THE ECONOMIC VIABILITY OF NUCLEAR POWER PLANTS IN LIBERALISED POWER MARKETS

by

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Overview

After several decades of negligible growth talk of a nuclear renaissance has been stimulated by oil price spikes, concerns over energy security and the requirement to reduce emissions of greenhouse gases. In its 450 scenario, the IEA (2008) projects a doubling of electricity generated by nuclear from 2007 to 2030, stimulated by a carbon price and favorable government policies for mitigating investment risks in the industry. This represents an ambitious target, particularly given nuclear's poor construction record over recent years, the incident at Fukushima, and uncertainties surrounding the cost of building new plant. This paper assesses the economic (i.e. financial plus environmental) viability of investment in nuclear power generation in liberalized power markets.

Methods

When comparing the environmental footprints of alternative energy technologies, it is important that the power generation or combustion stage of the technology not be isolated from other stages of the "cycle". For example, nuclear power plants emit virtually no greenhouse gases (GHGs) in their operation. However production of their "fuel" (enriched uranium), from mining to disposal, construction of the power plant and other process steps, may involve increases in GHG emissions in excess of those that would arise from using fossil fuel technologies to meet the same level of energy requirements. To avoid such distortions, the concept of life cycle analysis has been developed.

A number of studies have been undertaken with the intention of measuring GHG emissions from the nuclear fuel cycle, and three of them are compared by Beerten et al. (2009). The results are highly sensitive to contextual assumptions concerning the energy carriers used for the generation of thermal and electrical energy in the different processing steps. In the Australian context, the study quoted Lenzen et al. (2006) who derived a life cycle GHG intensity for nuclear of 57.7 g CO_2/kWh. This estimate was based upon coal being used exclusively as an energy carrier, reflecting its dominance in Australia's power generation fuel mix. Imposing a European fuel mix on Australia, and assuming natural gas was used in the enrichment process, this figure drops to 32.3g CO_2/kWh. For comparison, assuming best available power plant efficiencies, the IEA (2008) gives direct (i.e. power plant combustion only) emissions from a combined cycle gas turbine plant as 350g CO_2/kWh and from a typical super-critical coal-fired power plant 800g CO_2/kWh.

Nuclear power plants have a "front-loaded" cost structure; i.e. they are relatively expensive to build but relatively inexpensive to operate. Although costs vary both between and within countries, about two-thirds of the costs of generating electricity from a nuclear power plant are accounted for by fixed costs with the remainder being operating costs could be taken as indicative figures. The main fixed costs are capital repayments and interest on loans, but the decommissioning cost is also included in this item. Fuel is a relatively minor component of operating costs, because uranium is in relatively abundant supply in terms of current requirements.

The cost of capital (i.e. the interest rate) is, together with construction costs, a major determinant of the cost of power from a nuclear plant. Most nuclear plants currently operating in OECD countries were built in an era when the power generation sector was a regulated monopoly. Thus the cost of capital was low, as it was backed by government guarantee. In addition, any increase could be clawed back from consumers in the form of higher prices arising from the full cost recovery nature of the sector pricing regime. Thus investment risk, which effectively was vested in the consumer/tax payer, was minimal and hence the cost of capital reflected this.

However, OECD electricity markets have undergone reconstruction, to various degrees, to a model that is driven by competitive forces, and thus the investment risk now falls on the generator rather than consumer. In such circumstances the real cost of capital could be expected to be considerably higher than under the former regime. Of course, this risk could be reduced by government guarantees but this amounts to a subsidy and is therefore in conflict with the competitive market model.

Results

Combining the various market and environmental costs derived using the above methodology gives indicative guidance as to the cost of nuclear generated electricity under a carbon constraint, vis-à-vis power generated by super critical coal and combined cycle gas turbine technologies. The results are heavily dependent upon the construction period, the discount rate in use by the plant owner, and the price of carbon.

Conclusions

Government support in the form of risk support is an essential requirement for establishing a nuclear power capability. Without it, uncertainties over a potentially volatile carbon price and high discount rates would make the required investment commercially non-viable. Further, the short-term nature of investment in liberalized markets needs to be addressed in the interest of achieving an optimum long-term portfolio of low carbon generating assets. In addition, and before any investment reached the planning stage, it will be necessary to established the appropriate regulatory regime, gain acceptability from a very cynical public and to find appropriate sites close to water within densely populated areas. It's a significant challenge!

References

Beerten, J., Laes, E., Meskens, G., D'haeseleer, W., 2009. Greenhouse gas emissions in the nuclear life cycle: A balanced appraisal. Energy Policy 37, 5056-5068.

International Energy Agency (IEA), 2008. Energy Technology Perspectives 2008: Scenarios and Strategies to 2050, IEA, Paris, France.

Lenzen, M., Dey, C., Hardy, C., Bilek, M., 2006. Life-cycle energy balance and greenhouse gas emissions of nuclear energy in Australia. Report to the Prime Minister's uranium mining, processing and nuclear energy review (UMPNER).