GREATER LONDON AUTHORITY

BRIEF REPORT ON THE POTENTIAL IMPLICATIONS FOR NUCLEAR MATERIAL TRANSPORTATION ISSUES ACROSS LONDON IN ACCOUNT OF HM GOVERNMENT'S 2006 ENERGY REVIEW

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POTENTIAL IMPLICATIONS FOR NUCLEAR MATERIAL TRANSPORTATION ISSUES ACROSS LONDON IN ACCOUNT OF HM GOVERNMENT'S 2006 ENERGY REVIEW

SUMMARY

This brief review assesses the changes that may arise in the transportation of spent nuclear fuel and other radioactive materials through and around London from an interpretation of how the Government's 2006 Energy Review might be applied, particularly with regard to development of the existing and any new-build nuclear power stations located in the South East.

The policies and proposals of the 2006 Energy Review are neither a legal requirement or binding on any party. In effect, government has undertaken, subject to further consultation and changes of legislation, to provide an environment that it believes will be more conducive to the development of new nuclear power plants in the United Kingdom. Moreover, government assumes that if these changes are put in place then it follows that private developers and market forces will result in a nuclear power new-build programme being established and sustained in the United Kingdom over the next 20 or so years.

This review is based on the prognosis that government policy will result in a new series of *Generation III* nuclear power plants (NPPs) being built and commissioned over the next 20 to 25 years although, that said, the basis and outcome of the Energy Review has not itself been above criticism:

Energy Review and the Energy Gap: Some would argue that the government's Energy Review has concentrated primarily on the electricity generation sector, rather that taking a broader view of *energy* usage, demand and supply overall. Moreover, government's favouring of an expanded nuclear power programme could be considered to jeopardise further, sustained investment and development of renewable energy sources and, indeed, put at risk the promotion of energy efficiency.

This approach focusing on carbon emissions from electricity generating is at the expense of consideration of the heavy carbon emission contributions from transport and heating and, to a great extent, it ignores the savings yet to be fully realised by energy efficiency and conservation, particularly in building design and use – these are important elements that have been identified and incorporated into the Mayor's Energy Strategy for London.

The government's message via the Energy Review is that a programme of new-build NPPs would close the future electricity generation gap that it itself has identified, but it arrives at this somewhat skewed conclusion in the absence that much consideration of the overall energy situation in the UK. The supply and use of *energy* is more than just the generation of electricity so, with this major reservation in mind, the findings of the government's Energy Review as these might affect London are:

Scale of the New-Build: If the new-build NPP strategy of the government's Energy Review is followed through then, to achieve the internationally agreed carbon targets, 10 new-build NPPs will have to be constructed and commissioned in the UK by 2020-2025. With its strong and growing electricity demand, the South-East is likely to justify and attract at least 2 NPPs for completion early on in the new-build programme.

New-Build NPP Sites: It is judged that new-build NPPs will be preferentially sited at existing NPP sites. For the South-East Bradwell and Dungeness are prime sites because both are served by existing high capacity electricity distribution grid power lines, although Bradwell will need a degree of capacity upgrading of overhead transmission lines feeding to one or two of London's electricity network supply distribution points.

Time Scales to New-Build Operation: Assuming that government is able to provide an attractive investment environment, following one to two years establishing amendments to the town and country planning and nuclear safety statutory regimes, a new-build NPP could commence construction in or about 2008 for completion and commissioning by 2013-14 on the basis of a somewhat optimistic 5 to 6 year build-to-commissioning timescale.

Implications of Construction: Under construction at either Dungeness or Bradwell, a Generation III, pressurised water reactor NPP will be a very large civil engineering project that could have affect on London via its drain on human employment resources, construction materials and heavy use of London's road and rail transportation system. It might be argued that one sound reason for not commencing a new-build NPP in the South-East is that it could jeopardise progress of the 2012 Olympic construction programme at a crucial stage of its development, particularly because both of these prestigious projects would demand a high build quality and draw upon a limited labour and skills pool.

New-build NPP New and Spent Fuel Transportation Requirements: On the basis of an early development at either Dungeness or Bradwell, or both, new fuel movements to and possibly spent fuel movements from the new-build operational NPP(s) would commence in around 2013 to 2018 respectively:

a) Generation III NPPs will be suitable for plutonium-based mixed oxide (MOX) fuelling which, even as fresh unirradiated fuel, requires special controls for security and containment to prevent a radioactive release with potentially severe radiological consequences. MOX shipments would more than probably be by rail with fuel being delivered from the Sellafield MOX Plant (SMP) via the through-London rail routes that serve for the present consignments of spent fuel to Sellafield. Alternatively, MOX fuel might be sourced from the French plant at Marcoule for delivery via cross channel ship or directly via the Channel Tunnel.

b) Once a new-build NPP is fully operational, there are a number of options for the 40 tonnes or so of spent fuel removed from each NPP reactor core each year:

   i) The spent fuel could remain in storage at the NPP site for the projected 60 to 65 year service life of the plant for eventual disposal to a national or regional repository which is likely to commence receipt of spent fuel in or following 2035;

   ii) following about 5 years of on-site cooling, batches of spent fuel could be consigned to Sellafield in Cumbria for reprocessing using existing rail routes through London – this would involve about 12 to 15 flask movements annually for each new-build NPP; and

   iii) it is possible that, particularly if operated by the French based company EdF in arrangement with AREVA, the spent fuel could be exported to the French reprocessing facility at la Hague near Cherbourg, involving routing the flasks by rail to Dover or a similar UK port then to Cherbourg France, Alternatively, the spent fuel could be moved by rail to France by rail via the Channel Tunnel.

   iv) Other new-build NPPs located to the North or West of the United Kingdom might also move their spent fuel via Dover or the Channel Tunnel with this involving rail movement through or around London.

Existing NPP Spent Fuel Movements: There are existing nuclear power plants located at Bradwell in Essex, Dungeness in Kent, and Sizewell in Suffolk, that currently move spent fuel through London.

Spent fuel movements from the shut down Magnox NPP at Bradwell should be completed by the close of 2006. Spent fuel dispatches from the Magnox NPPs at Sizewell and Dungeness are expected to continue to about 2010-12, that is about four years following cessation of electricity generation from each NPP, and AGR fuel from Dungeness B NPP is scheduled to continue to about 2023 or thereabouts. The future commitment of the spent fuel from the single reactor NPP at Sizewell B has yet to be determined and all of the spent fuel (about 2,000 tonnes in total) is likely to remain in storage at this NPP site until 2030 or later.

Operational & Decommissioning Waste Transfers: The government's Energy Review also deals with the radioactive waste legacy from the past and present generations of NPPs and from other nuclear activities, including nuclear fuel reprocessing at Sellafield, the industrial-military activities of Britain's nuclear weapon programme from the late 1940s, and the manufacture and post-use management of radioisotopes, and radioactive sources used in medicine, engineering, research and development applications.

The government appointed committee (CoRWM) that recently considered the issues of present and future stockpiles of radioactive waste recommended adoption of a *'phased disposal'* strategy involving a period of i) *interim storage* followed by ii) permanent disposal to a *deep geological repository*. The earliest possible date for the completion of a deep repository (although a site for this has yet to be determined) is unlikely to be ahead of 2030 thus requiring radioactive waste and spent fuel not destined for reprocessing to be held either at the NPPs and other source localities, or moved and held in a specially constructed interim store. Until the interim storage facility is built then stockpiles of past, present and future radioactive waste arisings, except limited volumes of low-level waste, have to remain at the source sites including the existing and any new-build NPPs.

Implementation of the recommended phased disposal strategy at some future time has a number of implications for London which, on timing:

c) Logistically an interim storage facility will have to be located at or nearby the site of the national deep repository so, only when the repository siting decision is made can construction of an interim store be expected to commence - to reach this go-ahead stage might take three to five years. Until the interim store is commissioned (about 5 to 7 years from its go-ahead date) stockpiles of past and present NPP operating radioactive wastes will have to be retained at the NPP and other source localities.

d) If the final location of the interim store and deep repository (assuming both share a common site) is to the North or North-West of London then only radioactive waste movements from NPP sites to the South and to the East (Dungeness, Bradwell and, possibly, Sizewell) will dispatch radioactive waste through or around London. If the final repository location is to the South of London, which is considered most unlikely, then much large volumes of radioactive waste from the NPPs and other nuclear facilities to the North may travel through or around London.

As well as spent nuclear fuel, each NPP produces *operational* radioactive wastes in the form of used filters, resins and similar clean-up substances, and scrap and worn out components. Of these operational wastes, a proportion of the lower (radio)activity category wastes (Low-Level Waste or LLW) has been transferred (usually by road) to a disposal dump at Drigg, Cumbria. Since 1982-3 when the sea-dumping disposal route was closed, the higher activity intermediate level waste (ILW) has been retained in storage at each NPP site.

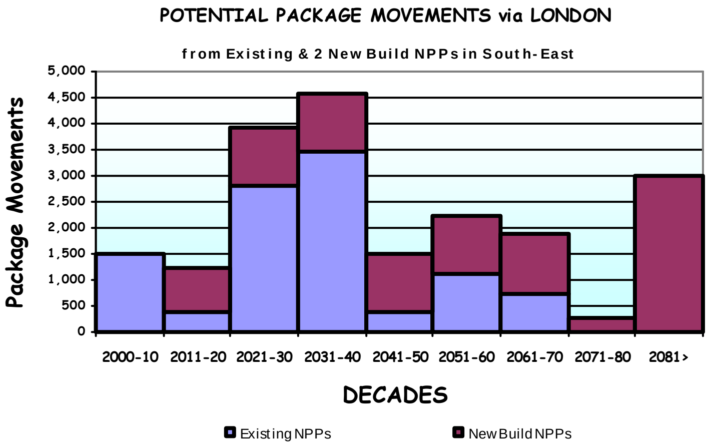
e) Until and depending on how government implements the recommendations of CoRWM, the shortest time before stockpiled *operational* radioactive wastes can be transferred from the existing and possibly new-build NPPs at Sizewell, Bradwell and Dungeness is likely to be at least 10 to 15 years hence.

f) Decommissioning of the existing NPPs will generate very large volumes of radioactive waste, about 25,000 to 30,000 cubic meters from each of the Magnox NPPs at Bradwell, Sizewell and Dungeness, about the same again for the two reactors of the Dungeness AGR NPP, and upwards of 11,000 cubic meters from the single Sizewell PWR reactor (see TABLE A of main text).

g) The greater part of decommissioning wastes arise during the final stages of dismantling which, for the Magnox NPPs at Bradwell, Dungeness and Sizewell, commences in earnest around 2020-25 taking thereafter about 10 to 5 years to complete. At this time it is not clear if these decommissioning wastes will be held at the respective NPP sites or transported to a central or regional storage facility in advance of the siting decision for a national radioactive waste disposal repository.

h) Once again, siting of the repository has a significant affect on London. A national repository site to the North or North-West could result in the decommissioning volumes from Bradwell, Dungeness and, possibly, Sizewell NPPs being moved through or around London. Siting the repository to the South of London could result in very much larger volumes of decommissioning wastes from the existing NPPs and other nuclear facilities to the North passing through or around London.

TABLE B (main text) summarises the volumes and, separately, the number of freight packages of low and intermediate level radioactive waste and spent fuel movements through or around London projected for the present and future NPP programme on the assumption that a national radioactive waste repository will be sited to the North. In terms of individual packages of new and spent fuel and radioactive wastes requiring transit through or around London the projection for the NPP programme alone is as follows:



In conclusion: The government's 2006 Energy Review raises a number of issues relating to the transportation of spent fuel and other nuclear materials through and around London. If the government's energy strategy of the Energy Review succeeds then it is likely that at least one new-build NPP will be sited in the South-East very early in the new-build programme, most likely followed by a second NPP within a year or so. It follows that a number of new nuclear transportation activities will take place in support of these NPPs and to clear the very large volumes of radioactive waste from dismantling the shut down reactors of the existing generation of NPPs. These new activities, particularly the possible delivery of MOX fuel to the new-build NPPs and the movement of very large volumes of decommissioning wastes from existing NPPs, along routes through or around London will impose a level of additional radiation exposure and, in the event of an untoward incident, present an additional risk of intolerable levels of health injury to members of public who live and/or work alongside the roads or rail track.

In these ways the impact of the government's Energy Review will reach into the lives of Londoners, particularly via the transportation of nuclear materials. It may be appropriate to seek to have these transportation activities scrutinised by the justification process in advance of the new-build NPP development planning process.

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LOCATION OF MAJOR SITES OF NUCLEAR MATERIALS AND RADWASTE IN THE UNITED KINGDOM

TABLE A EXISTING SITES & NUCLEAR FACILITIES LIKELY TO INVOLVE RAIL TRANSPORTATION THROUGH OR AROUND LONDON

ASSUMES WASTE STORE/REPOSITORY AVAILABLE TO RECEIVE RADWASTE NORTH OF LONDON

			CONDITIONED[a] RADWASTE VOLUME AT 2020[b] m^3 (N° of Packages)		
LOCATION	**OPERATION**	**COMMENTS**	**LLW**	**ILW**	**HLW SPENT FUEL**
SIZEWELL	**OPERATIONAL MAGNOX**	Current Spent Fuel Transportation including defuel to, say, 2012 Decommissioning and Operational Wastes Transportation from, say, 2020	29,900 (1,690)	4,400 (477)	~1,000 fuel flasks over 40 years
	OPERATIONAL PWR	Spent Fuel Transportation, say, commencing 2030 or earlier Decommissioning and Operational Wastes from, say, 2050	10,300 (601)	892 (897)	~700 fuel flasks at some future time (say 2030+)
BRADWELL	**SHUT DOWN MAGNOX**	Presently Spent Fuel Defuelling to 2006-7 Decommissioning and Operational Wastes Transportation from, say, 2020	31,200 (1,770)	4,270 (698)	~800 fuel flasks over 40 years
DUNGENESS	**OPERATIONAL MAGNOX**	Current Spent Fuel Transportation including defuel to, say, 2012 Decommissioning and Operational Wastes Transportation from, say, 2020	34,700 (1,970)	4,110 (583)	~1,000 fuel flasks over 40 years
	OPERATIONAL AGR	Current Spent Fuel Transportation including defuel to, say, 2024 Decommissioning and Operational Wastes Transportation from, say, 2040	12,900 (734)	3,900 (371)	~1,400 fuel flasks over 35years
FORT HALSTEAD	**WEAPONS LABORATORY**	Operational, Experimental and Decommissioning RadWastes when Store/Repository available	22 (47)	0.5 (8)	-
CHATHAM	**PREVIOUS REFUEL/REFIT DOCKYARD**	Although closed down in 1983, Chatham Dockyard is believed to retain some RadWaste in storage from the nuclear powered submarine programme.	–	–	–
PORTSMOUTH	**RADIOISOTOPES FROM WARSHIPS**	Possibly excludes decommissioning wastes.	23 (2)	0.2 (1)	-
ALDERMASTON BURGHFIELD	**WEAPONS LABORATORY**	Operational, Experimental and Decommissioning RadWastes when Store/Repository available which may be routed through or around London – decommissioning wastes continue to be generated until 2060 – ILW package numbers high because of plutonium contaminated content of waste	382,000 (24,500)	7,380 (14,400)	(could be fuel from weapons development reactor Viper)
AMERSHAM INTERNATIONAL (GE HEALTHCARE LTD)	**COMMERCIAL RADIOISOTOPE PRODUCTION**	Possibly excludes decommissioning wastes.	11,500 (736)	570 (924)	(could be HLW target material)
		TOTALS[c]	**522,500m³ 32,000 packages**	**25,500 m³ 18,400 packages**	**~4,900 flasks**

a *'As Stored'* waste volumes are prior to processing, compaction, packaging and shielding – Packaging assumed to be undertaken at operation/dismantling site that that the single package is the transport unit – data taken from the *2004 United Kingdom Radioactive Waste Inventory*, DEFRA-NIREX, Electrowatt-Ekono, 2005.

b Final date of transfer from site to waste repository not fixed and could be much later than 2020.

c The totals of radwaste volume and packages should be treated with great caution because final quantities have yet to be determined, some source locations may not transport through or around London by either road or rail, wastes may be disposed of on site, decommissioning may be delayed for 100 or more years following shutdown – the number of **packages** generated provides an indication although not an absolute number of freight movements (rail wagons or lorry loads).

TABLE B PROJECTED FLASK AND PACKAGE MOVEMENTS THROUGH OR AROUND LONDON – EXISTING AND BRADWELL AND DUNGENESS NEW-BUILD NPPS

TASK/YEAR		2000-10	2011-20	2021-30[a]	2031-40	2041-50	2051-60	2061-70	2071-80	2081>	
		N° OF FLASKS/PACKAGES[f]									
BRADWELL	Spent Fuel	300 (to 2006-7)									
MAGNOX	Decommissioning[b]			2,500							
BRADWELL	Spent Fuel		140	280	280	280	280	280	140		Spent fuel reprocessed[d]
NEW-BUILD	New MOX Fuel		280	280	280	280	280	280			Assumes a 60 year operating life
	Decommissioning									1,500	
DUNGENESS	Spent Fuel	400									
MAGNOX	Decommissioning			1,300	1,300						
DUNGENESS	Spent Fuel	400	400	400							
AGR	Decommissioning				370	370	370				
DUNGENESS	Spent Fuel		140	280	280	280	280	280	140		Spent fuel reprocessed[d]
NEW-BUILD	New MOX Fuel		280	280	280	280	280	280			
	Decommissioning									1,500	
SIZEWELL	Spent Fuel	400									
MAGNOX	Decommissioning			1,100	1,100						
SIZEWELL	Spent Fuel				700						Spent fuel stored at NPP[c]
PWR	Decommissioning						750	750			
NPP TOTALS PER DECADE		**1,500**	**400 - 840**	**2,800 – 1,120**	**3,470 – 1,120**	**370 – 1,120**	**1,120 – 1,120**	**750 – 1,120**	**280**	**3,000**	
FORT HALSTEAD				55							
PORTSMOUTH				3							
ALDERMASTON/BURGHFIELD[g]				10,000	10,000	10,000	10,000				
AMERSHAM				750	750						
OTHER TOTALS PER DECADE		**0**	**-**	**10,820**	**10,750**	**10,000**	**10,000**				
OVERALL TOTALS PER DECADE		**1,500**	**400 - 840**	**13,620 – 1,120**	**24,220 – 1,120**	**10,370 – 1,120**	**11,120 – 1,120**	**750 – 1,120**	**280**	**3,000**	

a Assumes regional or national interim store/repository will not be available until about 2030.

b Decommissioning of NPPs assumed over 25 years, waste transportation shown here to be equally dispersed over two decades but likely to be larger number of movements in second decade when reactor internals dismantling underway.

c Presently Sizewell B spent fuel is not contracted for reprocessing and so remains in store at the station site – the fuel is assumed to be transported from Sizewell early on in the decommissioning period (about 2035-40).

d Both new-build NPPs are assumed to have contracted the spent fuel for reprocessing at an early stage.

f See note c of TABLE A for caution over interpretation of the tabulated data.

g The routing of Aldermaston/Burghfield decommissioning wastes, like all other nuclear sites, has not been determined – there is a possibility that these wastes could be routed through or around London at some time in the future.

POTENTIAL IMPLICATIONS FOR NUCLEAR MATERIAL TRANSPORTATION ISSUES ACROSS LONDON IN ACCOUNT OF HM GOVERNMENT'S 2006 ENERGY REVIEW

HM GOVERNMENT ENERGY REVIEW

A not unreasonable interpretation of the Government's recently published Energy Review[1] is that an expansion of nuclear power in the UK is to be encouraged. The government argues that nuclear power has a role to play in the future UK mix alongside other low carbon and carbon-free means of generation.

Government policy is that any new nuclear power plant (NPP) would be proposed, developed, constructed, and operated by the private sector. The private sector would also meet the full NPP decommissioning costs and its share of the long-term waste management costs.

PRESENT AND PAST NUCLEAR ACTIVITIES

The UK's present and past nuclear programme comprises:

a) Operational NPPs
b) Shut down NPPs awaiting decommissioning
c) Radioactive Waste Legacy
d) Ministry of Defence Nuclear Facilities
e) Commercial and Medical Radioisotopic Materials
f) Other nuclear and radioactive facilities

It is quite clear from the 2003 Energy White Paper that resolving the nuclear waste legacy issue is to be prioritised via the funding of the Nuclear Decommissioning Authority (NDA) which is charged with setting a UK-wide strategy for more effective decommissioning and clean up of existing nuclear sites. Thus the expectation is that, running parallel with the government's encouragement of new-build NPPs, the radioactive waste arisings from past nuclear power, nuclear fuel cycle and other nuclear activities (hospitals, research, etc) will be addressed by moving forward on the construction and operation of a national interim radioactive waste store and, possibly, the development of a disposal repository.

The past and present programme of nuclear power stations is likely to relate to London in the following ways:

TABLE 1 PAST & PRESENT NPP ACTIVITIES - ASPECTS RELATING TO LONDON (SEE MAP)

a) NPPs	Present operational nuclear power plants that have a direct bearing on transportation of nuclear materials through London, by both rail and road, are the Magnox and AGR NPPs Dungeness in Kent (4 operating reactors) and Magnox and PWR Sizewell in Suffolk (3 operating reactors). Radioactive waste arisings from operation of NPPs are relatively small and, other than some volumes of very low- and low-level waste which is transported by road to Drigg in Cumbria, operational wastes remain at the NPP sites in temporary storage. For continued operation, the NPPs receive regular consignments of fresh, unirradiated uranium fuel (usually by road) with fuel for both Dungeness Magnox and AGR NPPs travelling by road from Springfields (near Preston, Lancashire) through or (more likely) around London on the orbital motorway.

1 *Energy Review*, HM Department of Trade and Industry, July 2006

b) NPPs Shut Down	The Magnox plant at Bradwell (2 reactors), shut down and presently defuelling, is scheduled for dismantling through the next 25 years according to NDA policy targets. The presently operational Magnox plants at Dungeness and Sizewell are scheduled to shut down over the next 2 or so years. The two AGRs at Dungeness are to operate until 2018 or thereabouts and the single PWR at Sizewell will operate to about 2035.
c) NPP Decomm'g RadWaste Legacy	Generally, low- and intermediate-level category wastes transported in IAEA TYPE A packages[2] by road and/or rail with the bulk of this traffic not likely to commence until a national or regional repository has been developed (2025 or later), these and *'exceptional'* transport consignments will be subject to REPPIR with the *'carrier'* responsible for compliance with the regulations.[3,4] i) Each Decommissioning Magnox NPP (2 reactors) will yield approximately 30,000^{+}m^{3} unconditioned and unshielded radioactive waste, comprised low- and intermediate-level (LLW and LLW),[5] from a) stored operational wastes arisings and b) decommissioning irradiated and contaminated materials.[6] Decommissioning scheduled to occur over 25 years from reactor shut down, although this may be subject to revision, so radioactive waste transits from each NPP will be phased (unevenly) over two decades or more. Depending on the location of the final national repository or regional radioactive waste repositories, transportation will be by a combination of rail and road. Some operational and decommissioning waste forms are not only radiologically hazardous but also unstable and or chemo-toxic, particularly flammability (pyrophoric ion-exchange resins), magnesium alloy sludges from fuel splitterings, etc.. For Dungeness and Bradwell, and possibly Sizewell A,[7] decommissioning wastes would be most likely carried through London on the rail system. However, such large scale movements of radioactive material are unlikely to commence until a national or regional radioactive waste disposal repository or interim term storage facility has been identified and commissioned. The general assumption is that the common interim storage and repository site will be located well North or to the North-West of London so only those rail and road links from Dungeness and Bradwell, and possibly Sizewell, will affect London. Of course, if the storage/repository site is to the South of London then the potential traffic of radioactive wastes through and/or around London could be much higher.

As well as the radioactive wastes arising from the existing nuclear power stations, the radioactive wastes from commercial, research and development, and military-industrial applications may relate to London as follows:

2 IAEA 1996 Regulations, TS-R-1 – see also *Regulations for the Safe Transport of Radioactive Material, Safety Standards Series* No ST-l Requirements, Edition, Vienna (1996) and there is an accompanying plethora of regulations and statutes relating to the transportation of Category II materials in addition to the IAEA regulations (ST 1, TS-R-1 and INFCIRC/225) for the safe transport and physical protection of radioactive materials. Referring to the IAEA 1996 Regulations approvals and compliance is required for Multilateral Shipment Approval (IAEA 820) and fissile packages (IAEA 566), special use vessels (IAEA 566), details of the proposed route, controls and shipment period (IAEA 822), flooding (IAEA 671), etc

3 *The Radiation (Emergency Preparedness and Public Information) Regulations* (REPPIR) are intended to implement articles 48 to 52 on intervention in cases of radiation emergency in a European Council Directive on the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (Euratom BSS96 Directive).

4 As specified by *Regulation 17* of REPPIR the Local Authority (in London the LCDFA) is responsible for informing members of the public in advance of and in the aftermath of any radiological incident although, that said, how this is practicably implemented over London with its flexible road and rail routing systems is difficult to foresee.

5 Caution should be applied when referring to LLW and ILW categories of waste in the context of potential radiological impact resulting from a transportation incident – this is because these categories are defined in terms of specific (radio)activity and not radiotoxicity.

6 DEFRA/NIREX *United Kingdom National Radioactive Waste Inventory*, biennially published, DEFRA-Electrowatt - Large volumes of moderator graphite (approximately 2,000m3), irradiated reactor vessel and structural steelwork (1,500t) and irradiated concrete dusts (2,500t), and various CRUDs are generated for each reactor during the decommissioning and decontamination processes.

7 For this discussion on the eventual disposal of decommissioning wastes it is assumed that any regional or national radioactive waste interim store and/or disposal repository will be located to the North or West of London so the larger volumes of decommissioning wastes are likely to be routed directly East-West or to the North from Sizewell rather than rerouting through London.

TABLE 2 OTHER NUCLEAR ACTIVITIES - ASPECTS RELATING TO LONDON (SEE MAP)

a) Other Nuclear Activities - RadWaste Legacy	Generally, low- and intermediate-level category wastes transported in IAEA TYPE A packages[8] by road and/or rail with the bulk of this traffic not likely to commence until a national or regional repository has been developed (2025 or later), these and *'exceptional'* transport consignments will be subject to REPPIR with the *'carrier'* responsible for compliance with the regulations.[9,10] In addition, various sources of radioactive wastes, some possibly yet to be discovered, such as commercial radium-zinc luminising works, depleted industrial and research radioisotopic sealed source terms, hospital wastes, etc., will require decontamination and movement of the waste arisings (mostly by road as exampled by past practice).
b) Ministry of Defence	There are a number of operational and closed down MoD sites that have radioactive materials extant either in storage and/or as contaminated waste, land, sub-soils etc. For a number of reasons the MoD has never been able to make a very accurate assessment of the amount of radioactively contaminated land in its ownership. In the quantifiable terms that are possible, however, it is thought to be a fairly minor problem – there are *'some tens'* of radioactively contaminated sites compared to *'some hundreds'* of all contaminated sites, according to MoD estimates.[11] Operational sites in the South-East in include Fort Halstead, Orpington in Kent, the Ranges on the Romney Marsh Site, clearances at Ashford in Kent, Chatham Dockyard may retain some radioactive wastes from its Naval Dockyard period when it serviced and refuelled nuclear powered submarines and as a port dispatching radioactive waste consignments for dumping in the Atlantic (prior to 1983), and there are known contaminated sites at Woolwich, Datchet-Slough and elsewhere in the South-East that may have been completely or partially decontaminated in recent years. Nuclear weapons manufacturing and assembly sites at Aldermaston and Burghfield have considerable volumes of radioactive wastes and building/facilities waiting decommissioning, both $\beta\gamma$ and α waste stocks and contamination, and some remaining wastes may be at the Woolwich AWRE Ha Ha Road site.
c) Commercial Sites	Numerous, including hospitals, industry and research establishments.

SUMMARY OF TABLES 1 & 2

Irradiated Fuel: Existing rail transport routes through and around London will continue to serve for the transportation of irradiated or spent fuel from the operational and defuelling NPPs at Sizewell, Bradwell and Dungeness. Once that Bradwell has been completely defuelled (by or about 2006-7) and Dungeness and Sizewell A Magnox NPPs have closed and defuelled (by about 2010-12), then fuel movements will be limited to dispatch from the AGR NPP at Dungeness.

Sizewell B: Although the present arrangement is for the irradiated fuel from Sizewell B NPP is to remain in storage in the cooling pond, this fuel could be committed at some future stage to movement for reprocessing or post-irradiated conditioning at Sellafield. The amount of spent fuel for eventual movement from Sizewell B will have, over the scheduled 40 years operational life (2035), accumulated to about 2,500t requiring about 600 to 800 individual flask movements to clear the NPP storage ponds. If a decision to move the spent fuel is made earlier then a pro rata amount will be transported from that time.

Spent Fuel Transport Mode: Apart from some short haul road transits from the NPP to the railhead, practicably all spent fuel movement will be via the public rail network in IAEA Type B compliant flasks.

NPP Operational & Decommissioning RadWaste Arisings: In the absence of any regional or national radioactive waste management, storage and/or disposal facilities, all radioactive waste arisings from past and future operation,[12] together with decommissioning and dismantling arisings, will remain on site until alternative storage and/or disposal facilities are available and operational (maybe by 2035).

8 IAEA 1996 Regulations, TS-R-1 – see also *Regulations for the Safe Transport of Radioactive Material, Safety Standards Series* No ST-l Requirements, Edition, Vienna (1996) and there is an accompanying plethora of regulations and statutes relating to the transportation of Category II materials in addition to the IAEA regulations (ST 1, TS-R-1 and INFCIRC/225) for the safe transport and physical protection of radioactive materials. Referring to the IAEA 1996 Regulations approvals and compliance is required for Multilateral Shipment Approval (IAEA 820) and fissile packages (IAEA 566), special use vessels (IAEA 566), details of the proposed route, controls and shipment period (IAEA 822), flooding (IAEA 671), etc

9 *The Radiation (Emergency Preparedness and Public Information) Regulations* (REPPIR) are intended to implement articles 48 to 52 on intervention in cases of radiation emergency in a European Council Directive on the basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (Euratom BSS96 Directive).

10 As specified by *Regulation 17* of REPPIR the Local Authority (in London the LCDFA) is responsible for informing members of the public in advance of and in the aftermath of any radiological incident although, that said, how this is practicably implemented over London with its flexible road and rail routing systems is difficult to foresee.

11 Radioactive Waste Management Advisory Committee (RWMAC), *MoD Radioactive Facilities and Sites,* 1996

12 Some past operational wastes were sea dumped up until 1983 and some low-level category waste has been transferred to Drigg by road, although this facility is now at capacity and limiting its receipt from the NPPs.

RadWaste Legacy & Other RadWaste Arisings: As above with no substantial movements of radioactive waste and other nuclear materials expected to occur until regional and/or national radioactive waste facilities are available and operational.

Vitrified HLW & Plutonium: The British Nuclear Group, now contracted to the NDA, has production facilities to vitrify the high-level radioactive wastes arisings from reprocessing fuels at Sellafield. For fuel reprocessing contracts agree post-1976 with overseas customers this waste, plus a substituted equivalent amount in account of the low and intermediate-level waste yielded in reprocessing, will be returned to the overseas customer. Similarly, the plutonium yield (in the form of plutonium dioxide) will be returned to certain overseas customers.

In the past, vitrified HLW and plutonium consignments have exported by ship embarking from Barrow in Furness. However, although *Category II* and *I* materials respectively,[13] there is no reason why either or both consignment types destined for Europe could not be moved by rail to a South-East port or via the Channel Tunnel, passing through or around London – other than the need for a security assessment (which may have already been undertaken), this mode of transport could be adopted without any substantial delay and, indeed, without prior notification.[14]

RADIOACTIVE WASTE LEGACY

Recently, the Committee on Radioactive Waste Management (CoRWM) which has been addressing the radioactive waste policy issue since its inception in 2003 published its final recommendations that, in principle, endorsed what it termed *'staged disposal'*, comprising interim term storage to complete post-institutional care disposal, at a centrally located national radioactive waste facility.

TABLE 3) RADIOACTIVE WASTE LEGACY - ASPECTS RELATING TO LONDON

a) CoRWM	The expectation is that CoRWM's final recommendations will not move that much beyond the staged disposal outlined in its draft recommendations published in April 2006.[15] The main features of this are likely to be an institutional management period of storage, probably above ground, followed by a phased move to post-institutional disposal to a deep repository – the interim storage period might be in terms of tens of years up to 300 or so years. Storage and disposal sites could be at entirely different locations: Storage might be retained at the site of radwaste generation, ie the NPPs, or be located regionally, whereas it more likely that there will be a single disposal repository at a site location yet to be determined. Time scales to have an interim storage system in place are 10 to 15 years and for an operational disposal repository 25 to 30 years.
b) NDA	Present budget allocation to the NDA for cleaning up the radioactive waste legacy and arisings from *past and current* nuclear activities is £70B, some of which the NDA is expected to fund from income from the remaining generational life of the Magnox NPPs (namely Wylfa and Oldbury), together with income from reprocessing of Magnox and mostly uranium dioxide AGR and light water reactor (PWR and BWR) irradiated fuels via THORP at Sellafield. The costs of decommissioning the 7 AGR NPPs and the single PWR at Sizewell are not presently within the NDA's remit, being with the financially troubled commercial operator British Energy.

13 International Atomic Energy Agency, The Physical Protection of Nuclear Material and Nuclear Facilities, IAEA INFCIRC/225 Rev b

14 *Nuclear Industries Security Regulations 2003*.

15 Now published (July 2006).

SUMMARY OF TABLE 3

TIME FRAMES

Radioactive Waste: The UK radioactive waste policy and strategy are in a state of flux at this time, although practicalities suggest that little will be done in terms of a need to move the operational and decommissioning wastes of the NPPs and other radwaste from the production sites for at least 10 to 15 years.

Unirradiated (Fresh) Nuclear Fuel: So long as a NPP continues in operation, fresh supplies of nuclear fuel will be delivered (most likely) by road – for London Dungeness B NPP will continue to receive new fuel until its closure in or about 2015.

Vitrified Waste & Plutonium: Movements of vitrified high level waste and, separately, plutonium from the reprocessing of overseas spent fuel at Sellafield, although currently moved from Barrow docks could be transferred to rail movement to a South-East port or export via the Channel Tunnel.

NPP NEW-BUILD PROGRAMME – CAPACITY AND SITING

Present Generation Mix: The present (2005) UK electricity demand varies over summer and winter months from a summer minimum of about 20GW to a peak winter demand of 50GW. To meet this demand, including for coverage of plant maintenance outages and making up in the event of a sudden loss of generating plants, the present UK installed capacity is about 78.5GW.

FIGURE 1 shows this installed capacity to comprise a generation mix of coal and gas fossil fuels dominating over all other generators at about 35% each of the total installed capacity. The existing nuclear plants, Magnox, AGRs and one PWR at Sizewell B, contribute about 20% or 74TWh.[16]

Future UK Electricity Demand: The peak winter demand is expected to steadily rise to at least 70GW by 2020. To meet this increased demand and replace current plant retirements (about 40 to 50GW in itself), a total new-build electricity generating requirement (fossil, renewables and nuclear mix) is forecast at 25GW[17] over the next two decades (at 2020). This is about 30% greater than the present electricity generation capacity or a projected increase in demand equivalent to 405TWh total generation.

Future Generation Mix: There are a number factors that will influence the composition of the future (2020) generation mix. These have been or are to be determined by the carbon abatement targets, fuel diversity, changing and limitations of the respective generation technologies involved.

For example, existing coal-fired stations, unless carbon emission abatement technology is retro-fitted, will close under EU environmental legislation[18] and unit generating costs by sometime following 2012 and certainly by 2015 which, with the coincidental end-of-service life closure of the AGR series of

FIGURE 1 2005 ELECTRICITY GENERATION MIX
Total 370TWh - 78.5GWe Installed

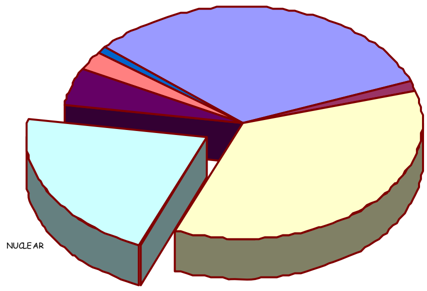
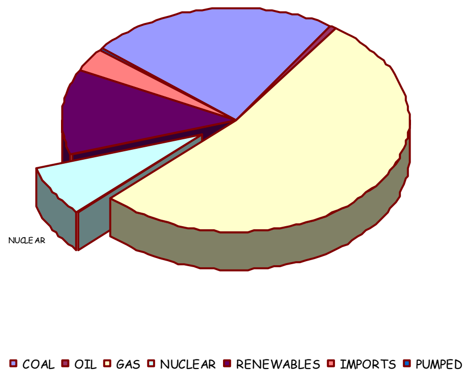


FIGURE 2 2020 ELECTRICITY GENERATION MIX
Total 405TWh



16 Actual breakdown of electricity generation mix for 2005 is Coal 34%, Oil 1%, Gas 37%, Nuclear 20%, Renewables 5%, Others 3%.

17 Prefixes used in the text are G – Giga = 109 T – Tera = 1012

18 EU Emissions Trading Scheme - EU ETS.

NPPs at around that time will,[19] it is claimed by government, stretch UK electricity generating resources.

According to the government's latest projections[20] if current market forces are allowed to play through then many of the closing existing coal and nuclear power stations would be replaced by gas-fired stations together with an increased proportion of renewables contributing to the generation mix. This outcome, as shown by FIGURE 2, is considered to be undesirable by government in that gas-fire generation element would increase from the present 37% to about 55% in 2020. This, government considers, would be an unwelcome dominance of gas at a time when the UK will be a net importer of gas.

Role of Wind Renewable Energy: In the 2006 Energy Review, government argues, some would consider quite persuasively, that the role of renewable generation in the low-carbon element of the generation mix is quite specific, it being not practicable to replace MW_e of fossil with MW_e renewable installed capacity on a pro rata basis. This is because renewable generation cannot be expected to reliably contribute to (ie be available when needed) and bolster system security whereas base load plants, such as NPPs, and particularly rapid load take-up (two-shifting) gas-fired plants could be available for this. Indeed, as the renewable generation element increases to a level of installed capacity exceeding, some estimate, 10 to 15% proportion of the total mix, it will not be possible for all renewable and conventional generation to operate simultaneously.[21,22]

The 2006 Energy Review adopts and carries through renewables strategy of the earlier government 2003 White Paper.[23,24] The 2003 White Paper at that time then predicted the disappearance of most of the conventional coal-fired generating capacity and a run down of nuclear generation, both offset by a huge expansion of gas-fired capacity and renewable energy. Government then assumed that renewables, of which the by far the greatest component is on- and off-shore wind generation,[25] could contribute up to ~25GW (or 42GW) to the UK distribution grid although, arguably, this is fundamentally wrong[26] and now acknowledged not to be at all feasible.[27,28,22,29]

Reference to the established Danish and German national wind turbine systems show that balancing the availability to meet demand can be most acute on a stormy summer day when demand is low but

19 By 2020 and unless there are new-build NPPs, all UK NPPs except Sizewell B will have closed or be near to impending closure by 2020, see Large J H, *Analysis of British Energy's Submission to the Energy Review: Part 1 Advanced Reactor Programme, Wastes and Irradiated Fuel Arisings, Part II The Westinghouse AP 600/1000 Nuclear Safety Case,* Review by the European Commission, Greenpeace UK July 2002

20 Appendix C, Energy Review 2006

21 In other words, it is the conventional fossil-fuelled plants that will increasingly adopt a regulating role, operating when the availability of renewable energy is low and reducing its output to accommodate increases in output of renewable generators, leaving an underlying and unchanged capacity of NPPs to satisfy the base load. All very well argued and rational but, some might counter, such an ordered system not readily obtainable and sustainable under free market conditions.

22 Sharman H, *UK Wind Power*, Proc ICivE, V158, I4 November 2005

23 However, the basis of the 2003 White Paper reasoning failed to recognise that the only near-commercial, renewable energy source that could be immediately developed on a large scale is wind energy but that, with its inherently stochastic intermittency, it would not be feasible to depend on this renewable source of carbon-free generation alone to meet the carbon targets.

24 Our Energy Future – Creating a Low-Carbon Economy, White Paper, HMSO 2003

25 There is, at this time and within the interim future, no firm prospect of alternative forms of renewable energy being developed and applied in the UK – schemes such as the proposed Severn Barrage will obviously contribute but not that significantly to the UK's generation mix.

26 The government's present targets for the renewables contribution to the generation mix is 10% by 2010 and 20% by 2020 of which, based on the government's own projection of the total electricity demand of ~405TWh (FIGURE 2) for 2020, about 100TWh would have to be by renewables - if nuclear power generation is excluded from this 'carbon-free' generation element, then most of this would be wind turbine developments which, at 30% load factor, requires 42GW of installed wind turbines which, again it may be argued, is just not feasible. The government's lower 25GW figure is based on a wind turbine load factor of 40%+ which is considered to be unrealistic for the UK as a whole.

27 Installing and operating such a large proportion of wind renewables within the UK grid distribution system is not feasible for a number of reasons, including:

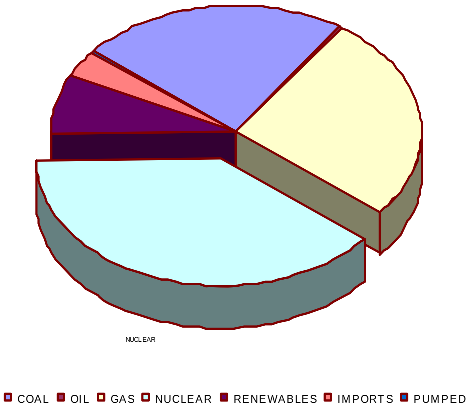
- **Supply-Demand Balancing:** The inability of the grid control to anticipate the power available27 because of the sensitivity of wind turbine output to wind speed which, for next day forecasting, is with a range of 25% to 70% of the availability at the mid-operating range of the turbine (about 45% at 9m/s).
- **Transmission Losses:** Most of the wind resources of the UK are in the North-West and, to date, this is where the majority of the wind turbines have been erected in that region. However, the centre of the UK electricity demand is to the south, about mid-way between Birmingham and London with this transmission distance entailing considerable energy losses (of around 10 to 15%). In fact, wind turbine developers are safeguarded against this loss because wind generators are paid at the site fence, so for about two-thirds of all the UK planned wind development being planned for Scotland the transmission losses are significant.
- **England and Wales Capacity:** In fact there is too much wind power presently under development in Scotland (about 7.5GW) which will only be able to absorb about 2 to 3GW of wind so to meet the government's carbon-free generation target the by far larger component of wind generation will have to be installed in England and Wales. The problem here is that the load factor for England and Wales, say an aggregate between equal development of on- and off-shore wind sites, will be no greater than 27% which takes into account development in low wind areas like the Wash and the Thames estuary.

28 The basic facts are that 42GW of installed wind capacity will require (42,000/3=) 14,000 individual turbine each of 3MW capacity which placed at 500m centres would occupy a wind carpet of about 3,500km2 or roughly the equivalent to the area enclosed by the M25 motorway.

29 Of course, some might argue that an over-dependence (ie unjustified optimism) upon wind renewables as depletion of fossil-fired generation capacity gathers pace runs the risk of encouraging an expansion of nuclear plant and along with that, because of the slow output make-up characteristics of nuclear plants generally, a resulting over capacity of nuclear generation capacity. In the UK there is an element buffering against this because of the long construction and commissioning times for nuclear plants, particularly in that the existing UK nuclear capacity cannot be that much eked out by lengthy life extensions of the graphite moderated reactors (Magnox and AGRs) because of life limiting degradation of the graphite moderator such as cracking and radiolytic density loss – Large J H, *Brief Review of the Documents Relating to the Graphite Moderator Cores at Hinkley Point B and Other Advanced Gas-Cooled Reactors*, R3154 5 July 2006 - http://www.largeassociates.com/3154%20Graphite%20AGR/R3154-Graphite%20FINAL%2028%2006%2006.pdf

availability subject to abrupt changes.[30] The difficulties experienced by the German system[31] with its per capital equivalent of 0.2kW of wind capacity suggests that the proposed UK ~0.5kW per capita wind capacity would impose severe strain on the English and Welsh grid system without extensive back-up by closed cycle gas turbine plant that would be extremely costly at the scale of generation required and, indeed, would erode the carbon-free target. The reckoning is that for the UK 2020 electricity demand, the evidence taken from the large wind systems in Denmark and Germany is that 10GW, or thereabouts, will probably be the safe, upper limit of all UK wind capacity.[22]

FIGURE 3 2020 ELECTRICITY GENERATION MIX AS DEDUCED - Total 405TWh



Role of Nuclear in the 2020 Generation Mix: So, if it is accepted that the carbon-free target cannot be reached by truly renewable generation (ie wind turbine) alone, then government argues that nuclear power generation could be deployed to supplement the renewable shortfall to achieve the government's treaty obligations its carbon-free target of about 20 to 25%. The government's preferred[32] programme of 6 to 10 NPPs each of 1,600MW$_e$ capacity would result in a practicably achievable generation mix by 2020 to 2025.

The resulting generation mix deduced on this basis is shown by FIGURE 3 with gas and CO_2 abated coal-fired plants maintain an equal contribution of about 20%, nuclear contributes about 40% and wind renewables a maximum of 7% (from a capacity of ~20%).

However, government's approach to this latest Energy Review has been subject to much criticism in that it focuses too much on electricity rather than *energy* overall, that it has largely ignored the contributions of transportation, heating (industrial, commercial and domestic) and energy conservation to carbon emissions, and that the time given to the Review has been insufficient (just six months). Moreover, the open commitment to nuclear power electricity generation is considered to commit the UK to a commitment from which it would have difficulty in turning back, particularly if the Generation III reactor technology failed to provide the reliability and cost-effectiveness claimed.[33]

Siting Factors: Siting factors include consideration of the connection to and capacity of the electricity supply and distribution grid and, of course, matching the local and regional demands, are important factors in any electricity generating siting process.

For large wind farm development wind-rich sites in the North-West (Scotland) are favoured, whereas potential off-shore sites in the South, such as the Wash and Thames Estuary, have low load factors which are only marginally offset by the lower transmission lines losses to the areas of greatest demand.

NPP units are typically large capacity units (Generation III EPR at 1,600MW$_e$) so copious quantities of cooling water in the environment favours seaside siting; and, of course, population density and dispersion routes and directions in the event of an untoward release of radioactivity have to be considered in the nuclear safety case. The policy of the Scottish Parliament may well preclude new-build NPPs in Scotland, or it may choose only to permit a new generating capacity proportionate to its electricity consumption demand which, as previously discussed, will be more than met by the renewable sector development. If so,

30 The problem is that during summer storms wind output exceeds demand for some part of the day but during which there is a drop in availability if and when the storms peters out abruptly or if the turbines do as they are designed to do close down in high winds to avoid mechanical damage – in one summer storm in Germany in 2004 the renewable wind generation element lost 4,800MW (about two-thirds) capacity in 4 hours.

31 *Eon Netz Wind Power Report*, 2004 EON Netz GmbH, 2004

32 The 2006 Energy Review does not actually specify the government's preferred generation mix but government statements and press releases have strongly alluded to maintaining the present 20% proportion of NPPs in the total generating mix by 2025 when all 7 AGR NPPs would have shut down (ie replace nuclear with nuclear) requires a NPP new-build of about 8,500MWe or 5 to 6 European Pressurised Reactor (EPR). Carrying this mix proportion through to the 25GWe capacity expansion by 2020-25 requires a further 4 NPPs of 1,600MWe output capacity, that is a total of 10 new-build NPPs by 2020 or thereabouts.

33 House of Commons, Trade and Industry Committee, *New Nuclear? Examining the Issues*, July 2006

the decision not to replace the existing NPP capacity, or to carry through the 25GW proportionality with NPP capacity in Scotland, could jeopardise the UK's achievement of its carbon-free treaty obligations.

Time Scales for NPP Programme Commencement to Commissioning: The time period for construction and commissioning a Generation III NPP, for both of the viable options of the advanced passive (AP) reactor series and EPR,[34] are reckoned to total around 5 to 6 years.[35,36] However, the presently structured planning process could introduce a considerable delay prior to construction commencing if the developer is not prepared to assume the risk of proceeding in the absence of a full planning grant or on a step-by-step construction licensing scheme.[37] There may arise similar delays if new arrangements for the *pre-licensing* of the nuclear safety and environmental impact authorisations cannot be implemented. On its part, the Health & Safety Executive is currently reviewing a pre-licensing and design authorisation procedure that might permit construction of a NPP to proceed incrementally although, that said, the similar approach in Finland has now run into considerable difficulties with about 20 to 30% of its nuclear safety case for the EPR under construction at Olkiluoto still unresolved.[38]

Government is presently proceeding with a public consultation process on a policy framework for nuclear new-build from which a new Energy White Paper will be published around the turn of the New Year (2007).

Once established, the economic, social and other benefits of any of the nuclear practices associated with the new-build nuclear programme may be subject to justification.[39] Justification is expected to commence relatively early in the overall NPP new-build programme with interested parties contributing during 2006/07. Thereafter, the justification assessment of the potential candidate designs is likely to supplant aspects of the planning inquiry process (ie effectively disqualifying debate on certain principled issues because these had been considered and determined in the justification process).[40]

TABLE 4) NEW-BUILD CAPACITY & SITING - ASPECTS RELATING TO LONDON

a) Siting	Limiting the new-build NPP to existing licensed sites could be attractive to government because, given modification to the planning legislation, the process and public inquiry process could be shortened by limiting inquiry to local topics by dealing with principled issues via the justification process. Certain existing NPP sites may require upgrading by additional grid connection for which, both overhead transmission lines and grid connection equipment siting, are likely to require scrutiny via the planning process. Government has indicated that grid upgrades specifically relating to a new-build generating plant (NPP or otherwise), should considered an intrinsic part of the planning process for the generating plant, being considered under a single planning inquiry. Electricity demands from the increasing population of the South-East certainly favour new-build NPPs at the existing Sizewell, Dungeness and Bradwell sites. Of these Bradwell will require grid connection upgrades to bring its electricity output to two of London's electricity distribution nodes and it may be a site to be nominated early in the overall process because currently it has no power generation on the site. However, political tokenism might prioritise new-builds in Scotland and Wales, although consent for large power plants in Scotland has been devolved under the Section 36 of the Electricity Act 1989 with the outcome that a new-build NPP may be difficult to establish in Scotland.

34 It is more than likely any future NPP to be built in the UK will be either a Westinghouse AP 1000 or larger pressurised water reactor (PWR) or an EPR (European Pressurised Reactor) also a PWR designed by the ARIVA-Siemens consortium.

35 The first EPR presently under construction at Olkiluoto in Finland is, after 17 months into its on-site construction programme, running 10 to 12 months overdue with little prospect of making up this lost time.

36 European Pressurised Reactor at Olkiluoto 3, Finland - *Brief & Interim Review of the Porosity and Durability Properties of the In Situ Cast Concrete at the Olkiluoto EPR Construction Site*, June 2006 - http://www.largeassociates.com/3149%20Olkiluoto/R3149-A1%20Final%20Issue.pdf

37 Example of the planning process delay is given by the last NPP to be built in the UK, this being Sizewell B which was locked into the planning process for a total of 73 months.

38 Large J H, *European Pressurised Reactor at Olkiluoto 3, Finland - Review of the Finnish Radiation & Nuclear Safety Authority (STUK) Assessment*, R3123-A2, July 2005 - http://largeassociates.com/R3123-a2%20final%20Issue.pdf

39 *The Justification of Practices Involving Ionising Radiation Regulations*, SI 2004/1769 - The UK legislation flows from the Euratom Basic Safety Standards Directive 96/29, which was implemented in the UK under the Justification of Practices Involving Ionising Radiation Regulations 2004, SI 2004/1769 (The 2004 Regulations).

40 The justification process is an initial regulatory step, which applies to all new classes or type of nuclear practice Justification is not about approving a particular design of reactor on safety, security and other grounds, rather it is a higher level assessment of these issues, to confirm whether the benefits outweigh the potential detriments. - European Union Member States are required under the Basic Safety Standards Directive to ensure that all new classes or type of practice resulting in exposure to ionising radiation are justified in advance of being first adopted or first approved by their economic, social or other benefits in relation to the health detriment they may cause. Existing classes or types of practice may be reviewed whenever new and important evidence about their efficacy or consequences is acquired. In the UK the Secretary of State for Trade and Industry is the "Justifying Authority" for civil nuclear power.

b) Capacity	The Energy Review implies that the final mix will be left to market forces although, government claims this could result in an undesirable dominance of gas-fired plants. There is high growth of electricity demand in the South-East and installation of the first new-build NPPs might assume priority at one or more of the existing NPP sites of Bradwell and/or Dungeness. Grid and other infrastructure costs to support increased generating capacity at Dungeness and the reintroduction of generation export from Bradwell are favourable compared to Sizewell and the other established UK NPP sites.

SUMMARY OF TABLE 4

New-build NPPs Sites & Capacity

Sites and Timing: On the assumption that no new *'green field'* sites will be considered seriously, the existing NPP sites at Bradwell and Dungeness are likely to be nominated for early development in the new-build NPP programme.[41] Both of these sites, once operational, would utilise existing road and rail routes for the movement of nuclear materials, such as fresh unirradiated, irradiated or spent fuel, and operational radioactive waste arisings.[42]

It may be that this new Generation III programme of reactors will not utilise Sellafield for fuel reprocessing – either storing the fuel on site or, possibly, if operated by the French company EdF the fuel could be shipped to la Hague in France for reprocessing.

Operational Features of Generation III NPPs: Generation III NPPs claim economic viability by offsetting and amortising the very high capital costs[43] over an operational service life of 60-65 years, using enriched fuel and having the unmodified capability to burn a high proportion of mixed oxide or MOX plutonium based fuel.

The use of MOX fuel would be entirely novel to commercial NPPs in the UK requiring special security and containment requirements for its unirradiated delivery to the Generation III NPPs. The radiotoxicity of both unirradiated (fresh) and irradiated (spent) MOX fuel has the potential for very much more significant radiological impacts in the event of an untoward release.[44] The overland transportation of MOX fuel, especially by rail through a large city such as London has never been justified and could be subject to due process under the justification regulations.

NPP NEW-BUILD PROGRAMME – ADDITIONAL RISK TO LONDONERS

Determining the additional risk posed to Londoners for any future new-build NPP programme is fraught with difficulty because, essentially, the government's 2006 Energy Review simply explores but does not commit to any specific electricity generation mix option. However, the overriding conclusion of the Energy Review is predicated on that it is only practicable to close the future *energy gap* via an ambitious programme of new-build NPPs. This, government argues, is the only politically acceptable and sustainable means of meeting the carbon emission targets, although some authoritative opinions have strongly doubted this.

Indeed, the uncertainties of the Energy Review are broad ranging, including the following that could impact directly on London and Londoners:

41 As part of setting the strategic context for new-build, the Government will be undertaking a further assessment of the suitability of sites for new nuclear build. This assessment is to involve a full assessment of the strategic and high level environmental impacts of new nuclear build and will identify the criteria for locations where the Government would support proposals for new nuclear power stations. It will also indicate how potential sites meet these criteria. Industry has indicated that the most viable sites for new-build are likely to be adjacent to existing nuclear generating plant, although there might be other attractive sites, for example other nuclear installations and sites with retiring fossil fuel generating stations. The Government will begin this strategic siting assessment in early 2007.

42 Of course, the Generation III NPPs are very large capital civil engineering projects so construction and resources traffic in and about London would likely increase significantly over the 5 to 6 year construction period.

43 Approximately 66% of the total cycle (cradle to grave) costs of a Generation III NPP are reckoned to be with its capital and refit costs, fuel accounts for 11% and back-end wastes and decommissioning at 3%.

44 Large J H, NRC Hearing Disposition of Surplus Weapons Plutonium Using Mixed Oxide Fuel, US Nuclear Regulatory Commission Hearing, 2004: *Comments on Opinion on the Applicability and Sufficiency of the Safety, Security and Environmental Requirements and Measures as these Apply to the Transatlantic Shipment, European Waters and France, The Role of PNTL Ships in the Atlantic Transit Phases, United States of America Nuclear Regulatory Commission, 26 November 2003, Summary of the Findings of the French-sourced Plutonium Dioxide Transportation, 23 March 2004* - http://www.largeassociates.com/NRC1.pdf

Market Forces: Government intends to leave any new-build NPP development entirely to market forces once that it has established changes in the planning and nuclear safety regulatory regimes. However, these changes have yet to be announced in detail and planning amendments at least will have to proceed through both Houses of the parliamentary system.

NPP Programme: If the government's strongly expressed desire to break the dependency upon gas-fired generation, maintain fuel diversity and meet its carbon emissions targets are followed through, the size of the new-build NPP programme settles between 6 to 10 units. International treaty obligations of carbon emissions require an early start to a new-build NPP programme if the existing but ageing AGR nuclear capacity is to be replaced MW for MW, the situation regarding the Scottish parliament's nuclear power strategy will have to be determined, and considerable amendments and modification to the grid distribution system will have to be completed if a mix of nuclear and renewables is to be successfully installed.

Location of New-Build NPP: The government has not expressed any preferred location but with the South-East's growing electricity demand the existing nuclear sites at Bradwell and Dungeness, both with established grid connections, may be amongst the first sites to attract new-build NPPs. Both these sites particularly in terms of the transportation of nuclear materials, would impact on London and, particularly, in the event of an incident involving radioactive release the radiological, health and economic consequences to Londoners have the potential to be more severe than similar incidents involving the present Magnox and AGR spent fuel transports.

Type of NPPs: There seems to be no government preferred NPP type, although stronger contenders are the EPR and AP series of Generation III pressurised water reactor both of which are suitable for plutonium-based or MOX fuelling.

MOX Fuel: Unlike uranium dioxide fuel, MOX fuel is sufficiently radiotoxic in its unirradiated (pre-reactor loading) condition to warrant full security and containment during transportation. If MOX fuel is adopted for the new-build NPPs then this alone would double the number of fuel flask movements accompanied by risk of serious radiological incident.

Back-End Fuel Cycle: Similarly, market forces are to dictate if the option for (either uranium dioxide or MOX) spent fuel reprocessing is to be taken: If it is, then regular spent fuel movements will occur throughout the period of operation of each NPP but, if not, spent fuel movements are likely to be deferred until the closure of the NPP and early stages of decommissioning.

Spent Fuel Toxic Potential: Both EPR and AP series NPPs are capable of utilising much higher fuel irradiation (burn-up for both uranium dioxide and MOX) levels so the resulting toxic potential of release incidents is greater than the present generation of AGR and single PWR uranium oxide fuelled NPPs. Hence, the radiological impact and consequences of a transportation incident involving spent fuel could be significantly higher than for the present UK nuclear fuel systems.

Interim Storage and Disposal Repository: Although the government's Committee on Radioactive Waste Management (CoRWM) has recently reported its preference for a phased waste management-disposal strategy, it is not entirely clear when and how this is to be implemented. At this time the implementation date and siting of a national radioactive waste facility has yet to be determined, so not knowing when and, particularly, where the radioactive wastes identified in TABLES A and B are to be disposed means that the risks to and impact upon London cannot be determined.

Assuming that the existing and potential new-build nuclear power plants in the South-East operate accident -free, the greatest impact on Londoners will be the increased risk of radiological incident from the movement of radioactive materials through and/or around London. An expanding programme of new-build NPPs will not only result in an increased amount of radioactivity in transit, but the range of nuclear materials and radioactive wastes will likely expand to include plutonium based fuels and the very large volumes of radioactive waste arisings from decommissioning the existing nuclear power stations within two to three decades hence and, about 100 years ahead, the decommissioning of new-build NPPs now under consideration.

On the assumption that there will be new-build, reprocessed contracted MOX fuelled NPPs located at Bradwell and Dungeness, that the existing Magnox, AGR and single PWR at Sizewell will be dismantled within 25 years of generation shut down, and that a national radioactive waste repository will be available somewhere North or North-West of London by 2020 to 2030, the increased risk from the transportation of nuclear materials through or around London, expressed as numbers of packages containing low-, intermediate- and high-level materials is summarised as follows:

FIGURE 4 - POTENTIAL PACKAGE MOVEMENTS via LONDON

from Existing & 2 New Build NPPs