Gordon MacKerron assesses the economics of nuclear power after Fukushima

It may be several years before the full ramifications of the Fukushima accident are understood. But some early effects around the world are starting to become visible and this article concentrates on the implications, visible and prospective, for the costs and overall economics of nuclear power.

Much is already being written about the potential effects of Fukushima relative to those experienced after Three Mile Island and Chernobyl, and whether or not these will be greater or less than the consequences of these earlier accidents. However it is the similarities rather than the differences that seem to matter most. All three did (or will) lead to a substantial pause in the international nuclear enterprise. More to the point in the context of the economic status of nuclear power, the basic message emerging from all three accidents is that from either internal (TMI and Chernobyl) or external (Fukushima) initiating events, the value of a highly capital-intensive investment can be written off in a matter of hours. But bad as this is, more follows. The clean-up bill after these accidents is also much larger than if standard decommissioning and waste management were involved. Fukushima therefore points up a large (but not the sole) financial and economic risk of a nuclear investment, and one which hardly applies at all to alternative electricity generating options.

Besides the re-iteration of this underlying financial risk of nuclear investment, the Fukushima accident is leading to reviews across the nuclear-using world of the design of potential new reactors – primarily, their robustness to major external threats to their integrity, and the capacity of multiple and redundant systems to respond quickly and effectively to major malfunctions. The implications of any given level of added costs that will result from these review processes depend on the extent of the competitiveness of nuclear power before the accident took place. So how was nuclear power doing relative to its competitors, mainly gas-fired and coal-fired power?

The answer is not clear. The nuclear 'renaissance' has not yet really got under way – in the OECD area, no reactor has yet been completed and only two have started construction – and so there is no experience of real costs. When the idea of the nuclear renaissance took hold around 2005, the nuclear industry suggested that some low costs were feasible. In the USA, target figures of $1000/kW were taken seriously, a level well below the figures achieved historically. The confidence behind these low numbers derived mainly from the expectation that a new generation of reactors would in principle be much cheaper than the previous generation, driven by substantially reduced material inputs (the Westinghouse AP1000) or expanded economies of scale (the Areva 1650 MW EPR). Even before Fukushima however, it was clear the costs would be much higher than $1000/kW. Rising costs were driven by rising raw material costs and a more realistic appreciation of what a design that was able to get regulatory approval would look like.

Nuclear construction costs have had a difficult history and the 'appraisal optimism' that has characterised many new technologies has been especially acute for nuclear power. While other new technologies have benefited from reduced costs as learning and economies of large numbers have reduced costs, in the case of nuclear, technical advances have been frustrated by increasingly stringent regulation, adding substantially to the cost. Even before Fukushima, prospective costs had already started to escalate substantially. The first new OECD-based reactor, the EPR being built by Areva at Olkiluoto in Finland was already running over three years late. It also had a revised cost estimate well over 50 percent above original 'turnkey' level, and was estimated to have reached 5.5 bn. euros. As the first of a kind, it was not surprising that the project was running well over budget especially as there were significant regulatory issues that had not been ironed out in advance of construction start. It is not yet clear what further escalations may now be the result of reviewing Fukushima.

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The second EPR, being built by EdF at Flamanville was already showing some signs of over-running (its cost estimate had escalated from 3.3 bn. to 4 bn. euros in advance of Fukushima). But in July, the first indications of the impact of cost reviews following Fukushima were announced, and they referred to Flamanville. The expected cost has now increased to 6 bn. euros and the time over-run will now be at least three years. It is worth looking at this number compared to earlier US expectations of $1000/kW. The Flamanville project is now running at c. $8.6 bn. or some $5200/kw, five times more than some early US hopes. It is also worth comparing this estimate with those made for the UK, especially as the analogy between French and UK costs might also be expected to be better than between France and the USA, as EdF will be the first vendor of a new reactor in the UK. In 2008, the UK government suggested that the cost for a new reactor might be of the order of £1250/kW, or $2000/kW. But translating the new Flamanville estimate into UK terms yields a cost of almost £3200/kW, over 150 percent higher than the UK government's 2008 expectation.

What do these large escalations mean for the competitiveness of nuclear plant? Taking the UK example, the government's 2008 expectation was that at £1250/kW nuclear would be cheaper than alternatives as long as the EU ETS price for carbon dioxide was at 36 euros/tonne. At £3200/kW competitiveness would require the price of carbon to be at a level well over 100 euros/tonne, something no one seriously imagines will eventuate. At these kinds of cost level, and bearing in mind that shale gas in the USA means that gas prices are unlikely to escalate in the next few years, gas-fired power will almost everywhere be cheaper than nuclear. Further, the cheaper renewables are also likely to do well in a direct cost comparison.

But things are somewhat worse than this. The numbers quoted above are engineering-based, taking no explicit account of project risk. The write-off risk mentioned above may be seen by investors as very small for new technology where there is less risk of earthquake/tsunami conditions, and following the new cost-increasing measures that will now be put in place to help robustness. But the overall financial risks of a nuclear project remain significantly higher than for alternative power projects – regulatory and political risk are especially important, quite separately from the effects of Fukushima. This means that where nuclear investment is expected from private sources, and subsidies and/or carbon prices are low, the attractiveness of new nuclear investment will now be very low.

This suggests that prospects for new nuclear build are now poor throughout all of the OECD, where private investment is now the norm and states are unwilling or unable to guarantee minimum levels of return. The picture may however be different for the non-OECD world, where activity in new-build was already stronger, especially in China and other parts of South and East Asia. Where governments either supply the bulk of the finance or are willing to guarantee the returns available to nuclear investment by allowing consumers to pay for whatever costs are incurred, the relatively higher risks of nuclear investment are either absorbed by the state or passed on to consumers. In these situations and in countries where nuclear is regarded as a strategic investment, then the delay and discouragement caused by Fukushima may be much more limited. As the article by Malcolm Keay also suggests, the expansion in nuclear power in the next decade or so may be mainly confined to developing Asia. And as China, with easily the world's largest nuclear programme, is now beginning to internalise the technology being transferred to it by both Westinghouse and Areva, this is the place, in ten years' time, that will be the world's main source of commercial reactor technology.