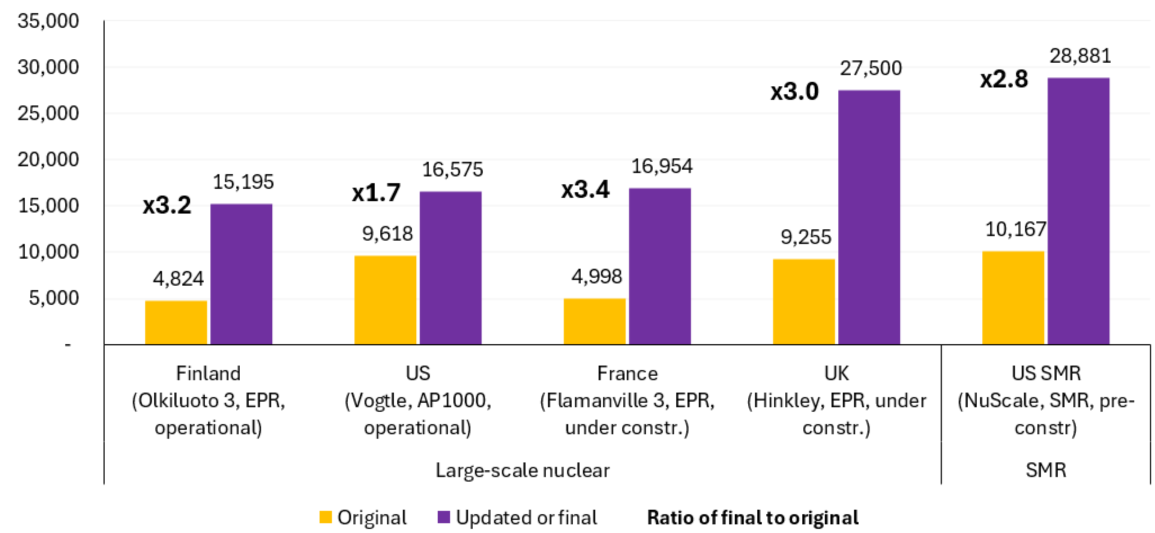
Source: Per discussion above, and IEEFA calculations.

[90] EIA. Nuclear explained: US nuclear statistics data as at 2021. Accessed 22 August 2024.
[91] IEEFA. Fast Erosion of Coal Plant Profits in the National Electricity Market. 24 February 2021.
[92] World Nuclear Association. Global Nuclear Industry Performance. Updated Tuesday 20 August 2024.

Nuclear costs tend to blow out, so financial risks are significant

Nuclear power plants have a history of cost blow-outs. From the recent experience of the proposed or under-construction nuclear power stations in Europe and the US, final capital costs have escalated from the original estimations by a factor of between 1.7 and 3.4.

Figure 8: Overnight capital costs – original compared with final/updated cost (AUD/kW) and ratio of final/updated cost to original



Source: Per discussion above and IEEFA calculations

Professor Paul Joskow, a leading electricity market economist and former head of economics at Massachusetts Institute of Technology (MIT), emphatically observes: "Nobody has ever overestimated the construction cost of a nuclear power plant at the pre-construction stage."[93] On nuclear construction cost estimates, Joskow comments: "The best estimates are drawn from actual experience rather than engineering cost models."[94]

These cost blow-outs lead to sometimes insurmountable challenges for investors. A number of companies have faced bankruptcy or severe financial distress from attempting to build, or from building, nuclear power stations. All the conventional nuclear projects built in the US and Europe in recent years – Vogtle, Olkiluoto, Hinkley and Flamanville – have caused financial difficulties for the companies involved.

[93] MIT. Prospectus for Nuclear Power - A US Perspective. 19 May 2006. Page 20.
[94] Ibid. Page 18.

- **Westinghouse** struggled with cost overruns and delays in the US while constructing two AP1000 new nuclear reactors at the **Vogtle** plant in Georgia, and two reactors at the **Virgil C Summer** plant in South Carolina (which were later abandoned in 2017). After the cost overruns, Westinghouse Electric Company filed for Chapter 11 bankruptcy protection in 2017.[95]
- **Toshiba** in 2017 faced a financial crisis due to its ownership of Westinghouse and the associated losses from its nuclear projects **Vogtle and Virgil C Summer.** Toshiba shares lost half their value after the nuclear problems surfaced.[96] The company sold its memory chip business in 2018 to support itself.[97] Toshiba eventually sold its stake in Westinghouse.[98]
- **SCANA Corporation**'s USD9 billion effort to build two new nuclear reactors at the **Virgil C Summer** plant in South Carolina was tainted by years of mismanagement, cost overruns and construction delays. SCANA struggled financially and was eventually acquired by Dominion Energy in 2019. Customers of SCANA's flagship subsidiary SCE&G paid more than USD2 billion in the form of higher power bills for the failed Virgil C Summer project. [99]
- **AREVA** suffered massive losses due to delays and cost overruns in the construction of the **Olkiluoto 3** nuclear reactor in Finland for the Finnish utility TVO. [100,101] There has been a long running legal dispute between AREVA and TVO over cost overruns and delays.[102] In 2015 AREVA Group faced technical bankruptcy, with a major contributor to that being the Olkiluoto 3 cost overruns.[103] AREVA was eventually restructured, with its reactor business being renamed Framatome and sold to EDF.[104]
- **EDF** saw a write down of approximately EUR13bn on the **Hinkley Point C** power plant project, after delays and cost overruns. The cost overruns of the project have reportedly caused international tensions between Britain and the French government, who now owns EDF after the full nationalisation of the company. [105] China General Nuclear (CGN) walked away from the project in December 2023.[106]
- **EDF** faced financial strain due to the escalating costs and delays at **Flamanville 3**. The project impacted EDF's financial position, exacerbating the company's broader financial

[95] The Guardian. Westinghouse bankruptcy move casts shadow over world nuclear industry.29 March 2017.
[96] Reuters. Huge nuclear cost overruns push Toshiba's Westinghouse into bankruptcy. 30 March 2017.
[97] BBC. Japan's Toshiba set to end 74-year stock market history. 21 September 2023.
[98] Reuters. Toshiba after the Westinghouse sale. 6 January 2018.
[99] The State. Dominion completes buyout of SCANA after 17-month nuclear fiasco. 2 January 2019.
[100] CarbonBrief. New nuclear: Finland's cautionary tale for the UK. 20 October 2015.
[101] Power. As Nuclear Giant AREVA Reforms, Framatome Is Resurrected. 1 March 2018.
[102] TVO. TVO confirms a settlement agreement signed on OL3 EPR project completion and related disputes. 12 March 2018. World Nuclear News. Olkiluoto 3 EPR parties agree settlement. 12 March 2018.
[103] World Nuclear Industry Status Report. Europe's First EPR: 13 Years Behind Schedule, Olkiluoto-3 in Finland Starts Up. 25 March 2022.
[104] Power. As Nuclear Giant AREVA Reforms, Framatome Is Resurrected. 1 March 2018.
[105] The Guardian. EDF takes €12.9bn hit after Hinkley Point C delays and cost overruns. 16 February 2024.
[106] Bloomberg. China's CGN Halts Funding for UK's Hinkley Nuclear Plant. 14 December 2023.

challenges, including high debt levels. In 2022 the President of France Emmanuel Macron decided to fully nationalise EDF.[107]

These examples illustrate the financial risks associated with nuclear power plant construction, particularly those flowing from cost overruns and delays. In light of these higher risks a rational commercial investor would demand a financial return or charge an interest rate that is noticeably higher than the generic weighted average cost of capital applied in the CSIRO GenCost to all technologies and which we have used in this analysis (6%). In that respect we have effectively understated the price nuclear power plants would need to receive based on private sector commercial requirements.

In this particular case, the Coalition has proposed government ownership of nuclear power plants, stating: "The Australian Government will own these assets, but form partnerships with experienced nuclear companies to build and operate them."[108] As seen with Snowy 2.0, a fixed price contract, even with an experienced construction firm, doesn't form a perfect shield against the impact of construction cost and time overruns.[109] Also, just because government can access finance at low rates, it doesn't mean that taxpayers should ignore the risks of investing this money into construction of a nuclear power plant.

High cost of nuclear hits power bills or public funds

So who pays for the high cost of nuclear power plants?

This depends on the electricity market structure, and whether government subsidies are granted to the project. As a general rule, the cost of electricity generation technologies is borne by electricity consumers or governments (taxpayers), or a mix of the two. Nuclear power plants are high capital cost technology. Once the high capital costs have been paid down (depreciated), the majority of any remaining project costs are operational and maintenance costs only.

CSIRO notes that: "Observations of low cost nuclear electricity overseas are in most cases referring to historical rather than new projects which could have been funded by governments or whose capital costs have already been recovered by investors. Either of these circumstances could mean that those existing nuclear plants are charging lower than the electricity price that would be required to recover the costs of new commercial nuclear deployment. Such prices are not available to countries that do not have existing nuclear generation such as Australia."[110]

Further, interpreting data on retail electricity price differences between countries to understand different generation technology costs is challenging, because power bills include the costs of

[107] Nuclear Engineering International. French government wins court approval for EDF nationalisation. 9 May 2023.
[108] Liberal Party of Australia . Australia's Energy Future. 19 June 2024.
[109] Australian Financial Review. Snowy needs $3b extra capital as 2.0 costs blow out. 31 August 2023.
[110] CSIRO. GenCost 2023-24. May 2024. Page 33.

networks, taxes and other fees, rather than just the costs associated with electricity generation technologies.[111]

So, what do we know about electricity system costs in countries with nuclear?

Ontario

The Coalition has cited Ontario, Canada, as a state with lower power prices in a high nuclear grid (59% nuclear).[112] However, Ontario's lower retail electricity bill costs are largely a function of low network costs and government power price subsidies. Ontario consumers pay for network costs via a charge which is separate to their kWh price charges and is denoted on the bill as "delivery",[113] whereas in Australia network fees make up a large proportion of kWh price charges.

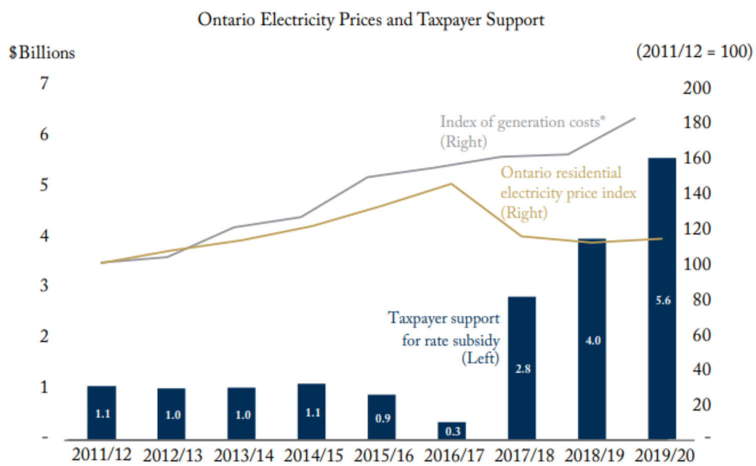
More importantly, disastrous blow-outs in the cost of Ontario's nuclear build program aren't fully reflected in current power prices. In fact, Ontario was forced to undertake a major restructure of its electricity sector in the 1990's due to the fact that the state-owned utility had accumulated unsustainable debts of CAD38.1 billion (as at 1999) due to large cost blow-outs in its nuclear build program and poor utilisation of these assets. Under this restructure, CAD20.9 billion (1999 Canadian dollars) of Ontario Hydro's debt was declared by the Ontario Electricity Financial Corporation as stranded debt which "cannot reasonably be serviced and retired in a competitive electricity market."[114]

It is also important to note there is a large annual subsidy costing billions of dollars each year from the government to energy companies.[115] This artificially lowers electricity bills, as shown in Figure 9 below.[116]

Further, in Ontario, electricity prices are regulated.[117] Nuclear power generators don't need to recover their costs via a competitive wholesale market. Instead, there is a specific regulated levy that consumers have to pay to Ontario Power Generation for it to recover the costs associated with its nuclear power plants. The decision and order EB-2020-0290 sets out the total amount Ontario Power Generation can recover from consumers each year from 2022 to 2026.[118] The total nuclear payments range from CAD104-CAD118/MWh over 2022-2026 – and this is for nuclear power plants built several decades ago and for which much of the construction cost was written off as unsustainable debt.

[111] https://www.aap.com.au/factcheck/barnaby-joyce-wrong-on-international-power-price-comparison/
[112] Peter Dutton. Leader of the Opposition – Transcript – Joint Doorstop Interview with the Hon Barnaby Joyce MP and Cr Steve Reynolds, Muswellbrook. 24 July 2024.
[113] Ontario Energy Board. Bill Calculator.
[114] Ontario Electricity Financial Corporation. Annual Report. 1 April 1999 to 31 March 2000.
[115] The Guardian. Dutton praises Canada to sell nuclear plan. But does Ontario really have cheaper power? 1 August 2024.
[116] C.D. Howe Institute. The Price of Power: Comparative Electricity Costs across Provinces. October 2020.
[117] Ontario Energy Board. Regulated Price Plan. 24 March 2024.
[118] Ontario Energy Board. Decision and Order EB-2020-0290. 15 November 2021.

Figure 9: Ontario electricity prices and taxpayer support



Source: C.D. HOWE Institute.[119]
Note: Generating costs are the sum of Hourly Ontario Energy Price (HOEP) and Global Adjustment (GA) (from IESO) converted from monthly costs to Ontario fiscal year (March 31 year-end) annual indices. Sources: Ontario government public accounts and expenditure estimates; Ontario Independent Electricity System Operator (IESO); Ontario Electricity Financial Corporation (OEFC) annual reports.

A regulated monopoly electricity market structure is also seen in Georgia, where the Vogtle nuclear power plant is located. [120]

France

In France, the nuclear fleet was already 75% amortised in 2010, and by now that figure would be higher.[121] This means that the nuclear capital cost to be recovered through electricity pricing in France is not fully indicative of the cost of a new nuclear power plant.

The selling price of nuclear power has been regulated in France at an average of EUR70/MWh.[122] Further, electricity prices are subsidised – this was projected to cost EUR45 billion in 2023.[123]

In France the government owns EDF and AREVA/Framatome – having taken on increasing government ownership of these companies over time as they faced financial challenges and high debt levels. EDF was nationalised in 2022.[124] EDF produced its lowest amount of electricity in 30 years in 2022. Many nuclear reactors had been taken offline as corrosion was found in emergency cooling systems.[125]

[119] C.D. Howe Institute. The Price of Power: Comparative Electricity Costs across Provinces. October 2020.
[120] Southface. Understanding the Electricity System in Georgia. May 2018.
[121] Cour Des Comptes. The costs of the nuclear power sector. January 2012.
[122] Euractiv. France to regulate nuclear electricity sales price at €70/MWh on average. 15 November 2023.
[123] Lemonde. France to continue subsidizing electricity bills until 2025. 21 April 2023.
[124] Nuclear Engineering International. French government wins court approval for EDF nationalisation. 9 May 2023.
[125] Lemonde. France to continue subsidizing electricity bills until 2025. 21 April 2023.

Subsidies and regulated prices in France obscure the full costs of nuclear borne by energy consumers and taxpayers.

UK

In the UK, most existing reactors are Advanced Gas-cooled Reactors (AGR), which were designed with a 25-year life expectancy and were commissioned in the 1970s and 1980s.[126] Their initial capital costs are very likely fully depreciated by now.[127] One exception is Sizewell B, commissioned in 1995. This is a Pressurised Water Reactor (PWR) type plant, which may be designed with a 40-year life and is most likely only partially depreciated.[128] This means that power prices are currently not indicative of the cost of new nuclear power in the UK.

The UK government owned the original nuclear power fleet in the UK, and when the UK power sector was being privatised in the 1990s there was limited private sector interest in acquiring the nuclear power stations. Eventually a private company British Energy took over the eight most modern UK power plants, but it soon experienced financial challenges and received a GBP3bn bailout from the government.[129] British Energy was eventually sold to France's EDF.[130]

Hinkley Point C will be supported by a government CFD, to provide a floor price in the event the power station cannot earn adequate revenue in the electricity market.[131]

In 2022 a new instrument was introduced to help new nuclear power plants recover their high capital costs. The Nuclear Energy (Financing) Act 2022 introduced the option of a Regulated Asset Base (RAB) model to help fund future nuclear energy projects.[132]

Australian context

In Australia, the Coalition has stated that the new nuclear power plants will be commercial power plants.[133] This means they would make a commercial return with their costs recovered through the electricity market. Since the Coalition anticipates the plants would run with 92.7% capacity factor, wholesale electricity market prices would need to be high enough to cover nuclear costs most of the time. This means wholesale costs for consumers would need to rise to nuclear cost levels. We have therefore completed this analysis under the assumption that the full costs of nuclear would be passed through to electricity bills.

[126] Investment Monitor. A history of radioactive decay: who really messed up the UK's nuclear industry? 25 May 2022.
[127] Note: however a number have had investments to extend their useful life to 40 years.
[128] UK Parliament. The future of the Advanced Gas-cooled Reactors. 20 May 2022.
[129] The Guardian. Hinkley Point: the 'dreadful deal' behind the world's most expensive power plant. 21 December 2017.
[130] Investment Monitor. A history of radioactive decay: who really messed up the UK's nuclear industry? 25 May 2022.
[131] Renewable Press. Hinkley Point C: Electricity from new British nuclear power plant costs over 15 cents per kilowatt hour. 21 December 2023.
[132] Ofgem. Nuclear Regulated Asset Base (RAB) model. Accessed August 2024.
[133] Angus Taylor. National Press Club Q & A - Wednesday 22 May 2024. 27 May 2024.

In a scenario where nuclear were supported by government subsidies, nuclear costs would still be borne by the public – but via taxes, rather than electricity bills.

The Coalition has also stated that it proposes to own the nuclear power plants meaning that the project would be publicly financed, although Shadow Treasurer Angus Taylor has indicated they would operate as a commercially viable entity, in a similar manner to how Snowy Hydro currently operates in the electricity market.

Current power bills

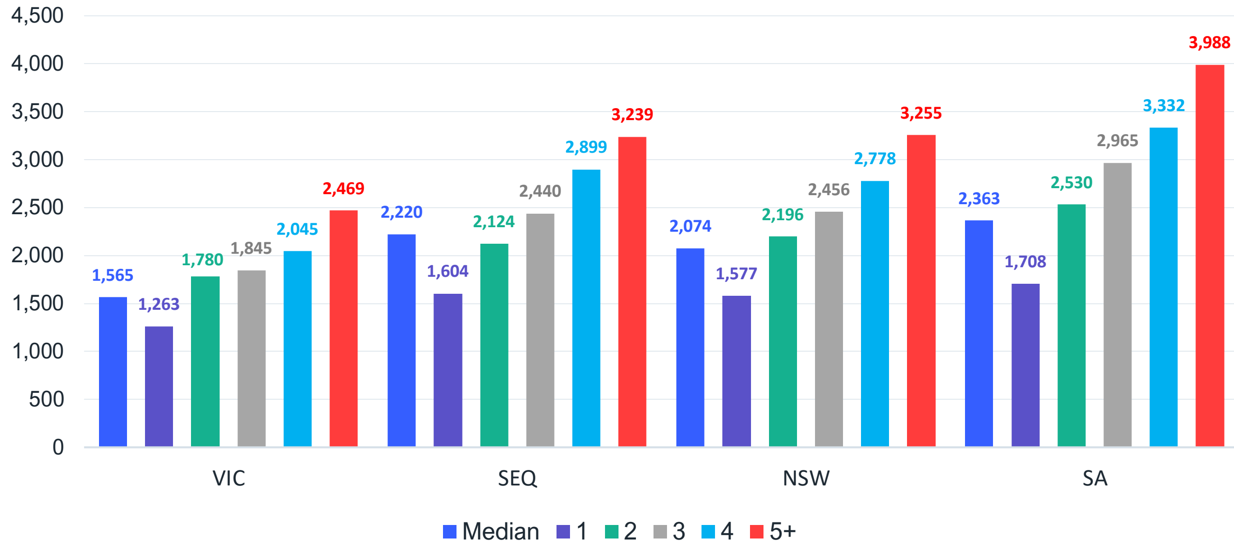
Current power bills in key National Electricity Market (NEM) regions have been analysed by taking the current flat rate electricity tariffs for the big three retailers (which had a 63% share of the retail market in 2023[134]) from Energy Made Easy[135] and Victorian Energy Compare[136], and using the Default Market Offer (DMO)[137] and Victorian Default Offer (VDO)[138] assumptions regarding demand to construct an annual energy bill.

Flat rate tariffs were used for current power bill benchmarks, as only 30% of households are on cost reflective tariffs in the NEM.[139] Then, the DMO and VDO data was used to deconstruct the annual energy bill into its various cost segments: network, retail cost and margin, environmental costs, and any fixed elements of the wholesale cost. The remainder was assumed to be the variable wholesale cost component. Note that the weighted average of cost components by network in NSW and Victoria were taken to provide state-based figures. Further information can be found in the Appendix.

Current annual bills for households using the median amount of energy (per the ACCC's 2022-23 data[140]) range from AUD1,565 in Victoria to AUD2,363 in South Australia. However, households use a varying amount of energy, which is dependent on the number of people living in the household. Using AER benchmark data to understand the consumption by household, there is a broad range of power bills for households of one person to households of five-plus people ranging from AUD1,263 to AUD3,988.[141]

[134] Statista. Residential market share of electricity in Australia in 2023, by retailer category. 21 February 2024.
[135] Australian Government. Energy Made Easy. Accessed 26 July 2024.
[136] Victoria State Government. Victorian Energy Compare. Accessed 16 July 2024.
[137] AER. AER - Final Determination - Default market offer prices 2024-25 - Cost assessment model. 3 June 2024.
[138] ESCV. Victorian Default Offer 2024–25: Decision Model. 20 May 2024.
[139] AER. Network tariff reform. Accessed August 2024.
[140] Australian Competition and Consumer Commission (ACCC).. Inquiry into the National Electricity Market report - June 2024. Appendix E - Supplementary spreadsheet with billing data and figures - Inquiry into the National Electricity Market report - June 2024. 28 June 2024.
[141] AER and Frontier Economics. Simple electricity and gas benchmarks - From June 2021. June 2021.

Figure 10: Current power bills (AUD/year) by state and by consumption levels (median or per various household size per AER benchmarks)



Source: IEEFA calculation based on current rates, DMO and VDO, ACCC, and AER benchmark data. Includes GST. SEQ: South East Queensland.

Bills with nuclear

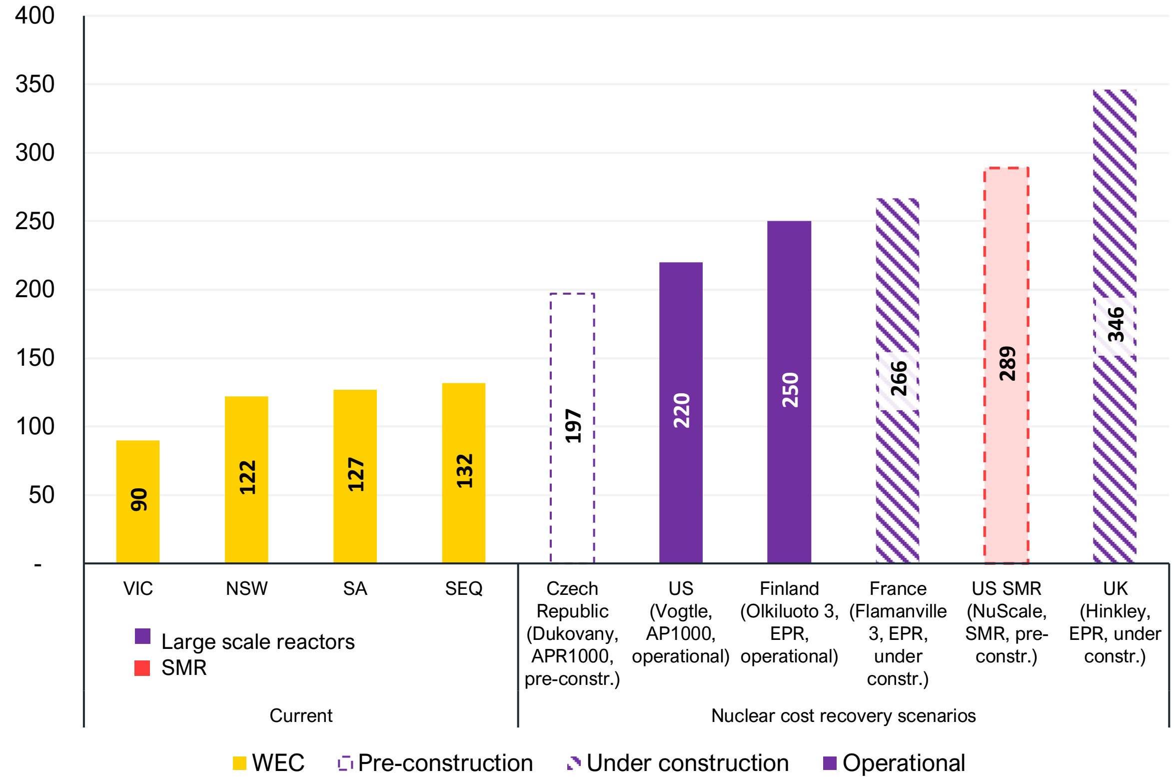
Nuclear would raise wholesale costs

We have calculated the potential electricity bill impact for a range of nuclear cost recovery scenarios, based on the following real-world examples:

- **Finland:** Olkiluoto Unit 3.
- **France:** Flamanville Unit 3.
- **UK:** Hinkley Point C.
- **US:** Vogtle Units 3 and 4.
- **US SMR:** NuScale SMR.
- **Czech Republic:** Dukovany proposed plant expansion.

The wholesale energy cost (WEC) implied by nuclear power in these real-world examples is higher than the current WEC in every region analysed. This means that moving to a system with more nuclear power – in which nuclear power plants are commercial and recovering their costs in the electricity market – would raise electricity bills rather than lower them.

Figure 11: Current wholesale energy cost (WEC) component of current household bills compared to commercial price to recover nuclear plant costs in Australian context (AUD/MWh)



Source: Various – see Appendix. SEQ: South East Queensland. Current wholesale energy cost is based on market rates, the DMO and the VDO. Current WEC excludes GST, losses, ancillary services, RERT, directions cost, prudential costs and fees. Nuclear LCOEs represent the cost of these projects translated to an Australian context with specific assumptions taken.

Therefore, power bills in a nuclear grid would be higher

But by how much might bills be raised with nuclear?

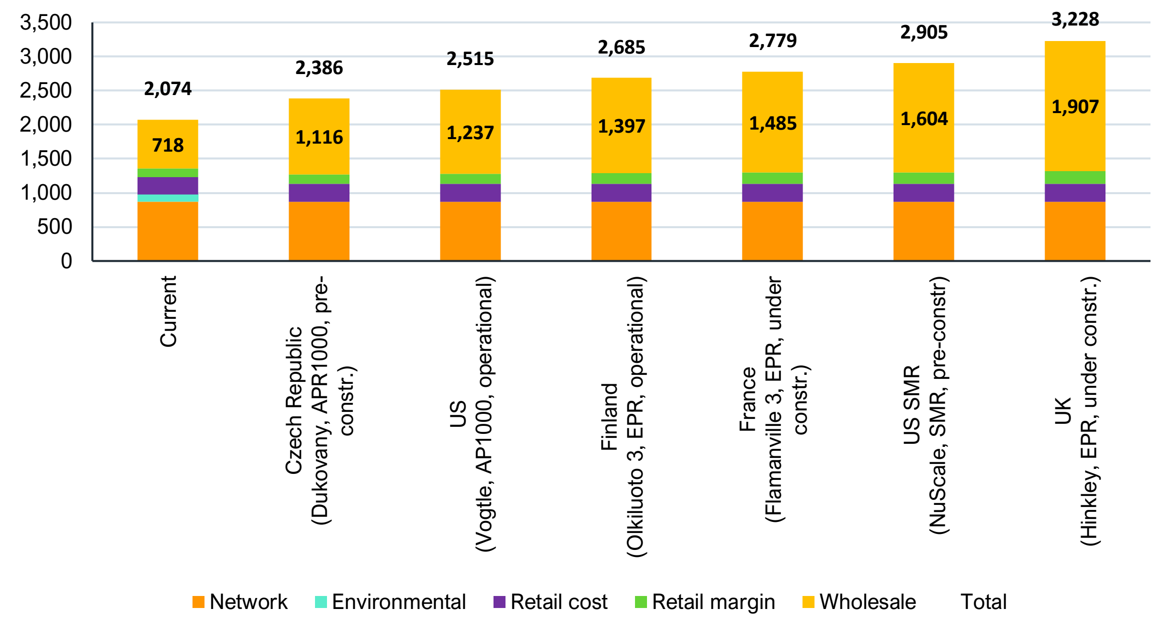
In order for a nuclear plant to be a commercial investment without government subsidies (as per Shadow Treasurer Angus Taylor's statements), it would need to capture wholesale energy market prices consistent with what is known as its levelised costs (which encompass construction and operational costs as well as an allowance for cost of financing). Also given, Shadow Energy Minister Ted O'Brien's assertion that these plants would operate on a continuous, baseload basis close to their maximum capacity, one would expect the overall market price would end up averaging at a level close to what the nuclear power plant requires.

As the chart above shows, real-world experience with specific nuclear power plants indicates they would need wholesale energy prices significantly higher than the wholesale energy costs that household consumers currently pay. To understand the impact of nuclear power on electricity bills, we substitute the nuclear levelised cost of energy (above) to the portion of household energy bill that currently goes towards covering wholesale energy costs. We assume environmental costs in the nuclear grid are zero, and network and retail costs remain as per current levels. See the Appendix for further details on methodology.

Now in reality, across most countries that operate liberalised wholesale electricity markets, nuclear power plants find it difficult to compete against alternative sources of generation. This means they typically are unable to recover the replacement cost of their plant from the wholesale electricity market and have instead relied on government subsidies to be viable. This study has not analysed an alternative scenario where taxpayers, rather than energy consumers, bear the cost of pursuing nuclear power because it is not what the Coalition is currently proposing.

The graph below illustrates how nuclear costs would impact electricity bills for a household with a median level of consumption in NSW.

Figure 12: NSW typical household electricity bill in nuclear cost recovery scenarios (AUD/year)



Source: Various sources per Appendix and IEEFA calculations. Note figures shown are for a household with median consumption levels. GST inclusive.

Below the bills in each nuclear cost recovery scenario are shown for each state, for median household consumption levels.

Table 1: Annual bills (AUD/year) currently and in various nuclear cost recovery scenarios

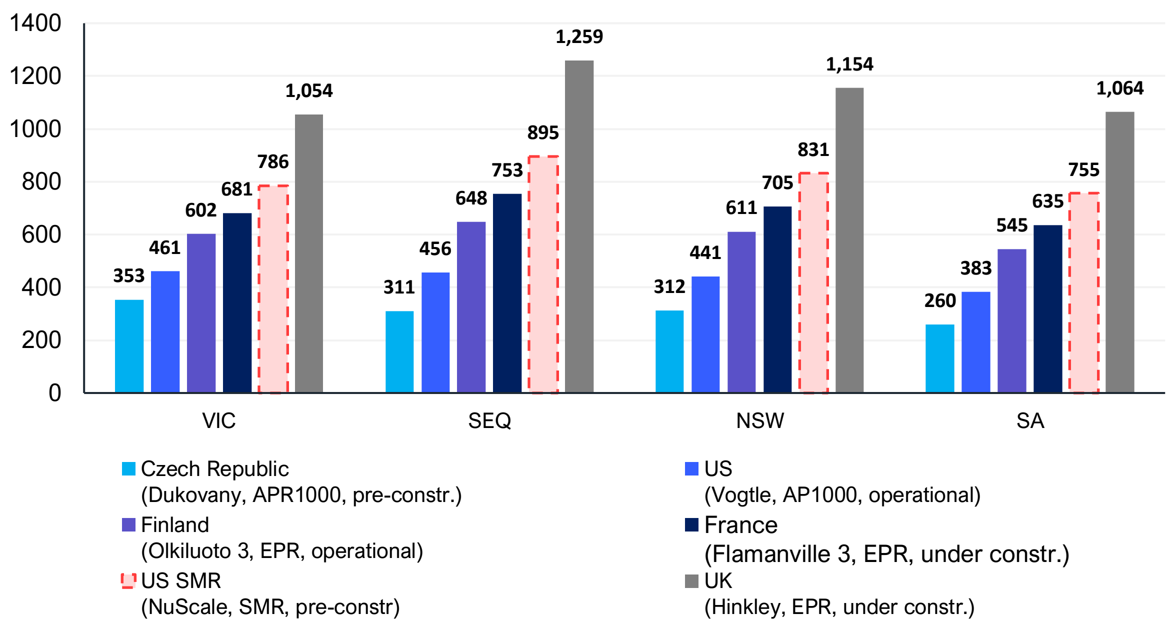
Scenario	VIC	SEQ	NSW	SA
Current	1,565	2,220	2,074	2,363
Czech Republic (Dukovany, APR1000, pre-constr.)	1,918	2,531	2,386	2,623
US (Vogtle, AP1000, operational)	2,026	2,676	2,515	2,746
Finland (Olkiluoto 3, EPR, operational)	2,167	2,868	2,685	2,909
France (Flamanville 3, EPR, under constr.)	2,245	2,973	2,779	2,998
US SMR (NuScale, SMR, pre-constr.)	2,351	3,116	2,905	3,119
UK (Hinkley, EPR, under constr.)	2,619	3,479	3,228	3,427

Source: Various sources per Appendix and IEEFA calculations. Note figures shown are for a household with median consumption levels. GST inclusive.

The graph below presents indicative bill increases across regions, for households with median consumption levels. For these households, bills impacted by nuclear costs could rise by:

- AUD353 to AUD1,054 in Victoria.
- AUD311 to AUD1,259 in South East Queensland (SEQ).
- AUD312 to AUD1,154 in NSW.
- AUD260 to AUD1,064 in South Australia.

Figure 13: Increase in median electricity bills to recover cost of nuclear plants based on different countries' experience (AUD/year)



Source: Various sources (see Appendix) and IEEFA calculations. Note: Bill increases are for a household with median electricity consumption levels. GST inclusive.

The lowest bill increase estimate corresponds to Dukovany, which is currently in pre-construction. As discussed, costs tend to increase materially as projects progress from pre-construction to construction and finalisation. The lowest bill impact increases to AUD383-AUD461 across states (AUD435 on average) when looking at successfully constructed nuclear power plants, associated with the Vogtle nuclear plant in the US. Based on European nuclear experience from completed or near-complete projects Olkiluoto 3 and Flamanville 3, bill impacts range from AUD545-753 (AUD648 on average across states). The highest bill impact is associated with the UK experience, which sees bill impacts of over AUD1,000 to enable Hinkley Point C levels of nuclear cost recovery.

Note that the bill impact by state differs due to different electricity usage in different regions (i.e. SEQ has the largest median household consumption), and different current power bill structures and costs (i.e. Victoria has the lowest current wholesale energy cost).

We completed this analysis for a number of regions (VIC, NSW, SEQ and SA) and for different household sizes. For households with different energy consumption levels – i.e. households of one person to five-plus people – the results are shown in the Appendix. In summary average bill impacts across nuclear scenarios and across the examined regions, for different consumption levels, were:

- Median consumption: AUD665/year average bill increase
- 1-person household: AUD441/year average bill increase
- 2-person household: AUD714/year average bill increase
- 3-person household: AUD825/year average bill increase
- 4-person household: AUD972/year average bill increase
- 5+ person household: AUD1,182/year average bill increase

The average bill increase across nuclear scenarios, for each region is shown in the table below.

Table 2: Increase in electricity bills to recover cost of nuclear plants based for various regions, by consumption levels – averaged across nuclear scenarios (AUD/year)

Region	Consumption levels					
	Median	Household size (number of people)				
		1	2	3	4	5+
VIC	656	478	783	822	939	1190
NSW	676	450	732	850	996	1213
SEQ	720	451	678	816	1016	1165
SA	607	384	664	812	937	1160
Average for all regions	**665**	**441**	**714**	**825**	**972**	**1182**

These results illustrate that nuclear power in Australia would likely drive material bill increases for Australians.

Conclusion

In conclusion, Australian wholesale electricity prices would need to rise considerably to cover the costs of an unsubsidised nuclear power fleet. This would raise electricity bills. Based on experience of recent nuclear power plant builds in other countries comparable to Australia, the resulting rise in median household energy bills could be AUD665/year on average across the examined regions and across nuclear scenarios. The scenarios analysed showed a large range of potential bill increases – between AUD260/year to AUD1,259/year for households with median consumption, depending on which state they are based in, and which international nuclear experience is used to indicate Australian nuclear costs.

For households with higher energy consumption, bills would rise by a greater extent. A four-person household could see bill rises of AUD972/year on average across nuclear scenarios and regions, and a five-plus-person household could see bill increase of AUD1,182/year average across nuclear scenarios and regions.

Nuclear would an expensive power generation option for Australia. Globally, real-world experience with nuclear has delivered cost blowouts and financial challenges including bankruptcy for several of the firms involved, and taxpayer bail-outs in other cases. Australia has an opportunity to learn from others' mistakes rather than repeat them.

Our analysis suggests household power bills would need to rise significantly for nuclear power plants to become a commercially viable investment in the absence of substantial, taxpayer-funded government subsidies. In IEEFA's opinion, any plan to introduce nuclear energy in Australia – such as that proposed by the Coalition – should be examined thoroughly. In particular, any evaluation should focus on the potential impact on electricity system costs and household bills, and with detailed analysis of alternative technologies such as renewables and firming.

Appendix A: Methodology and assumptions

Capital costs of nuclear power stations worldwide

The nuclear capital cost presented in this report is the overnight cost, which is the capital cost excluding financing costs that accrue through the construction period. The overnight cost includes: engineering, procurement and construction (EPC) costs; contingency costs; and owners' costs (land, cooling infrastructure, associated buildings, site works, switchyards, project management, licences, etc).[142]

The all-in costs take the overnight cost and add financing costs during the construction period. This has been calculated using the Annual Technology Baseline (ATB) model.[143] IEEFA adjusted the ATB model to suit power stations with construction timelines longer than nine years, and we used a weighted average cost of capital (WACC) of 6% aligning with CSIRO's GenCost discount rate. Therefore all-in costs in this report represent the all-in cost in an Australian context, rather than in the original context where the plant is located.

Costs in this report are inflated to 2024 figures. Costs throughout this report are presented in Australian dollars (AUD) unless otherwise stated. Costs in alternative currencies are converted from their original currency using the past six months currency conversion rate from OFX (April-September 2024).[144]

142 World Nuclear Association. Economics of nuclear power. 29 September 2023.
143 NREL. 2024 Annual Technology Baseline (ATB) Excel Workbook. 25 June 2024.
144 OFX. Monthly average rates. Accessed 9 September 2024.

Table 3: Capital cost of nuclear power stations

	Type of plant	Large-scale					SMR
PLANT	Nuclear Power Plant	Hinkley	Flamanville 3	Olkiluoto 3	Dukovany	Vogtle	NuScale SMR
	Country	UK	France	Finland	Czech Republic	US	USA
	Type of reactor	EPR-1750	EPR	EPR	APR1000	AP1000	SMR
ORIGINAL ESTIMATES	Original capacity (MW)	3,260	1,630	1,600	2,000	2,234	720
	Original project cost (billions - various currency and year)	9.0	3.3	3.0	n.a.	9.7	3.7
	Currency	Pound	Euro	Euro	n.a.	USD	USD
	Currency conversion	1.928	1.639	1.639	n.a.	1.507	1.507
	Year of dollar cost	2007	2005	2003	n.a.	2009	2014
	Inflation adjustment to 2024	1.739	1.507	1.570	n.a.	1.470	1.329
	Original overnight cost (AUD billion 2024)	30.2	8.1	7.7	n.a.	21.5	7.3
	Original overnight cost (USD billion 2024)	20.0	5.4	5.1	n.a.	14.3	4.9
	Original overnight capital cost (2024 AUD/kW)	9,255	4,998	4,824	n.a.	9,618	10,167
	Original overnight capital cost (2024 USD/kW)	6,142	3,317	3,201	n.a.	6,383	6,747
FINAL/ UPDATED COSTS	Final capacity (MW, net)	3,260	1,630	1,600	2,000	2,234	462
	Project cost (billions - various currency and year)	46.5	13.2	14.7	456.0	24.6	13.2
	Currency	Pound	Euro	Euro	Czech Crown	USD	AUD
	Currency conversion	1.928	1.639	1.639	0.065	1.507	1.000
	Year of dollar cost	2024	2015	2023	2024	2024	2023
	Inflation adjustment to 2024	1.000	1.278	1.008	1.000	1.000	1.011
	Final overnight cost (AUD billion 2024)	89.7	27.6	24.3	29.8	37.0	13.3
	Final overnight cost (USD billion 2024)	59.5	18.3	16.1	19.8	24.6	8.9
	Final overnight capital cost (2024 AUD/kW)	27,500	16,954	15,195	14,901	16,575	28,881
	Final overnight capital cost (2024 USD/kW)	18,250	11,252	10,084	9,889	11,000	19,167
	Ratio of final to original capital cost (%)	297%	339%	315%	n.a.	172%	284%
	Construction start	2019	2007	2005	2029	2013	
	Construction end	2030	2024	2023	2038	2023	
	Construction length (years)	11	17	18	9	10	3.25
	All-in cost from ATB model (2024 USD/kW)	26,517	19,591	18,146	13,534	15,520	22,102
	All-in cost in Australian context (2024 AUD/kW)	39,956	29,521	27,343	20,393	23,387	33,304
	All-in cost in Australian context (USD billion)	86	32	29	27	35	10
	All-in cost in Australian context (AUD billion)	130	48	44	41	52	15
	Ratio of all-in cost on overnight cost	145%	174%	180%	137%	141%	115%

Note: Since Dukovany has only one set of estimates, which are preliminary, these are the only estimates shown in the table.

South Korea and the United Arab Emirates

Aside from the examples examined in this report, South Korea is the only member of the OECD that has experience with construction and completion of non-Russian derived nuclear power plants over the past 20 years. It is also the only country that has not suffered from dramatic blow-outs in construction budgets and timeframes over this period.[145] Consequently, the Korean experience is commonly cited to support the adoption of nuclear power in other countries, including Australia.

However, there are some significant reasons to doubt that the Korean costs could be replicated in the Australian context.

Korea's nuclear build program in its own country has been of a scale that is far larger than what the Coalition is proposing for Australia. Since 2005 the country has had 11 reactors brought online or put into construction, totalling over 13,000MW. In all cases these have involved plants with multiple reactors. This came on top of bringing online around 15 reactors in the 20 years prior to 2005.[146] Importantly Korea's nuclear power generation is concentrated within four locations:

- Hanbit, with four reactors.
- Hanul/Shin Hanul, with eight reactors
- Wolsong/Shin Wolsong, with six reactors
- Kori/Shin Kori, with six reactors.[147]

This construction of multiple reactors within a single location has allowed the Koreans to build up (and critically, retain) skills, knowledge and capabilities in nuclear reactor construction, with these learnings then applied in subsequent reactor builds to achieve efficiencies in the build process.[148] Such opportunities for exploiting learning and improvement through repetition would be limited for an Australian program, where each power plant would likely involve only one to two reactors, plant sites would in some cases be separated by long distances (exceeding 1,000 kilometres), and several plants would need to be built in parallel rather than sequentially to ensure timely replacement of coal generators.

Since the scale of the Korean nuclear build program is not applicable to the Australian context, a better guide to the likely economics of building the Korean APR reactors is provided by the Czech Republic's Dukovany tender. This tender was to build two reactors of around 1,000MW each at the site of the existing Dukovany nuclear power plant. This is similar in scale to the coal power stations at Liddell, Tarong and Loy Yang A, which have been nominated as nuclear plant sites in the Coalition's plan (although 2,000MW is larger than the coal power stations at the sites of Mt Piper and Callide). This tender concluded in July this year with KHNP selected. This was based on a quoted price of

[145] Institute for Progress. Why Does Nuclear Power Plant Construction Cost so Much? 1 May 2023.
[146] World Nuclear Association. Reactor Database – Nuclear Reactors in South Korea. Accessed August 2024.
[147] World Nuclear Association. Reactor Database – Nuclear Reactors in South Korea. Accessed August 2024.
[148] Energy Technologies Institute. The ETI Nuclear Cost Drivers Project – Full Technical Report. September 2020. *Ingersoll, Gogan, Herter and Foss*.

CZK200 billion per reactor – or around AUD15,000/kW, which is of similar magnitude to the costs of the Olkiluoto reactor in Finland.

As a final note on this matter, sometimes the experience of the Korean-built Barakah Plant in the UAE is used as an example to suggest Australia could achieve lower costs than have unfolded in the US and Europe. Again, there are good reasons to doubt the replicability of UAE nuclear build experience in Australia due to:

- **Completely different labour market conditions** – The UAE plant was built using significant levels of migrant labour from developing countries in South Asia, who were not eligible for the minimum wage and were likely to have been paid a small fraction of the wages which prevail in Australia.[149] Human Rights Watch has observed that: "The UAE's *kafala* (sponsorship) system ties migrant workers' visas to their employers, preventing them from changing or leaving employers without permission." Those who left their employers without permission faced punishment for "absconding", including "fines, arrest, detention, and deportation, all without any due process guarantees".[150] Human Rights Watch also notes that "UAE's laws prohibit workers from collectively organizing, bargaining, or striking".[151]
- **A completely different system of government** – The UAE is governed by an absolute monarchy that is not answerable to the general public via democratic elections. According to Amnesty International, government authorities "unduly restrict the rights to freedom of expression and peaceful assembly". Amnesty International also notes that: "UAE law imposes a mandatory minimum 15-year prison sentence for 'damaging the reputation or prestige of the President', as well as life imprisonment for involvement in a demonstration 'with the aim of…infringing on public order'."[152]

Capital cost of additional SMRs

There are a number of SMRs that have been proposed in recent years however were not far enough progressed to consider the cost estimates in this analysis. There is also a prototype 25MW SMR in Argentina under construction, for which the scale too small to provide a clear understanding of SMR costs for the purpose of this analysis.

- In the US, the **TerraPower Natrium** sodium-cooled reactor has been proposed in Kemmerer, Wyoming, and is expected to cost USD4 billion with a capacity of 345MW.[153] However, in an interview on CBS in June, TerraPower founder Bill Gates said that the cost of the proposed reactor now looks like it could be in the order of USD10 billion if all the first-of-a-kind costs are

[149] Energy Technologies Institute. The ETI Nuclear Cost Drivers Project – Full Technical Report. September 2020. Ingersoll, Gogan, Herter and Foss.
[150] Human Rights Watch. World Report 2024 – United Arab Emirates Chapter. 2024.
[151] Human Rights Watch. Questions and Answers: Migrant Worker Abuses in the UAE and COP28. 2023.
[152] Amnesty International. United Arab Emirates 2023. Accessed August 2024.
[153] AP. In Wyoming, Bill Gates moves ahead with nuclear project aimed at revolutionizing power generation. 16 August 2024.

included.[154] Gates says this reactor is designed to complement renewables – to only produce power when renewables are not abundant.[155] Although about a hundred billion dollars have reportedly been spent on sodium-cooled reactors worldwide since 1950, critics say they have been "commercial failures globally".[156]

- The **X-energy SMR** in the US has progressed to Final Design Readiness Review phase. The design consists of four Xe-100 reactors (each with 80MW capacity) to be installed in Texas, with a cost estimate of between USD4.75-USD5.75 billion.[157,158]

- The proposed **GE Hitachi** project in Saskatchewan, Canada, comprises four BWRX-300 reactors with total output of 1,200MW. The cost is estimated at CAD12-CAD20 billion.[159]

- Construction began on the **CAREM25** SMR prototype reactor in Argentina in 2014.[160] It was expected to receive its first fuel load in 2017, but now it is not expected to begin operation until 2027.[161] This is the only OECD SMR project for which actual construction has started. It had an original construction cost estimate in 2005 of USD105 million, and by 2014 this had risen to USD446 million (in 2014 dollars).[162]

[154] CBS News. Transcript: Bill Gates on "Face the Nation." 16 June 2024. *"Well, if you count all the first of a kind costs, you know, where we've been working for many years designing this thing, you could get a number close to 10 billion"*
[155] Ibid. *"You have to design a reactor that can coexist with renewable energy because we have a lot of that. So this reactor only makes electricity when the renewables aren't- aren't super cheap. It just makes heat 24 hours a day and then electricity when it's needed."*
[156] EWG. Why Small Modular Nuclear Reactors Won't Help Counter the Climate Crisis. 25 March 2021.
[157] X-energy. Small Modular Nuclear Reactor: Xe-100. Accessed 21 August 2024.
[158] X-energy. X-energy and Areas Acquisition Corporation Announce Strategic Update to Business Combination Terms to Reinforce Long-Term Value Creation Opportunity and Alignment with Shareholders. 12 June 2023. "*This scope includes the design and licensing of the Xe-100 standard plant, the design, licensing, and construction of the TRISO-X commercial fuel fabrication facility, and the construction of a four-unit Xe-100 facility at the Dow Inc. ("Dow") UCC Seadrift Operations site (the "Seadrift site") in Texas*."
[159] Pipeline Online. Four reactors could cost Saskatchewan $12 to $20 billion. The feds just gave us $74 million. 21 August 2023.
[160] World Nuclear Association. Nuclear Power in Argentina. 13 May 2023.
[161] World Nuclear Industry Status Report. The World Nuclear Industry Status Report 2023. December 2023. Page 161.
[162] Ibid. Page 438.

LCOE Assumptions

Table 4: Nuclear LCOE in Australian context

Plant	Dukovany	Vogtle	Olkiluoto 3	Flamanville 3	Hinkley	NuScale SMR	Source
Economic life (years)	60	60	60	60	60	60	Manufacturer's claim on technical lifetime
Construction time (years)	9.0	10.0	18.0	17.0	11.0	3.3	Actual data
Efficiency	33%	33%	33%	33%	33%	33%	CSIRO
O&M fixed (AUD/kW)	200	200	200	200	200	200	CSIRO
O&M variable (AUD/MWh)	5.3	5.3	5.3	5.3	5.3	5.3	CSIRO
Overnight capital (AUD/kW)	14,901	16,575	15,195	16,954	27,500	28,881	Various
All-in capital cost in Australian context (AUD/kW)	20,393	23,387	27,343	29,521	39,956	33,304	ATB model
Fuel (AUD/kG)	1.09	1.09	1.09	1.09	1.09	0.50	CSIRO
Capacity factor	92.7%	92.7%	92.7%	92.7%	92.7%	92.7%	Coalition
Discount rate	6%	6%	6%	6%	6%	6%	CSIRO
Capital including financing cost (AUD/MWh)	155	178	208	225	304	253	Calculation
Fuel (AUD/MWh)	11.9	11.9	11.9	11.9	11.9	5.5	Calculation
O&M (AUD/MWh)	30	30	30	30	30	30	Calculation
Total (AUD/MWh)	**197**	**220**	**250**	**266**	**346**	**289**	Calculation

Current energy bill baseline

Market rates from Energy Made Easy[163] and Victorian Energy Compare[164], along with consumption figures from the 2024-25 Default Market Offer (DMO)[165] and 2024-25 Victorian Default Offer (VDO)[166], were used to construct the current energy bill baseline. The DMO or VDO annual energy bill deconstruction was not directly used because many customers are on lower rates than the DMO or VDO rate – only 8.6% of residential customers are on the standing offer tariffs.[167]

Table 5: Energy tariffs – market rates – to construct the current energy bill baseline

State	VIC	VIC	VIC	VIC	VIC	NSW	NSW	NSW	SEQ	SA
Network business	AusNet Services	CitiPower	Jemena	Powercor	United Energy	Ausgrid	Endeavour	Essential	Energex	SAPN
DMO consumption	4.0	4.0	4.0	4.0	4.0	3.9	4.9	4.6	4.6	4.0
Origin fixed c/day	120	105	109	118	99	81	84	163	131	98
Origin variable c/kWh	32	23	27	27	26	31	35	37	32	43
AGL fixed c/day	114	99	103	112	93	84	107	156	132	108
AGL variable c/kWh	30	22	26	26	25	30	37	32	32	42
Energy Australia fixed c/day	134	117	121	132	110	101	103	183	116	114
Energy Australia variable c/kWh	36	26	31	30	29	37	38	40	34	45
Fixed cost average c/day	122	107	111	121	100	89	98	167	126	106
Variable cost average c/kWh	33	24	28	28	26	33	37	36	33	43
Total fixed cost AUD/yr	447	391	405	440	367	324	359	611	460	389
Total variable cost AUD/yr	1,311	944	1,120	1,116	1,057	1,274	1,797	1,675	1,504	1,737
Total bill AUD/yr	1,758	1,335	1,525	1,557	1,424	1,598	2,155	2,286	1,964	2,126

Source: Energy Made Easy[168] and Victorian Energy Compare[169], accessed 26 July 2024. Note: for inclining block tariffs – the average was presented. A number of Energy Australia rates were the standing offer. DMO or VDO consumption levels used to construct this baseline.

The annual energy bill was then deconstructed to determine the various cost components. The network, environmental, retail cost and retail margin (%) were taken directly from the DMO and VDO for residential without controlled load consumers. These costs were either in yearly figures, per MWh figures or percentage on the total bill figures (retail margin).

Then the remainder of the annual energy bill is assumed to be the wholesale component. After removing the fixed (AUD/year) portion of the wholesale component from the DMO/VDO, the remaining element is the variable wholesale component. Part of the variable wholesale component is the wholesale energy cost (WEC) related to the spot and contract market, and another part is what

[163] Australian Government. Energy Made Easy. Accessed 26 July 2024.
[164] Victoria State Government. Victorian Energy Compare. Accessed 16 July 2024.
[165] AER. AER - Final Determination - Default market offer prices 2024-25 - Cost assessment model. 3 June 2024.
[166] ESCV. Victorian Default Offer 2024–25: Decision Model. 20 May 2024.
[167] AER. Default Market Offer (DMO) 2024–25 Draft Determination. 19 March 2024.
[168] Australian Government. Energy Made Easy. Accessed 26 July 2024.
[169] Victoria State Government. Victorian Energy Compare. Accessed 16 July 2024.

we are calling a non-WEC component, which is made up of costs such as losses, NEM fees, ancillary services, the reliability and emergency reserve trader (RERT) mechanism, prudential costs, directions and other such costs. The non-WEC, variable component of wholesale costs is removed when calculating and presenting the WEC AUD/MWh throughout this report.

For Victoria and NSW, a typical bill was constructed using the weighted average (by customer number) of the cost components from each network area.

Table 6: Deconstruction of total bill into components

Network area	**AusNet Services**	**CitiPower**	**Jemena**	**Powercor**	**United Energy**	**Ausgrid**	**Endeavour**	**Essential**	**SEQ**	**SA**	**VIC**	**NSW**
Bill inc GST AUD/yr	1,758	1,335	1,525	1,557	1,424	1,598	2,155	2,286	1,964	2,126	1,550	1,929
Bill ex GST AUD/yr	1,598	1,213	1,386	1,415	1,295	1,453	1,959	2,078	1,786	1,932	1,409	1,753
Consumption DMO 2024-25 MWh/yr	4.0	4.0	4.0	4.0	4.0	3.9	4.9	4.6	4.6	4.0	4.0	4.4
Wholesale cost - fixed AUD/yr	9	9	9	9	9	12	12	12	12	12	9	12
Network cost - fixed AUD/yr	223	170	183	217	147	176	203	467	254	237	193	255
Network cost - variable AUD/MWh	140	81	104	97	93	108	101	127	97	150	106	110
Network AUD/yr	783	494	597	604	518	597	695	1,050	698	838	617	737
Retail cost - fixed AUD/yr	188	188	188	188	188	226	244	245	220	246	188	236
Retail cost - variable AUD/MWh	0	0	0	0	0	0	0	0	0	0	0	0
Retail cost AUD/yr	188	188	188	188	188	226	244	245	220	246	188	236
Environmental cost - fixed AUD/yr	0	0	0	0	0	0	0	0	0	0	0	0
Environmental cost - variable AUD/MWh	32	32	32	32	32	20	20	19	17	22	32	20
Environmental AUD/yr	128	128	128	128	128	77	97	89	76	89	128	86
Retail margin %	5.3%	5.3%	5.3%	5.3%	5.3%	6.0%	6.0%	6.0%	6.0%	6.0%	5.3%	6.0%
Retail margin AUD/yr	85	64	73	75	69	87	118	125	107	116	75	105
Subtotal (network, retail cost, retail margin,environmental) AUD/yr	1,183	874	987	995	902	986	1,154	1,509	1,102	1,289	1,008	1,163
Remaining bill (wholesale) AUD/yr	415	339	399	420	392	467	805	569	684	643	401	590
Wholesale cost - variable AUD/yr	405	330	390	411	383	455	793	557	672	631	392	578
Wholesale cost - variable AUD/MWh	101	82	98	103	96	117	162	121	146	158	98	132
Wholesale cost - variable non-WEC AUD/MWh	11	5	7	9	6	10	12	8	14	31	8.0	10.3
WEC AUD/MWh	91	77	91	94	90	106	149	113	132	127	90	122
Wholesale AUD/yr	415	339	399	420	392	467	805	569	684	643	401	590
Total bill ex GST AUD/yr	1,598	1,213	1,386	1,415	1,295	1,453	1,959	2,078	1,786	1,932	1,409	1,753
Total bill inc GST AUD/yr	1,758	1,335	1,525	1,557	1,424	1,598	2,155	2,286	1,964	2,126	1,550	1,929
# customers for VIC and NSW DNSPs, '000s	789.3	334.5	370.3	889.8	707.0	1,787.9	1,114.4	943.9				

Note all dollar figures are AUD. DMO and VDO consumption levels were used in this bill baseline.

Note that the breakdown of costs into components in the VDO report was different to the DMO, as a large portion of costs in the VDO are shown as "other costs" while the DMO has no "other costs" category. IEEFA assumed a split of these VDO "other costs" into various categories: network, wholesale, and retail. Wholesale "other costs" IEEFA assumed were: AEMO, ESC, NEM fees, ancillary services, RERT, ECA and IT upgrades for five-minute settlement costs. Network "other costs" IEEFA assumed as: National Transmission Planner & DER program costs. Full retail contestability cost was assumed to be a retail cost.

Using the deconstructed energy bill components, current energy bills were then calculated for various levels of consumption including:

- ACCC median energy consumption figures from the retail price inquiry.[170] IEEFA considers this data to present a good representation of household energy consumption for typical households, as it is quite recent (2022-23) and is based on actual household data.
- Various energy consumption levels for 1 to 5+ person household from AER benchmarks.[171]

Replacing the WEC with nuclear costs

After calculating the current energy bill baseline WEC AUD/MWh, this was then adjusted in the nuclear scenario to calculate energy bills implied by nuclear power.

The WEC has been replaced with the nuclear LCOE to understand how wholesale energy costs could look in a nuclear grid with very high nuclear capacity factors, in a situation where the nuclear power plants recover their costs from consumer bills (i.e. are commercial).

Note that full wholesale costs include fixed costs and a variable component of the wholesale cost (made up of losses, fees, ancillary services, directions and other such components), which are assumed to be the same under the current energy bill scenario and the nuclear scenarios. This may underestimate nuclear costs as losses may be higher in the nuclear scenario.

Estimating the nuclear energy bills

Then the full nuclear energy bills were calculated using:

- The nuclear WEC – representative of various nuclear LCOEs.
- Non-WEC variable and fixed component of wholesale costs: assumed to be the same in current energy bills and nuclear energy bills (this includes components like losses, fees, ancillary services, directions and other such components).
- Network costs: assumed to be the same in current energy bills and nuclear energy bills.

[170] ACCC. Inquiry into the National Electricity Market report - June 2024. Appendix E - Supplementary spreadsheet with billing data and figures - Inquiry into the National Electricity Market report - June 2024.
[171] AER and Frontier Economics. Simple electricity and gas benchmarks - From June 2021. June 2021.

- Environmental costs: assumed to be zero in the nuclear energy bills.
- Retail costs and margin: assumed to be the same in current energy bills and nuclear energy bills.

GST was added in to represent all bills through this report as GST inclusive.

The current and nuclear energy bills were calculated for different levels of household consumption: including for 1, 2, 3, 4 and 5+ person households (from AER benchmark data[172]) and the median household consumption from the ACCC (price inquiry[173]). IEEFA made assumptions on the climate zones that were covered by each network area by comparing the network maps with climate zone maps. For NSW the average of the 3 DNSP areas consumption was used and for Victoria, the mild temperate climate zone consumption was assumed.

Table 7: Consumption (kWh) for various household sizes in various regions

State	Network	Climate Zone Assumed	Zone description	Climate zone number	Consumption (kWh) for each household size (# people)				
					1	2	3	4	5+
NSW	Ausgrid	Green	Warm temperate	5	3,110	5,238	6,362	7,311	9,008
NSW	Endeavour	Light blue	Mild temperate	6	3,541	6,060	6,569	7,193	9,320
NSW	Essential	Yellow	Warm humid summer, mild winter	2	3,371	5,086	6,127	7,641	8,763
SEQ	Energex	Yellow	Warm humid summer, mild winter	2	**3,411**	**5,126**	**6,168**	**7,682**	**8,804**
SA	SAPN	Green	Warm temperate	5	**2,919**	**5,047**	**6,171**	**7,121**	**8,818**
VIC	Average VDO	Light blue	Mild temperate	6	**2,954**	**4,840**	**5,077**	**5,805**	**7,351**
NSW	Average DMO				**3,218**	**5,233**	**6,079**	**7,126**	**8,677**

Source: AER benchmark data.[174]

Table 8: Consumption levels data

State	DMO / VDO	Median ACCC 2022-23	Household size (number of people				
			1	2	3	4	5+
VIC	4.0	4.1	2.95	4.84	5.08	5.80	7.35
NSW	4.4	4.8	3.22	5.23	6.08	7.13	8.68
SEQ	4.6	5.4	3.41	5.13	6.17	7.68	8.80
SA	4.0	4.6	2.92	5.05	6.17	7.12	8.82

Source: AER benchmark data[175] , DMO, VDO and ACCC.

See the Appendix B: Extended results for the full results set of nuclear energy bills.

[172] AER and Frontier Economics. Simple electricity and gas benchmarks - From June 2021. June 2021.
[173] ACCC. Inquiry into the National Electricity Market report - June 2024. Appendix E - Supplementary spreadsheet with billing data and figures - Inquiry into the National Electricity Market report - June 2024.
[174] AER and Frontier Economics. Simple electricity and gas benchmarks - From June 2021. June 2021.
[175] AER and Frontier Economics. Simple electricity and gas benchmarks - From June 2021. June 2021.

Appendix B: Extended results

All regions

Table 9: Increases in electricity bills to recover cost of nuclear plants based on different countries' experience – for household with median consumption levels

State	VIC	SEQ	NSW	SA	Average	Min	Max
Scenarios							
Czech Republic (Dukovany, APR1000, pre-constr.)	353	311	312	260	309	260	353
US (Vogtle, AP1000, operational)	461	456	441	383	435	383	461
Finland (Olkiluoto 3, EPR, operational)	602	648	611	545	602	545	648
France (Flamanville 3, EPR, under constr.)	681	753	705	635	693	635	753
US SMR (NuScale, SMR, pre-constr)	786	895	831	755	817	755	895
UK (Hinkley, EPR, under constr.)	1054	1259	1154	1064	1133	1054	1259
Range							
Min	353	311	312	260	309	260	353
Max	1054	1259	1154	1064	1133	1054	1259

Table 10: Average bill impacts across nuclear scenarios and across the examined regions, for different consumption levels (AUD/year)

		Household size (number of people)				
Scenario	**Median**	**1**	**2**	**3**	**4**	**5+**
Czech Republic (Dukovany, APR1000, pre-constr.)	309	206	334	384	451	550
US (Vogtle, AP1000, operational)	435	289	469	540	636	774
Finland (Olkiluoto 3, EPR, operational)	602	399	647	747	880	1070
France (Flamanville 3, EPR, under constr.)	693	460	745	860	1014	1233
US SMR (NuScale, SMR, pre-constr)	817	541	877	1013	1195	1452
UK (Hinkley, EPR, under constr.)	1133	750	1214	1405	1657	2013
Averages						
Average US complete (Vogtle)	435	289	469	540	636	774
Average EU complete or near complete (Olkiluoto, Flamanville)	648	429	696	803	947	1151
Average EU all	684	454	735	849	1001	1216
Average US all	626	415	673	777	915	1113
Average for nuclear scenarios	665	441	714	825	972	1182

Victoria

Table 11: Victoria bills – for different household consumption levels in various nuclear cost recovery scenarios (AUD/year)

		Household size (number of people)				
Scenario	**Median**	**1**	**2**	**3**	**4**	**5+**
Current	1565	1263	1780	1845	2045	2469
Czech Republic (Dukovany, APR1000, pre-constr.)	1918	1520	2202	2288	2550	3109
US (Vogtle, AP1000, operational)	2026	1599	2330	2422	2704	3304
Finland (Olkiluoto 3, EPR, operational)	2167	1702	2499	2600	2907	3561
France (Flamanville 3, EPR, under constr.)	2245	1759	2592	2697	3019	3702
US SMR (NuScale, SMR, pre-constr)	2351	1835	2718	2829	3169	3893
UK (Hinkley, EPR, under constr.)	2619	2031	3039	3166	3554	4380
Average for nuclear scenarios	2221	1741	2563	2667	2984	3658

Table 12: Victoria increases in electricity bills to recover cost of nuclear plants based on different countries' experience (AUD/year)

		Household size (number of people)				
Scenario	**Median**	**1**	**2**	**3**	**4**	**5+**
Czech Republic (Dukovany, APR1000, pre-constr.)	353	257	422	442	506	641
US (Vogtle, AP1000, operational)	461	336	550	577	659	835
Finland (Olkiluoto 3, EPR, operational)	602	439	719	754	862	1092
France (Flamanville 3, EPR, under constr.)	681	496	812	852	974	1234
US SMR (NuScale, SMR, pre-constr)	786	572	938	984	1125	1424
UK (Hinkley, EPR, under constr.)	1054	768	1259	1320	1509	1912
Average for nuclear scenarios	656	478	783	822	939	1190

New South Wales

Table 13: NSW bills for different household consumption levels in various nuclear cost recovery scenarios (AUD/year)

		Household size (number of people)				
Scenario	**Median**	**1**	**2**	**3**	**4**	**5+**
Current	2074	1577	2196	2456	2778	3255
Czech Republic (Dukovany, APR1000, pre-constr.)	2386	1785	2534	2849	3238	3815
US (Vogtle, AP1000, operational)	2515	1871	2674	3011	3428	4046
Finland (Olkiluoto 3, EPR, operational)	2685	1984	2858	3225	3679	4352
France (Flamanville 3, EPR, under constr.)	2779	2046	2960	3343	3817	4520
US SMR (NuScale, SMR, pre-constr)	2905	2130	3096	3502	4003	4747
UK (Hinkley, EPR, under constr.)	3228	2345	3446	3908	4479	5327
Average for nuclear scenarios	2750	2027	2928	3306	3774	4468

Table 14: NSW increases in electricity bills to recover cost of nuclear plants based on different countries' experience (AUD/year)

		Household size (number of people)				
Scenario	**Median**	**1**	**2**	**3**	**4**	**5+**
Czech Republic (Dukovany, APR1000, pre-constr.)	312	208	338	393	460	561
US (Vogtle, AP1000, operational)	441	294	478	555	650	792
Finland (Olkiluoto 3, EPR, operational)	611	407	662	769	901	1097
France (Flamanville 3, EPR, under constr.)	705	469	763	887	1039	1266
US SMR (NuScale, SMR, pre-constr)	831	553	900	1,045	1,225	1,492
UK (Hinkley, EPR, under constr.)	1154	768	1,250	1,452	1,701	2,072
Average for nuclear scenarios	676	450	732	850	996	1213

South Australia

Table 15: SA bills for different household consumption levels in various nuclear cost recovery scenarios (AUD/year)

		Household size (number of people)				
Scenario	**Median**	**1**	**2**	**3**	**4**	**5+**
Current	2363	1708	2530	2965	3332	3988
Czech Republic (Dukovany, APR1000, pre-constr.)	2623	1872	2815	3313	3733	4485
US (Vogtle, AP1000, operational)	2746	1950	2949	3477	3923	4720
Finland (Olkiluoto 3, EPR, operational)	2909	2053	3127	3694	4174	5030
France (Flamanville 3, EPR, under constr.)	2998	2109	3225	3814	4312	5201
US SMR (NuScale, SMR, pre-constr)	3119	2186	3357	3975	4498	5432
UK (Hinkley, EPR, under constr.)	3427	2381	3694	4387	4974	6021
Average for nuclear scenarios	2971	2092	3194	3777	4269	5148

Table 16: SA increases in electricity bills to recover cost of nuclear plants based on different countries' experience (AUD/year)

		Household size (number of people)				
Scenario	**Median**	**1**	**2**	**3**	**4**	**5+**
Czech Republic (Dukovany, APR1000, pre-constr.)	260	164	284	347	401	496
US (Vogtle, AP1000, operational)	383	242	419	512	591	732
Finland (Olkiluoto 3, EPR, operational)	545	345	596	729	842	1042
France (Flamanville 3, EPR, under constr.)	635	402	694	849	980	1213
US SMR (NuScale, SMR, pre-constr)	755	478	826	1010	1166	1443
UK (Hinkley, EPR, under constr.)	1064	673	1163	1422	1641	2032
Average for nuclear scenarios	607	384	664	812	937	1160

South East Queensland

Table 17: SEQ bills for different household consumption levels in various nuclear cost recovery scenarios (AUD/year)

		Household size (number of people)				
Scenario	**Median**	**1**	**2**	**3**	**4**	**5+**
Current	2220	1604	2124	2440	2899	3239
Czech Republic (Dukovany, APR1000, pre-constr.)	2531	1798	2416	2792	3337	3742
US (Vogtle, AP1000, operational)	2676	1889	2553	2956	3542	3976
Finland (Olkiluoto 3, EPR, operational)	2868	2010	2734	3173	3813	4286
France (Flamanville 3, EPR, under constr.)	2973	2076	2833	3293	3962	4457
US SMR (NuScale, SMR, pre-constr)	3116	2165	2967	3454	4162	4687
UK (Hinkley, EPR, under constr.)	3479	2393	3309	3866	4675	5275
Average for nuclear scenarios	2940	2055	2802	3256	3915	4404

Table 18: SEQ increases in electricity bills to recover cost of nuclear plants based on different countries' experience (AUD/year)

		Household size (number of people)				
Scenario	**Median**	**1**	**2**	**3**	**4**	**5+**
Czech Republic (Dukovany, APR1000, pre-constr.)	311	195	293	352	438	502
US (Vogtle, AP1000, operational)	456	286	429	516	643	737
Finland (Olkiluoto 3, EPR, operational)	648	406	610	734	914	1047
France (Flamanville 3, EPR, under constr.)	753	472	709	853	1063	1218
US SMR (NuScale, SMR, pre-constr)	895	561	843	1014	1263	1448
UK (Hinkley, EPR, under constr.)	1259	789	1186	1426	1776	2036
Average for nuclear scenarios	720	451	678	816	1016	1165

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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