Uncertainty and High Economic Risk

The Net Present Value of an investment in nuclear power

BRIEFING

FEBRUARY 2009

GREENPEACE

Catalysing an energy revolution

fact: investing in wind power is far more profitable than investing in nuclear power

Introduction

Greenpeace has calculated the Net Present Value (NPV) of an investment in a new nuclear power plant in the Netherlands using a methodology developed by PricewaterhouseCoopers for the report ‘A financial and economic comparison of coal, gas and wind options for Dutch electricity generation’[1]. The results of Greenpeace’s calculations show that losses can be as high as €3 million per installed MW capacity and are highly dependent on market electricity prices and investment costs.

PwC calculated for Greenpeace the NPV of an investment in a new coal-fired power plant, gas-fired power plant and wind park in the Netherlands. Investing in a coal-fired power plant would lead to losses of €250,000 per MW; investing in a gas-fired power plant is profitable (NPV of €7,000/MW)[2]; the NPV of wind power is slightly negative (-€37 000 per MW)

The climate crisis has provided the nuclear industry with a new argument in promoting nuclear power plants. CO_2 emissions from nuclear power are limited, and so it is presented as a ‘clean’ source of energy. However, nuclear power plants are the source of various forms of radioactive pollution and therefore never clean. As this report shows, alongside the problem of nuclear waste and the safety of nuclear power plants that can never be guaranteed, the costs of nuclear power are so high that - without a set of governmental subsidies and guarantees - a company would have no interest in investing in new nuclear power capacity.

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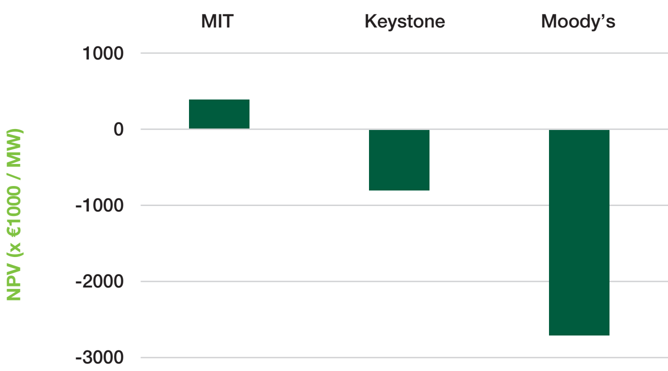
Methodology

Defining the Net Present Value (NPV) of an investment is a way to determine the current value of money that is invested in long-term projects. A positive NPV means that the return on an investment is higher than the required rate of return. An investment with a positive NPV is therefore profitable in the long term. A negative NPV means that the investment will lead to losses in the future and should therefore be rejected.

The (NPV) of an investment in a new nuclear power plant in the Netherlands was determined using a methodology developed by PricewaterhouseCoopers – referred to herein as the 'PwC-2008'.

Figure 1 NPV of investment in nuclear power in the Netherlands



Three scenarios were developed to cover the range in data found for the various parameters. The three scenarios are based on data retrieved from three studies on nuclear economics, by Massachusetts Institute of Technology (MIT, 2003)[3], Moody's Investors Service[4] (2008) and The Keystone Centre[5] (2007) respectively. These studies were selected as they represent the view of an academic technology institute, a corporate finance institute, and an independent not-for-profit organisation. Steve Thomas, professor in Energy Policy at the Public Services International Research Unit (PSIRU) of the Business School of the University of Greenwich has verified that the data used by these studies has been accurately transcribed to the model.

The NPV was determined by generating cash flows until 2030, which were subsequently discounted to obtain a NPV for the investment in 2007. The NPV answers the question of how much cash an investor would need to have today as a substitute for making the investment. If the NPV is positive, the investment is worth taking on because doing so is essentially the same as receiving a cash payment now equal to the NPV. If the NPV is negative, taking on the investment today is equivalent to giving up some cash today.

The results of the calculations are presented in figure 1. The NPV of the investment in nuclear power is only positive (€395,000 / MW) in the MIT scenario. The Keystone and Moody's scenarios show highly unprofitable investments (€829,000 loss per MW and €2,976,000 loss per MW, respectively).

Key assumptions

Input data was retrieved from the three previously mentioned studies and PwC-2008. Table 1 gives an overview of the different input variables used in the MIT, Keystone and Moody's scenario.

Table 1 Input data nuclear power (all numbers are in 2007 €)

		MIT	Keystone	Moody's
Commodity price nuclear fuel[6]	€/MWh	4.27	12.59	3.49
Capital cost for new build capacity	€/kW	1,674	2,185	5,241
Variable O&M costs[7]	€/MWh	0.39	3.70	6.99
Fixed O&M costs[8]	€/kW	144	103	174
Load factor[9]		0.85	0.75	0.90
Depreciation time	years	15	15	50
Construction time[10]	years	5	6	-
Plant life time	years	40	30	50

Discount Rate: Cost of Capital

For the discounting of the cash flows, the same cost of capital (WACC) was used as in PwC-2008 on investments in coal, gas or wind power. This assumption does not take into account that the risk factor for investment in nuclear power plants is considered higher than that of the other investment options. The discount rate used was 5.28%, based on the assumption that the power plant is financed with 30% debt and 70% equity. The cost of debt was set at a pre-tax rate of 7% while a post-tax nominal equity rate of 12.2% was used. The nominal post-tax WACC with these assumptions is 7.31%. The assumed inflation rate was 2% resulting in a real post-tax WACC of 5.21%[11].

Electricity prices

IPA, an economic consultant in infrastructure, provided electricity prices for the Dutch electricity sector for the period 2007-2030. The electricity price in 2008 is assumed to be between €59.2 and €64.1 / MWh and changes to values between €42.4 and €65.1 / MWh in 2030. The low scenario (in line with the nuclear MIT scenario) assumes a decrease of the electricity price to €42.4 / MWh, the base scenario (in line with Keystone) assumes a decrease to €53.7 / MWh and the high scenario (in line with Moody's) assumes an increase to €65.1 / MWh.

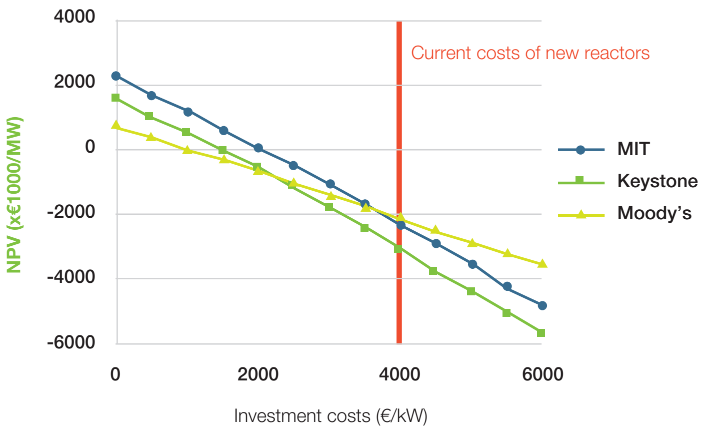
Discussion

Investment costs

The investment costs for new build nuclear capacity are a very uncertain yet decisive factor in the total costs of nuclear power. In this study, values are used ranging from €1,674 / kW installed capacity to €5,241 / kW. Recently, investment costs for a new build have increased sharply, making the assumptions of the 2003 MIT study outdated. More recent experiences with the construction of new nuclear power plants show investment costs closer to the Moody's scenario than the MIT scenario. The costs for the new European Pressurised Reactor (EPR) currently under construction in Olkiluoto, Finland, have risen to almost €3,000 / kW[12] and are expected to increase even further. EDF, the French constructor of the EPR, declared that the costs of future EPRs will be as high as €4,000 / kW[13].

Figure 2 shows the effect of different investment costs assumptions on the NPV of an investment in nuclear power. Nuclear power becomes a profitable investment if investment costs are below €1,034 / kW for the Moody's scenario, below €1,470 / kW for the Keystone scenario and below €2,030 / kW for the MIT scenario.

Figure 2 NPV of investment in nuclear power in the Netherlands with different investment costs

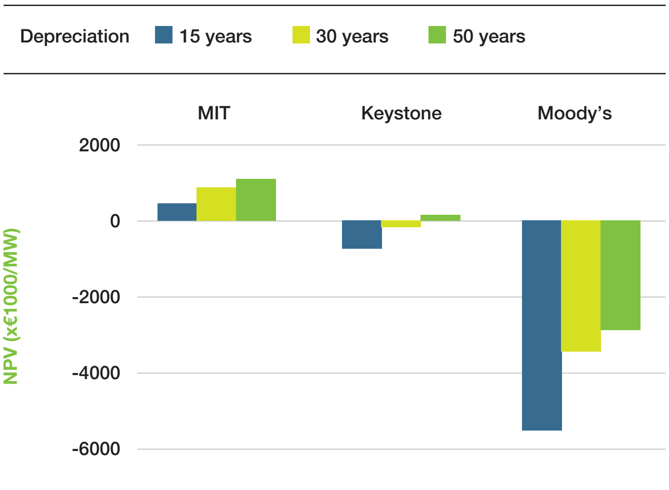


Depreciation period

The capital costs of the investment in nuclear power are annualised using an annuity method. It is assumed that, after the power plant is depreciated, a new one is built with exactly the same real costs as in 2007. Therefore, in this model a longer lifetime does not influence the profitability of the nuclear power plant. However, a longer depreciation time does make a plant more profitable.

The Moody's study uses a depreciation period of 50 years. Both the MIT and the Keystone study choose an accelerated depreciation time of 15 years. Changing the depreciation period to 50 years in the Keystone scenario would bring the NPV just out of the red figures; in the MIT scenario the NPV would increase threefold. However, in a liberalised competitive energy market such as Europe, a 15-year depreciation period is very reasonable, while a 50-year depreciation period will only be reasonable for a government-controlled energy market. Figure 3 shows the effect of different depreciation periods on the NPV of the investment.

Figure 3 NPV of investment in nuclear power in the Netherlands with different depreciation periods



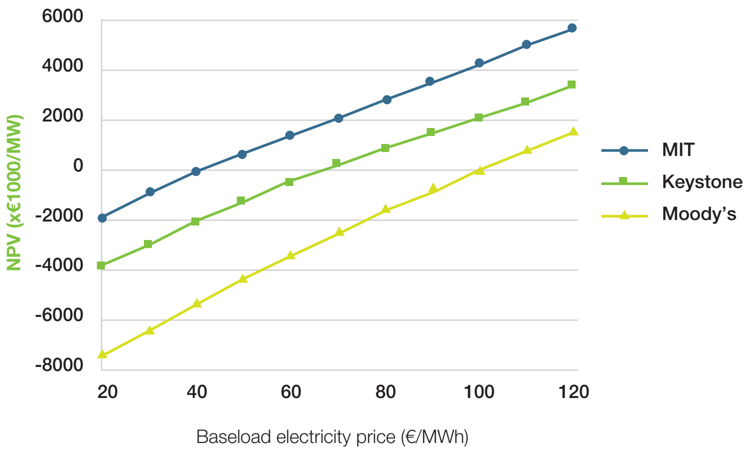
Discussion - continued

Electricity price

Sensitivity analysis showed that the most influential factor on the NPV is the market electricity price, as this price determines the income of the power plant. Market electricity prices are hard to predict and therefore often debated. IPA assumes a conservative electricity price development. An increase in market electricity prices will benefit the investors of a nuclear power plant. Figure 4 shows the effect of a change in the electricity price on the NPV of investing in nuclear power in the Netherlands.

In order to be profitable, the wholesale electricity price should be higher than €43 / MWh in the MIT scenario, €70 / MWh in the Keystone scenario and €100 / MWh in the Moody's scenario. Energy prices in the Netherlands are, at time of writing, around €60 / MWh, meaning that only under the MIT scenario, which includes unreasonable low assumptions on investment costs, could a nuclear power plant make a profit.

Figure 4 NPV of investment in nuclear power in the Netherlands with different baseload power prices



Construction time

The methodology used in this report assumes overnight construction costs, which means that the model assumes that the plant is constructed overnight and will start generating electricity and income from Day 1. Construction of a nuclear power plant can take up to 10 years[14] and delays are common practice; the Olkiluoto power plant in Finland is already 2.5 years behind schedule, after only 3 years of construction. Therefore, the NPV of nuclear power plants calculated according to this model – using construction periods of 5 to 6 years - is likely to be an underestimation of the real costs of construction in the European market.

Hidden costs of nuclear power

Insurance of nuclear power plants not included

The costs of insurance of a nuclear power plant were not included in this study because of the absence of reliable data. The insurance costs for operating nuclear power plants are, under current conditions, not very high and will therefore not influence the NPV calculations significantly. However, current insurances of nuclear power plants cover just a fraction of the potential damage; the rest is covered by the state. No insurance company is willing to fully cover the disastrous effects of a nuclear accident. If owners of nuclear power plants were fairly forced to cover the whole risk of a nuclear accident, this would have a very negative impact on the NPV.

Permanent storage of nuclear waste not included

In this study only short-term costs of storage of nuclear waste were included. Long-term costs – nuclear waste should be stored safely for millions of years – are very hard to determine because no single, final solution for waste storage is available worldwide. Therefore, the state is responsible for the costs related to the final disposal of nuclear fuel. If owners were forced to cover these costs, this could have a negative impact on the NPV.

Conclusion: invest in wind-power and gas fired power plants

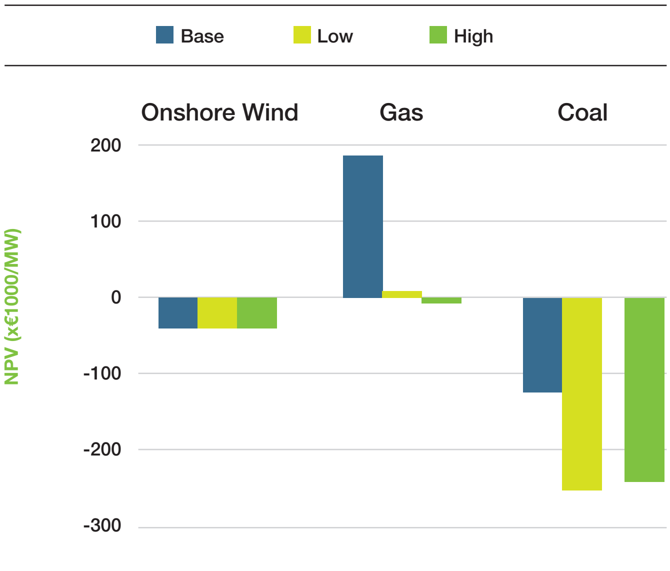
This study shows that investing in nuclear power under the current investment costs and electricity prices in the Netherlands is highly risky and is likely to lead to the loss of substantial amounts of money. This leads to the conclusion that nuclear power only can be profitable in the unlikely event of a sharp decline in construction costs or with the help of government subsidies and guarantees.

Figure 5 shows that investment in coal-fired power plants – taking into account the price of CO_2 – is also an unprofitable investment, whereas investment in gas-fired power plants can be profitable. The investment in onshore wind parks has a slightly negative NPV.

The difference in the predicted NPV of a new nuclear power plant between the MIT and the Moody's is around €3.5 million / MW, while the difference between low and high scenarios of coal-fired and gas-fired power plants is no more than €200,000 / MW.

This shows that there are far more uncertainties and higher economic risks involved in nuclear power plants than in other power options.

Figure 5 NPV of investment in onshore wind power, gas fired power plant and coal fired power plant in the Netherlands



Source: PwC 2008 (see footnote 1).

GREENPEACE

Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace.

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1 Financial and Economic comparison of coal, gas and wind options for Dutch electricity generation, PwC, 2008. Available at: http://www.greenpeace.nl/raw/content/reports/a-financial-and-economic-compa.pdf

2 Assuming CO_2 price between €20 and €35 / tonne CO_2

3 Massachusetts Institute of Technology (2003), 'Future of Nuclear Power' http://web.mit.edu/nuclearpower

4 Moody's Corporate Finance (May 2008), 'New Nuclear Generating Capacity'

5 The Keystone Centre (June 2007), 'Nuclear Power Joint Fact-Finding' http://www.nuclear.gov/pdfFiles/rpt_KeystoneReportNuclearPower JointFactFinding_2007.pdf

6 Keystone: constant over time, Moody's: 5-10% increase per year, MIT: 2-5%increase per year. Short-term storage costs of spent fuel is included in fuel costs.

7 Keystone: constant over time, Moody's: 5% increase per year, MIT: 1% increase per year.

8 Keystone: constant over time, Moody's: 5% increase per year: MIT: 1% increase per year. Decommissioning costs are included in the O&M costs.

9 Constant over time.

10 Construction time in Moody's is not specified. The model does not incorporate construction time but assumes overnight construction costs.

11 These numbers are derived by PwC-2008 from the Energy Review by the UK Department of Trade and Industry (DTI) http://www.berr.gov.uk/energy

12 Nucleonics Week, Platts, 4 September 2008

13 Le Figaro, Devenir un «acteur majeur du nucléaire outre-Manche>>, Interview with Pierre Gadonneix, 25 September 2008

14 'The Economics of Nuclear Power', Stephen Thomas, Antony Frogatt, Peter Bradford and David Milborrow, November 2007 http://www.greenpeace.org/international/press/reports/the-economics-of-nuclear-power

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