Nuclear power – they can't be serious

Mark Whitby argues that energy should be 'invested' to maximise its return and that against this imperative, nuclear power does not compare well with renewable energy options.

Nuclear power - not a good return for the energy 'invested'?

In the debate about energy and the security of supply it would appear that almost every possible scenario has been covered from every viewpoint and persuasion. However there is a gap which possibly has more to do with economists than engineers which, nonetheless, I shall attempt to explore.

Over the next 20 years and more we are inevitably going to continue to burn fossil fuels and the question is not only about how much we use, but also how wisely we use it. After all, whilst we can each question the amount of journeys we make as individuals, some journeys will be essential and, likewise, some consumption of power in the home necessary. What we shall all try to do, I hope, is to reduce our needs, and some of this reduction will come at the expense of spending more energy to create a more benign environment. A classic example is insulating one's home, where a little energy spent up front will go a long way in reducing long-term consumption.

What has been interesting for me as an engineer is the balance point at which investing energy in making a building more sustainable uses more energy than would be delivered by a similar investment of energy in a renewable generator. You will notice here that I am talking in terms of energy: it could be money (the economist's measure of value) but, if we are looking at the Earth being able to tolerate a finite amount of emission over a period of time, then it is best to stick to the energy side of the equation.

What is obvious is that, while we can make a zero-energy building, to do so could be at the expense of the environment, if the energy used to achieve that extra amount of performance might have been invested better. Conversely, if those last units of energy had been invested in an alternative generation system, then that could have delivered more renewable energy than the losses associated with not investing the energy in the building.

Imagine a new village with a thousand dwellings. We can choose to make them 'super-efficient', with the increased costs for super-efficiency being x. Alternatively we could buy that community a share in a wind farm that makes up the difference, x, and leave them as just plain 'efficient'.

For an engineer, the question is how do we determine this balance point? For instance, the energy payback for a wind turbine is between 25:1 and 40:1, which means that over the 25-year life of the turbine we are going to get back each year between 1 and 1.6 times the energy originally invested in building the turbine. The implication of this is that if the energy-saving device you wish to build into your home doesn't save each year at least one times the energy invested it may have been better to use that energy in an alternative way.

Of course, this only makes sense if you can invest in an alternative renewable source and, whilst your investment in the turbine makes sense on day one, if your house is to last 100 years and the turbine only lasts 25, the equation can become distorted by the need to reserve some of the energy being produced for reinvesting in maintenance and replacement.

However, let's stop and look at that argument from the opposite point of view. Whilst ultimately simplistic, this is fundamental good housekeeping or, more to the point, good investment practice. All the housing developers I work with are mad about 'capex', the rate of return on capital expended, which means how much money they have tied up in unsold property compared to the profit they are making on sales. For each project the developer looks at, he asks 'how much money do I need to invest before I get a return and what is the rate of return?' He may have a very big development but if he can deal with it in small bits his risks will be lower and he can work to a tighter margin. Alternatively, if the development involves major commitments to infrastructure in advance, his risks will be high and he will need to have better margins.

We can look in the same way at the energy we use and examine the 'capex' of energy. What are the different rates of return on energy invested in generation?

Theoretical energy investment in hydro-power

Year	Energy in hydro 1	Energy out hydro 1	Energy in hydro 2	Energy out hydro 2	Energy in hydro 3*	Energy out hydro 3	Total output
1	1						
2	1						
3	1						
4	1						
5	1						
6		2 x 5 = 10	1		10		
7		10	1		10		
8		10	1		10		
9		10	1		10		
10		10	1		10		
11		10		2 x 5 = 10		2 x 50 = 100	120
12		10		10		100	120
13		10		10		100	120
…		…		…		…	…

* from output of hydro 1

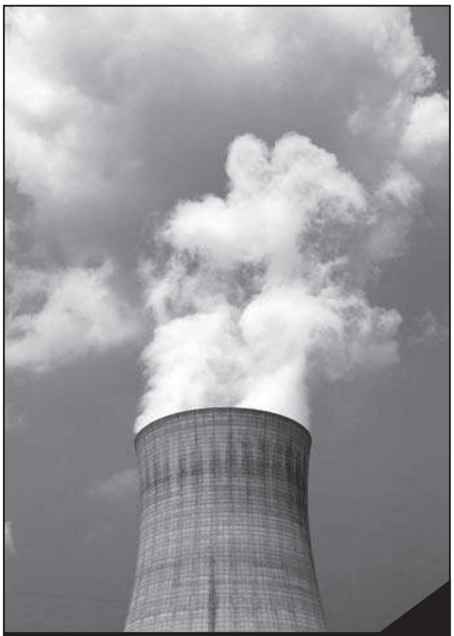
We can start by looking at hydro-power. A hydro station takes five years to build and will produce 200 times the energy invested over a life of 100 years: i.e. for one unit put in, we get two back every year. However, it takes five years to build so, if we invest one unit a year over ten years, after five years we get our first functioning hydro station with an output of ten units per year and a second after ten years. Using the same argument we had for the house, we choose to reinvest the ten-unit per annum output from the first hydro station in another station, giving us a third, much larger, station built from 50 units with an output of 100 units per annum. So, by the end of the ten-year period, we have a production capacity, for an investment of ten units of energy, of: 10 + 10 + 100 = 120 units per annum. This example is shown in the table.

Alternatively, imagine we were investing in a nuclear power station, which would take 10 years to build, last 20 years and yield 40 units of energy for each unit of energy invested: i.e. two per year for every one unit initially invested. If we invest 1 unit per year for 10 years, we shall achieve an output of 20 units per annum compared to 120 for hydroelectric. Clearly, it is in the interests of society to find as much hydro as we can.

Let's go one step further. Wind turbines generate between 1 and 1.6 units of energy per annum for every one invested and are built in six months. To keep the sums simple, imagine this construction period is a year (perhaps they are off-shore). After the first year we have invested one unit that delivers a return of one over the second year. We reinvest this new output along with the second unit of borrowed energy so that the total output capacity at the end of the second year is three. Over the next year we invest another unit of borrowed energy and reinvest the output of the original three to give three more new turbines, so the output is seven units at the end of third year. The next year we reinvest the output of the seven plus another one unit of borrowed energy to produce eight more, giving a total of 15. In the fifth year, on the same basis, the 15 plus one more borrowed unit give 16 more, increasing the total to 31. At the end of the sixth year, it is 63, at the end of the seventh year it is 127, at the end of the eighth year it is 255, after the ninth year it is 511 and finally, at the end of the tenth year, we have a return of 1023 from the same ten units of energy invested in the nuclear power station: a 50 times better investment.

The current energy debate focuses on the need for action now, while things are still OK, because nuclear has such a long lead in and construction time. The reality is that there is no need to panic. The renewable systems have gone through their proving stages and their rapid deployment, at an exponential rate, is the challenge for engineers. We have been there before.

The nuclear lobby are surely joking.



A waste of energy?

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