Opportunity Costs of Nuclear Power

- Climate change is a serious and urgent problem, so we must spend our money on the most cost effective solutions.
- The idea that we need every energy technology implies we have unlimited funds which is nonsense.
- Nuclear power is probably the most expensive method of carbon abatement we could choose. Investing in nuclear power will, in effect, worsen climate change because we will be saving less carbon for each dollar spent.
- Investing in nuclear power will also take too long. While reactors are being built capital is tied up which could have been spent on energy efficiency or renewables making more immediate carbon savings.
- Nuclear power only addresses carbon emissions from the electricity sector, but we need to look at the whole energy sector.
- Spending on nuclear power is likely to impact negatively on other stainable energy investments, diverting resources and attention from more effective ways of moving to a low carbon economy. In the worst case scenario nuclear power could make us worse off in terms of carbon emissions.
- Once the decision was made to build Finland's fifth reactor the country lost interest in alternative energy sources.
- Support for nuclear power will bolster the centralised model of electricity distribution, and damage efforts to shift to a more sustainable, low carbon model, which maximizes use of renewables and demand management.

Introduction

The opportunity cost of any investment is the cost of forgoing the alternative outcomes that could have been purchased with the same money. So, of course all investments will forego other opportunities, but this briefing looks at those potential investments, which would be foregone, if we invest in nuclear power.

Many advocates of new nuclear construction call for a "balanced energy policy" and promote the idea that 'we need every energy technology' in order to successfully tackle the climate change problem. This idea suggests that we have infinite amounts of money to spend on energy projects, which is obviously nonsense. Resources are scarce, so we need to make choices. Because climate change is a serious and urgent problem then we must spend our limited resources as effectively and quickly as possible - best buys first, not the more the merrier. For each dollar we spend we need to buy the maximum amount of "solution" possible. (The "least cost" solution) On both criteria, cost *and* speed, nuclear power is probably the least effective climate-stabilizing option on offer.

As well as being more expensive, and taking longer to implement, the problem with spending on nuclear power is that it will detract from spending on other more effective options. Not only does nuclear power drain resources away from other options, but it also distracts attention from important decisions that have to be made to support those other options. And because there are so many problems associated with getting new reactor construction off the ground, it might not work. So in the worst case we might find that efforts to tackle climate change are seriously damaged by a decision to go ahead with reactor construction.

Although the nuclear industry likes to give the impression that it can now finance new reactors without taxpayer subsidies, there are still large uncertainties about how the waste and

decommissioning liabilities will be financed in many countries. Thus building new reactors could be potentially storing up future opportunity costs for taxpayers which they will have to accept whether they like it or not.

Catastrophic opportunity cost

Since we do not have unlimited resources, we have to choose how we spend. If we buy more of one thing, then it will be necessary for us to have less of another. Because of the seriousness of the climate change threat, it is essential that we spend our limited resources on the fastest and most effective climate solutions. Nuclear power is just the opposite. Investment in more expensive nuclear power will, in effect, worsen climate change because each dollar we spend is buying less solution than it would do if we were to spend it on energy efficiency. (1)

Amory Lovins, of the respected Rocky Mountain Institute, says investing in nuclear power would be the worst thing we could do for climate change, because efforts to 'revive' this moribund technology will divert investment from cheaper market winners – cogeneration, renewables, and efficiency. Standard studies tend to compare the cost of new reactors with alternative centralised fossil-fuelled plants. They conclude that it might be possible to revive nuclear power if construction and operation is heavily subsidised or if carbon is heavily taxed. Lovins says these efforts would be futile, because large centralised power stations are not the real competition. Neither fossil-fuel or nuclear can compete with windpower, some other renewables, combined heat and power (CHP) and energy efficiency.

We should not allow fears of a looming energy gap, or the urgency of tackling climate change to stampede us into making irrational decisions. Diversification has its merits, but the strategic value of a diversified portfolio would not be enough to justify buying every technology on offer at whatever cost.

Lovins calculates that one US dollar buys roughly:-

- 10kWh of new nuclear electricity (at its 2004 subsidised level)
- 12-17kWh of wind powered electricity
- 9-17kWh of gas-fired industrial cogeneration (adjusted for carbon emissions)
- 20-65kWh of residential building cogeneration (again adjusted for carbon)
- anything up to 100kWh of savings from energy efficiency

A portfolio of least-cost investments in energy efficiency and decentralised generation will beat nuclear power by a large and rising margin.

Timing

To tackle climate change the speed with which carbon abatement measures can be introduced is also important. The construction of nuclear power stations will have a long lead-time. During the period when reactors are being constructed, capital is tied up and therefore unavailable for investing in alternative carbon abatement techniques. Because nuclear investments are also inherently slower to deploy, then such investments also retard carbon displacement.

Delivering a kilowatt-hour from a new nuclear power station costs at least three times as much as saving one through efficiency measures. Thus every dollar spent on efficiency would displace three times more coal than a dollar spent on new reactors. But, perhaps more importantly, the savings from spending on efficiency can go into effect much more quickly, because it takes so long to build reactors. (2)

The UK Association for the Conservation of Energy, for example, says that the most optimistic assumption is that one new nuclear power plant could be operating in the UK by 2020, delivering perhaps just over one million tonnes of carbon saving. In contrast energy efficiency "*could save around 25 million tonnes of carbon through cost-effective energy efficiency measures*" by that date. (3)

In 2004, decentralised low- and no-carbon generation added 28GW of capacity worldwide – six times more than nuclear power, with three times more extra output. (4) This was achieved despite nuclear power's generally higher subsidies per kWh and its far easier access to the grid. Decentralised energy can be installed quickly without needing complex regulatory processes. Despite moves around the globe to speed up regulatory approval of new reactors it is hard to imagine how this balance of speed could ever shift in favor of nuclear power. New reactors take a long time to build are delay-prone, complex, and contentious technology, and one a single major accident or terrorist attack could scuttle nuclear stations virtually everywhere.

Carbon emissions from non-electricity sectors

Carbon dioxide emissions are not only produced by electricity generation. We need to look at the whole energy system, including, for example, transport and how heat is supplied. Nuclear power can only supply electricity, so could only ever have a small role in reducing carbon dioxide emissions. In the US, for example, electricity generation is responsible for only 40% of CO_2 emissions. (5) To spend our resources most wisely and find the most effective way of reducing carbon emissions per dollar spent, we need to look at the whole energy system.

Globally nuclear power supplies about 15.8% of current electricity generation, which is only 2.5% of global final energy consumption. (6) It is, therefore, not wise to focus almost exclusively on electricity – we need to look at the problem of carbon emissions more holistically. The Tyndall Centre for Climate Change Research says it is a mistake to focus so much on electricity and ignore carbon emissions from heat and transport. (7)

Stephen Hale, who until spring 2006 was special adviser to the then UK Environment Secretary, Margaret Beckett, points out that the UK Government's aviation policy has given the industry permission to produce up to three times the volume of carbon emissions by 2030 than can be avoided by replacing the UK's nuclear power stations. A rethink of aviation policy would be a far more effective way to tackle climate change**.** (8)

Nuclear power's impact on sustainable energy

As well as spending our scarce resources as effectively as possible, we also need to ensure that our spending decisions do not impact negatively on other carbon abatement solutions.

In the United Kingdom nuclear power provides around 20% of electricity, but only about 8% of total energy. If you allow for losses at the power station, nuclear power's current contribution to the UK's final energy consumption is only 3.6 % (80 TWh/y out of a final consumption of about 2,250 TWh/y). (9) So the UK Government will need to consider the impact of any decision to replace existing nuclear power stations on the other 96.4% of energy consumption. And, at a global level, we need to know what impact building new nuclear stations might have on the energy which provides for the other 97.5% of final energy consumption, and on moves towards more sustainable energy systems. (10)

The UK Government's Sustainable Development Commission (SDC) points out that, even with a doubling of nuclear capacity from current levels, cuts of at least 50% would still be needed from other measures if the UK is to meet its climate targets for 2050. (11)

So it is important that our capacity to implement other carbon abatement measures is not damaged by a decision to go ahead with the construction of new reactors.

Warwick Business School (UK) (WBS) argues that, far from complementing the necessary shift to a low carbon economy, the scale of the financial and institutional arrangements needed for new nuclear stations means they would fatally undermine the implementation of low carbon technologies and measures such as demand management, and therefore will ultimately undermine the shift to a true low carbon economy. (12)

The SDC says a new nuclear programme would give out the wrong signal to consumers and businesses, implying that a major technological fix is all that's required, weakening the urgent action needed on energy efficiency. The Commission says a decision to proceed with a new reactor programme will require "*a substantial slice of political leadership ... political attention would shift, and in all likelihood undermine efforts to pursue a strategy based on energy efficiency, renewables and more CHP*." (13) Sir Jonathon Porritt, chair of the Commission, says nuclear power is seriously diverting attention from the hard decisions required to solve the UK's energy challenges. (14)

There needs to be sufficient development of renewable energy and energy efficiency to start switching the 97.5% of world energy consumption to a low carbon system. At best a decision to promote new reactors might replace existing nuclear capacity, but have no impact on how the other 97.5% of energy consumption is supplied. At worst the decision might not even result in existing stations being replaced because of construction delays or public opposition, but the development of a low carbon energy system is stalled, because resources have been drained from the alternatives, as the Environment Agency (of England and Wales) warns could happen. (15)

The Finnish experience

Very soon after the Finnish Parliament voted in 2002 to build a new reactor, Olkiluoto 3, many people – industry and trade union leaders - who had argued that because of Finland's Kyoto commitments a new nuclear power station was necessary, started to say that the Kyoto agreement was a big mistake, unfair to Finland, and far too costly. After falling in 2001 and 2002, Finland's carbon emissions are now rising. Measures promised in the climate report of 2001 have not been implemented, for example, energy taxation. The tone in Finland is now that Kyoto is in practice, impossible. (16) According to Finland's former environment minister, Satu Hassi MEP, once the decision was made, the country lost interest in alternative energy sources. (17)

Under the Kyoto Protocol, Finland has agreed to keep its greenhouse gas emissions at 1990 levels during the 2008-2012 target period. Emissions were around 9% above 1990 levels in 2002. Measures will have to be implemented to address this issue given that business-as-usual projections by the government indicate further increases in greenhouse gases, reaching 15% above 1990 levels during the first target window.

The International Energy Agency highlights the risk to Finland of relying on carbon dioxide reductions coming from the operation of the new reactor. It says this may inhibit Finland's ability to meet its greenhouse gas reduction targets under Kyoto, if the operation of the plant is in any way delayed. (18) In fact construction of Olkiluoto 3 has now fallen eighteen months behind schedule. (19) It's original target date for completion was 2009, so there is a danger that it will not be available in time to contribute to meeting Finland's target.

Centralised vs decentralised energy

The developed world is currently dominated by centralised electricity generating systems, which are the embodiment of technological inertia, performing little better today than in the 1970s. This centralised system is hugely wasteful and environmentally damaging. Technological advances over the past 30 years suggest an optimum model of electricity supply and distribution, which is entirely different. Around two thirds of the energy in the fuels used is thrown away as waste heat, and in the electricity transmission wires. So 65% of the energy is lost before it even reaches consumers. If we could make use of this waste heat it would make a very large contribution to tackling climate change and improving security of supply.

Within the 25 (pre-2007) European Union nations, for example, the electricity sector is responsible for releasing more than 1.2 billion tonnes of carbon dioxide (CO_2) and over 2600 tonnes of dangerous radioactive waste every year. At the same time more than half of Europe's power plants are more than 20 years old, and will need to be replaced over the next decade or so, offering an opportunity to move towards a more sustainable system which protects the climate and provides future generations with secure energy. (20)

Nuclear power stations are the epitome of centralised generation. In contrast, renewable generation and combined heat and power stations lend themselves towards a more decentralised system and a greater use of demand management. Projects tend to be smaller and sited closer to the point of demand, with greater flexibility. Customer involvement - a key aspect to behavioural change is easier to achieve.

The question for policy makers is whether support for nuclear power, which will bolster the centralised model of electricity distribution, will also damage efforts to shift to a more sustainable, low carbon, model which maximizes use of renewables and demand management.

Warwick Business School concludes that support for new reactors is more likely to strengthen the momentum of the conventional energy system than enable a decentralised energy system to develop. This is because it would:

• Reduce the pressure for appropriate network infrastructure development;
• Reduce the pressure for policy measures to ensure the removal of barriers within economic regulation for small-scale technologies;
• Reduce the pressure for policy measures to ensure greater links within an energy system between supply and demand reduction, for example a move to a service culture or a push for metering reform, and
• Reduce the pressure for behavioural change.

If governments are serious about wishing to combat climate change and moving towards a low carbon energy system, then they must choose between a centralised energy system and a decentralised one. A low carbon energy system would be a decentralised energy system. Governments need to implement policies which all work in the same direction, and ensure that the broader political and institutional support, socio-cultural attitudes and trends are all in line. Cherry picking, say nuclear power, from a centralised system and trying to get it to work in concert with a decentralised sustainable system will not work.

A portfolio of least-cost investments in efficiency and decentralized generation will be cheaper, than nuclear power and faster to implement. According to Lovins, this isn't hypothetical; it's what today's marketplace is proving decisively. Nuclear power has already died of an incurable attack of market forces, with no credible prospect of revival. Current efforts to deny this reality will only waste money, further distort markets, and reduce and retard carbon dioxide displacement. Cheaper, faster, abundant decentralized alternatives are now being bought an order of magnitude faster, and offer far greater ultimate potential. (21)

Investing in new nuclear power stations would have a huge opportunity cost – the opportunity to kick-start a new approach to energy, in which every building and community contributes to generating the power they need. The closure of nuclear, as well as fossil fuel plant across the world over the next twenty years provides us all with an exciting opportunity to develop a decentralised low-carbon energy system more compatible with the needs of the post Kyoto world. (22)

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