Presentation by Dr Robert Hawley to the Foundation for Science and Technology

8th March, 2006

Nuclear Power – What has changed?
[The slides are at the end of this document]

1 Introduction

[Slide 1]
Originally I was given twenty minutes to convince you that new nuclear power should be part of our future energy mix. Now due to time constraints I have ten minutes to persuade you that, against the background of concerns of gas supply, rising gas prices and the risk of not achieving carbon dioxide targets, new nuclear should be an essential part of our future energy strategy.

Before I begin I must emphasise that I am speaking from a personal point of view – I am Deputy Chairman of the Foundation but the Foundation does not take a position on any policy issue.

I have spent my career building and operating power generation equipment and power stations around the world. I want to reflect today on the history of power generation in the UK and draw out some of the lessons learned and give you my personal thoughts about what has changed. There are lot of myths and prejudices about power generation particularly from nuclear that may sway those who must make some key decisions on how the UK will generate electricity over the next fifty years. I want to put the record straight and highlight some of the mistakes of the past and suggest ways to avoid repeating these in the future.

I will focus on nuclear power generation although some of the lessons apply to all major capital projects including, for example, new coal fired power generation.

Deloittes have just published an excellent analysis of the future options for power generation and, as I have explained, I have given up time to Ross Howard from Deloitte to present the key conclusions of their report – you received a copy of the report when you arrived.

I was also grateful to attend the workshop organised by the Foundation and CUGPOP and hosted by Lord Rees in Trinity on the nuclear options – a record note of this meeting is on the Foundation web site and available outside.

I am grateful to many people particularly Sue Ion and Robert Armour for their help in pulling material together for this talk.

2 The UK History

The UK led the world in developing nuclear power generation but state ownership and bureaucracy did not achieve delivery of projects on time and on budget. We also were too tempted to make every new station an experimental one rather than build a run of designs using common components and designs.

[Slide 2]
This lead to a legacy nuclear power stations which are of three types – Magnox, Advanced Gas Cooled reactors (AGR) and one Pressurised Water Reactor (PWR). Although it must be remembered that the Magnox stations played a role in our nuclear deterrent programme. Together today they have a total installed generating capacity of 11.9 Gigawatt.

[Slide 3]
The remaining life of the AGR stations might be extended but the current predicted profile of end of life is shown on this slide. The UK nuclear power generation capacity could fall by 50% as soon as 2012 and be down to 3% of our generation requirements by 2023.

In the past new stations were subject to complex regulatory and planning constraints that greatly added to the cost of the final facilities built.

Once built not all the stations met the design, economic and reliability expectations.

Not surprisingly government and the public became nervous about opting for nuclear power continuing to provide a substantial part of our total generating capacity.

But things have rapidly changed. Ofgem estimated that over the winter of 2004/5 alone consumers in the UK paid £5.2 billion more for their gas and electricity than they had the previous year. Russian actions at the

turn of the year have given concerns over security of gas supplies as does the potential monopoly situation in France.

So today we are in the situation that Government must decide how much to intervene in the market to manage the mix of supply and decide how much either the consumer or tax payer will pay to meet carbon dioxide emission targets or security of supply policy choices? The market cannot make these choices.

3 The Options Today

Today new power generation plant, nuclear, gas or coal, would be built by a private companies not the government and would sell electricity into a competitive market. The expertise to build such a plant would draw on the global experience of nuclear operating companies, large construction and power generation companies.

[Slide 4]
For current designs there are now many examples of projects being completed to time and cost and, in addition, construction times have been markedly reduced leading to lower financing costs. Here the Korean experience is a good example as this slide shows.

[Slide 5]
Capacity factors have also significantly improved since 1980.

[Slide 6]
For future designs, larger unit sizes, passive safety features, modularisation of equipment, with more components built off site, will lead to even faster construction times and less capital cost. The Westinghouse AP1000 design is a typical example with far less components than previous designs.

A challenge for the government will be whether the Nuclear Industries Inspectorate will be prepared to accept without significant modification a foreign design and have the resources to deal with this situation. Our Chairman, Lord Jenkin, in his opening speech to the House of Lords on 16th February on Energy Policy – Nuclear Power, quoted the NII Chief Inspector, Mike Weightman, as saying that out of 179 inspector posts only 163 were filled.

The number of places at universities to study nuclear engineering and safety has fallen significantly – not surprisingly we are short of such

skills in the UK. However, the movement of labour is much greater than it used to be and so we will have to compete globally for these skills as we do today for doctors and nurses.

4 Turning to Waste Management and Decommissioning

BNFL and UKAEA estimated in their 2005 accounts the total clean up costs to deal with all the sites – military, research and fuel processing – they were responsible for to be around £25 bn using the discounted FRS12 basis. British Energy estimate £5.3 bn is required for waste management and decommissioning of its own sites.

[Slide 7]
In the UK currently waste spent fuel management and decommissioning costs are less than 4% (after discounting) of the total generating cost and will be even less for future designs that will produce less waste per MWhr of generation through design improvements. EE (UK) in a report to the Committee on Radioactive Waste Management (CoWRM) who are tasked by the government to report on disposal options by July of this year, estimate that ten AP1000 reactors (10 GW) would generate 14,000 tonnes of spent fuel, 9,000 m^3 of ILW and 80,000 m^3 of LLW from operations and decommissioning. Thus waste from a new build programme is a small fraction of what the government already has to deal with.

5 Uranium Availability

[Slide 8]
Nuclear electricity production is rising globally and this is creating demand for increased production and development of new deposits of uranium.

[Slide 9]
The World Nuclear Association put current usage at about 68,000 tU/yr and forecast that the world's present measured resources of uranium in the lower cost category (3.5 Mt) and used only in conventional reactors, are enough to last for some 50 years. They also state that further exploration and higher prices will certainly, on the basis of present geological knowledge, yield further resources as present ones are used up. There was very little uranium exploration between 1985 and 2005, so a significant increase in exploration effort could readily double the known economic resources, and a doubling of price from present levels could be

expected to create about a tenfold increase in measured resources, over time

6 Carbon Dioxide Emissions for Nuclear Build

Finally I would like to make a comment about Carbon Dioxide and nuclear. Nuclear is not totally carbon dioxide emission free because energy derived from carbon dioxide emitting sources is used to make the components of the power station, extract the uranium and decommissioning.

[Slide 10]
A comprehensive study of the comparative emissions from all sources of energy was published by Spadero et al in the IAEA bulletin. The comparison for projections incorporating technology improvements are shown the table – indicating the major role nuclear generation can contribute to the government's carbon dioxide reduction targets.

7 Conclusions

In evaluating the policy for our future energy supplies government must take proper account of the significant changes that have taken place in the nuclear power generation industry. The new generation of reactors can produce electricity at a lower capital cost, with less waste, more safely than the legacy reactors built in the 60s, 70s, 80s and 90s.

Radioactive waste in UK remains an issue – how do we insure the legacy we will we leave for future generations? Other nations have solved this question by deep depositories and we must also set it against the issue that affects the whole human race global warming and population growth.

[Slide 11]
So what the UK Government needs to do is:

1 Ask the Nuclear Installations Inspectorate to follow the US lead and begin the process of licensing a choice of reactors for construction on existing nuclear sites in Britain rather than a site by site licence.
2 End the discrimination against nuclear power by exempting it from the climate levy since nuclear emits next to no greenhouse gases.
3 After the CoRWM report is published in July, the government should set out a clear strategy for waste management.

Before a decision can be made about new nuclear builds we need to reach a consensus on what the economics look like – Ross Howard and Keith Palmer I am sure will enlighten us on this – and agree how radioactive waste will be dealt with and how the costs of waste disposal and decommissioning will be shared between the tax payer and the operator of a nuclear plant.

To do all this requires an informed national discussion about UK energy needs and how they might realistically be met. The UK Energy Review gives us the chance to do just that. Perhaps the outcome will be a change from this **[Slide 12]** to this **[Slide 13]**…

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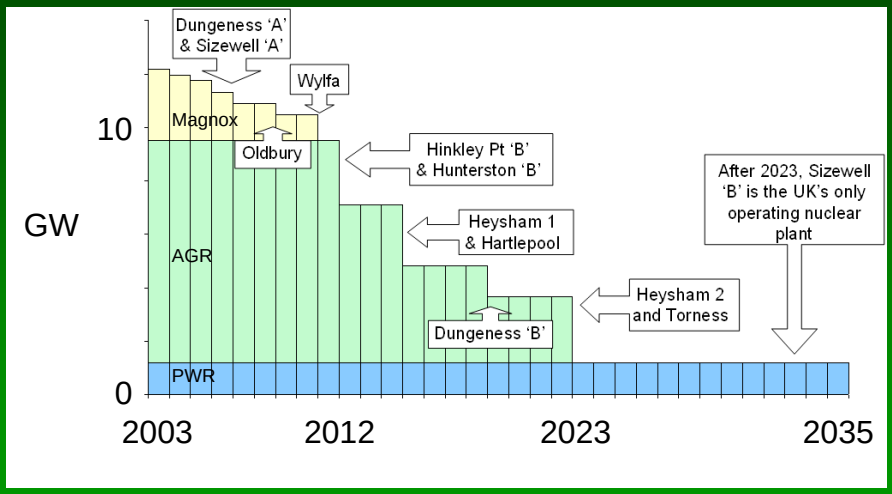
Nuclear Energy - what has changed?

Dr Robert Hawley CBE DSc FRS FRSE

Installed Nuclear Capacity

Reactors	Type		Start Operation
Dungeness A 1 & 2	Magnox	225 MWe	1965
Oldbury 1 & 2	Magnox	217 MWe	1968
Sizewell A 1 & 2	Magnox	210 MWe	1966
Wylfa 1 & 2	Magnox	490 MWe	1971-72
Dungeness B 1 & 2	AGR	555 MWe	1985-86
Hartlepool 1 & 2	AGR	605 MWe	1984-85
Heysham 1 & 2	AGR	575 MWe	1985-86
Heysham 3 & 4	AGR	625 MWe	1988-89
Hinkley Point B 1 & 2	AGR	610 MWe	1976-78
Hunterston B 1 & 2	AGR	595 MWe	1976-77
Torness 1 & 2	AGR	625 MWe	1988-89
Sizewell B	PWR	1188 MWe	1995
Total 23		11852 MWe	

Run Down of Current Nuclear Capacity



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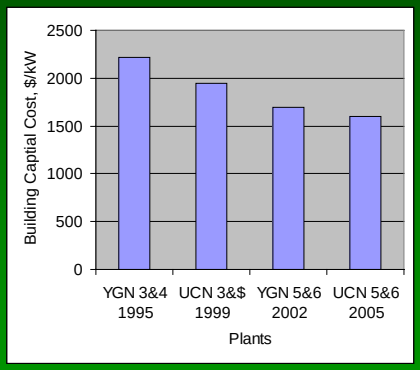
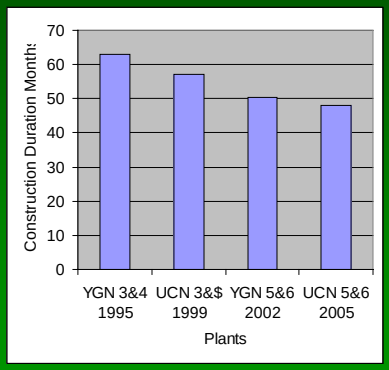
Korean Experience

Capital Costs ($/kW)



Construction Time (months)



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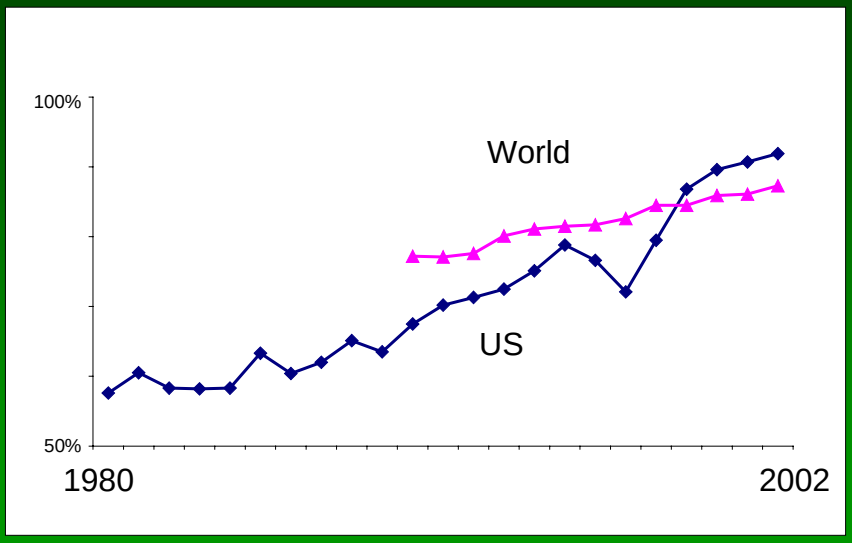
Nuclear Capacity Factor Improvements



Source: WANO and Nuclear Energy Institute

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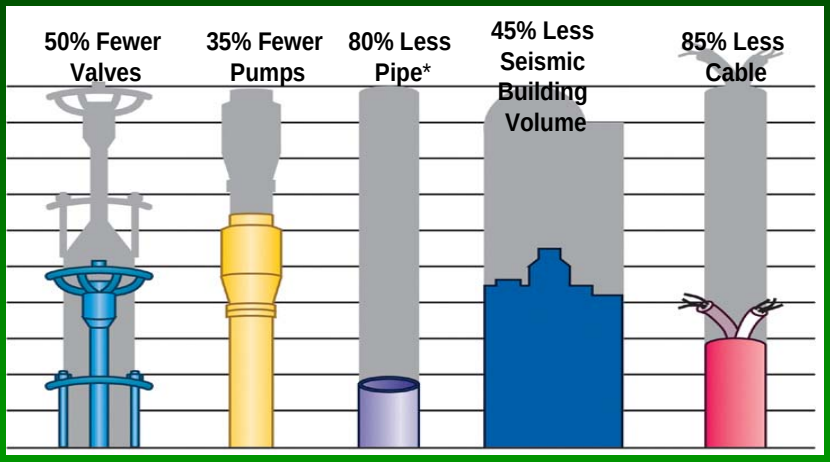
AP1000 compared to PWR Design



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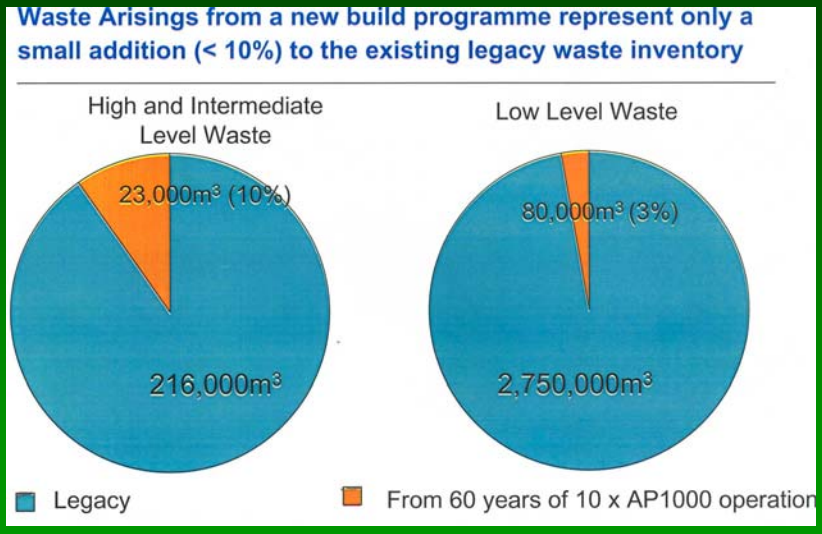
Waste Estimates



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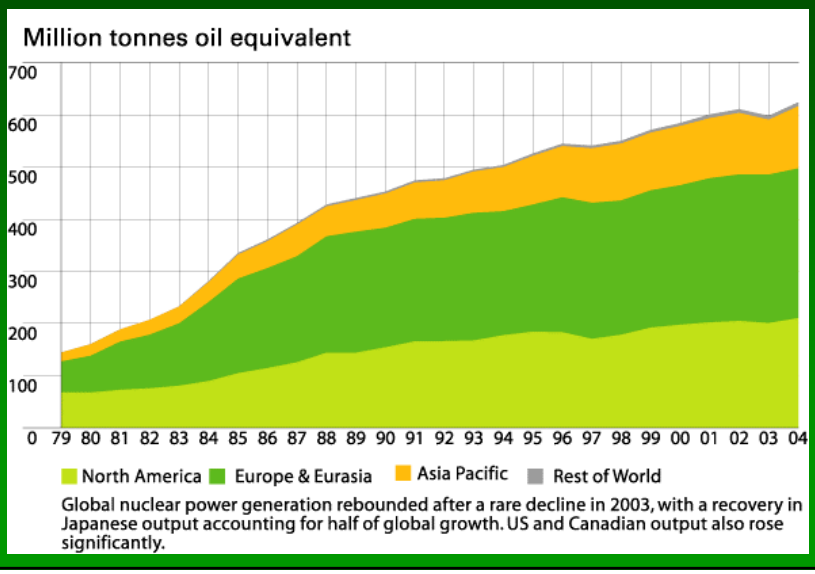
Nuclear energy consumption by area

1 tonne oil equivalent equals 12 megawatt hours

BP Statistical Review



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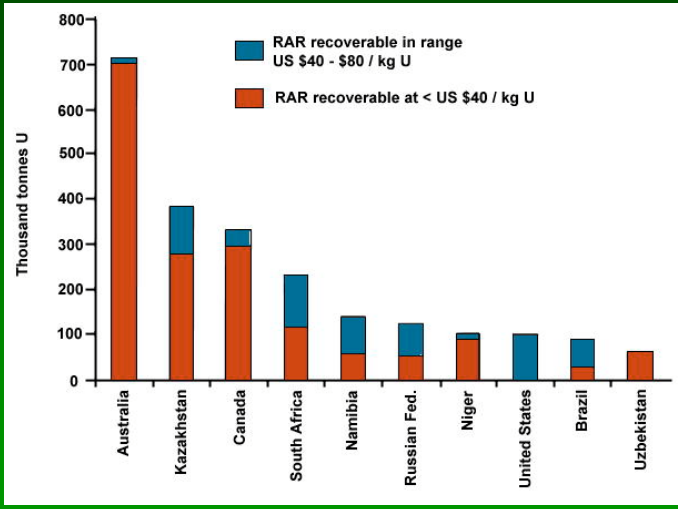
Uranium Recoverable Reserves



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Carbon Dioxide Emitted per kWh Produced

Lignite	217
Coal	181
Oil	121
Natural Gas	90
Solar	8.2
Hydroelectric	4.4
Biomass	8.4
Wind	2.5
Nuclear	2.6

gCarbon equivalent/kWh

From Spadaro et al., IAEA Bulletin, Vol. 42, No. 2, Vienna, Austria, 2000

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Recommendations to Government:

1 Ask the Nuclear Installations Inspectorate to follow the US lead and begin the process of licensing a choice of reactors for construction on existing nuclear sites in Britain rather than a site by site licence

2 End the discrimination against nuclear power by exempting it from the climate levy since nuclear emits next to no greenhouse gases

3 Set out a clear strategy for nuclear waste management

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