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# New nuclear power generation in the UK: Cost benefit analysis

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**Abstract**

This paper provides an economic analysis of possible nuclear new build in the UK. It compares costs and benefits of nuclear new build against conventional gas-fired generation and low carbon technologies (CCS, wind, etc.). A range of scenarios are considered to allow for uncertainty as regards nuclear and other technology costs, gas prices and carbon prices.

In the base case, the analysis suggests that there is a small cost penalty for new nuclear generation relative to conventional gas-fired generation, but that this is offset by environmental and security of supply benefits. More generally nuclear new build has a positive net benefit for a range of plausible nuclear costs, gas prices and carbon prices.

This supports the UK policy of developing an enabling framework for nuclear new build in a market-based context. To the extent that assumptions in the analysis are not borne out in reality (e.g. as regards nuclear cost), this is a no regrets policy, given that the market would not invest in nuclear if it is prohibitively costly.


*Keywords:* Nuclear power; Nuclear cost effectiveness; Nuclear welfare balance

## 1. Introduction

The approach in this analysis is to attempt to look at the range of costs and benefits associated with investment in new nuclear generation capacity. In theory, if the benefits exceed costs, it would be a good idea for the Government to enable (if not necessarily directly support) new nuclear build. If the costs exceed the benefits, then such a policy would, in theory, not be justified.

The analysis is economic rather than financial and, as such, cannot be used as a basis for determining likely commercial appetite for bringing forward nuclear projects. It would be for the private sector to conduct financial analysis as part of project due diligence and to bring forward projects accordingly. The aim of this analysis is to determine whether there is potential benefit in keeping the door open for such projects.

Costs and benefits have been accounted for as fully as possible. The analysis considers resource costs associated with nuclear plant relative to alternatives of gas-fired generation and other technologies. It includes valuation of environmental benefits (there are carbon emission reductions to be gained from adding nuclear rather than gas-fired capacity) and security of supply benefits (nuclear power is subject to lower probabilities of fuel supply interruption than gas-fired generation).

A proviso is necessary: the analysis does not attempt to monetise all costs and benefits. Specifically, a monetary value associated with potential accidents is not estimated. Evidence suggests that the likelihood of such accidents is negligible, particularly in the UK context.[1] Though accident risk should not be dismissed, the assumption is that this can be managed through design of regulatory and

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[1]The literature suggests a range for the probability of major accidents (core meltdown plus containment failure) from $2\times10^{-6}$ in France, to $4\times10^{-9}$ in the UK. The associated expected cost is estimated to be of the order £0.03–0.30/MWh depending on assumptions about discount rates and the value of life; using the figure at the top end of this range would not change the results of the cost benefit analysis. Introducing risk aversion, the results of the cost benefit analysis in the central case (defined in Section 3 below) would be robust for a risk aversion factor of 20 at the highest estimated value for the expected accident cost. For a summary of the relevant literature, see EC (2005).

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corporate governance arrangements for the nuclear industry.[2]

The analysis attempts to provide answers to the following questions:

- What is the scope for new nuclear power generation given the existing generation capacity stock and its likely evolution?
- What is the net economic benefit associated with nuclear relative to a do nothing case where new investment in electricity generation is likely to flow to gas-fired plant?

These questions are answered within the following structure:

- Section 2 assesses the need for new generation capacity given the current and evolving capacity stock. The discussion here emphasises the fact that new nuclear capacity could only be added in the medium/long term given the substantial lead-time for projects; this places a constraint on the timing/magnitude of any future nuclear programme.
- Section 3 contains a discussion of nuclear costs, and a comparison of nuclear costs with those of gas-fired power generation. The analysis recognises the need to allow for the considerable uncertainty associated with nuclear costs and other variables, and the need for a cautious approach to modelling nuclear costs.
- Section 4 considers various perspectives on environmental benefits of nuclear investment. Cost effectiveness of new nuclear generation as regards carbon reduction is compared to cost effectiveness of other forms of low carbon generation. Nuclear carbon reduction is valued at various carbon prices/abatement costs and at the *social cost of carbon*.
- Section 5 estimates security of supply benefits of adding new nuclear capacity. These are modelled as reduced costs of insuring against fuel supply interruption (e.g. costs of adding extra gas storage capacity) that would otherwise be added in a world where investment flows to gas fired rather than nuclear generation.
- Section 6 provides welfare balances—monetised environmental and security of supply benefits net of cost penalties—for nuclear investment under a range of scenarios modelling alternative nuclear costs, gas prices and carbon prices.

## 2. There is a relatively small need for new capacity between 2018–25

*New investment should only take place when there is a need for capacity—to replace existing capacity upon retirement and to meet demand growth.*

In general, there are two contingencies where it would be economic to add new capacity:

- When existing capacity is retired. Assuming that there is capacity balance prior to retirement, failure to replace existing plant upon retirement would lead to capacity imbalance.
- As demand grows, there is a need for investment in new generation in order to maintain capacity balance.

The assumption in this analysis is that investment in nuclear plant is only considered when there is a need for new generation capacity. Investment in nuclear power when there is no need for capacity would incur excessive cost and could not be justified economically.

From a financial perspective, un-necessary investment in new capacity would displace existing plant, leaving investors unable to recoup their investment. The upper bound on displaced investment would reflect the capital cost of gas-fired plant, of the order £450 million/GW. In practice this could be lower, to the extent that existing plant would be partially depreciated by the time new nuclear capacity could be added.

*The timeframe for possible nuclear investment: 2018 and beyond.*

Given the long lead-time for nuclear projects, it is realistic that new nuclear plant could come on line only after 2018 at the earliest. This assumes an aggressive schedule based on a 6-year pre-development period starting in 2007 followed by a 5-year construction period.

The *base case* assumption in the analysis is that the first new nuclear plant could be added from 2021, with subsequent plants added at 12–18-month intervals, resulting in around 6 GW of new build by 2025.[3] This assumption allows for an 8-year pre-development period starting in 2007 followed by a 6-year construction period. It reflects the possibility that there may be a resource constraint, both as regards capacity of the UK construction industry, and as regards the ability/willingness of investors to add nuclear new build in the UK given demand in other markets (e.g. China, India).

*There will be need for adding up to 3.6 GW of new capacity between 2018–25 to replace existing nuclear plant scheduled for retirement during this period, and more as the life of plant due to retire before 2018 is extended.*

Planned plant retirement is summarised in Table 1.[4] The table shows that there is 3.6 GW of existing nuclear capacity scheduled for retirement during the period 2018–25. Of this, 2.5 GW could potentially be replaced by

[2]This assumption is similar to the position of the Sustainable Development Commission, see SDC (2006).

[3]Capacity of new nuclear plants that might be added in the UK context varies from around 1–1.6 GW; the number of plants comprising a 6 GW programme would vary according to type of plant.

[4]Underpinning the table is the following schedule for closure: Oldbury (2008), Wylfa (2010), Hinkley Point B (2011), Hunterson B (2011), Hartlepool (2014), Heysham 1 (2014), Dungeness B (2018), Heysham 2 (2023), Torness (2023).