The cost of producing future of nuclear power operated beyond 40 years

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Summary

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The cost of producing future of nuclear power operated beyond 40 years - Summary

Greenpeace France has commissioned a study that compares the future production costs of continuing to operate nuclear reactors in France with the future costs of electricity from renewable energy. Fifty eight nuclear reactors are owned and operated by Electricite de France and during the next year decisions will be made on whether to extend the life of these reactors beyond 40 years. The objective of the Greenpeace commissioned study is to evaluate the cost of production if existing reactors are given life extensions beyond 40 years, taking into account the required modifications/safety upgrades and compared with the viable alternatives available, including onshore wind, marine and solar energy.

The study was prepared for Greenpeace by independent consultancy Global Chance[1] and Wise-Paris[2] and uses the method of the current economic data provided by the French Court of Auditors to assess production costs of nuclear power. The cost of renewable energy was based on data from various institutional and industrial bodies including the International Energy Agency (IEA), the Court of Auditors and the European Wind Energy Association (EWEA) and others.[3]

The current industrial strategy of EdF is to seek lifetime extension beyond 40 years for their nuclear reactor fleet, however, the decision to approve extension or not will be made by the French nuclear safety authority (ASN)[4] The ASN is expected to make its preliminary decision for on extension in 2015, with the final decision expected between 2018 and 2019, followed by a reactor by reactor review.

The Greenpeace commissioned study has found that:

- The economic cost of electricity generated by each reactor after major modifications, so-called safety upgrades, and that is supposed to bring them into compliance with current safety standards (based on the European Pressurized Reactor, EPR)[5] will reach € 133 / Mwh by 2020. This corresponds to an investment of € 4.4 billion per reactor (Wise report);

- These costs would exceed current nuclear and future costs of renewable electricity generation, with current onshore wind costs of between 40 and 80 € / MWh), nuclear costs would be the equivalent of solar PV in 2018 and and offshore wind costs expected in 2020.(see figure one in report);

- If a decision was made to limit the increased costs of nuclear electricity and to provide a margin of profit over renewable energy, in other words less investment per reactor it would lead to a reduction in the margin of safety for nuclear power;

- To replace older existing reactors with the new EPR design does not provide the same economic benefits as production from renewable energy.

1 Chance is a global association that provides independent scientific expertise in the field of energy and environment. Its president is the engineer and economist Benjamin Dessus.

2 Wise-Paris is an independent agency of information, research and consulting on nuclear and energy policies. It is directed by Yves Marignac.

3 As well as Fraunhofer, IRENA, and ADEME.

4 See, http://www.asn.fr/Presse/Actualites-ASN/Des-enjeux-majeurs-pour-la-surete-nucleaire-et-la-radioprotection-en-2014 and http://www.french-nuclear-safety.fr/

5 Greenpeace notes however that evidence shows that these reactors cannot be brought to a safe standard.

Investments needed for the renovation of older reactors (Yves Marignac, Wise-Paris)

The main findings of Wise-Paris are:

a. The ageing of EdF's 58 nuclear reactors is looming and the French state has not anticipated or adequately considered the implications. Nearly two-thirds of French reactors will reach 40 years of operation by 2025. Given this delay, urgent decisions become crucial to control safety and costs.

b. The study presents scenarios which could lead to different levels of safety requirements applicable beyond 40 years. The study shows that the investment needed to extend life may be more than four times higher than that currently envisaged by EdF, if the safety requirements are to approach those of new reactors such as the EPR. (Though it is in reality not possible to reach these standards, and the EPR itself is not a 'safe' reactor.)

c. The original EdF plan of spending € 23 billion, has since been revised to a total of € 55 billion if they are to achieve a "major overhaul" program initiated since 2012. However there are major uncertainties about costs, and there is a credible scenario which could lead to a required investment of € 4.4 billion per reactor, according to an analysis of their plans and cost assessments.

d. The life extension of reactors in France requires that they be modified to comply with safety standards adopted as a result of the Fukushima accident. EdF's reactors were not designed for such accident scenarios and their vulnerability is also increased as a result of their ageing. At the same time it is not assured that it is possible to reconcile these safety standards with the actual design of the reactors.

e. A key challenge is the time available to make decisions. There is a risk that decisions to extend the reactors will be made to avoid losing the original investment in the reactors taking precedence over the need to avoid future losses by not investing in reactor extensions.

Impact on the production costs of the old reactor fleet (Benjamin Dessus, Global Chance)

Based on the scenarios of safety and study costs produced by Wise-Paris, economist Benjamin Dessus of Global Chance, has detailed the evolution of the production costs of the old reactor fleet based upon the current cost estimates for their modification.

a. The approach of the current cost estimate, given by the Court of Auditors in its report on the costs of the nuclear sector, is *"to measure the annual cost of remuneration and reimbursement for capital at the lifetime end of a production plant or energy plant and to reconstruct in constant currency the amount of the initial investment, which is the amount that would rebuild the same facility at the end of its life".* This method appears, according to the Court of Auditors, as the most relevant when assessing the cost of production of old nuclear power plants.

b. Specific long-term investments such as dismantling facilities are updated and integrated into the annual economic burden.

c. EdF existing reactors are estimated to operate at 70 percent capacity to reflect the requirement for safe operation of modified reactors. For the sake of consistency with the work of the Court of Auditors in its 2012 report, the discount rate is taken at 5%, including inflation and the corresponding economic rent rate is 7.8%.

d. The assumption is that the initial investment required for the construction and maintenance of reactors of the current fleet is fully depreciated after 40 years. This is a conservative assumption since it minimizes the current economic cost of a reactor whose initial investment was not amortized.

e. The study published by Global Chance analyzes the current economic costs in € / MWh associated with the extension of the current fleet of 10 or 20 years.

f. The analysis is based on taking into account the investments identified in the study of Wise-Paris and takes into account the cost per kW of ranging between € 1,300 / kW to 3900 € / kW. These amounts correspond to the range of € 1.4 billion to € 4.4 billion per reactor identified for the median scenario “maintaining existing safety” 'and Wise-Paris report “enhanced safety."

Current economic costs (CEC) of a new EPR reactor have seen numerous evaluations in recent years.

a. In 2012, in its thematic report on the costs of the nuclear sector[6], the Court of Auditors considered a Current Economic Cost (CEC) of between 70 and 90 € / MWh for an initial investment of nearly € 6 billion and an operating time of 40 years.

b. At the end of 2012, EDF announced a further delay in the construction of the Flamanville EPR. At that time Greenpeace estimated the minimum cost of production of an EPR to 100 € / MWh, which corresponds to the median of a range between 90 and 116 € / MWh. In 2013, the agreement between the UK and EDF for both Hinkley Point reactors contract called a purchase guarantee to 114 € / MWh over 35 years.

This state aid is not strictly representative of a current economic cost of the EPR in particular because it includes operating margins and corresponds to costs of specific work in the United Kingdom. However, it confirms the order of magnitude of the production cost per MWh of the EPR.

c. In 2014, Benjamin Dessus in his study of the current economic costs of nuclear power estimated costs of between 77 and 93 € / MWh EPR on a life of 60 years for cost assumptions between the €8.5 billion current estimated cost of the Flamanville EPR and the € 6.5 billion anticipated by EDF[7].

d. In 2014, Nicolas Boccard an economist at CERNA (Centre d'Economie Industrielle Mines Paris Tech)[8], estimated the cost of producing electricity from the EPR at between 76 € / MWh and 117 € / Mwh.

This analysis will retain a current economic cost of the EPR within the range from 70 to 116 € / MWh, and use a median value of 95 € / MWh.

From 2017, France first commercial nuclear reactors will reach 40 years of operation.[9] For each reactor a decision will have to be made as to whether to close the reactor and replace it or to extend its life beyond 40 years and with considerable modifications.

For each of the scenarios from the Wise-Paris report "current safety" and "enhanced safety" options, we compared the projected production costs of renewable energy costs compared to the costs of maintaining existing aging reactors, including safety modification and the assumption of a life extension of 10 and 20 years. The results are shown in the following graphs. To complete the analysis for future costs of nuclear power, we integrated the production costs of new nuclear power (EPR) in each comparison.

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6 2012, Cour des comptes, Rapport thématique sur les coûts de la filière nucléaire.

7 2014, audition de M. Machenaud, EDF, devant la commission d’enquête de l’Assemblée nationale relative aux coûts futurs du nucléaire. http://www.assemblee-nationale.fr/14/cr-cenucleaire/13-14/c1314024.asp

8 Étude de Nicolas Boccard, audition commission d’enquête sur les coûts du nucléaire. http://www.assemblee-nationale.fr/14/cr-cenucleaire/13-14/c1314053.asp

9 Durée d’exploitation considérée à partir de la première divergence du réacteur.

Overall comparison between the costs of nuclear power and renewable energy

The Greenpeace study shows that by 2020, all projections of future costs of renewable electricity is below the highest projections of future costs for nuclear power. This competitiveness increases for all renewable energy from 2025 when the cost of renewable MWh are below the median cost of future nuclear MWh (or 133 € / Mwh). See table five in French report.

Comparison between nuclear and solar photovoltaic

In the case of solar energy in France by 2018 solar photovoltaic (PV) in most cases will be competitive with a existing nuclear reactors following their modification and granted a 10-year extension (blue zone); by 2025, solar PV will be in most cases competitive with existing nuclear reactors following their modification and granted a life extension of 20 years as well as new nuclear reactors (EPR).

It is necessary to remain cautious on the data presented for the solar PV due to the different geographical areas in France and Europe.

Comparison between nuclear and onshore wind

The projections of future costs for onshore wind. The EPR and the former existing nuclear reactors following modification and based on being granted a 10 year extension leads to higher costs for nuclear than onshore wind. For existing nuclear reactors, with modifications and granted 20 year extensions in the case of low cost scenario assumptions and "enhanced safety", the costs would comparable to onshore wind current cost estimates.

We also note the competitiveness of onshore wind in relation to new nuclear (EPR).

Comparison between nuclear and offshore wind

The competitiveness of offshore wind compared to existing nuclear reactors and modified to post-Fukushima standards is highly dependent on the assumptions used to estimate the costs of modification to the reactors, whether it is to the existing standards or so called enhanced safety and the duration of amortization of the investment in 10 or 20 years.

Offshore wind becomes competitive from 2020 in the scenario of "enhanced safety", amortized over a 10-year operating period. In addition, from 2025, offshore wind has cost levels similar to those from existing nuclear reactors, modified to current safety standards and amortized over 20 years, as well as new nuclear reactors (EPR: orange dotted).

As a reminder, the amortization period of 20 years is strongly dependent upon the decision of ASN as to whether to allow reactor operation beyond an initial extension of 10 years.[10]

Finally, it is important to note that the experience and information on current offshore wind projects is currently much less than that for solar and onshore wind projects.

Conclusions

The study finds that:

- The current economic cost of electricity generated by each modified existing reactor to a level approaching the safety requirements of the EPR reaches € 133 / MWh. This corresponds to an investment of nearly € 4.4 billion per reactor (Wise report).

10 http://www.asn.fr/Presse/Actualites-ASN/Des-enjeux-majeurs-pour-la-surete-nucleaire-et-la-radioprotection-en-2014

- The economic cost, under these conditions, for existing nuclear would exceed the future costs of production from renewable energy. As of today these costs exceed onshore wind (cost between 40 and 80 € / MWh) and by 2018 for solar and from 2020 for offshore wind power (see Figure 1).

- By choosing to extend existing nuclear reactors, while also attempting to limit the increase in production costs of nuclear electricity, while also seeking to ensure a degree of profitability when challenged by renewable energy, it will lead to a reduction in the level of nuclear reactor safety.

- Replacement of aging nuclear reactors with the new EPR will not provide the same production cost benefits as renewable energy.