Radarweg 60
1043 NT Amsterdam
The Netherlands

www.tno.nl

T +31 88 866 50 10

TNO report

Nuclear energy economics:
An update to Fact Finding Nuclear Energy

TNO 2018 P11577

Date	13 December 2018
Author(s)	Gamboa Palacios, S. (Silvana) and Jansen, J. (Jaap)
Copy no.	1
No. of copies	
Number of pages	13
Number of appendices	2
Customer	SMO
Project name	Technology factsheets
Project number	060.33948

All rights reserved.
No part of this publication may be reproduced and/or published by print, photoprint, microfilm or any other means without the previous written consent of TNO.

In case this report was drafted on instructions, the rights and obligations of contracting parties are subject to either the General Terms and Conditions for commissions to TNO, or the relevant agreement concluded between the contracting parties. Submitting the report for inspection to parties who have a direct interest is permitted.

© 2018 TNO

Contents

1 An update to nuclear energy economics

In 2007, the ECN report Fact Finding Nuclear Energy was commissioned by the Social Economic Council of the Netherlands (SER) to answer the question whether more nuclear energy should be generated to support the objective of realizing a cost effective CO_2 neutral energy system in the Netherlands. In the study, facts and data on nuclear energy were collected on the basis of existing insights and literature. The present report has been written to update the economics aspects of nuclear energy of the Fact Finding Nuclear Energy 2007 report of ECN using recent data. Non-economic aspects are not considered.

1.1 Recent developments on nuclear energy

A nuclear fission reactor produces and controls the release of energy from splitting the atoms of certain heavy elements. Subsequently, the energy released is used as heat to make steam that powers a turbine generator that generates electricity. Most nuclear power plants use enriched uranium as nuclear fuel. Currently, the most common nuclear reactor designs are the pressurized water reactor (PWR) and the boiling water reactor (BWR). In western Europe, the European Pressurized Reactor (EPR) technology, a third generation PWR, is setting the standard on future nuclear generation with improved safety performance and more efficiency.

At the end of 2017, there were 448 nuclear reactors in operation worldwide with a global generating capacity of 392 gigawatt, covering about 10% of the world electricity demand (IAEA, 2018; WNA, 2018b). In addition, there are 54 nuclear power reactors currently under construction (IAEA/PRIS, 2018). Within EU-28, there are 128 nuclear reactors operating in 14 countries, representing over 25% of the electricity production (WNA, 2018a). Historically, three accidents with nuclear power plants (i.e. Harrisburg in 1979, Chernobyl in 1986, Fukushima in 2011) had a major impact on developments. After these accidents, the construction of new nuclear power plants was delayed significantly and, at the same time, these accidents led to more strict safety regulations and more international cooperation. Safety requirements have been tightened substantially over the years for which the International Atomic Energy Agency of the United Nations in Vienna (IAEA) plays an important role by drawing up safety standards and monitoring the use of nuclear technology and materials. Most of the anticipated growth in nuclear capacity in the coming decades will come with the deployment of large generation III reactors[1] (in the range between 1000 - 1700 MW unit size), either PWRs or BWRs. These reactors have enhanced safety features and higher efficiency, and currently, half of the reactors in construction belong to this generation (NEA, 2015).

1.2 Economic aspects of nuclear energy[2]

Nuclear energy is a mature low-carbon technology. However, the trend on increased safety levels has resulted in an increased cost for generation III reactors in comparison with previous ones (NEA, 2015).

---

1 Improved nuclear reactor types developed after the Harrisburg incident are indicated as generation III reactors.

2 All costs are expressed in $€_{2017}$ using the Harmonized Index of Consumer Prices (HICP) from Statistics Netherlands (CBS).

To date, the estimated total investment costs[3] for a nuclear power plant of generation III[4], excluding interest during construction, range between €$_{2017}$3600 and €$_{2017}$7200 per kilowatt electric capacity (See Table 1). These costs are also referred as overnight construction costs (OCC) of a nuclear plant. OCC costs include civil and structural costs, equipment costs, balance of plant costs, electrical and instrumentation and control (I&C) supply and installation, project indirect costs, development costs and interconnection costs. OCC costs may also include owner's costs and provision for contingency. For a nuclear power plant with a capacity of 1600 megawatt, total construction costs amount to €$_{2017}$5.7 to €$_{2017}$11.5 billion.

In the Fact Finding Nuclear Energy 2007 report, construction costs of such a nuclear power plant, excluding interest during construction, were estimated to range between €$_{2017}$1900 and €$_{2017}$2700 per kilowatt electric capacity, which boils down to an amount of €$_{2017}$3 to €$_{2017}$4.3 billion for a nuclear power plant of 1600 MW. This overall increase on investment costs can be mainly attributed to tightened safety requirements and innovation of nuclear technology with a subsequent increase of construction time. To date, the planned construction time in western countries has gone up from roughly 5 years a decade ago to at least 7-10 years now. Recent experience with nuclear plant construction projects in western Europe and the US indicates a tendency of upward revisions of total construction periods and likewise of cost overruns. Moreover, a lack of standardization or discontinuous flow of plant construction (i.e. de-learning effect) can also result in increased overall costs (see also section 1.4 below).

Financing during construction represents an extra layer of the total investment costs, depending on the interest rate during construction and the construction period. A sensitivity analysis from EC (2016) shows the impact of financing costs with longer construction times, whereas financing costs may represent an extra of 20-29% of OCC for 7 years construction time and 37-57% of OCC for increased construction time to 10 years, considering a real WACC (weighted average cost of capital excluding the rate of general price inflation) between 7-10%.

Table 1 Nuclear energy cost comparison between 2007 and 2018

Costs		2007[5]	2018[6]
Overnight construction costs	€$_{2017}$/kWe	1900-2700	3600-7200
Construction time	years	4,5-6	7
Financing costs[7]	% of OCC	14-21	20-29
Nuclear fuel costs	€$_{2017}$ct/kWh	0,3-0,7	0,54-0,95
Cost of nuclear waste	€$_{2017}$ct/kWh	0,1	0,16-0,3
Decommissioning costs	€$_{2017}$ct/kWh	0,1	0,18

Operation & Maintenance (O&M) fixed costs range from 33 to 160 €$_{2017}$/kW per year and variable costs (excluding fuel costs) from 0.07 to 1.4 €$_{2017}$ct/kWh (See Appendix A). Nuclear fuel cycle costs involve the cost of the nuclear fuel (incl. mining, enrichment, conditioning) that is estimated between 0.54 and 0.95 €$_{2017}$ct/kWh, and the processing and disposal of nuclear waste estimated between 0.16 and 0.3 €$_{2017}$ct/kWh (see Appendix A). In ECN (2007), the costs of the nuclear fuel cycle were 0.3 to 0.7 €$_{2017}$ct/kWh for nuclear fuel costs, and costs of processing and disposal of nuclear waste approximately 0.1 €$_{2017}$ct/kWh.

3 Investment costs are rounded to the nearest 100.
4 Data from western Europe and US (based on different literature sources – see Appendix A) where planning and construction commences mostly up to and around 2020.
5 Sources: ECN (2007) and EC (2016).
6 See Appendix A.
7 WACC between 5-10%

It should be emphasized that recent estimates on waste disposal costs indicate an average of 0.3 €$_{2017}$ct/kWh with large discrepancies between countries, mainly due to uncertainties around the costs of building a final waste disposal facility (EC, 2016).

The decommissioning of a nuclear facility includes the removal of all radioactive materials, decontamination and dismantling, demolition and site clearance. According to NEA (2015), the lack of information on decommissioning activities has resulted in a lower public acceptance of nuclear power. This activity will become increasingly important in the coming years, however the current experience is rather limited. Where no data is available, IEA/NEA (2015) uses a default value for decommissioning costs of nuclear energy to be 15% of the overnight construction costs at the end of operating life, in comparison of 5% of overnight costs given for all other technologies. The EC (2016) estimated decommissioning costs for a generic nuclear power plant throughout its lifetime as 0.18 €$_{2017}$ct/kWh (calculated as 15% of OCC). However, this source reports that estimations of costs of decommissioning vary significantly between countries, technologies, size, location and dismantling strategy. Similarly, in ECN (2007), decommissioning costs were estimated as 0.1 €$_{2017}$ct/kWh. Furthermore, based on a questionnaire for members of the Decommissioning Funding Group (DFG), the EC (2016), average decommissioning costs were estimated as €$_{2017}$810/kW. Nevertheless a case-by-case basis is recommended because the data is frequently reported under different scopes and regulatory schemes.

Around 60% of the nuclear reactors in operation had been operating for 30 years or longer, and while a nuclear reactor is typically licensed for 30-40 years, the operating lifetime can be significantly extended (IAEA, 2018). Overnight Refurbishment Cost (ORC) range between €$_{2017}$400 and €$_{2017}$900 per kilowatt (rounded) for additional 20 years of extended operation (D'haeseleer, W.D., 2013).

1.3 Comparison with other electricity generation sources

Based on different literature sources, the levelized cost of electricity (LCOE) for nuclear energy is projected to range from 6.5 to 12 €$_{2017}$ct/kWh with discount rates between 7 and 10% (see Appendix B). However, LCOE varies because of diverse exploitation periods used (30-60 years) and many assumptions are made about interest on loans and different returns on invested private capital used. Figure 1 shows the LCOE comparison of nuclear with other electricity generation technologies for commissioning between 2018-2020 (in €$_{2017}$).

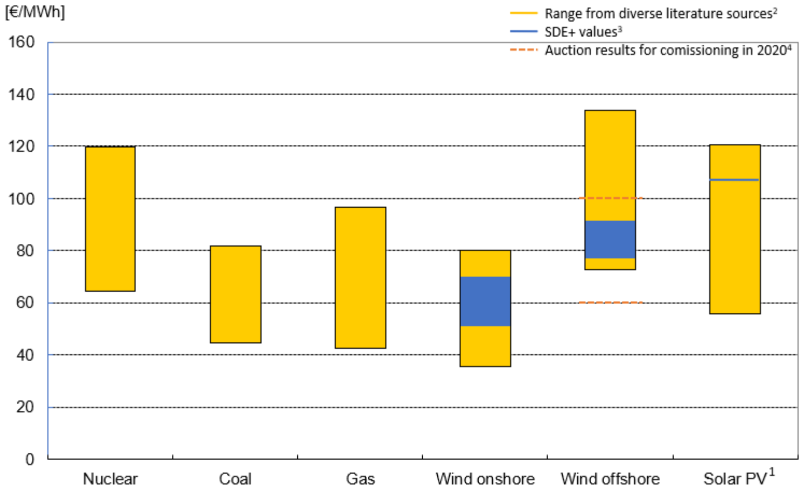

Figure 1 LCOE nuclear energy and other electricity generation technologies (€$_{2017}$)[8]

Notes:
1 *Solar PV refers to ground based solar PV ≥1MWp.*
2 *The LCOE ranges for the electricity generation technologies are based on data from MIT (2018), EIA (2018b), IEA/NEA (2015), Fraunhofer (2018) and D'haeseleer, W.D. (2013). Commissioning dates range between 2018 and 2020 and discount rates range between 6-10%. See Appendix B for more details on the LCOE for nuclear energy.*
3 *The SDE+ values for wind onshore and solar PV are taken from Dutch subsidy base rates in SDE+ (PBL, 2018; ECN, 2017b) and are based on specific assumptions regarding project preparation, land costs, energy yield, lifetime and interest rate, which may differ from the international literature sources. The reference unit costs for wind offshore were calculated in line with SDE+ methodology (ECN, 2017a) and do not include offshore wind farm connection costs.*
4 *Based on global auction results in 2016 and 2017 (IRENA, 2017).*

In the figure, wind onshore, natural gas (CCGT) and coal are more competitive than nuclear (based on the average LCOE value). Here however, LCOE data on wind offshore and large-scale ground-based solar PV remains uncertain due to rapid recent developments, location-dependency and undertaken assumptions. A recent study from Fraunhofer (2018) states that the main reason for higher LCOE for offshore wind than onshore wind is the higher investment and installation costs (as well as operating and financing costs). When compared to the ECN (2017a)'s assessment of wind offshore costs in the Netherlands, investment costs are lower and full-load hours are higher, resulting in a range of 77-91 €$_{2017}$/MWh[9], which contrast in downward direction with the high upper-end from international literature sources. Global auction results in 2016 and 2017 suggest that costs of wind offshore projects commissioned in 2020 will move downward to a level between €60-100 €/MWh (IRENA, 2017). Moreover, the LCOE comparison between nuclear energy and renewable energy does not take into account that pre-construction preparations and building a standardised nuclear power plant will take at least 7-10 years. Even by the earliest commissioning date, the LCOE for renewables is expected to have diminished considerably. To carry-out a fair comparison, it is recommended to estimate the LCOE for renewable energies close to the commissioning year of the nuclear power plant.

8 Resembling the situation in the Netherlands. Where data is not fully available, data from western European countries and/or the U.S. was used.
9 ECN (2017a). Externe notitie: Kosten wind op zee 2017. ECN-N--17-022. Values for wind offshore are based on the calculation of the 'basisbedragen'.

1.4 Cost uncertainties

The break-down of economic aspects of nuclear energy shows an increase on costs and uncertainty between 2007 and 2018 that can be partially assigned to an increase on safety requirements and strict regulations. Cost uncertainties on nuclear energy are backed-up with recent nuclear power plants developments that became more expensive than initially planned. After an idle period of roughly 20 years, three projects in western Europe started construction, i.e. Oilkiluoto-3 (Finland), Flamanville 3 (France), and Hinkley Point C (UK), in 2005, 2007 and 2017, respectively. It concerned 1 EPR unit (1650 MW) in Olkiluoto and in Flamanville, as well as 2 EPR units at Hinkley point C. The implementation of these projects faced several setbacks and associated upward cost revisions. Notably, both Olkiluoto and Flamanville have tripled their initially planned budget and construction periods (from 4-5 years initially planned to 15 years). These setbacks may be related to inter alia the following factors (MIT, 2018):

- These first few built plants can be considered first-of-a-kind (FOAK) plants. The upscaling of the second-generation 1000 MW PWR standard, frequently applied in France in the 1970s and 1980s, to the 1650 MW EPR model turned out to be a very complex undertaking, more than just an anticipated incremental innovation, which also involves high material costs.
- The long idle period implied high additional cost to re-learn all of the expertise and know-how that is required.
- For example, a scarcity of qualified welders has been reported in newspaper articles, regarding the ongoing EPR projects in western Europe.
- High-labour costs in western countries prompted a more modular construction approach with partial outsourcing to lower-wage countries. This enhanced the complexity of project planning and quality insurance.

In the United States, two new projects with 1000 MW AP1000 model light-water reactors (LWRs) - again after a long idle period - were facing similar experiences. It concerns the Vogtle 2&3 and V.C. Summer 2&3 projects, of which the later project has already been cancelled due to cost overruns.

East Asian countries, such as China and South Korea, show a better track record on construction time and cost management based on a standardized approach with a more stable activity level over time. For instance, construction costs in China, excluding interest during construction, are estimated to be about €$_{2017}$2500 per kilowatt electric capacity (MIT, 2018). The South Korean nuclear plant construction industry was also successful in the overseas Middle East market with implementation of the Barakah project being on schedule and lower reported investment costs (see Figure 2). However, disclosed cost information by East Asian nuclear power construction firms is less detailed and transparent than the case of their western counterparts.

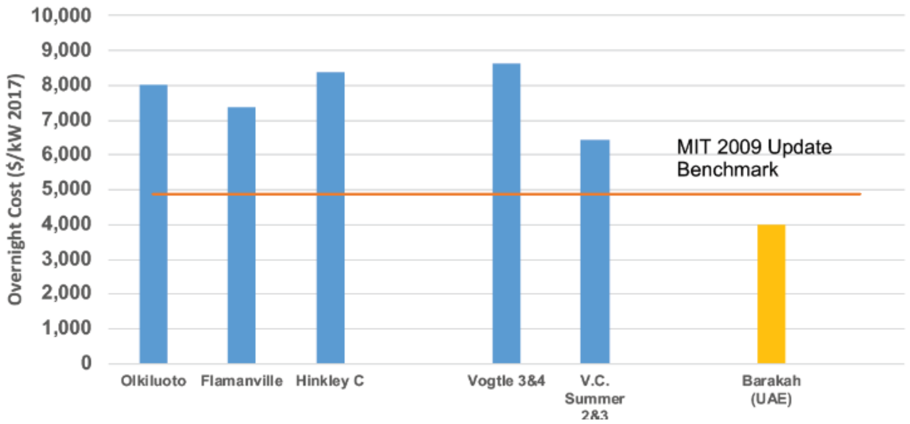

Figure 2 Projected overnight investment costs of recent new builds, reported by MIT (2018)[10]

Overall, FOAK plants tend to be typically 30% more expensive than a subsequent plant of the same design (MIT, 2018), and costs are also higher when the firm/industry needs to re-learn all the know-how. A paper from Berthélemy and Escobar Rangel (2015) shows that there are positive learning effects when the same nuclear model is built by the same Architect-Engineer. In general, cost reductions can be achieved through replication and standardization of reactors, economies of scale, simpler designs and a predictable and consistent licensing process (WNA, 2017). The reduction of construction and permitting risk associated with standardization allows greater predictability, as seen in recent experiences in Asia.

Sudden ad-hoc tightening of safety regulations and changing political environments can also result in construction delays. During the construction time, funds must be made available without revenues from electricity generation, and the interest cost on loans during the construction period is relatively high. If there is an extension on the building period, total investment costs will rise due to construction interest. Moreover, the planned investment costs also depend on the extent to which the risks of cost overruns are included. The risks of construction delays and cost-overruns are crucial for financing considerations. Most plants under construction have strong government involvement or are often government-sponsored, as few utilities are able to develop new nuclear plants without a sort of government guarantee or long-term power purchase agreement (NEA, 2015). No utility can accept unlimited liability for the costs of nuclear accidents and permanent storage of nuclear waste. Hence, any new nuclear build project has to rely at least on the latter form of state support.

In a liberalized market, financing on nuclear power can be more difficult due to uncertainties on future electricity prices that result in higher cost of capital, thus making nuclear power projects less attractive for investors. Long-term power purchase agreements can shield investors from power market volatility, especially from a large share of intermittent renewable sources. In the absence of a significant carbon price, governments have to continue providing policy incentives that improve the NPV of low-carbon investments and mitigate the market risks (NEA, 2015). In the United States, nuclear power plants are experiencing lower electricity prices, which can result in unprofitable conditions. Six nuclear plants are scheduled to shut-down by 2025 for economic reasons and five other nuclear plants have requested state-level price support (EIA, 2018c).

To conclude, the costs of nuclear energy have experienced an increase when compared to data from the Fact Finding Nuclear Energy report of ECN (2007). This increase is notably attributed to tightened safety requirements and innovation on

10 Figure from MIT (2018) p.36. The MIT 2009 Update Benchmark refers to the 2009 update to MIT's original Future of Nuclear study (2003).

nuclear technology. In addition, the introduction of nuclear power plants after a long idle period also results on costs of re-learning that have been underestimated in some cases. Consequently, eventual cost uncertainties have increased along with construction delays and associated extra financing costs during the construction period before the first revenues for generating electricity can be generated. Standardization can lead to cost reductions and economies of scale. However, for the standardised implementation of nuclear energy, a clear commitment and long-term strategy at the national level and at the level of willing EU member states is critical, whilst state support is necessary for adequate attractiveness on investment.

REFERENCES

Berthélemy, M. and Escobar Rangel, L. (2015). Nuclear reactors' construction costs: The role of lead-time, standardization and technological progress. Energy Policy 82. 118-130.

D'haeseleer, W.D. (2013). Synthesis on the Economics of Nuclear Energy. European Commission.

EIRP (2017). What will advanced nuclear power plants cost? A Standardized Cost Analysis of Advanced Nuclear Technologies in Commercial Development. Energy Options Network.

ECN (2007). Fact Finding Nuclear Energy.

ECN (2017a). Externe notitie. Kosten wind op zee 2017 (versie 2 met update netwerkkosten). ECN-N--17-022.

ECN (2017b). Eindadvies Basisbedragen SDE+ 2018. ECN-E--17-048.

EIA (2018a). Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2018. Available at: https://www.eia.gov/outlooks/aeo/assumptions/pdf/table_8.2.pdf

EIA (2018b). Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2018. Available at: https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf

EIA (2018c). Nuclear Power Outlook. Issues in Focus from the Annual Energy Outlook 2018. U.S. Department of Energy.

EC (2016). Nuclear Illustrative Programme presented under Article 40 of the Euratom Treaty for the opinion of the European Economic and Social Committee. European Commission. Brussels, 4.4.2016. SWD(2016) 102 final.

Fraunhofer (2018). Levelized cost of electricity renewable energy technologies. Fraunhofer Institute for Solar Energy Systems (ISE).

IRENA (2017). Renewable Power Generation Costs in 2017. International Renewable Energy Agency, Abu Dhabi.

Jain, S., Roelofs, F. and Oosterlee, C.W. (2014). Decision-support tool for assessing future nuclear reactor generation portfolios. Energy Economics 44. 99-112.

JRC (2014). Energy Technology Reference Indicator (ETRI) projections for 2010-2050. Joint Research Centre of the European Commission.

IAEA (2018). Annual Report 2018.

IAEA/PRIS (2018). Database on Nuclear Power Reactors at: https://pris.iaea.org/PRIS/home.aspx [Accessed on November 2018]

IEA/NEA (2015). Projected Costs of Generating Electricity.

MIT (2018). The Future of Nuclear Energy in a Carbon-Constrained World.

NEA (2012). Economics of Long-Term Operation of Nuclear Power Plants.

NEA (2015). Technology Roadmap - Nuclear Energy.

PBL (2018). Conceptadvies SDE+ 2019. Windenergie op land. PBL-publicatienummer: 3271

WNA (2017). Nuclear Power Economics and Project Structuring.

WNA (2018a). Nuclear Power in the European Union at: http://www.world-nuclear.org/information-library/country-profiles/others/european-union.aspx [Accessed on November 2018]

WNA (2018b). Reactor Database at: http://www.world-nuclear.org/information-library/facts-and-figures.aspx [Accessed on November 2018]

APPENDIX A: NUCLEAR ENERGY COSTS FROM DIFFERENT LITERATURE SOURCES €$_{2017}$[11]

Source		MIT, 2018[1]	MIT, 2018[2]	MIT, 2018[3]	EIA, 2018[4]	EC, 2016[5]	IEA/NEA, 2015[6]	IEA/NEA, 2015[7]	JRC, 2014[8]	D'haeseleer, W. D., 2013[9]
Country		United States	UK	France	United States	Finland / France	OECD and China	Belgium	EU	EU
Reactor Type		PWR or BWR			Advanced LWR	EPR	LWR	PWR or BWR	LWR	LWR
Reference year (currency)		2017	2017	2017	2017	2016	2013	2013	2013	2012
Capacity	[MWe]	1000	1000	1000	2234	1670	1300 (535-3300)	1000-1600	1420	
Investment costs[12]	[€/kW]	4867 (3628-6088)	7204	6018	5262	4654 / 5737	3753	3894	4434 (3925-5916)	4443 (3555-5776)
Operation & Maintenance (O&M)										
Fixed	[€/kW/year]	84	160	102	90		53 (33-157)		93	
Variable	[€ct/kWh]	0,61	1,16	0,74	0,21		0,53 (0,07-1,12)	1,04	0,25	1,05 (0,68-1,41)
Fuel cycle costs	[€ct/kWh]	0,95 (fuel cost)					0,54 (fuel cost)			0,63 (0,55-0,71)
Decommissioning costs	[€ct/kWh]					0,1823				
Cost of radioactive waste	[€ct/kWh]					0,3	0,18			0,16

11 All costs in the table are expressed in €$_{2017}$ using the Harmonized Index of Consumer Prices (HICP) from Statistics Netherlands (CBS). Costs information under 'Notes' are from the original report, currency and date.

12 Investment costs refer to Overnight Construction Costs (OCC) and do not include financing costs. Investment costs have been rounded the nearest 100.

Notes:

1. The MIT (2018) source is based on Gen X simulation results. A Nuclear-Nominal Cost case concerns a nuclear technology at the currently projected ‘nth-of-a-kind’ (NOAK) overnight cost of $5500/kW without interest during construction cost. A Nuclear-Low Cost (Nuclear-High Cost) case at a cost 25% lower (higher) than currently projected. Investment costs in brackets: Low and High cases. Fuel costs are calculated from fuel cost of $1,02/MMBtu and heat rate 10,49 MMBtu/MWh = $10,7/MWh.
2. Refers to above source. Nominal values are specified.
3. Refers to above source. Nominal values are specified.
4. The reference is for an advanced nuclear plant first available in 2022 of 2,234,000 kW and built at a Greenfield location.
5. EPR cases for Finland and France are based on Olkiluoto and Flamanville-3 (both corresponding to FOAK). OCC costs for include civil and structural costs, mechanical equipment supply and installation, electrical and instrumentation and control, project indirect costs, owners’ costs and provision for contingency. Decommissioning costs in €/kWh are estimated for a generic nuclear power plant of 1670 MW throughout its operating life with 80% capacity factor and OCC of €5379/kWe, whereas decommissioning costs are 15% of OCC. The average cost of waste management is €3/MWh.
6. The data is based on nine nuclear plants from OECD-member countries and two from China (a mix of LWRs and generation III nuclear reactors). Investment costs are OCC with a median value of $4896/kWe. OCC include pre-construction (owner’s) costs, construction (engineering, procurement and construction) and contingency costs (15%), but not interest during construction (IDC). The front end of the nuclear fuel cycle is $7/MWh (mining, enrichment, conditioning) and the back end is $2,33/MWh (spent fuel removal, disposal and storage).
7. Refers to the source above. The investment cost is $6498/kWe with 7% discount rate and $7222/kWe with 10%, without discount rate it is $5081/kWe (OCC above).
8. The capacity value is the net electrical power. Values are projected for 2020. For investment costs, financing costs are not included, they refer to CAPEX that includes civil and structural costs, major equipment costs, balance of plant costs, electrical and I&C supply and installation, project indirect costs, development costs and interconnection costs. FOM is 2.1% from investment costs.
9. OCC costs are for a FOAK single unit on brownfield.

APPENDIX B: LEVELIZED COST OF ELECTRICITY (LCOE) FOR NUCLEAR ENERGY FROM DIFFERENT LITERATURE SOURCES €$_{2017}$

Source	Lifetime [years]	Capacity factor [%]	Discount rate [%]	LCOE [€$_{2017}$/MWh]
MIT, 2018	30	85	10	73
EIA, 2018[10]	30	90	6.2	82 (79-86)
IEA/NEA, 2015[11]	60	85	7-10	65-120
D'haeseleer, W. D., 2013[12]	60	85	10	93

Notes:

10. LCOE values are calculated based on a 30-year cost recovery period and the nominal WACC used to calculate LCOE was 6.2% for plants entering service in 2020.
11. Minimum and maximum LCOE values (with 7% and 10% discount rate respectively) for nuclear energy in Belgium and UK. The impact of a 50% increase on the lead time has been applied to the maximum LCOE value of $135/MWh (UK), which given the sensitivity analysis in IEA/NEA (2015), this represents an increase of approximately 15% to the LCOE value.
12. LCOE based on FOAK brownfield single.