

Prerequisites for Nuclear Renaissance

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Platt's Nuclear Conference
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Agenda

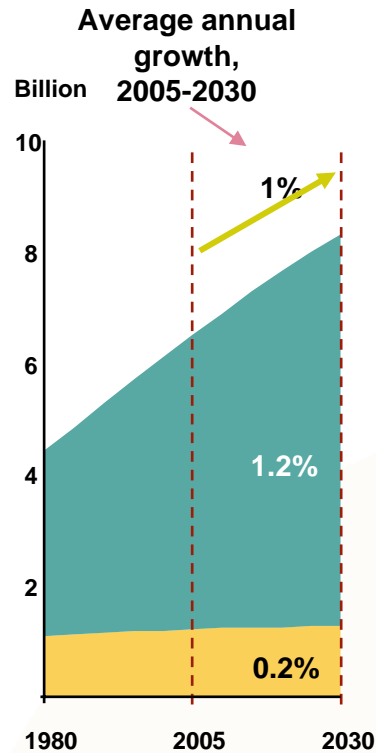
- **Global Energy Outlook**
- **Nuclear renaissance**
- **Pre-requisites for the Nuclear Renaissance to materialize**
- **Nuclear market's attractiveness for operators and vendors**

Population and economic growth will redraw the map in 2030

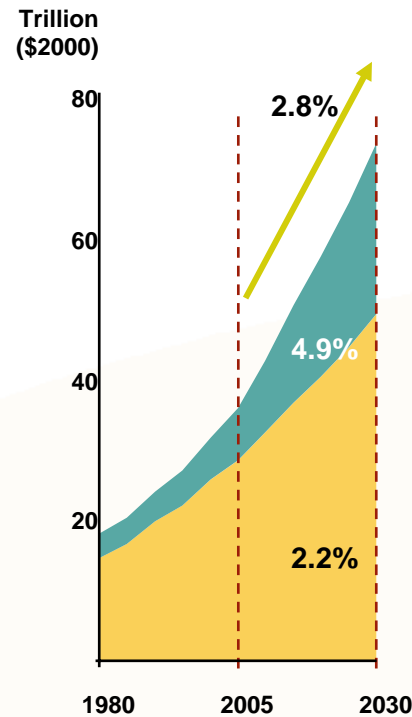
● OECD ● Non-OECD

Source: United Nations, *World Population Prospects 2006*; IEA; Total.

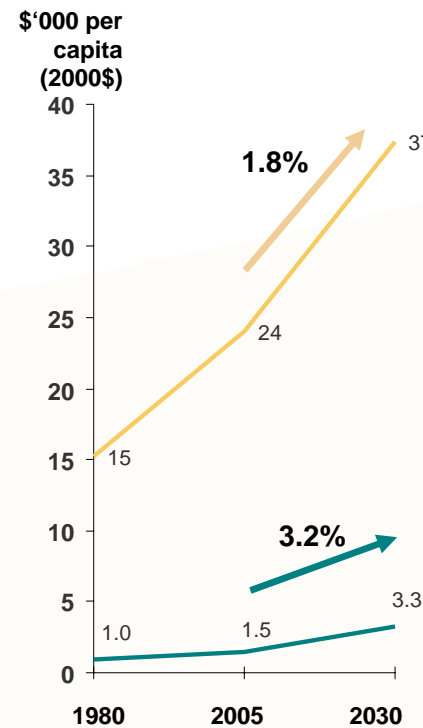
Population



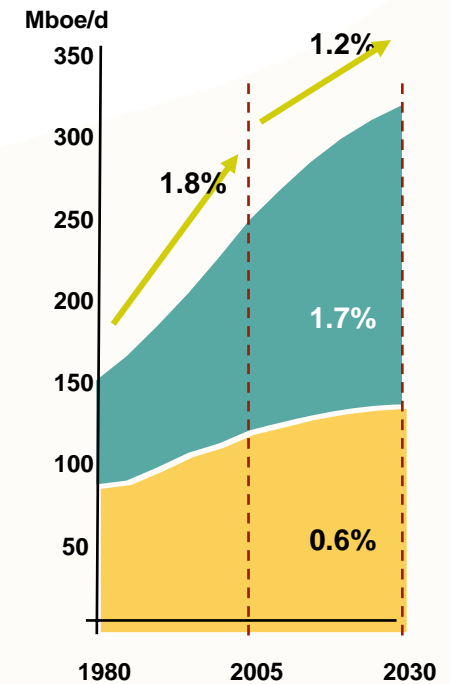
GDP (at constant exchange rates)



Per capita GDP



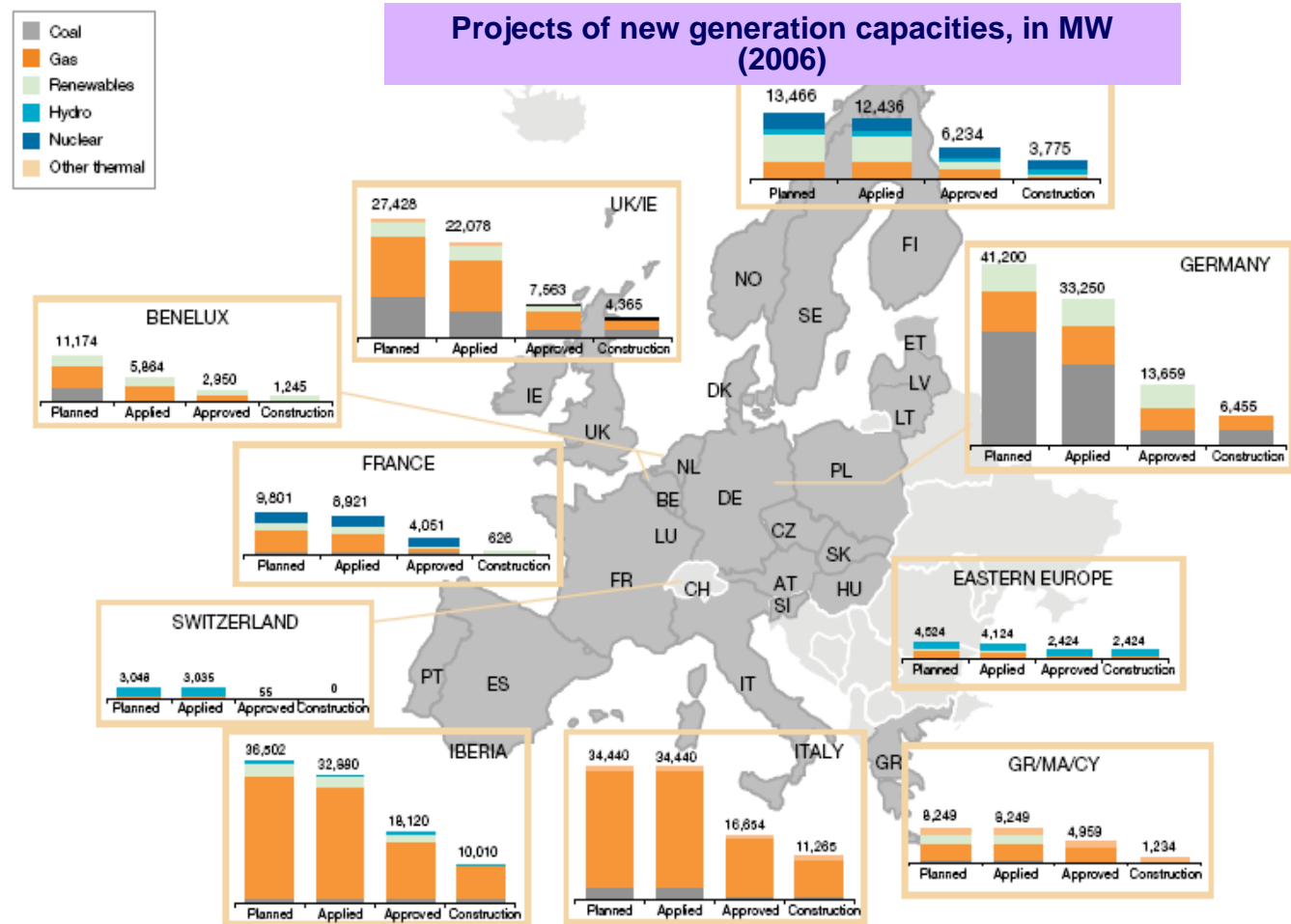
Energy demand



IEA report estimates at 22 000 Bn \$ the Oil, Gas and Electricity infrastructure worldwide investments needed by 2030

1 000 Bn Euros investments are needed for power plants in Europe

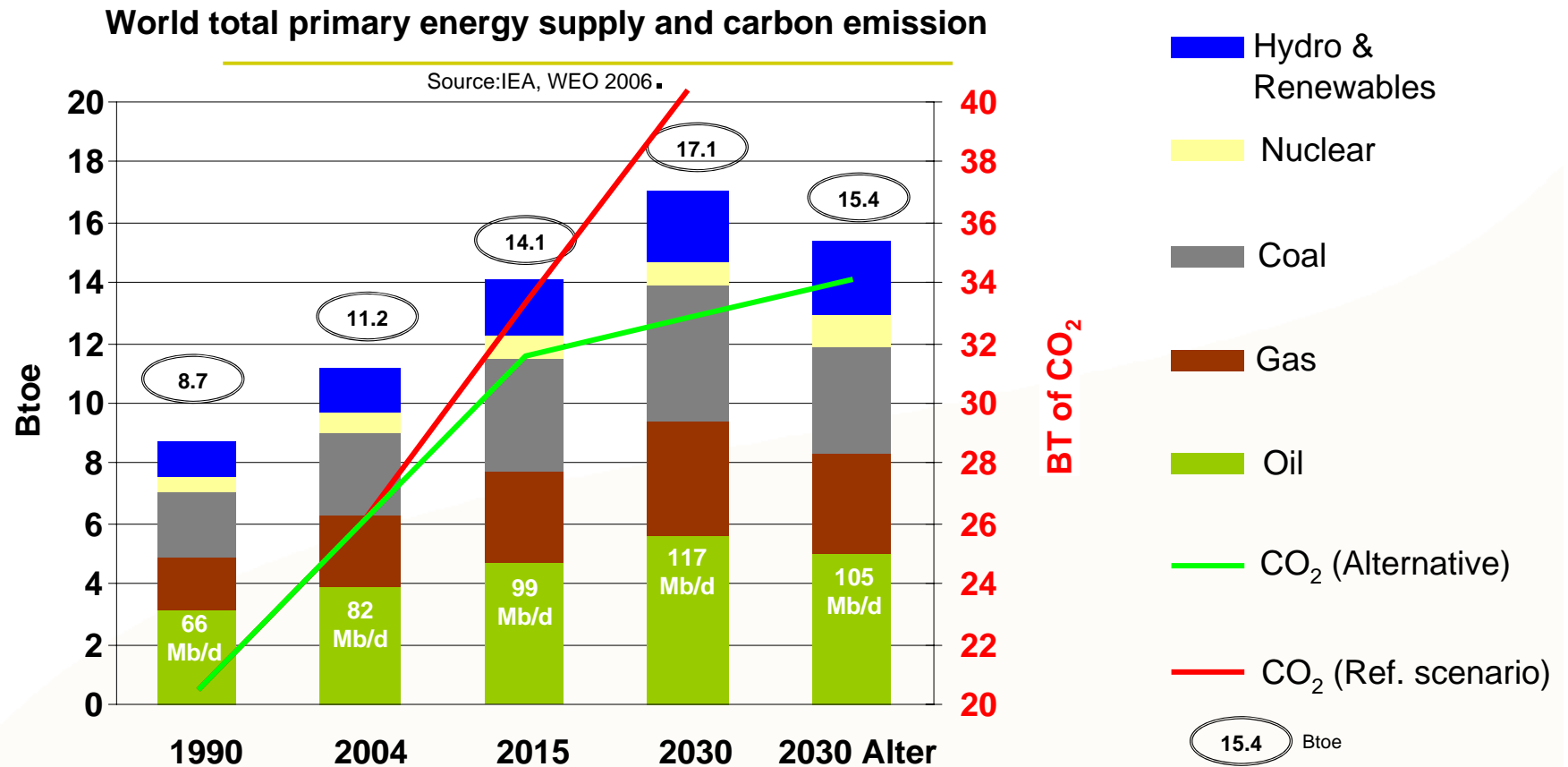
- The energy mix choices for these investments are not aligned with the EU climate change objectives for 2020
- 81% of the planned generation plants will be fossil fuelled, a majority gas fired
- ... But these plants:
 - Have high and volatile fuel cost
 - Are CO₂ emitters
 - Are contributing to increasing European dependencies on imported gas



Source: Platt's - Capgemini EEMO9

Investment has picked up, however the energy mix choices raise climate change related issues.

2030 world energy supply: CO₂ a major concern



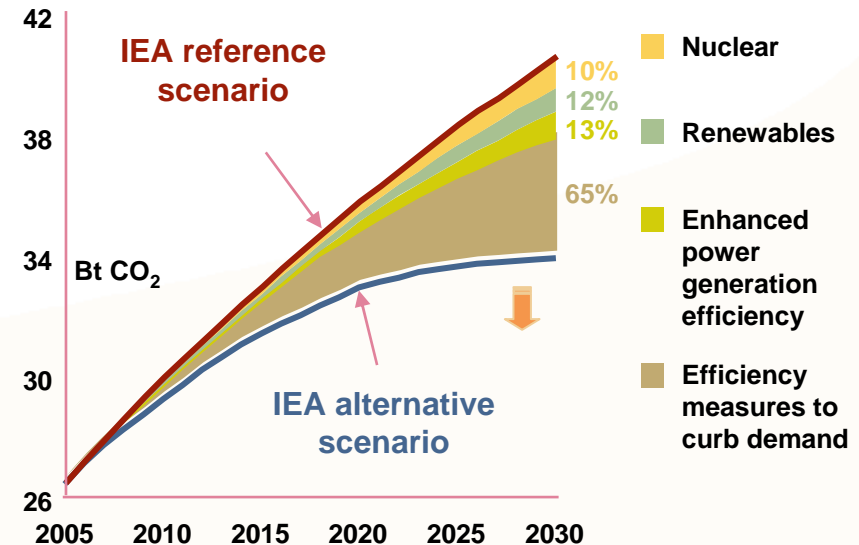
EU roadmap of 20% CO₂ emissions reductions by 2020 is bullish

How to limit our energy consumption and our CO2 emissions?

- **Energy consumption:** increase from BRICs and other developing countries will not be balanced by the stabilization of developed world countries' resulting in an overall 1.2% per year growth
- Our planet **fossil fuel resources are limited:** 40 years in Oil, 60 years in Gas, 146 years in Coal. We need to use them cautiously and they generate CO2
- We have to **limit our Green House Effect Gases** (including CO2) emissions in order to avoid global warming which would be very damageable for our planet

Carbon capture and storage is at a development stage and very expensive (increases by 50% the kWh cost). It could eventually be implemented.

CO2 emissions: potential savings



Energy savings together with Renewable and Nuclear energy are needed.

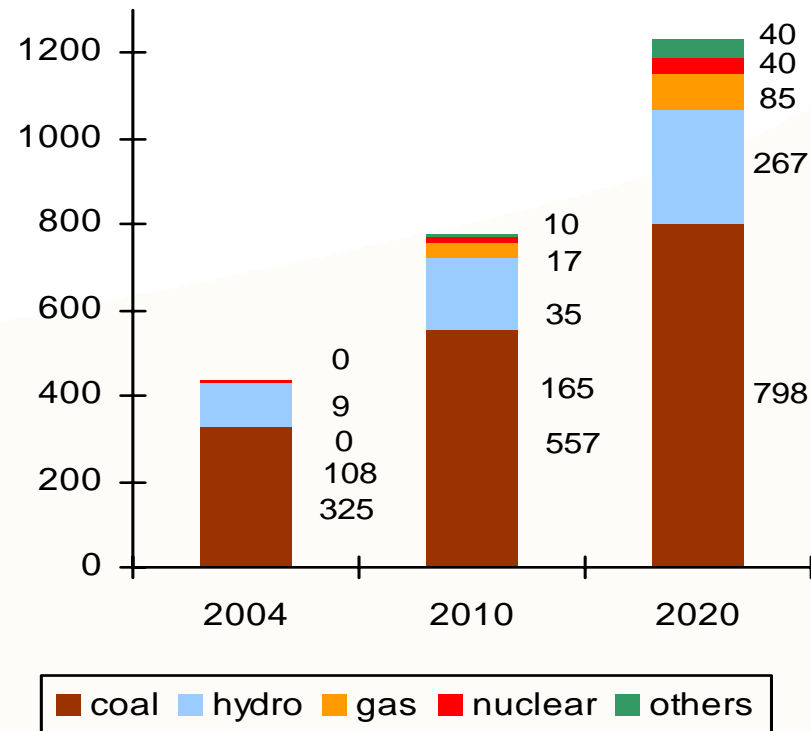
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We are witnessing a worldwide nuclear renaissance triggered by high oil prices and climate change concerns

- **Asia** is the most active areas
 - **China:** the government has decided to speed the nuclear program in order to reach 40 000 MW installed capacity, by 2020. Currently there are 8 reactors under construction, 7900 MW capacity.
 - **India:** 7 reactors under construction. The Country plans an 8-fold increase by 2020 to 10% of the electricity supply
 - **Japan:** 11 new units are scheduled to start commercial operation by 2014
 - **South Korea :** 6 reactors under construction, Plans for 11 new nuclear plants that should increase by 2035 to 60% the nuclear share in electricity
- **Europe**
 - **Finland:** EPR reactor in construction at Olkiluoto to be put online in 2011.
 - **France:** EPR reactor in construction at Flamanville (estimated amount of €3.4 bn) operational in 2012
 - **UK:** The government has committed in January to the continued use of nuclear power It wants the first new nuclear station to come online before 2020, The current estimations are 25 000 MW by 2030.
 - **Former Eastern European Countries:** Romania, Slovakia, Bulgaria and Lithuania are pursuing nuclear programs
 - **Italy:** after the 1987 nuclear phase out referendum, the new government plans new NPP construction.
 - **Swiss** operator ATEL has submitted an application to build a new third generation light-water reactor
- **Russia and the former CIS**
 - **Russia,** which is a dominant gas exporter, has seven reactors in construction and 26 more are planned.
 - **Ukraine:** has 2 plants under construction

China electricity generation energy mix (GW)



Despite a very large nuclear program and investments of more than 450 bn RMB by 2020, China will still have 73% coal fired plants capacity in 2020

Source: U.S. Bureau of Labor Statistics, 2005

We are witnessing a worldwide nuclear renaissance triggered by high oil prices and climate change concerns

North America:

- **US:** Companies and consortia are pursuing licenses for more 34 nuclear power plants at 23 sites.

NRC has received Construction / Operating License Applications (COLAs) for 7 sites and more are expected in 2008.

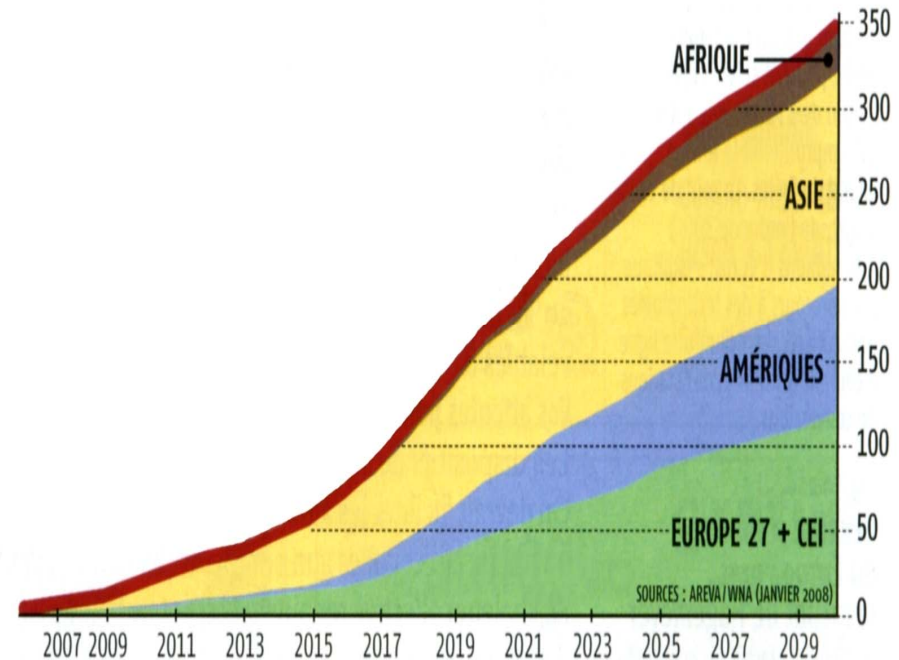
One firm order: Georgia Power (2 x AP1000)

- **Canada:** *Ontario* is moving forward in its plan to replace its nuclear fleet and is launching an RFP to select vendors

Alberta is considering building up to 2 twin unit plants

- **South Africa:** RFP launched for 2 and then 10 new 3rd generation power plants.
- **Gulf countries:** confronted to high domestic electricity demand growth, wish to generate nuclear electricity in order to comply with their O&G exportation commitments.
 - Abu Dhabi has signed an agreement with French companies to build new 3rd generation EPRs
 - United Arab Emirates has signed a Nuclear Agreement with the US

2007-2030 new nuclear reactors worldwide projects (in GW)



Worldwide: 439 reactors in operation, 34 under construction and 319 planned or forecasted

Source WNA

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Pre-requisites for Nuclear renaissance to materialize

- **International compliance & sound safety policy**
- **Long term Green House Gases legislation**
- **Simple, long term and sustained regulatory framework**
- **Sound treatment of used fuel and wastes**
- **Attractive financial conditions**
- **Competent operators and industrial providers**
- **Knowledgeable work forces**
- **Positive public opinion**

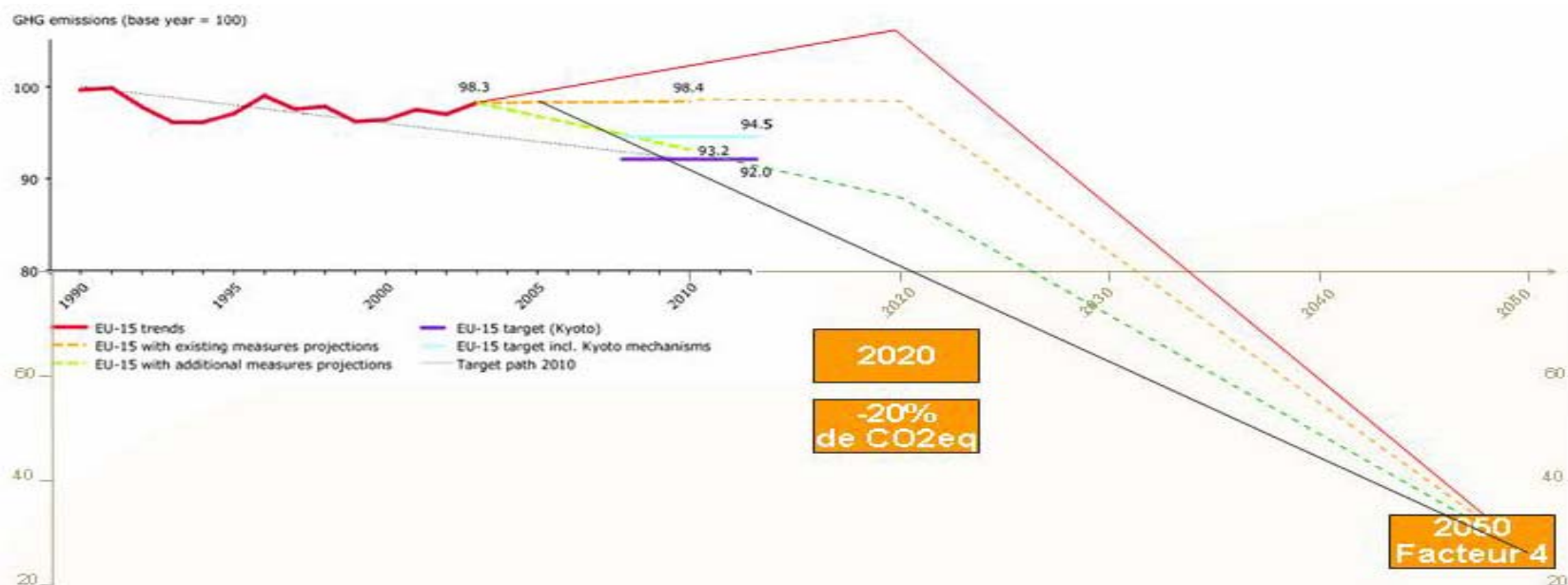
International Treaties compliance and sound safety policies

- Sign and comply with Non Proliferation and other relevant Treaties:
 - Prevents leakage from civilian towards weapons usages
 - Gives access to international technologies
 - Increases safety and security
 - Countries having to act: India, Gulf countries, North Africa..
- Establishing or reinforcing competent safety authorities
 - **New nuclear countries** need to establish the right safety structure with the right governance and train the future collaborators
 - **Countries having nuclear energy** need to reinforce their safety authorities staff. NRC asked lately a budget increase of 91 m\$ for “enhanced regulatory activities driven primarily by new nuclear plants and increased oversight of existing facilities
 - A **holistic** approach should reduce the human resources needs by avoiding duplications:
 - Seamless relationship with other government bodies
 - *European cooperation*: March 2008 the French and British Chief regulators said: “This joint regulatory project approach is anticipated to increase the scope for enhancing safety, and for optimising delivery of our respective regulatory processes through efficiency gains”.
 - *International cooperation* (UK and French with the Americans and Finnish nuclear safety regulators)

International safety training centers for new nuclear countries’ engineers as well as for the existing ones, should be launched

Long term Green House Gases legislation European Union climate change objectives are a first step but too short term

- EU Objective: Green House Effect gases emissions reductions of 20% by 2020
- To limit the average worldwide temperature increase to +2° or +3° degrees, it is necessary until 2050 t
 - Divide by 2 the CO2 emissions at the worldwide level (Factor 2)
 - Or to divide by 4 the emissions of industrialized countries (Factor 4)



- 2009 will be an important year (New American President, Copenhagen post Kyoto conference)

Long term prices for CO2 Emission Rights are needed.

In order to mitigate the big industrial risks taken by the nuclear operators, government have to establish clear and long term regulatory frameworks

Risk limitations for Nuclear operators: the 2005 **US Energy Bill act** main provisions:

- Electricity produced from a qualifying advanced NPP can claim credit of 1.8 cents per kWh for the first 8 years of operation. This provision applies up to 6,000 MW.
- The Secretary of Energy is authorized to provide a loan guarantee of up to 80% of the project cost of advanced NPPs
- Standby support for delays beyond 180 days in the commencement of full operation due to litigation or the U.S. Nuclear Regulatory Commission approval (up to 6 reactors for a total of up to 2 bn \$).
- Funding support for construction of advanced new NPPs: 1.18 bn \$ over 2007 -2009.
- Price-Anderson Act Amendments extending liability protection to 2025.

A recent US survey shows that nearly 80 percent of US citizens support financial incentives from the government to promote the development of carbon-free energy technologies, including new nuclear power plants,

Procedures: US and U.K government are streamlined their design, site approvals, construction and operations procedures:

- U.K: current legislative activities are underway to tackle unnecessary New Nuclear Build approval delays: the Planning Reform Bill, a new independent Infrastructure Planning Commission, a new Nuclear National Policy Statement and other measures are taken .
- Americans have established a combined Construction and Operation Licence agreement (COLA)

Other regulations having an impact on plant efficiencies (river water temperature) or decommissioning costs (radioactivity limit for wastes) have to be sustained.

Regulators have to stick to their long term framework and resist campaigns from anti nuclear NGOs built on false scientific ground and amplified by media

Sound treatment of used fuel cycle and radioactive wastes

Two main options:

- **The open fuel cycle** : consists in storing the used nuclear fuel in geological stable repositories. It is the Swedish and Finnish option
- **The closed fuel cycle**: consists in reprocessing the used fuel, recycling the extracted uranium and plutonium in MOX fuel, vitrifying the high-level radioactive wastes and storing them in geological stable repositories. It is the French, British, Japanese and Russian option
- **US:**
 - Has stopped reprocessing under Jimmy Carter's mandate
 - Has elected to store the used fuel in Yuka Mountain's site.
 - Is up to now unable to implement this solution

This unsettled situation represents an obstacle for the Country's nuclear renaissance.

- The **Fourth French Plant Generation** is designed to generate less radioactive wastes and use less uranium.

**La Hague (France) reprocessing plant
(capacity 1700 t of used fuel /year)**



In France* the volume of the high level radioactive wastes generated per habitant per year is that of a child's marble

*80% of its electricity provided by Nuclear plants

Financial conditions : Nuclear Power should be built without public subsidies

- The majority of the present "western" nuclear reactors were built without public subsidies. The construction, operations and financial risks were taken by the Utilities themselves.
- These Utilities have established provisions in order to "keep the money aside" for the future treatments of used nuclear fuel and nuclear waste. There are two different schemes: financial accruals or dedicated external fund
- The full investment and operation costs are incorporated in the prices at which these Utilities sell electricity to their consumers.
- In addition to construction, operation and financial risk operators have to take a market related risk in deregulated markets
- Government can encourage and accelerate plant develop by providing tax credits, loan guarantees, support for construction delays (US Energy bill act)

This is a sound model, in line with the British scheme, and should be widely adopted.

Financial conditions: with the today high oil and carbon prices nuclear energy is competitive.

- The tight supply and demand for crude oil, coupled with unsafe & more difficult technical production conditions, and nationalistic attitudes should keep the oil prices high
- The new European Rules on GHG emissions decrease and certificates auctioning should raise the CO2 price to 40 Euros/t by 2013
- Nuclear energy allows countries to be more independent of oil and gas importations and less sensitive to political pressures.

Nuclear is, with hydropower, the only large scale schedulable CO2 free source of energy. It's competitive edge should grow in the future

Electricity generating cost (US\$ c/kWh)
 projections for 2010
 on 5% discount rate
 40 years life time
 85% availability

	nuclear	coal	gas
Finland	2.76	3.64	-
France	2.54	3.33	3.92
Germany	2.86	3.52	4.90
Switzerland	2.88	-	4.36
Netherlands	3.58	-	6.04
Czech Rep	2.30	2.94	4.97
Slovakia	3.13	4.78	5.59
Romania	3.06	4.55	-
Japan	4.80	4.95	5.21
Korea	2.34	2.16	4.65
USA	3.01	2.71	4.67
Canada	2.60	3.11	4.00

Source: OECD/IEA NEA 2005

Large and experienced operators & industrial environment

Large and knowledgeable operators able to

- Take the financial, construction and operational risks
- Select safe NPP design
- Implement a safety culture
- Promote nuclear safety and operational exchange through national or international bodies (INPO, WANO)

Create or reinvigorate an **industrial network** of nuclear components and services providers

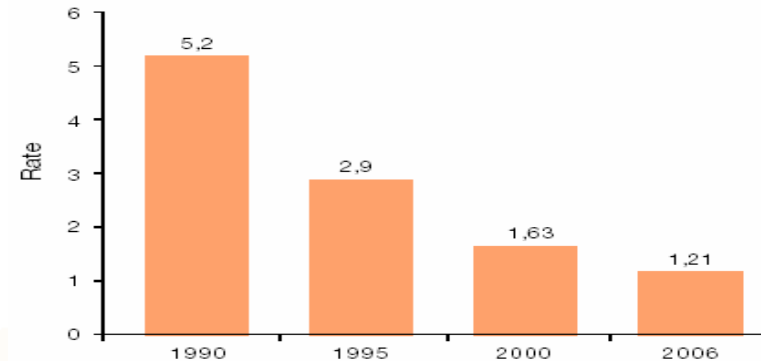
- Establish a mapping to identify critical competencies
- Decide which should be provided at national or local level
- and which could be imported
- Establish the gaps
- Operators and local authorities should incentivise the needed companies

Finance **nuclear R&D** and incentivize venture capital and capital development firms to invest in nuclear technology

UK business secretary John Hutton declared: a new fleet of reactors would potentially create up to 100,000 jobs and represent about 20 bn £ worth of business for UK companies.”

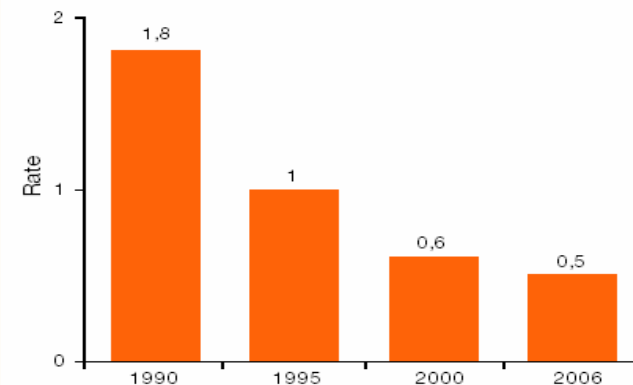
Commercial Nuclear Plants Worldwide

Industrial Safety Accident Rate



* Number per 1,000,000 man-hours worked

Unplanned Automatic Shutdowns



* Mean automatic shutdown rate per 7,000 hours of operation

| Energy, Utilities & Chemicals Global Sector

Competent human resources: aging workforce is a major issue

Vendors and operators need to massively recruit engineers to

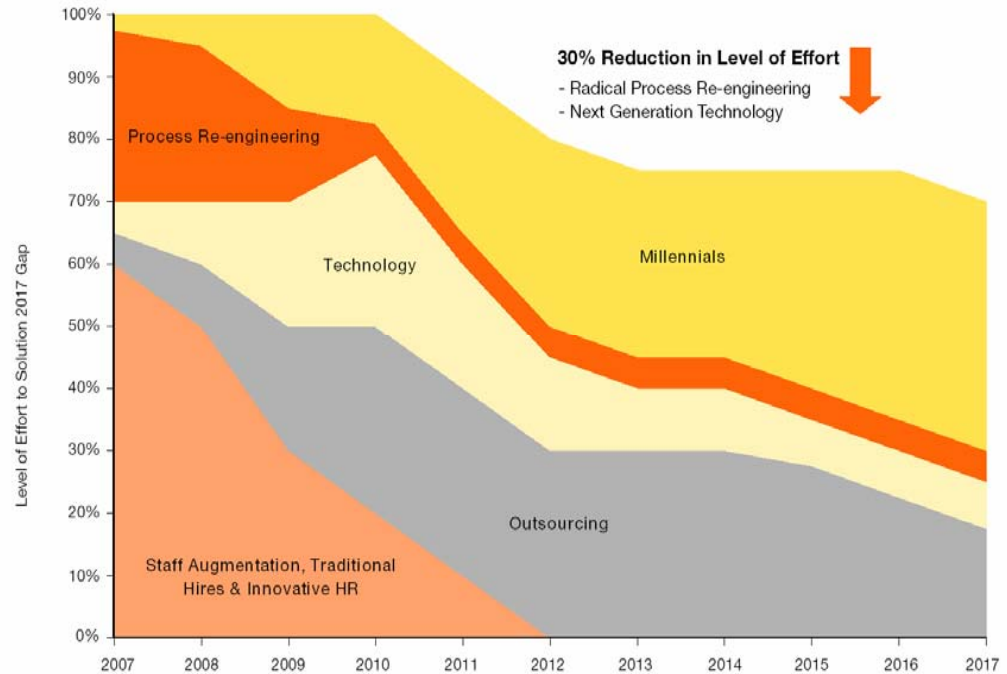
- replace baby boomers retiring
- to meet the growing demand

This squeeze is exacerbated by

- the staff lay outs done in the past 10 years to control cost
- student's lack of interest in engineering studies
- decline of nuclear engineering courses

Nuclear Energy Institute estimates that the US nuclear power industry needs to attract about 26 000 new employees over the next ten years

How to bridge the talent gap in the nuclear industry by 2017?

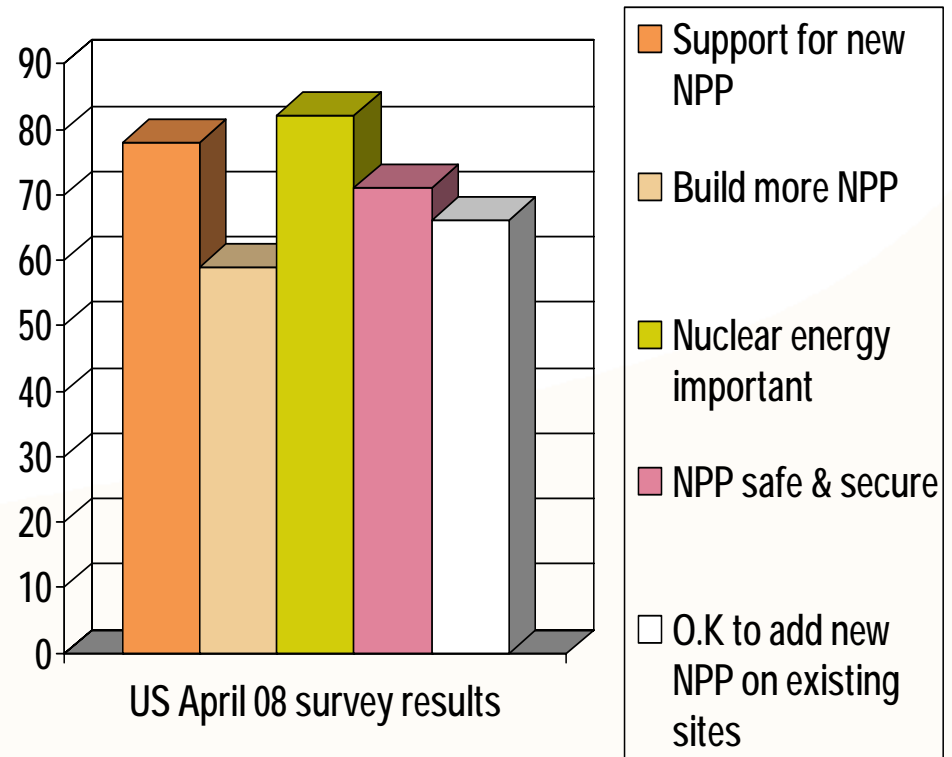


Nuclear Companies need to:

- launch specific training and recruitment programs,
- use new Knowledge Management tools,
- streamline their internal processes,
- outsourcing the non core activities and
- modify the working environment to retain the new generations

Public opinion

- The **climate change issues** are widely adopted by leaders and citizens. This influences favourably public opinion on nuclear energy as reflected in recent surveys
- The view adopted by many is to build new plants on **existing sites** where public opinion is more positive
- In **France** the present policy of tax allocation to the local area and EDF's policy to favour local employment has created a local positive image among mayors
- In **U.K:**
 - **British Energy** said all its sites have potential for replacement nuclear and there is suitable land at all locations.
 - Who will be the new owner
 - How sites will be allocated?
 - **UK's Nuclear Decommissioning Authority** called recently for proposals from developers interested in using it's. EDF has responded positively



**Information, information, information..
It is a duty for the nuclear industry**

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China market attractiveness

- Size: 50 GW in 2020 ✓✓✓
- International compliance & safety policy ✓✓
- Long term Green House Gases legislation ✗
- Simple, long term, sustained regulatory framework ✓
- Large and experienced operators ✓
- Sound treatment of used fuel and radioactive wastes ✗
- Financial attractive conditions ✓
- Local industrial providers ✓
- Sites ✓✓
- Competent engineers and work forces ✓
- Public opinion ✓✓
- Other: knowledge transfer ✗

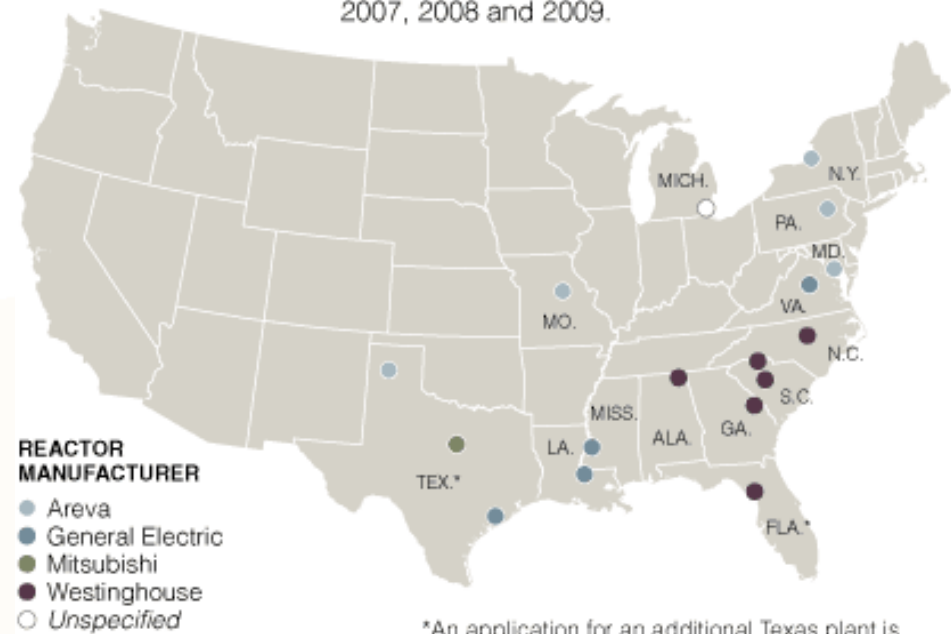


U.S market attractiveness

- Size: ✓✓✓
- International compliance ✓✓✓
- Long term Green House Gases legislation x
- Simple long term, sustained regulatory framework ✓✓
- Large and experienced operators ✓✓
- Sound treatment of used fuel cycle and radioactive wastes xx
- Financial conditions ✓✓
- Local industrial providers ✓✓
- Sites ✓✓
- Competent engineers and work forces ✓✓
- Public opinion ✓✓

A Wish List of New Nuclear Reactors

Expected nuclear power plant license applications in 2007, 2008 and 2009.



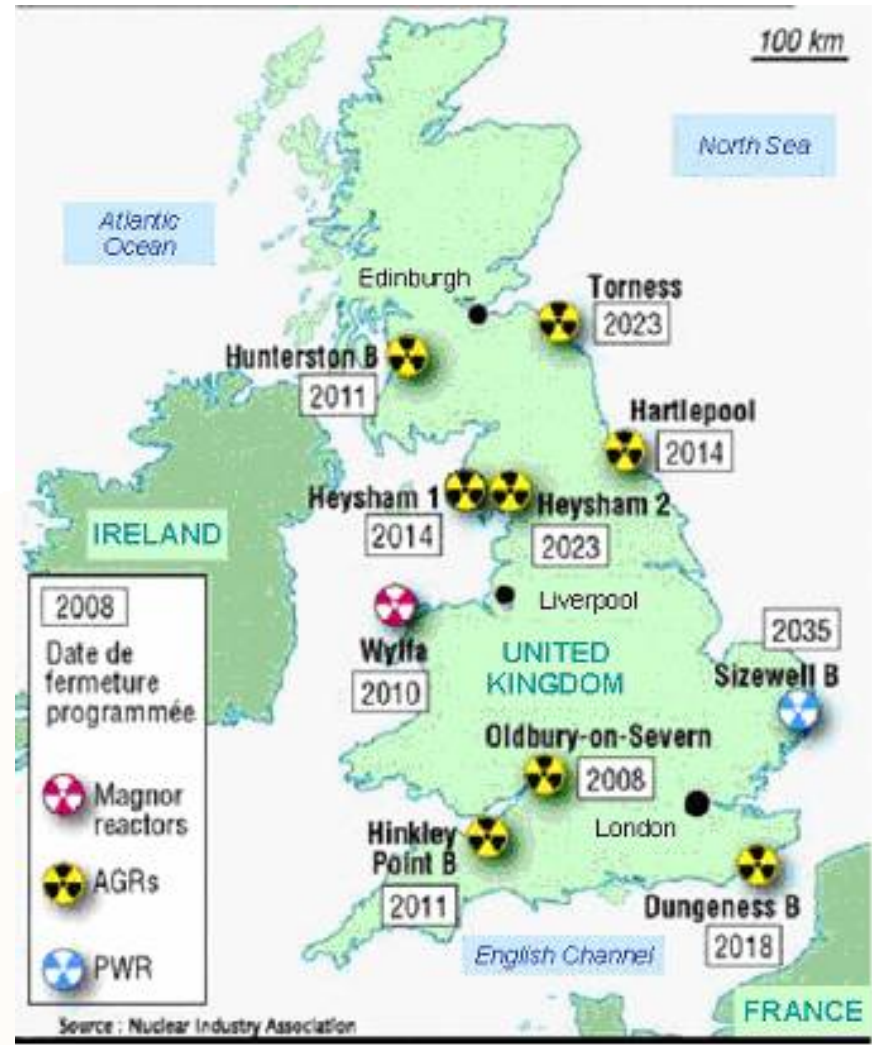
*An application for an additional Texas plant is expected in 2008, and another in Florida in 2009. Locations and manufacturers are to be determined.

Source: Nuclear Regulatory Commission

The New York Times

U.K market attractiveness

- Size: 25 GW by 2030 ✓✓
- International compliance ✓✓✓
- Long term Green House Gases legislation ✓✓
- Simple, long term, sustained regulatory framework ✓✓
- Large and experienced operators (if foreign) ✓✓
- Sound treatment of used fuel cycle and radioactive wastes ✓
- Financial attractive conditions ✓
- Local industrial providers ✓✓
- Sites ✓✓
- Competent engineers and work forces ✓✓
- Public opinion ✓✓



Governmental actions to make the UK market attractive for vendors_and operators-a case in point

- GDA (Generic Design Assessment) to select reactor designs (EPR, API000, GE- ESBW) completed by 2011
- Selection of a limited number of operators having the right size and knowledge
- Get a “first mover advantage” by
 - Developing UK industrial nuclear companies all along the value chain
 - Taking measures to meet the expected high levels of demand for trained staff in the industry
- Publish clear criteria for deciding on the siting of new nuclear power plants.
- Adopt the June 2008 framework for implementing Geological Disposal for Higher Radioactive Wastes
- Build more effective cross government working by creating a new office of Nuclear Development
- Maintain momentum and discuss key issues by launching a Government and Industry Nuclear Development Forum

John Hutton wants to see a new generation of nuclear power plants built and operating “as quickly as possible”, given the urgency of reducing carbon emissions and combating other energy threats.