

THE FUTURE OF NUCLEAR POWER



**THE ROLE OF NUCLEAR POWER IN
A LOW CARBON UK ECONOMY**

**AREVA RESPONSES TO
THE UK GOVERNMENT
CONSULTATION DOCUMENT**





International & Marketing
JJG/mcs/07.011

Department for Business, Enterprise and
Regulatory Reform
Nuclear Consultations Directorate
1 Victoria Street
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October 1st, 2007

AREVA presents its compliments to the Department for Business, Enterprise and Regulatory Reform (BERR) and thanks it for opportunity to contribute to its current Nuclear Consultation (The Role of Nuclear Power in a Low Carbon UK Economy). AREVA regards this process as very important, both for the UK and internationally.

In 2006 AREVA made a detailed submission to the UK Energy Review. We think it helpful, rather than to reproduce this at length, to give concise responses to the individual questions, supported by factual information wherever possible. Please find our responses following this letter.

If BERR would like more detail on any responses to particular questions, AREVA would be very happy to provide this.

As BERR will see from our responses, we strongly support the UK Government's views on new nuclear generation power making an essential secure, low carbon, safe, environmentally positive, economic and reliable contribution to the UK's future energy mix.

AREVA has some divergent views from BERR on the future of reprocessing and recycling of used nuclear fuel, as BERR will see from our response to Question 14. Indeed we consider that recycling used fuel has a positive impact from a sustainable development viewpoint, both in making better use of nuclear material resources, and in reducing volume and toxicity of the waste to be disposed of in a future HLW repository.



Finally, and most critically, AREVA particularly stresses the decisive importance of the early resolution of practical and legislative steps, such as streamlining the regulatory process, and of their early implementation - in order to ensure that new generation nuclear power can make a timely contribution to addressing future UK energy requirements.

AREVA has no objection to BERR publishing this letter and the following Responses to the Consultation Document. Indeed, AREVA welcomes the open nature of any such debate.

AREVA remains at BERR's disposal for any further contribution to this Nuclear Consultation.

A handwritten signature in black ink, appearing to read 'JJG', is written over a horizontal line.

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AREVA RESPONSES TO QUESTIONS IN THE CONSULTATION DOCUMENT

1. To what extent do you believe that tackling climate change and ensuring the security of energy supplies are critical challenges for the UK that require significant action in the near term and a sustained strategy between now and 2050?

AREVA believes that climate change and energy security are critical challenges for the UK, which will also require strong and sustained solutions in the long term, for which a clear strategy is needed urgently.

Tackling climate change and ensuring security of supply are certainly critical challenges, which require a robust response by the Government. The UK is not alone in having to address both these issues. UK has already put in place the framework to bring some solutions for the short term. AREVA believes that the UK also needs strong additional solutions for the longer term.

As advocated by many experts, including Yvo de Boer, Executive Secretary of the United Nations Framework Convention on Climate Change, there is no credible scenario for reducing greenhouse emissions that does not include nuclear energy. Also, energy experts agree that nuclear power contributes to improve energy security significantly, both in terms of volume and cost of energy supplies, as well as in terms of improved economies of generation.

But this requires action to be taken now. Not only will the climate change costs of delay be considerable (see conclusions of Stern Report), but also energy facilities are long term assets. Countries do not often have opportunities to modify their energy mix. The fact that around 30% of UK's generation capacity will be replaced by 2020 will create such a unique opportunity. If UK wants nuclear energy to continue contributing to tackling climate change and to ensuring security of supply in the long term, a strong and sustained strategy is needed as soon as possible.

2. Do you agree or disagree with the Government's views on carbon emissions from new nuclear power stations? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA agrees.

Nuclear power generation as such does not emit greenhouse gases directly (no combustion in the reactor). However, the construction, the operation and the

dismantling of a nuclear power reactor does involve some emission of greenhouse gases. AREVA agrees with the Sustainable Development Commission, which did not support new nuclear build in the UK, that nuclear power has life-cycle greenhouse gas emissions similar to wind power, and thus can be regarded as low carbon.

Furthermore, AREVA is currently working on further reduction of nuclear life-cycle emissions. As a company, AREVA has already achieved a 25% reduction of its own greenhouse gas emissions from its total industrial activities between 2004 and 2006, and aims to reduce them by a further 20% between 2006 and 2009.

As noted in the Stern Report p.203-4: role of nuclear in reducing France's CO2 equivalent emissions: *".....by switching to a nuclear power-based economy, [France] saw energy-related emissions fall by almost 1% per year between 1977 and 2003, whilst maintaining strong economic growth."*

AREVA believes that nuclear can contribute significantly to reduce the carbon-content of electricity.

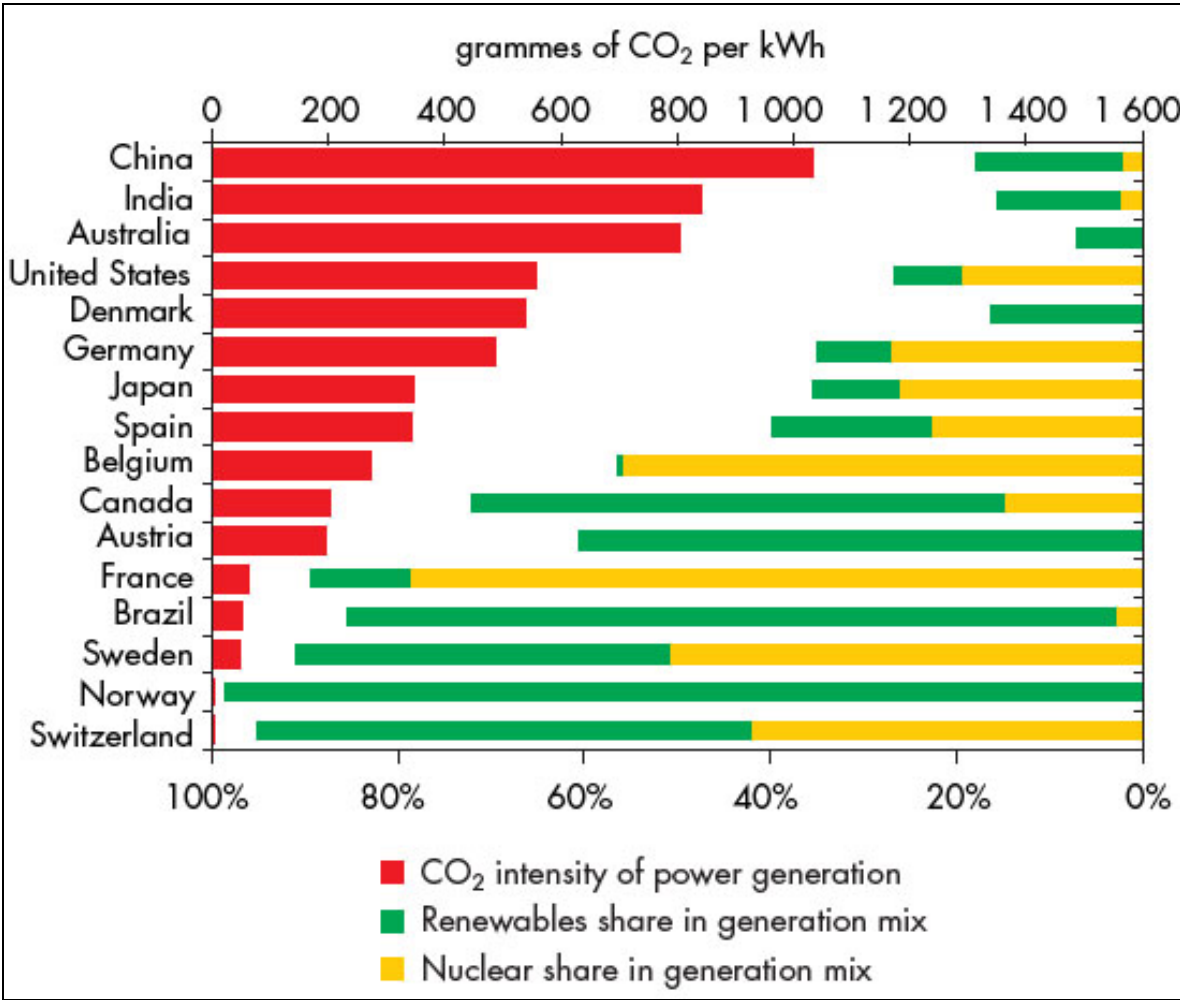


Figure: World Energy Outlook 2006

Thus, AREVA believes that the Government should ensure that nuclear, as a proven low carbon baseload technology, remains an important component within its diversified electricity mix, in order to achieve its long term carbon objectives.

3. Do you agree or disagree with the Government's views on the security of supply impact of new nuclear power stations? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA agrees.

Security of supply is driven by the source of fuel needed to generate electricity, and by its cost. The proportion of uranium cost to the overall cost of electricity generated is less than 10% for nuclear, as opposed to about 70-80% for CCGT. In addition, the sources of uranium ore are more widely dispersed than those for oil or gas, and are generally in countries with which UK has good relations. So, not only is nuclear power less sensitive to fuel price fluctuations than coal, gas or oil, but its fuel sources are more secure.

Thus, nuclear provides good fuel diversification, and enhances the UK's security of supply. It is in the interests of the UK to have a diverse portfolio of fuel supplies, including that of nuclear, to minimise any threat to the UK's fuel supply.

4. Do you agree or disagree with the Government's views on the economics of new nuclear power stations? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA agrees that the private sector can invest in new nuclear reactors with no subsidies from the government (other than the "investment" in effective regulatory and licensing resources). This requires that the Government should create confidence in a clear and sustained national nuclear energy strategy.



Computer generated image of future EPR at Olkiluoto, Finland. In the background the two BWR reactors.

It is for the Government to create a landscape in which the market decides on the economic merits of any source of generation, including that of nuclear. In today's market, in comparison with the past, the investors, i.e. the private sector and not the taxpayer, will be responsible for all costs of new nuclear, including the eventual costs of plant decommissioning and waste management.

Nuclear is an economic source of electricity generation, compared with the full life costs of other forms of generation, when the environmental impact is included. Thus, an ongoing stable market for carbon is essential to reflect the environmental impact of all generation forms on the ultimate cost of electricity.

It is worth noting that the new generation of nuclear reactors, with increasing availability, provides significant economic improvements when compared with existing reactors.

5. Do you agree or disagree with the Government's views on the value of having nuclear power as an option? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA agrees.



EPR construction site (TVO), June 2007, Olkiluoto, Finland

Generators should have the option of investing in nuclear, as with any other form of generation. Nuclear power provides about 20% of UK's electricity generation primary base load. Most of this will cease in the next 15 years. A nuclear replacement programme is required to meet national climate change and security of supply drivers. Nuclear power provides, and should continue to provide, low carbon baseload electricity generation. It is

complementary to, not an alternative to, renewable forms of generation.

The first new nuclear power station in UK could be brought online by 2017, with site construction commencing around 2012 – the planned construction time for an EPR is 54 months. This would allow a staged introduction of new nuclear plants from 2017 onwards, to replace the planned reduction in UK's current nuclear plants. Thus by 2020, the first *tranche* of new nuclear could be on line, with the next *tranche* close to completion. But, even a short delay to the new build process would increasingly commit the UK to higher carbon forms of electricity generation

for its baseload generation, thereby generating significantly higher greenhouse gas emissions during the decades after 2020.

6. Do you agree or disagree with the Government's views on the safety, security, health and non-proliferation issues? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA agrees.



Vitrification shop hall, UP3 used fuel treatment plant, La Hague, France

The global experience of the nuclear industry is some 12000 reactor years, an international experience that shares best practice within the framework of the UN. The resulting safety record of the Western nuclear industry is very strong. AREVA in particular has already built about 100 reactors worldwide, with exemplary safety results.

With regard to safety, new design improvements, as reflected in the AREVA designs currently being constructed in both Finland and France, minimise the likelihood of accidents and further decrease any consequences. Such designs are very robust, and are built to withstand many hazards including that of a major airplane crash.

AREVA believes that the Government should encourage the Nuclear Installation Inspectorate (NII), whenever possible, to draw on the existing significant international licensing experience for Generation III reactors. This would benefit the UK on one hand in terms of costs and time, on the other hand in term of safety analysis experience feedback, and would enable utilities to achieve better international standardisation of reactor designs and understanding of operating experience.

7. Do you agree or disagree with the Government's views on the transport of nuclear materials? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA agrees that the risks of transportation of nuclear materials are very small, and that the regulatory framework in place is effective.

Quantities of transported used nuclear material are negligible (less than 23t per year out of a 1000MW reactor), compared with the much larger transport volumes for fossil fuel power generation (26,000 coal railcars or 16 oil tankers @ 100,000t) per year.



Used fuel transportation cask, Cherbourg, France

Transports of nuclear material are performed under strict regulation and with outstanding track records. For example, AREVA carries out some 1,000 transports of nuclear material (back-end of the fuel-cycle) worldwide per year without any significant incidents.

Should a decision be made to reprocess some or all of the UK's used fuel resulting from new build, transport of the resulting nuclear materials would still be carried out in a safe and secure manner, as is evidenced by decades of nuclear material transport worldwide.

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The UK and France, where used fuel has been reprocessed, both demonstrate an excellent safety record in transporting nuclear material (used fuel, recovered and reusable fuel, operational and ultimate waste) over more than thirty years.

8. Do you agree or disagree with the Government's views on waste and decommissioning? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA agrees that the costs of decommissioning and whole life waste costs of new nuclear power plants should be fully borne by the private sector.

Modern, international designs are characterised by the minimisation of operational waste and the simplicity of future decommissioning, in comparison with today's reactors. New light water reactors, such as AREVA's EPR, would produce around 10% of the weight of radioactive waste arising from decommissioning of existing Gas Cooled Reactors ("Decommissioning Nuclear Power Plants", OECD/NEA, 2003).

Furthermore, these reactors would produce less toxicity per unit of electricity, due to their increased energy efficiency compared with the earlier reactors.

Decommissioning and waste/used fuel management costs will be the responsibility of the private, and not the public, sector. These costs will be included in overall cost of electricity and, as seen in Finland, will represent only a small percentage of the overall cost of electricity.

9. What are the implications for the management of existing nuclear waste of taking a decision to allow energy companies to build new nuclear power stations?

The Government has already taken measures to define future UK waste management routes (CoRWM Recommendations), and further work is needed to resolve the remaining issues.

The scale of the UK's current used fuel and radioactive materials inventory¹ is a legacy of UK's defence and civil nuclear industry, and must be clearly distinguished from the waste that will be generated by any new generation of nuclear power plants, even if similar technical solutions may be used.

AREVA recommends that the costs of waste arising from any new nuclear power plants are taken into account when planning overall waste estimates and the future associated planned repository storage.

However, new nuclear power plants should only bear the cost of managing the waste which they have produced.

10. What do you think are the ethical considerations related to a decision to allow new nuclear power stations to be built? And how should these be balanced against the need to address climate change?



Universal waste canister

AREVA believes it would be ethically irresponsible not to give future generations the full range of low carbon technologies that are available, in order to meet the challenges of today and tomorrow, especially that of climate change.

Similarly, the strategy for the handling of long term waste must be finalised, and a workable solution agreed with Government, industry and stakeholders. This will ensure that coming generations have sensible low carbon options, where the long term consequences have been addressed today and not left for tomorrow.

¹ See, for example; CoRWM's Radioactive waste and materials inventory, July 2005

11. Do you agree or disagree with the Government's views on environmental issues? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?



Sand sampling near La Hague treatment plant, France

AREVA does not fully agree with the assumption that the environmental impacts of new nuclear power stations would not be significantly different from other forms of electricity generation. In AREVA's view the environmental impacts of nuclear are, in fact, lower than many forms of other low carbon generation, especially when compared to the power generated.

AREVA welcomes the proposed Strategic Siting Assessment and Strategic Environmental Assessment, to support the early identification of environmental effects and appropriate sites.

The Consultation Document describes some of the key environmental impacts that require management, e.g. the impact of uranium mining and milling, as well as fuel preparation. AREVA notes that the 10 year ExternE socio-economic energy research project supported by the European Commission has shown that the environmental impact of nuclear generation throughout its cycle remains amongst the lowest of all energy sources (see below). In particular, the environmental footprint of activities linked to nuclear – mining, milling, siting, discharges - is very low compared to that of fossil fuels in relation to the amount of energy generated.

External costs for electricity production in the EU (in EUR-cent per kWh**)

Country	Coal & lignite	Peat	Oil	Gas	Nuclear	Biomass	Hydro	PV	Wind
AUT				1-3		2-3	0.1		
BE	4-15			1-2	0.5				
DE	3-6		5-8	1-2	0.2	3		0.6	0.05
DK	4-7			2-3		1			0.1
ES	5-8			1-2		3-5*			0.2
FI	2-4	2-5				1			
FR	7-10		8-11	2-4	0.3	1	1		
GR	5-8		3-5	1		0-0.8	1		0.25
IE	6-8	3-4							
IT			3-6	2-3			0.3		
NL	3-4			1-2	0.7	0.5			
NO				1-2		0.2	0.2		0-0.25
PT	4-7			1-2		1-2	0.03		
SE	2-4					0.3	0-0.7		
UK	4-7		3-5	1-2	0.25	1			0.15

* : biomass co-fired with lignites
 ** : sub-total of quantifiable externalities
 (such as global warming, public health, occupational health, material damage)

The assertion (para 9.4) that in many cases the effect on the environment does not depend on the fuel used in the power station is questionable – for example, coal or lignite, sulphured gas or not. There are further issues, such as the emission of acid rain and other pollutants – which nuclear power does not, of course, produce.

12. Do you agree or disagree with the Government's views on the supply of nuclear fuel? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA agrees.

According to the 2006 version of the joint report produced by OECD's Nuclear Energy Agency and the International Atomic Energy Agency ('Uranium – Resources, Production and Demand' - the "Red Book"), the world's identified uranium resources from conventional sources for the world's fleet of nuclear reactors (water-cooled and once-through fuel cycle, at 2004 consumption rates) would amount to some 270 years of supply.

I



Somair open pit mine, Arlit, Niger

In addition, other types of uranium resources (“unconventional resources”) would bring significant additional quantities, if required. According to the “Red Book”, the identified resources of uranium content of phosphate rocks would be equivalent to further world supplies for some 400 years.

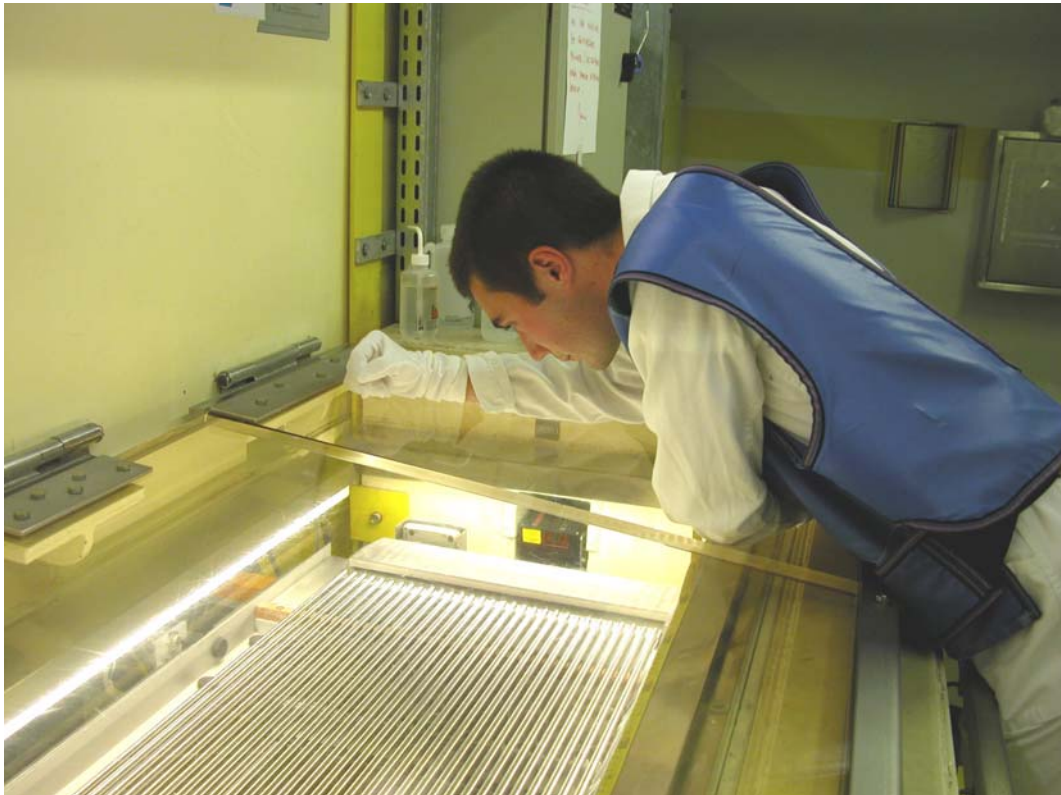
In addition, the reprocessing and recycling of used nuclear fuel could significantly increase future supplies.

13. Do you agree or disagree with the Government’s views on the supply chain and skills capacity? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA agrees.

A nuclear new build programme would reflect international designs by international companies, using an international supply chain for key components and skills. Even though not all the components could be manufactured in UK, the majority of any construction programme would use national suppliers and local resources.

AREVA, like other vendors and nuclear suppliers, is investing significantly to provide the necessary industrial capacity to respond to the increasing global demand. UK will benefit from this investment. The UK also has the opportunity of using its current industrial infrastructure and resources, to not only support a national nuclear replacement programme, but also to become future suppliers to the international new build market.



Mixed-oxide Fuel rods inspection, MELOX plant, France

However, the development of the necessary skills is an important issue. AREVA is investing significantly in developing future skills and human resources to support the emerging market, and is ready to support a training/education effort designed to fill the skills gap.

The need to develop the appropriate skills and experience to provide future regulatory and licensing capacity, e.g. for the NII, will be of particular importance.

14. Do you agree or disagree with the Government's views on reprocessing? What are your reasons? Are there any significant considerations that you believe are missing? If so, what are they?

AREVA believes that the Government should ensure that the reprocessing option remains open, in order that utilities and industry would have a competitive option of reprocessing and recycling in the longer term.

Reprocessing and recycling provide the optimum flexibility and economics for the management of used fuel, and it is the best route to maximise the sustainability of nuclear fuel. It would be sensible to leave the door open to any decision on the future of reprocessing and recycling of the UK's future used fuel. While the UK's domestic record on reprocessing has not been ideal (as stated in the Consultation Document), elsewhere, e.g. in France, reprocessing is seen to be an economic, safe and effective used fuel strategy. It is of note that many countries around the

world, which are currently considering new build, are also considering using a closed fuel cycle: the USA, China, India, South Korea, etc. Studies undertaken by the OECD and the Boston Consulting Group show that the costs of both options (reprocessing and recycling, or direct disposal) are similar, while the former reduces the uranium requirement of any new nuclear fleet by up to 25%.



Control room at UP2 800 treatment plant, La Hague, France

Reprocessing in the UK has generated significant quantities of recyclable materials: the NDA is the owner of 50,000 tons of Heavy Metal (tHM): in addition UKAEA and MOD as well as BE have holdings or own significant amounts of re-useable materials (plutonium and uranium), which could be recycled as MOX (Mixed

Oxide U-Pu fuel) as well as Recycled/Reprocessed Uranium fuel. Some of it is already being recycled in this way. There would be significant savings in used fuel disposal volumes (by up to a factor of 4), toxicity (by a factor of 10), and costs.

Such recycling is technically and economically feasible, and has already been implemented successfully on an industrial scale in several countries in Europe and Japan.

The French experience over many years has demonstrated that reprocessing and recycling of used fuel (into MOX) can be managed both safely and efficiently: over 23,000 tons have been reprocessed at the AREVA La Hague reprocessing plant, and 1200 tHM of MOX fuel assemblies have been fabricated at the AREVA MELOX plant. Moreover EDF is currently recycling 350 tons of Uranium per year, recovered from reprocessing, and is planning to double this figure by 2009 (IAEA technical meeting, August 2007). If THORP were eventually to close down (an option which AREVA certainly does not advocate), solutions would still exist in France to reprocess UK materials.

It should also be noted that the UK plutonium stockpile represents a valuable energy resource in its own right, and as noted in the response to Question 7, transport of plutonium and MOX has been demonstrated to be safe. Two EPRs in the UK would be able safely to consume all this inventory of plutonium within their operating lifetimes.

Furthermore, this would decrease the security risks and needs for heavy physical protection measures involved with separated plutonium. The Royal Society Report of September 2007 on Strategy Options for the UK's Separated Plutonium states: "4.4. The most effective means of minimising the security risks associated with the

[plutonium] stockpile is to convert as much of it as possible into MOX fuel and then burn this in a thermal reactor to the spent fuel standard (US DoE 1996). In this form the plutonium is inaccessible for retrieval and weapons use."

15. Are there any other issues or information that you believe need to be considered before taking a decision on giving energy companies the option of investing in nuclear power stations? And why?

AREVA believes that, in order to meet essential climate and energy security challenges, decisions need to be taken urgently: in particular – a streamlined licensing/regulatory process, coherent electricity/carbon pricing, and industrial confidence in the stability of current and future energy policy.



EPR construction site (TVO), September 2007, Olkiluoto, Finland

If these decisions are taken, and implemented expeditiously, AREVA believes that the necessary investment in new nuclear power stations will proceed. However, if there are further delays or uncertainty, this could set back the whole investment process, risking UK's prime position within the international market, and thus falling behind the international demand for components and skills, and increasing the risk of a future UK energy gap.

This is a matter which will be of special significance for future employment in local communities, with relevant skills and generally supportive of nuclear power, in the vicinity of current civil nuclear installations.

16. In the context of tackling climate change and ensuring energy security, do you agree or disagree that it would be in the public interest to give energy companies the option of investing in new nuclear power stations?

AREVA agrees.

Current and future generations deserve the full range of available technologies to meet the challenges of climate change and security of supply. Nuclear power provides, and will continue to provide, a clean, affordable, safe and secure source of electricity baseload power generation.

17. Are there other conditions that you believe should be put in place before giving energy companies the option of investing in new nuclear power stations? (for example, restricting build to the vicinity of existing sites, or restricting build to approximately replacing the existing capacity)

AREVA believes that Government should not impose other conditions.

AREVA's view is that investors will commit to a nuclear replacement programme, if the outstanding issues (Question 15) are resolved in a timely manner.

18. Do you think these are the right facilitative actions to reduce the regulatory and planning risks associated with such investments? Are there any other measures that you think the Government should consider?

As regards the licensing process in the UK, AREVA thinks that it is important for the UK licensing authorities to draw on the existing, internationally recognized experience of licensing authorities in comparable countries, such as France and Finland, where new build is currently under construction.

There also should be open market conditions for new nuclear and energy technologies, including the up-dating of historic electricity grid rules to allow for the higher capacities of new power station designs.



EPR construction site (EDF), July 2007, Flamanville, France

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