

A GREENER ENERGY POLICY – LESSONS FROM EUROPE

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Energy Seminar

Mark Leonard: I would like to welcome you all to the Foreign Policy Centre. For those of who haven't heard of the centre, we were launched just under 5 years ago by the Prime Minister and the then Foreign Secretary Robin Cook, to try and inject some fresh thinking into the debate about foreign policy, and also to try and provide a link between those big global debates and domestic policy. I don't think that there are any issues that challenge us more starkly than climate change. It is an issue that we have to clearly think in global terms but the levers and tools are constrained in by the national regulatory framework. So we are particularly pleased to welcome several colleagues from around the European Union to provide us with a comparative discussion. I am now going to hand over to Rob Blackhurst who is from the centre who has organised the event today. He will be chairing today's event.

Rob Blackhurst: Great, thanks Mark. Thanks very much everyone for coming here today despite the heat to discuss what is a new area of work for the Foreign Policy Centre. The background to this seminar is well known and well trodden. Britain has committed itself to exacting targets of a 20% reduction in carbon emissions from 1990 levels by 2010. Another commitment was added in the energy white paper- a 60% cut in 1990 levels by 2050, since Tony Blair will be firmly ensconced in the Lords by 2050 and celebrating his 97th birthday, it is not something that is going to come back to haunt him unlike some other issues. Obviously vehicles cause half of the emissions we are concerned with, but the focuses of today's seminar are the fuel sources that are used in the generation of electricity. Up until now things have been relatively easy. Progress in reducing emissions over the last ten years have been relatively painless, caused by a market driven replacement of coal power stations being replaced by gas. But we are now at the point where the market won't do the work for us and over the next 20 years reducing emissions will require firm political leadership. Nuclear power generation, which was responsible for 23% generation in 2001, will decline to 17% or 18% in 2010 and 7-8% by 2020 as all nuclear power stations are decommissioned. Meanwhile renewable resources are currently responsible for 2.8% generation. A pitiful figure considering that we have a 10% target by 2010 (and something that has remained an aspiration), a 20% target by 2020. Although before we are too critical, we should acknowledge Patricia Hewitt announcement yesterday that up to 3000 wind farms will be established off shore, which if should happen get us halfway towards those targets. The three issues that I want to consider today are: will renewables be able to increase their capacity quickly enough to meet emissions targets? Or will nuclear generated power be simply replaced by cheaper fossil fuels like gas effectively ending our chances of achieving our carbon commitments. Secondly what lessons are there from the rest of Europe in terms of encouraging renewable power through planning regimes, tax incentives, dealing with intermittency issues, even picking winners- which I know is something that Des and his colleagues referred to in the Science committee report. Thirdly, will British governments of the future have to revive the nuclear option and if so how will they deal with the costs and public anxieties that go with that. I think it is interesting to compare how countries like France, Finland, South Korea and Japan have dealt with those issues whereas in other parts of Europe there have been very different kinds of decisions made. These issues have obviously been addressed in the Government White Paper that placed its faith in energy efficiency and renewable power rather than a rejuvenated nuclear programme, though the door was kept slightly ajar for the future. Today we would like to face these issues in a European context and discuss how European countries are grappling with the dilemma themselves. I should note that

it is going to be a gallop over a lot of territory so I apologise to those here who listen to these arguments daily, but I think its good to get an overview for us who aren't. We have brought together an excellent panel of speakers- Nick Eyre from the Energy Saving Trust, Desmond Turner MP from the House of Commons Science Committee and Malcolm Grimston from Imperial College. After we have heard them we would like to get a brief response from Andrew Stunnel MP who is the Liberal Democrat Energy Spokesman and then we can open up the discussion to the floor. So firstly I would like to thank all our speakers for coming and introduce Nick Eyre who is Director of Policy Development at the Energy Saving Trust. Nick has written numerous papers and pamphlets on energy efficiency, sustainable development and the environmental impact of energy use. He was also seconded by the Performance and Innovation Unit to work on their energy review, and it is that work that he has become quite an expert on what is happening in other European countries and lessons which we can draw particular on Nuclear power.
Over to you Nick.

Nick Eyre: Thank you very much Rob. I would like to draw a few introductory lessons from two areas. The first is from the Energy review that was conducted by the PIU in 2001 (it was actually the work that led up to this year's Energy White Paper) on where we are in the medium term by which I mean 2020 vis a vie the need for additional power and the sources from which it could come from. And then I will look very briefly at the experience of a couple of other European countries and draw some quick lessons from that. But I think that there are probably people in this audience who know more about the details and how it has progressed in the last few years than I do so it will be brief.

This is a graph showing where we get our primary yield from in the UK now on the left hand side and 3 scenarios for 2020. I have chosen 2020 because partly it was a timesale that was looked at in the Energy review, but also 2020 is long enough for things to change significantly (which given the infrastructure of the energy industry – it does take time) but not so far away that you can't speculate it in a meaningful way. At the moment as you can see we get most of our primary fuels (and this is just not from gas, there is also a significant amount from coal and oil just above that) quite a bit from nuclear, but less than people imagine because people tend to think that there is a lot from nuclear in terms of its contribution to electricity generation, though it is of course a lot more significant, and a tiny bit which is renewable. That just puts in perspective where we are now. The three scenarios are all for 2020.

The first is a business as usual case; what would happen if things went on much as they are now and the government didn't intervene very much. Well, the coal would virtually disappear, nuclear would be very significantly reduced as the old power stations closed; we'd still be burning oil in vehicles, we probably will be anyway under any scenario; we'd use quite a bit more gas, and we'd probably have quite a bit more renewals, based on the 10% target from the policies already in place. Clearly there is an issue about gas in the news, and people can discuss whether they think its problematic or not, but if government chose to intervene, for example, if it were worried about diversity - the increase in the use of gas, or more likely worried about the increase in carbon emissions – there ways it could do that. If it were more concerned about diversity, it could go to traditional sources for power generation: coal and nuclear, and the second of the scenarios looks at that.

A significant coal programme would just about keep coal burn constant, a significant nuclear programme could just about get nuclear back to where it is now by 2020, maybe a bit above (bearing about the length of time it takes to plan, licence and construct nuclear stations).

The last scenario looks at something closer to what the energy white paper is recommending as a way forward, with reliance on energy efficiency and renewables, and you should remember the energy efficiency because the reason that bar is much lower than all the others is an increased use of energy efficiency which actually means we need less energy from all the other sources. The other major change of course is the increased use of renewables. But that's even with a very ambitious renewables programme. It's worth emphasising that by 2020 most of our energy is not going to come from renewables by a very long chalk.

This shows what the same three scenarios mean for new power generating capacity – the capacity we have to build between 2000 and 2020 to deliver in the electricity sector – bearing in mind that something like 30,000 megawatts is going to close by then. If we get some increase in demand we are going to need an additional 45,000 megawatts of new build. If you look at the business as usual scenario (a bit of renewables, a bit more combined heat and power, which incidentally is gas fired, but mainly combined cycle gas turbines) that's what will happen if the government chooses not to intervene, assuming the gas continues to flow.

In the nuclear and coal scenario, a big nuclear programme gets you seven or eight gigawatts (some people might go as high as ten), a coal programme could be even more significant, but the carbon penalty is huge – but you get a nice diverse build, so you get diversity, but you don't get a particularly good carbon outcome from that middle scenario.

In the sustainable scenario – let me emphasise renewables can't do it all. I can't see any feasible way that renewables can deliver all the new capacity we need by 2020, but renewables such as gas fired CHP might be able to, that was the conclusion we drew. So, what are the conclusions that I draw? They are pretty consistent with what the PRU drew for 2020.

Firstly, don't worry about us being able to build sufficient power generating capacity – that can be done, we are not going to run out of power stations. Energy efficiency is important because in a 20-year period it can reduce maybe by 10,000 gigawatts the amount of new capacity we need, so the old concept of the 'negawatt', the negative megawatt, the capacity you don't need because you are improving efficiency, is important. You wouldn't expect me to say that working for who I do, but it is true. The cheapest option is likely to be gas, so if government doesn't intervene, we'll get gas and more gas, and ever more gas. Coal and nuclear could have a role to play, but they're more expensive than gas, so they'll be a penalty – you'll improve your diversity, reduce your reliance on gas, and reduce costs. Similarly, CHP, and particularly renewables, would also increase costs, people might see it as a more sustainable scenario, and were think that between them they could deliver all the new capacity needed. On the basis of the PIU's work, they could probably do it a little more cheaply than nuclear could. So those are the conclusions looking at the UK energy scene.

Let me just move on now and look at a couple of European examples, because the big question must be can we get that amount of renewables, can we get something like 100 terawatt hours over twenty years. Well, this is the Danish experience over the period 1990 – 2000, and it's fairly graphic: it goes up. In some cases this is renewable electricity. The biggest contributor is wind, which grows from a relatively small level, even in 1990, when Denmark was already a pioneer of the European wind industry, of course, something like 4000

gigawatt house in 2000, and still strongly rising, and Denmark intends to get 40% of its electricity in the next 20 years from renewable power. So, they've done something that allowed them to beat us fairly spectacularly.

This shows actually something that looks different but is actually quite similar for Germany. It's the same thing, electricity from renewables from 1990 to 2000. The bottom part is old hydropower, basically depending how wet the years are. But if you see the bars on top of that for wind energy – again, the same trend as in Denmark – in fact, more spectacular than Denmark – going from nothing in 1993 to something like 10 terawatt hours – that's the equivalent of 3% of UK electricity use, over 5 or 6 years. So, there have been policies put in place in those two countries that have been significantly more effective than policies over the same period in the UK. Now, to be fair, I think the UK government has already learnt from these, but let me just show what I think that those key lessons are:

If we are to deliver sustained investment in renewables, the first thing people need to believe is that there is going to be sustained investment in renewables, it's self-reinforcing. So, a clear government commitment, a clear commitment across society, with targets, is probably very helpful, and I think that the UK government, perhaps with a slight wobble on the 2020 target, has learnt that lesson. We certainly need incentives on the deployment – I'm not sure we need to pay an arm and a leg for each unit of solar energy in the way that the German government does, but I think with the renewables obligation, the government has again learnt that lesson, and there are now very significant incentives for renewable electricity, something like 3p per kilowatt-hour will be delivered by that. I think the German and Danish experience also indicate that actually supporting the industries on your own countries can actually make a lot of difference, and that is certainly the case in Denmark, which now has a massive wind-exporting industry, one of the major exports from that country is wind turbines. That has been achieved not by support over ten years, but more like support over 30 years to develop that industry. It's not a very surprising lesson, but it is one that is worth drawing. Lastly, another lesson from Denmark, and one that could address one of the barriers in this country to wind energy, certainly on shore, which is the planning issue. My reading of opposition to wind turbines locally is 'why should we have these when there's nothing in it for us', and in Denmark, there has been something in it for them in that a very large part of the growth had been through community-owner, municipally-owned, cooperatively-owned projects where it is very clear that the turbines which they see on the hill above them are giving them some payback in the pocket, and they are connected with the electricity that they use. So, those would be the policy lessons that we would draw from Europe. The Danish and German examples have shown that rapid growth is possible with those sorts of policies in place. Given that we have in this country a significantly better renewables resource base, I think it would be possible in this country. So, my final comment is that the UK government is achievable, if it learns these policy lessons, but the converse is also true, that the UK government won't achieve if they don't learn these policy lessons.

Rob Blackhurst: Thanks very much Nick, I'm not sure what Des Turner will say about whether the government has learnt those lessons or not, certainly yesterday they seemed to do something which took quite a lot of people by surprise. I am delighted to welcome Des Turner today. He represents Brighton Kemptown and is a member of the House of Commons science committee. As I am sure everyone in this room will know, the committee recently produced a very hard hitting report which recently called Britain's energy structures inadequate, warned that there would be few sleepless nights in our competitor countries about British levels of funding for renewables, and pointed out that delaying a decision on nuclear would leave the UK

with an energy shortfall that could only be made up by fossil fuels. So hopefully, Des will now take a little about the international lessons that the committee learnt and give us a feeling about how he thinks that things have progressed with yesterday's announcement. Des is also a scientist, having gained a PhD in biochemistry at Imperial College, which must be a refreshing rigor in a House of Commons full of journalists and lawyers, I would have thought.

Desmond Turner: Well, I don't entirely disagree with what Nick has said. He's absolutely right to point to the lessons of Denmark and Germany, who have achieved impressive results in deploying renewable power, albeit wind – but that is the only genuinely renewable source that they've got – and the lesson to be drawn is quite simple: governments can intervene with success if they're determined ... doesn't necessarily have to cost the government and the public a great deal, it's the determination and effectiveness of the action that really matters. When we turn to the white paper, and we did turn to the white paper when we produced this report – or perhaps to be more accurate we turned on the white paper! Because unfortunately, though the white paper is an excellent document, it doesn't actually take us very much further than the PRU report, because it virtually sets out all the stuff that was in the PRU report, because it virtually sets out all the stuff that was in the PRU report to start out with – good stuff – but it's reporting what's there, rather than trying to get from here to there in the future, which is what really matters. There was in fact no substantial new investment, no new policy of substitute, in the white paper, so we like to think that we have filled the gap, and we would wish that the government would adopt the policy structures that we have set out in this white paper, because we think they would produce the results we need in this country. But the paper does include one very important statement, which is the commitment to CO² reduction, adopting the Royal Commission for the Environment report on the 60% target. That has to be the most powerful political driver that there ever was. I am sure that you have all read the climate change scenarios, and that you have all read that the most extreme scenarios are terrifying, and that even if we achieve the 60% CO² reduction by 2050, our succeeding generations are still going to have quite a tough time of it. So, if we don't achieve the 60%, they're going to hate us. We need to make the decisions and the progress now, not in a few years time; otherwise we'll be always too late trying to catch up. The White Paper also rather ducked the question about whether we needed to retain a nuclear capacity or whether we could do it with renewables. Well, my personal answer, and I think the committee would agree with me, is that renewables have the technical capacity to fill the 10% target, or the 20% target, or probably more. It's not a question of the technical feasibility, it's a question of actual administering its implementation – that's what really counts. And that's why we set out a basic recommendation in this report which would replace all the disparate policy instruments that we have in this country at the moment (climate change levels, renewables obligation, emissions trading scheme, the energy saving scheme, the carbon saving trust, etc) into one unified structure, because we want to see, just as Germany has, a renewable energy act, which will not only focus political attention on the field, but will set up a renewable energy authority, which will have the sole obligation of ensuring the most rapid deployment of renewable energy so that they would be responsible for sorting out all the planning issues, and then as Patricia Hewitt is doing for the wind farms, inviting bidders to tender to deploy on those sites. We propose that the fiscal instruments should be replaced by a carbon tax – a tax on generators per KW/H, if they are producing CO². We hypothesise that the revenues from that – and depending on the level of the tax could easily be £6bn per year – could be used to support the deployment of renewable energy. And renewable generators could receive a tax credit, the level of which would depend on the state of development of their technology, so if it's a brand new technology just coming to market, with all the costs that implies, they get more after a few years it goes down, and when it is fully competitive, then they get none – and by then we'll be well on the

way. This, we think, would give a guaranteed market drive to encourage investment on a commercial basis in renewable energy. I actually know that this can work because things are moving on all the time, and we know that right now the marine resources are the most promising, and of them offshore winds – and we have the best offshore winds of just about anywhere in the world – can come in using the renewable obligation in particular, so that it is highly commercially competitive. It's something that I think people will invest in. I think that we can be reasonable optimistic that people will take up the leases that have been offered on the potential sites. But that's not all our resources. Remember that our total offshore resource – wind, wave and tide – amounts to double the amount of electricity we generate annually as it is, if its deployed. So there's a potential for over-capacity, even, for those three renewables alone. As to cost, this is very interesting. There has been an assumption that up to now wave and tidal power were going to be too expensive, and an equal assumption that it couldn't deliver in time. But things do move on – for instance, the guy from Imperial College, who was the advisor on the first tidal power report we did about 3 years ago, is now into commercial deployment. Could he get it funded in this country? Could he hell. He couldn't get any help out of the DTI, he's still in protracted negotiations with the Carbon Trust to get a project launched in Britain, but he is contracted with the city of San Francisco to deploy the things under the Golden Gate Bridge, and at a construction cost which is less than a wind turbine – and that's before we start out with economies of scale. He's a bit coy about his generating costs; he keeps overstating them because nobody will believe him. And they won't before they see it happening. But now that he's signed up and everyone can read on the web that the city of San Francisco has signed up to it, suddenly people are starting to take interest, and I think that where you've got a technical breakthrough as we clearly have here that can drive costs down in a really spectacular fashion, then I think that despite the poor fiscal framework, the poor market arrangements that we've got in this country, then I think that we can break through the barrier, and once it does that then the major energy players will start to want to move in and invest, and we could very well reach the 10% target despite the lack of correct government policy, though I think that it would still be extremely desirable if we exceeded those targets and exceeded the amount of renewable electricity that we could generate. Because, as Nick has already pointed out, not all of the CO₂ emitted is already coming from electrical generation, an awful lot of it is coming from transport. Electrical energy can be used to drive virtually all forms of transport. Either electric trains, or producing hydrogen to run vehicles – a little problem with planes yet, I think you'd have a little problem with passenger confidence in a hydrogen powered plane, they'd think of the 'Hindenberg', but I'm sure that technology will get round that in the fullness of time. So, we've got many issues left where the government can really activate and help this process. They could introduce much more radical fiscal arrangements without destroying the notional liberalisation of the market. Another provision that we want to see is in the German Renewable Act, which requires the generators to connect renewables to the grid. Our grid really does need serious reinforcement. It is in the wrong places, and by and large it simply connects the current chain of nuclear stations, so there is a lot of work to be done there. That again, if there is a major requirement that they connect, and they have to raise the capital to do it, and pay for it, it can all be handled commercially, then I think we can get around that one. I think that there is nothing that we can't get around with sufficient will, and that's what it comes down to at the end of the day is political will. The scientists and engineers with the know how are out there; all we've got to do is to give them the framework and the environment that they will work and they can generate the commercial backing to pay for it, and I think that we can then enjoy a real contribution towards a better environmental future.

Rob Blackhurst: Well, thanks very much Des, its very encouraging and unusual to hear someone who thinks that 10% target can be met, so there's a note of hope there. Out third

speaker today I'd like to introduce is Malcolm Grimston, who since 1995 has been senior research fellow at the Centre for Environmental Technology, and T. H. Huxley School of Environment, Earth Sciences, and Engineering at Imperial College. He's acted as an energy issues advisor to the British Nuclear Industry Forum, and until recently was based at the Royal Institute for International Affairs, where he recently conducted a review of the international future for civil nuclear energy. Malcolm is now going to look at the worldwide experience of nuclear power and the possibilities of building a new generation of nuclear power stations here in the UK.

Malcolm Grimston: Thanks, Rob. I have been observing the nuclear industry in various capacities for the last 15 years or so now, and during that time there has been a rather interesting shift in the emphasis that the industry gives to its wares which can perhaps more or less be summed up from the position of the 1980s, which was broadly 'we know we're a bit dirty but look how cheap we are' to the current message, which is broadly 'we know we're a bit expensive, but look how clean we are'. It's been quite an interesting transition through that period of time that I think reflects wider changes in the energy market.

So what I'd like to do is just to give a brief background of how we got to where we are now, focus in on what seems to be the central issue at the moment, which seems to be the future of liberalised markets, and that cuts across all fuel resources. And maybe from that draw one or two possible conclusions. Clearly, if we wanted to rehearse the benefits of nuclear technology, this is an alternative to fossil fuels, its based on an enormous and very widespread mineral resource, uranium, it isn't subject to the problem of intermittency that affects some of the more attractive renewables (notably wind power, but also tidal and solar in a slightly different way), and extraordinary impressive safety record – a single incident with demonstrable off site health consequences in the history of use of civil nuclear energy, and that in a peculiar set of circumstances – and effectively zero greenhouse gas emissions.

If we look at what has been done, if we look at the issues, despite what Nick was saying there (he quite rightly points out that wind power is now producing the equivalent energy to about half a nuclear power station), nonetheless Denmark is enormously dependent on coal for its emissions, and so its greenhouse emissions are up there approaching the one million tonnes of carbon dioxide per terawatt hour of production. Germany is heavily dependent on coal, but with a larger nuclear industry, the Netherlands and the UK both now with significant gas used for electricity, and as we go down, Belgium 50% nuclear, and down at the very low end, France predominantly nuclear now, and Sweden more or less divided between nuclear and hydropower for its electricity. In other words, it is demonstrated that nuclear power can produce the carbon reductions being talked about, and indeed can go significantly beyond that if that was the way we decided to do it, and indeed at the moment it is the only one of these technologies that have demonstrated that capacity.

So, what is the issue? Well, of course the issues is far wider than that. There are economic questions over nuclear power – both the poor record of some countries, notably the US and UK, with plants taking longer and costing significantly more to build than was initially assumed, and having a relatively poor output record, certainly in their early years. It's heavily capital intensive, it required long term electricity contracts at something like a guaranteed price if you are going to pay that investment back safely. Relatively inflexible. You can't load follow as easily with nuclear stations as you can with combined cycle gas turbines, partly for technical reasons, and also because you don't save much money by switching a nuclear station off, since most of the money is in managing the initial capital; and in staff costs that are still

incurred even when generation is not occurring. This is opposed to CCGT, where you save about a third of the costs when you switch it off, which is the cost of the gas. Certainly an issue of public perceptions, and this is one of the issues that Rob put in the initial invitation for this. The past arrogance of the industry has certainly left a legacy which the industry is working to overcome, the failure to progress on issues such as radioactive waste management, the particular issue of fears about radiation, a risk which is new and unfamiliar, which is largely speaking regarded as an involuntary risk which looks as though it could affect a very large number of people, and then there are also issues of civil liberties, what sort of society would be necessary in order to safely to allow transport of spent nuclear fuel and plutonium bearing fuel, and issues of planning and nuclear proliferation on the back of that. Just as an aside, Nick asked the question 'Are governments underestimating public pragmatism?' – quite an interesting set of work being done in most developed countries now on this. It turns out that if you ask if nuclear power is a good thing or not, you get about a quarter in favour, a quarter opposed, and about half with no strong opinion, but if you ask MPs, you get more or less the same proportion pro and anti, and a much smaller proportion of don't knows. I've never met an MP who didn't have an opinion on everything! Nevertheless, the balance is about the same. If you ask MPs what they think the public would answer to this question, you get of course quite extraordinarily skewed results, and they think that almost everyone is opposed. I think that is a tribute to the media and the green movement that they've managed to create such a level of misapprehension amongst decision makers. Of course, that is the background level, and when new proposals are made for new plants, this may change. But the assumption that people are not aware of the issues is a mistake that is made I think by the nuclear industry as much as by anyone else.

Where we are at the moment in terms of plant generating capacity. There was an extraordinary increase in the output from nuclear stations between about 1970 and 1990 when it went from practically 0% of world electricity to around 17% of world electricity. Since 1990 up to date, the rate of new plant coming online has not quite kept up with the rate of old plant being retired. The proportion of the amount of electricity being generated rose in the 1990s because the plants performed much better, but the plant capacity was more or less flat, and so was the 17% figure, because the rate of nuclear was pretty much the same as the rate of electricity growth in the world. But assuming that all the plants currently planned in the world are finished, then almost immediately after the first compliance period of Kyoto on 2012, the nuclear capacity starts to drop, and by the year 2030, it will be more or less gone unless some more capacity is ordered. Nuclear power is the single biggest source of electricity within the EU at the moment, and produce about 1/6th of world electricity, and that will have to be replaced somehow, if it is not replaced with nuclear, against this background of needing to cut greenhouse emissions by 60%, and indeed expecting energy demands to double between now and 2050.

What can draw in terms of lessons for success from the European experience so far? I think that we can say that standardised designs, rather than a series of prototypes, is probably rather a sensible thing. The French nuclear industry very much benefited from a consistent approach rather than, for example, the UK having 11 Magnox stations, each taking a different sized fuel element. You need market structures that give you the opportunity of paying back this initial period of very heavy investment over a long period of time. Something looking like the old franchised markets that at the moment are very much out of favour in most of Europe, and even France and Germany look like being pulled kicking and screaming towards liberalisation. You need an honest debate and engagement with stakeholders. Finland, for example, one of the countries intending to build more nuclear stations, has been a model of getting communities

involved in decision making at a far earlier stage than the UK model, which as Patrick Jenkinson says went from DAD (Decide Announce Defend) in his term of office, to a new model DADA (Decide Announce Defend Abandon). The centralised approach simply seems not to work in many modern countries. Also, a stable regulatory regime, both in terms of the market in which you are selling, but also in terms of the plants themselves.

A couple of observations as to where we are at the moment: An obvious point: there are as many ways of making electricity from uranium as there are of making electricity from water. There is sometimes a statement that nuclear technology is now a mature technology because one particular approach to nuclear power – the large centralised plant – has been used for some time. I think that statement is as bizarre as saying that wave power is now mature because we've had water wheels for a long time, or that wind power is more mature because the Chinese were using it 3000 years ago. In reality, a single nuclear technology developed for very sensible reasons – and I think there is a need if we are going to take the whole environmental and energy issue seriously for much more research and development over a whole range of fronts. That technology emerged in centralised electricity markets where very large plants point input into the grid, and were required by economies of scale, and the way that the whole system worked. That economic profile is not well suited to liberalised power markets, and therefore one of the key issues here is what is the future of liberalisation, and I think that is an issue for all markets.

Liberalisation is the established trend in many countries. By 2007 all EU countries should have full competition in their domestic electricity markets as with the rest of their power markets. Characteristic of liberalisation is relatively short term power contracts, relatively small power units, nobody with a duty to supply – if nobody knows who their market is they can't be expected to accept a duty to supply it. Very severe pressure on reducing the cost base, and a very strong emphasis on reliability of output, and some of those are extremely good things, obviously. Large nuclear units, at least those with the very heavy investment costs of the traditional plant, are unlikely to flourish in those circumstances. Similarly, the intermittency of the renewables becomes extremely difficult to manage in that sort of structure.

Electricity in my view is not like a normal commodity. There are two reasons for that: firstly, you can't stockpile the product, so if we are going to keep the lights on, we need to keep a plant available which isn't going to be generating electricity for much time during the year, but is only going to be generating for a small period of time. It's a large-scale experiment, liberalisation, really. It's dead easy to do when you've got enormous plant overcapacity as we had in the year 2000. It's a much more difficult question as to when the signals enter the marketplace to invest in the next round of power to prevent the first power cuts. As Nick rightly says, we could build plenty of power capacity by the year 2020 to prevent power cuts. The question at the moment is why on earth anybody would want to build sufficient power plants to prevent power cuts. Power cuts could well be very, very good for those people who are in the generation market, and this is why everyone is very keen that either British Energy, or AES Drax should exit the market for the time being, because in doing so the likelihood of power cuts would be significantly increased. The Royal Society of Engineers talk about possible power cuts in 20 years, but I have to say I am much more interested in the possibility of power cuts in 20 months and in 20 weeks, because I think the first shots – it will be a phoney way – but I think the first shots of the security arguments could well come rather more rapidly than people think.

At the centre of liberalisation is this real paradox. These are enormous investments in energy. If we are going to expect private companies to invest like that, they need a pretty firm idea that they are going to be allowed to make money on their investment, and to do that government has to divest itself of pretty much all the ways that it has of interfering with the market. I have to say, I don't see a way past that paradox. There's a wonderful statement in the white paper. I think it's one of the sweetest, most naive statements I've read for many years, that says that the government will not intervene in the market except in extreme circumstances such as to avert, as a last resort, a potentially serious risk to safety. Well, when the first pensioners are knocking on the door because their power bill has just trebled, when the first major power cuts are happening, I hope government sticks to this, because it's the only way a market could work. I don't believe it for a second, and, what's more important, nobody investing in the market is going to believe that for a second. From Ontario, where government was intervening in the liberalisation within a fortnight of it happening, on power price, right the way through all the other experiences we've got, our knowledge is that difficult as it is to modify the behaviour of oil markets or the future price of renewables, it's impossible to modify the behaviour of panicking politicians, and in those circumstances, the degree of economic risk in the market is bound to increase, and that is bound to result in a reduction in the willingness of people to invest in time to prevent those first power cuts.

Now, if liberalisation does continue down the current road, there is going to be a need for smaller, cheaper, more flexible nuclear technologies. That in turn will require a significant R&D and commercialisation deployment work. There will also be a need for a much more stable and more rapid regulatory structure. Frankly, if we continue down the current route, I think nuclear will remain very unattractive as an investment option for a market like the UK.

On the other hand, I have come strongly to the view that liberalisation is incoherent for a product like electricity. If we do see a return towards centralisation in markets – it needn't be a return to the old CGB days because it would undoubtedly be more internationalised, they'd be more interconnection, they'll be more of an international market in terms of plant and components and the like. But under these circumstances one could imagine that the new simpler, cheaper to build, supposedly more reliable nuclear technologies, if they work and if they fulfil the promise, may be attractive.

Finally, one could imagine some sort of hybrid market where some countries were liberalised and some were not, which would be sort of like the liberalised market, but against which you might find a thriving nuclear industry with a product to sell in some of the other countries. I don't know which way it's going, but what worries me most about the white paper is that it paints a single view of the future, and this by a government which really has no way of getting to that view since it's got no power left really to intervene in such a way. What I don't see is the flexibility to be there in case things don't work.

Finally, traditional technology could be re-used. We saw in the 1980s an enormously rapid deployment of nuclear resulting in very significant benefits in terms of carbon reduction and diversity, but in more liberalised markets that technology is unlikely to be more attractive. Longer term R&D investment is unlikely to be produced by the power companies alone – there has to be a role for the state in that. Finally, the need for a more stable regulatory regime, and I think that many of these issues go far beyond the boundaries of the nuclear industry.

Rob Blackhurst: Thanks very much Malcolm, I hope that frightened everyone, and I think we could have done with you at the Third Way conference at the weekend! Finally in terms of our

speakers, I'd like to now go to Andrew Stunnel MP who is the Liberal Democrat spokesperson for energy issues, who has agreed at quite short notice to join the panel and respond to the wealth of points made.

Andrew Stunnel: Thanks very much, Rob. If I can just pick up a few points which I've heard this afternoon. First of all, what Nick had to say from the Energy Savings Trust - I would want to make the point very clearly that the cheapest way of reducing carbon emissions in this country is efficiency and conservation. It's not nuclear, it's not wind, it's not any fancy generating technology that we now have. For a long time it's been true that you would save as much power as any plant could generate if you invested the same money in efficiency measures. The problem is: where is the profit motive for doing that, and how do you get into the market? A major challenge for all of us who are policy makers is to find the levers to get the cheapest way of reducing carbon into practice. Nick didn't make very much of the main point of his argument, actually, which does not imply a hair shirt society, and reducing energy use does not mean we have to return to the nineteenth century. I was looking at the figures of energy growth in the UK. In the ten years from 1992 to 2002 there was a 2.5% increase in gross energy use in the UK - that's not per year, that's per decade. In the same decade there was a 20% increase in real earnings, and a 34% increase in GDP, so energy growth is decoupled from growth in personal prosperity and growth in the prosperity of the country. I just want to emphasise that point very strongly from Nick's presentation.

All three speakers talked about the need for consistent, long term signals in order to get results in the energy market, and I would say that when Des was talking about the possibilities of tidal and wave energy, again one of the things that we need to look at is that we are not looking at a single generation of development, we are talking about several generations, and I personally think that the technology is developing at a rather which means that we've got a generation of marketable renewables at the moment, and we've got another generation which is following along, probably in about 20 years time which will be tidal and wave. A point I would make here: when debates on the future of energy are conducted, particularly by people who are already active in the energy market, they seem remarkably blind to history, because in 1900, if you'd have asked people to predict what the energy market of 1950 would have been like, you would have come out a miserable failure. And if you'd have done the same in 1950 to predict what the year 2000 would produce for the energy market, you would have been a remarkable failure, certainly nobody would have understood that gas would be the main way of generating electricity in this country, and in the year 2000, of 2003, it's not surprising that we haven't got a clear picture of where we should be in 2050. There are going to be generations of development, and things are going to move on.

I agree with Des about a carbon tax as a signal, but I think that we must not overlook the importance of carbon trading, which is clearly going to be with us in terms of the EU over the next few years, and is certainly of major importance to the major carbon consumers and electricity generators.

The last time Malcolm and I had a discussion I couldn't remember that we agreed about anything, but this time I did find myself agreeing with quite a bit of what Malcolm had to say. Again, and in particular, I think his analysis of the pros and cons of nuclear power are very apposite. The main reason why they are not going to be built in the immediate future is the huge, front loaded capital expenditure, which means that no banker is in favour of it, and the very definite perceived risks, which however unreal they may be, are also inhibiting public policy makers, and I don't see personally that as a route out of our current policy questions.

His point about rises in domestic prices: even the most renewable countries, Norway, which produced 98% of its electricity by hydro, found its domestic consumers facing a threefold price increase this spring, because it didn't raise enough in Norway last year. Every technology has got its problems, every technology presents its challenges. I'm very strongly in favour of developing a renewable solution to this, but I think it would be a very, very foolish politician who always assumes that you can put all of your eggs in one basket.

Rob Blackhurst: Great, thanks very much Andrew. Now, we've got about 20-25 minutes left, and we'd like to open the discussion up to the floor. If we can start talking about renewables, and then we can talk about Malcolm and Des's points about the nuclear industry as well. There were some interesting points that came out there, particularly Nick's point about how we get more local buy in on renewable energy, and also Des's interesting point about needing to pick winners, in a way which I think is deeply unfashionable in modern politics, but something which people have been doing on the continent. Let's start with the gentleman at the front:

Richard Mason: Nick chose his words very carefully regarding the availability of CHP and renewables to deliver 'more cheaply'. Clearly, those PIU report costs were based upon the long term projection of learning curves, and I'd just like to ask the general question: 'do you think that the renewable industry is over-promising in a similar way to the way the nuclear industry was over promising two or three decades. Will therefore in a few years time there be a strong plea on the part of the renewables lobby for an increase in the renewables obligation, because it is not enough to create the relevant incentive. Just by way of illustration of that, the promising element that came out of Patricia Hewitt's statement yesterday was when she was talking about no less than 20,000 jobs in renewable energy. I thought that when you worked out how much each job cost, that works out at an absolutely massive cost per job – it doesn't sound like a very cheap industry if it manages to generate 20,000 jobs.

Nick Eyre: I haven't done the sums on the 20,000 jobs, but I'd of thought that it would not be unrealistic for that scale of investment. As you say, the number of jobs you create is to do with the amount of money you invest, and I have never been convinced by jobs arguments for one technology or another. As far as the assessment of costs is concerned, yes, you're right, we did try to base the analysis on projections of costs to 2020, because that's clearly what matters if you are looking at 2020, and there's always a problem there because, put crudely, you don't know what the costs will be in 2020. The further you go out, the bigger the uncertainty gets. Are the renewable energy proponents promising they can deliver more cheaply than they actually can? Yes, probably. I've yet to find a proponent of a technology who doesn't promise something cheaper than they end up delivering. I think the same would be true of the fossil fuel industry at the moment, I don't believe the numbers that British Energy put in their report about the long term costs. What we did at the PIU was I hope to provide a healthy dose of scepticism to all of them. We certainly didn't come up with a proposal for long term costs that the wind industry would propose, and certainly not that the solar industry would propose, any more than what we did for the nuclear industry. We tried to base it on sound evidence and analysis, obviously with some uncertainty. But is the renewable energy industry going to come back and demand a better deal than the current renewables obligation? I don't see why they should because the renewables obligation isn't based on those long term costs, indeed if those long term costs are correct, they won't need any subsidy at all – that's clearly the point. Now, I think they may need some subsidy, because I doubt that even by 2020 it will be as cheap as gas. This doesn't mean that the cost of renewables won't go down, it means that the cost of gas technology will go down as well because we are still learning there. But I think that the renewables obligation is based on a reasonable assessment of what renewables cost now, and

with the capital grants that are available for some of the technologies like offshore wind are probably set at about the level that is required to get people to invest now. Given that costs should fall, the level of subsidy should fall in the long term as well. The question is how much it will fall, and how fast it will fall, and we don't know the answer to that.

Unknown Speaker: Can I say to the man who is trying to flog us a dead dinosaur that given the long history of very real and justifiable doubts about the nuclear industry's estimates of generation costs, I think that it ill-behoves them to distrust the renewables industry on that score. I personally am satisfied that the figures that are published in the PRU report for 2020, for instance for wave and tidal, are very pessimistic. I don't think they're being understated at all because these costs – 4p – 8p per kw/h – are already way out of date, and that's before they've started to enjoy the benefits of economies of scale. So, I think that you will have a very hard job convincing anyone that nuclear power was going to be any cheaper than renewables.

Rob Blackhurst: Thanks. Sir Michael, do you want to come in?

Sir Michel: I'd just like to ask the question about the economics of wind power because if there is an anti cyclone in the winter and the wind doesn't blow for two or three months, you have to have backup production. Now when it's a small quantity, it doesn't really matter, but if Patricia Hewitt's numbers of turbines off shore were to be built and be generating quite large quantities of power, who would be paying to maintain the replacement energy when there wasn't any wind?

Desmond Turner: Well, you've raised a very real problem with the nature of wind power – it's variable in stochastic nature, which is why I should suggest that wind power should never be more than a certain proportion of the mix. Now the nuclear lobby is very keen to promote nuclear energy as a sort of reliable base-line note factor. Well, that can be equally replicated by tidal power, which is predictable to the minute, and is a constant power source because the times of tidal streams vary around the country, so if you have sufficient tidal power producing areas, you can be guaranteed a minimum base-line load from that source alone. So although there is a difficulty with wind, it is dependent on weather, tide isn't at all.

Malcolm Grimston: Can I just add something to that? There are serious practical issues that have got to be confronted as well as some political ones. The first thing to say is that at the moment the questioner is right to say that we've got a surplus of capacity and it isn't going to be a problem at least out to the horizon where nuclear has seriously dropped off the charts in about, say, 15 years time. The question does have to be answered, and really it has to be answered by reference to consideration of whether there is some other technology that we haven't even mentioned. I actually think there is because I think there are Micro CHP and a whole range of developments there that will provide us with the flexibility. I would be very happy to deploy that argument in private afterwards. There are plenty of other technologies that provide the buffer that we need until the sort of technology that Des is talking about is realistic and feasible.

Rob Blackhurst: Thanks. Can we have a few short points rather than questions so we can get through quite a few. We're particularly interested to hear from any of our European embassies, or anyone else who'd like to speak.

Becky Willis: I just wanted to make a point about the politics of all this, because I was very struck by something Nick said about Denmark's success with wind farms coming about

because they are embedded within the community so everyone can say 'there's my wind turbine up there'. I was wondering whether we are missing a trick in the UK with that sort of approach. To caricature, the UK system is dependent upon a big box factory out there that generates electricity that ends up in your home somehow, and nuclear is the epitome of this approach. There is a lot of good stuff in the white paper about a vision for the future energy use which will depend on very decentralised, very localised levels of power like micro-level CHP, like solar panels, so that every building can generate a bit of its own electricity. But the policies that we are seeing at the moment don't support that at all. Even the renewables, the investment is very welcome, but effectively it is massive power plants offshore where no one will see them. So, I just wonder if a way of actually selling the politics of this is actually, to use a pun, to reconnect people with their power source, so that every building generates electricity, so that everyone has a conception of what it is to make electricity. Also, then getting in the energy efficiency side of the equation, because everyone then knows how they can save electricity. The idea is to get power suppliers, rather than just selling power, to sell warmth, or light, or the kind of comfort that electricity gives you. So, much more emphasis on that reconnecting people with their power, and I don't see that with the current policy structures.

James Denny, Head of Offshore, British Wind Energy Association: I wanted to pick up on two points. One was about this issue of the renewables industry over-promising: we do expect that prices will fall. They have already come down from about 30p per kw/h to 3p per kw/h. This is real progress, and we have done an awful lot in the last few years, and we will continue to do that. The other point I'd like to pick up on is whether we as an industry are going to come back and want more out of the renewables obligation. I think that this actually touches on the point made by Malcolm. We as an industry would like to see increased certainty, less volatility in the markets, and more regulatory control of the markets. Thank you.

Rob Blackhurst: Thanks a lot. Just one final point.

Roland Cliff, University of Surrey: I am also a member of the Royal Commission on Environmental Pollution, and therefore one of the authors that put out this target of 60% reduction in carbon dioxide by 2050. The target was carbon dioxide reductions, and let's not forget that is an important boundary within which this debate is being conducted. I should also say that there has been a fundamental mistake made this afternoon that runs all the way through UK energy policy. This is the separation of electricity from the rest of the UK energy sector. This was done in the early days of the CEGB, which was set up to trade in electricity and no other form of energy, and there are those who think this was a stitch up by the nuclear industry. The things I'd like to ask are why has nobody mentioned carbon dioxide sequestration? Significantly. The point about the intermittency of most renewable sources is absolutely right, and of course it's right that you can't have more than a certain level of wind generation. What that certain level is, is the interesting question. I don't think that we actually got an answer to that. Widespread wind generation is probably a good thing on the crude basis that wind is usually blowing somewhere. But then the question is what do you have in the electrical mix to provide the base load that you need to stabilise the grid. If it is not nuclear, what is it? It's probably got to be fossil, because it's dispatchable in large scale, and that's where carbon monoxide sequestration comes in. The low carbon scenarios are either nuclear, or fossil with carbon sequestration. That's the trade-off. Not the trade off between nuclear and renewables. The other question is why has no one mentioned biomass? It's about the only one of the renewables that is dispatchable. The reason they have done so well in Denmark is that they have made the link between biomass and wind. They haven't separated electricity off

from the rest of the energy saving. The biomass in Denmark is usually used usually on CHP glass. They are built for the heat output. They are built on a small scale, so people can see them, own them and love them, and they are linked in with the wind generation so that when the wind is blowing, they just put out heat, and when the wind isn't blowing, they put out electricity as well. That's another significant part of stabilising the grid.

Rob Blackhurst: I'd like to return to Malcolm's point, and in particular, the twin obstacles to the rejuvenation of the nuclear industry. Firstly, that it will find it very difficult to cope in a liberalised market, and also that amazing statistic on the beliefs of our MPs, that 84% think that the public are hostile. So, is there anyone who'd like to respond to anything in Malcolm's presentation?

Mark Johnston, Friends of the Earth: I'd like to respond to Malcolm's point. Liberalised markets is one aspect right at the top of new European institutions, so if the industries supporters want to attach liberalised markets and to change them in some way, then they've got a very big hill to climb, it is going to be difficult to do that. Elsewhere in the constitution, I feel a little disappointed that we keep re-heating old and familiar arguments. I think that the most pressing question for the UK at the moment is not Kyoto 2, and the UK targets, which are important, but will not become political issues for decisions for several years yet. The constitution – so called – is a pressing foreign policy subject, and in particular in relation to our subject here, because there is of course the proposal here for the first time to share the energy policy between the different capitals and institutions in Brussels. So, that's the point, that energy policy could change in a fundamental way in the next 12 months.

Rob Blackhurst: Anyone else?

Unknown Speaker: My question is for Malcolm. The discussion today was supposed to be about learning the lessons from Europe. Perhaps he'd like to make some comment about the situation in Italy, where the renewables have failed, and their supply from EDF has failed. You don't need to learn the lessons in this country, do you?

Malcolm Grimston: That's right, and you can take exactly the same from Austria as well. What I think will happen across Europe is a greater degree of interconnection. We talk about Danish wind, and one of the key reasons is that because of the Scandinavian grid, the Danes have access to Norwegian hydropower. You can turn on a hydro-dam very rapidly, much more rapidly than biofuel, or any of the other backups. Clearly, the more that happened, you begin to be able to spread these issues across Europe more, and that is one approach to the problems that Italy has faced and others have faced. That said, however big your market is, and however the peak moves in your market – and that's an extremely important point, that the peak in the UK is not going to be the same as the peak in Hungary, and that gives you an extra degree of lopping off the load with power flowing one way and then the other way across Europe as time goes by – but in any of these circumstances, I still find myself thinking about liberalisation. As Mark rightly says, it's at the top of the European agenda right now, if we get to 2007 and there are significant power cuts across the UK – which is one scenario ... these political priorities change enormously under particular political circumstances. If it happens before 2007, then we'll have an interesting position of a very varied Europe. If it happened post 2007, it's going to be much more interesting, because then you've committed Europe to a whole range of things, and it's much more difficult if you discover that the whole thing doesn't work, to pull yourselves back. Just because a political priority is there now does not mean that it is going to be there forever, and I think we've seen some dramatic examples of that. I've quite a few comments on this renewables argument, but I'll keep them for another time.

Rob Blackhurst: we need to wrap up, but first I'd like to come back to our panellists and to ask them firstly if there's anything that they've heard which they'd like to comment on, and secondly to two quick questions. What is our energy mix going to look like in 2050, and are we going to meet our CO² commitments?

Andrew Stunell: If we are using 100 units of energy now, we should be using 70 units in 2050, but have a far higher lifestyle, so conservation is the top priority. If you have that as an objective, you can then work out the milestones on the way to it.

Desmond Turner: I have been very critical of the current regulator, who is retiring shortly, because he has focussed entirely on getting the wholesale price of electricity down to an unsustainable level, and that has not been good for anybody. There has been a new regulator appointed, and I expect better things from him, and I feel fairly confident that he will be taking more note of environmental factors. Andrew says 'use less electricity', and that's fine, I'm a great supporter of energy conservation. But I think that we maybe generating and using more electricity because we will want that energy to replace carbon on transport, and surplus electrical energy is the way to do it because we can use it to manufacture hydrogen, and we can run cars on hydrogen. There is already there, needs more refinement, but teetering on commerciality already. The comment that we were going to be either be stuck with a choice of nuclear energy, or fossil generation plus carbon sequestration is simply not true. Tidal energy, which is on the brink of deployment, is on the brink of being able to provide baseline load, because of the predictability and the constancy of the tide. That is relatively straightforward – you shake your head, but I have spoken to electrical engineers who see no problem of balancing with that. As for the comments about the difficulties that the current market structures present for sources like micro CHP or embedded generators like solar panels, I'm very sympathetic about that. We have the technology now in the world to build zero energy buildings, but the market doesn't allow it. We have to have a government intervention to demand net metering, so that we can actually take advantage of micro sources of embedded generation to contribute to the mix. As for the comment about the energy majors, why aren't they investing, that's a very good question. We have asked them this. Their short answer is that it is uneconomic given the present electricity price, but I suspect that the real answer is that they are waiting in the wings to see which of the horses that are waiting in the wings to run this particular race is going to be the good one to back. I think that in the not very distant future they will suddenly start piling in when they see that one or more technologies is really going to be commercially viable and is going to be profitable for them. They want a piece of the action then, but they don't want to take the risks now.

Rob Blackhurst: Thanks a lot, Des. Nick, I wonder if you can try and go next, and also try and answer my questions – are we going to meet our CO² targets, and what's our mix going to look like in 2050?

Nick Eyre: The answer to those is very obviously 'I don't know'. To go back to the last point in my presentation: with the right policies, yes we can do it. Without the right policies, no we won't do it. It almost is that simple.

Just to pick up on a few points. To Roland Cliff's excellent point: Yes, we do need to think about the whole energy system, and I think that points to an important issue about intermittency

towards 2050. If, as has been indicated, we can move towards a hydrogen economy, when we have a fully developed hydrogen economy, these problems will be substantially diminished. But of course we won't have a fully developed hydrogen economy for a long time, and it's that interesting period in perhaps the second quarter of this century where I think there is a lot of work to be done on those sorts of intermittency issues.

The whole issue of liberalisation and capacity: I do think sometimes that the nuclear industry is trying to have its cake and eat it on this one. Firstly, we hear that we are so short of capacity that the lights are going to go out; but on the other hand, we've so much capacity that the prices are so low that we can't afford to invest. One of those can be true. But both of them can't be true simultaneously.

Malcolm Grimston: They can be true six months apart from each other.

Nick Eyre: Well, you're going next Malcolm, so explain it to me please. It does seem a real issue. Guy Thompson's point about green tariffs. Yes, it is a real issue. We've chosen in this country, I think rightly, to go down the route of regulating people to produce green electricity. If you require significant regulated targets, there isn't going to be much of a voluntary market, because there isn't much to supply it. That is a price we pay for having the renewables obligation uncertainty, I think. Just tell your clients that, that public policy doesn't always deliver through a voluntary route.

The point I want to end on is one that Becky Willis raised, even though she is not here, about distributed generation. I think people should be fair to the DTI and OFGEN on this. I'm not always fair to either the DTI or OFGEN, as one member of the audience will know. But there is an awful lot of work going on distributed generation. I don't think it will be renewables first, I think it will be micro scale CHP first. We already know of two very significant companies who are going to launch products. These are one kw power stations, essentially, for use in people's homes next year. There is no reason why these shouldn't replace domestic central heating boilers really quite quickly. That marks a fundamental change to a system based on of order ten power stations, to a system based on of order ten million power stations. There isn't anything much more fundamental than that, so I think big changes are going to happen in the next twenty years, or at least possible provided policy allows us to move down that route. So, this could be a very exciting time. Just to end, I don't think we are going to see a one kw nuclear station. I may not work on nuclear now, but I did spend twelve years working for the Atomic Energy Authority; I don't think one kw stations are the way of the future for nuclear.

Rob Blackhurst: Thanks a lot, Nick. Malcolm.

Malcolm Grimston: Right, CO₂ targets. 2010: probably. Beyond that, yes, because the targets will be altered as time goes on to what is likely to be reached [laughter]. We know that this government's use of the word 'target' is an interesting one. Aspiration is a different matter, but that word is chosen to mean you're not going to get there.

In terms of the mix by 2050, I reckon it will be 50% fusion, 30% energy beamed directly from space, and 20% these one kw nuclear plants which are being discussed [LAUGHTER]. Alternatively, it might be 50% gas, 30% big nuclear, 20% geothermal. Andrew made the point that it's a silly question, and it's important that it's a silly question because the whole point about the future is ... I go further ... not that we don't know what the future is, but if we believe in a particular future, it certainly will not happen. The very fact that we believe the white paper,

which is in effect saying that there is not much of a problem in getting to where we need to go in 2020, means by definition that we will not get where we need to go by 2020. The whole point of that planning and energy is that you need a flexibility; you need to deliberately follow contradictory policies, knowing that all of the routes which you develop will not be needed, but none the less not knowing which ones will, and so following them all. There are huge technical questions. Quite frankly, the statement that tidal power is not intermittent is I find just crazy. Most of our tidal reserve is at a single point: the Severn. 7.2kw at the Severn, which comes twice in a twenty-five hour cycle. The next two, the Mersey and the Humber are much smaller. There are no other big sites where you funnel the tide in such a way that you get a large scale, viable tidal machine. Quite frankly, I'm frightened if that is the level of debate on some of these technologies. But there may be a time in the future when tidal power can be smoothed in that way, when there may be a way of developing some tidal power such as you combine a tidal dam with a hydro dam, so you phase the point of high tide, or whatever. So, there needs to be, it seems to me, a much more straightforward recognition that we have got to spend a heck of a lot more on research and development of all these technologies. The scale of the problem – twice as much energy being used in 2050 as there is today, globally, yet we've got to cut carbon dioxide emissions by more than half at their current levels. It's an astonishing task. There are probably half a dozen ways of getting there, but we've got to start putting the right amount of research in. If you look at the amount of research being spent now compared to the year 1980, in the UK it's 1/9th as much being spent today as in 1980 on energy reserves, and that seems to me to be a crazy thing.

Just very briefly, don't mistake conservation for an energy source. It's economically illiterate to regard changes in the supply side and changes in the demand side having the same effect. If you improve the demand side, reduce the amount of that, then you make the use of energy more attractive, or use of energy services more attractive, because you cut the effective cost of that service. At least part of that benefit, between ten and forty percent, the electricity regulator reckons, will be taken in increased economic activity, not in reduced energy use. This 'negawatts' concept is extraordinary ... it's dead easy if you just follow it through for a few moments to realise it's illiterate, but nevertheless we continue to hear it. In terms of the wider future though, statements like 'when we have a fully functioning hydrogen economy seem to me to demonstrate the whole issue. We might never have a fully functioning hydrogen economy. It's a useless way of transporting energy, 1/3 of the calorific value of methane. It's very explosive. We may get there, but we may not. We have to hope for the best, we prepare for the worst, and that means keeping a lot more options open than at present through the white paper route.

Rob Blackhurst: Thanks very much, Malcolm. I've got some more silly questions which I'll ask you afterwards! Des just wants twenty seconds before we wrap up.

Desmond Turner: I just wanted to put Malcolm straight. He seems to be thinking in terms of tidal barrages. Nobody has contemplated following that route for many, many years, so I'm afraid you're talking from the back of your reactor on that one.

Rob Blackhurst: Someone from OFGEN, who we have ignored for far too long:

Unknown Speaker, OFGEN: Within the spirit of the meeting, I'd like to say something about the European angle in all of this. Because the energy directive for 2000 introduced into the formal decision making process [INAUDIBLE] European electricity regulator, so that means that a concept of regulation within European policy making will be formalised for the first time. But I

would also say that in each country the regulator is the function of the political process from within which it is generated, and so each has a different basis. So when you talk about independence, some are more, some are less, independent. But I think that it is very important to recognise that there is this concept of European electricity regulators, and I think that has to be seen alongside European competition laws, you will have to look as a whole at how the European competition laws work at a European level.

ENDS