Nuclear Renaissance

An option for security of supply and climate change challenges: an operator’s point of view

Jean-Paul BOUTTES

Executive Vice-President Prospective and International Affairs, Electricité de France

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Nuclear contribution to key energy challenges

1.1 Energy: 3 major challenges for Europe and worldwide

Present global energy outlook: altogether different from the 1990s

- **Oil & gas and security of supply**
  - ➢ Oil & gas located in few and generally faraway countries
  - ➢ Production expected to peak in the coming decades
  - ➢ Prices have already nearly trebled since the end of the 1990s
    - CCGT is no longer the miracle technology for power generation
- **Coal and climate change**
  - ➢ Coal is abundant worldwide & is an inexpensive way to generate power
  - ➢ Work in progress on CO_2 capture & storage, but until CCS maturity (beyond 2030?), coal remains one of the main sources of CO_2 emissions
- **Investment and competitiveness**
  - ➢ Considerable investment required in new equipment (G-T-D)
    - Opportunity to build efficient and available low or no CO_2 emitting technologies

1.2 Contribution of nuclear power
a) to energy independance and security of supply

- **Most uranium & thorium resources located in "non-sensitive" regions**
  - Uranium resources, as used with Gen II & III technologies
  - Price of natural uranium: less than 5% of the full cost of a nuclear plant
    - impact of fuel price increase < impact of gas price on cost of CCGTs
- **known resources: 4 Million tons at $80/kg (market price in 2005)**
  - around 60 years to run the current number of nuclear plants worldwide
- **known + yet undiscovered resources: 15 M tons, mostly at < $ 130/kg**
  - enough to run 3-4 times the current number of nuclear plants worldwide
- **By 2040: maturity of Gen IV technologies**
  - 5 of the 6 reactors under study use U^{238} (fast breeders) or thorium
    - multiply the potential of current resources by 50

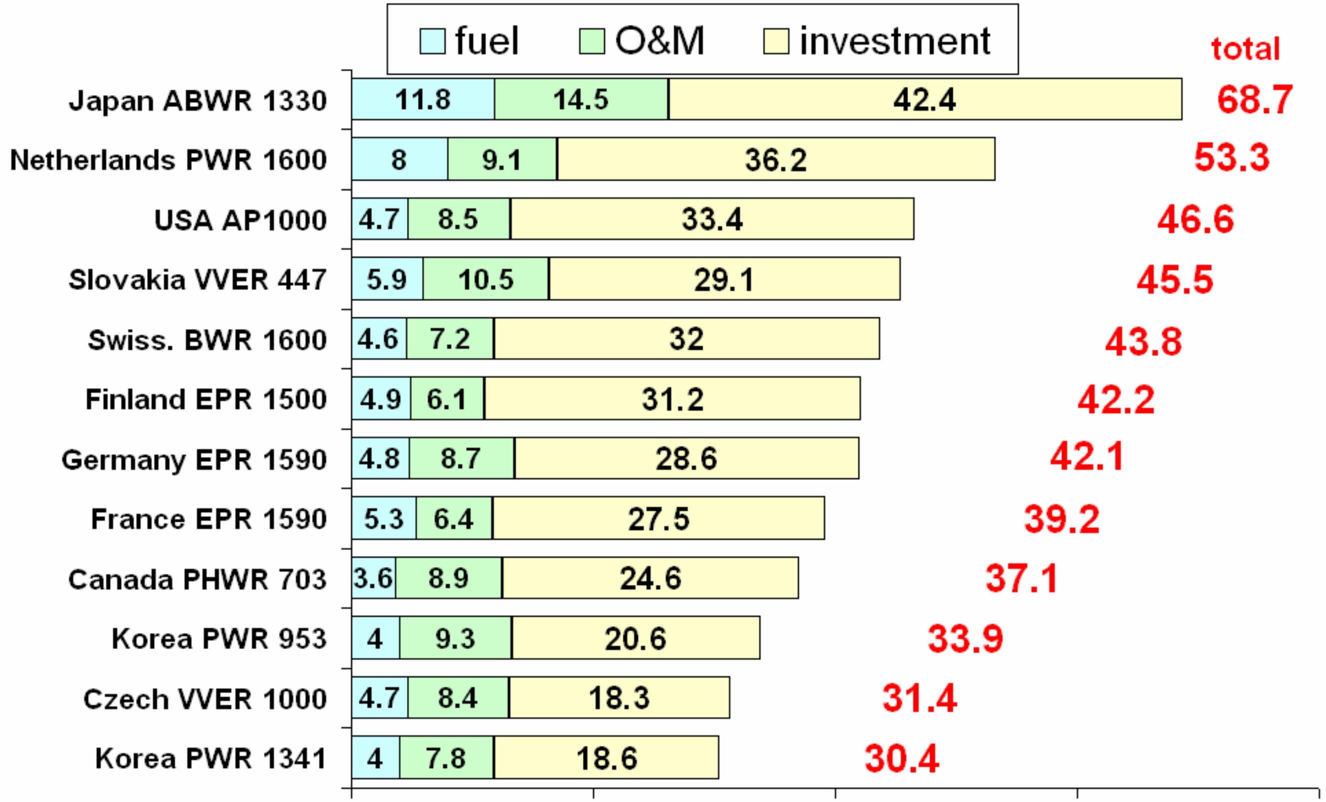
(Natural Uranium composed of 0.7% of U^{235} and 99.3% of U^{238})

1.3 Contribution of nuclear power
b) to competitiveness

- **Up to 2000-2002: US studies show a high cost**
  - ➢ Cautious approach, remembering the failures of the 1980s
    - escalation of overnight costs and construction times
    - contrast with French experience (around 50 plants commissioned within 10 years)
- **In past 2 years, US range have moved down** (now nearer to costs in Europe)
  - ➢ Reflect a change in the industry, knowing how to draw lessons from the past
  - ➢ *Under appropriate industrial & regulatory conditions, the overnight investment costs and construction times can be controlled*
- **Cost of least expensive available technolgies**
  - ➢ Coal is competitive … when there is no CO_2 cost
  - ➢ Gas is no longer the cheap technology of the 90s

EDF

1.4 Current forecasts: OECD-NEA-IEA data (2005)



Levelized cost of nuclear power at 10% discount rate in $US 2003 / MWh

Forecasts provided by National Public Administrations (Hypotheses of OECD-NEA-IEA report: discount rate: 10% in real terms, with variant at 5%, lifetime 40 years, load factor 85%)

Globally, costs are less than $50 /MWh, which is competitive with costs of coal or gas plants without CO_2 cost

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Lessons learnt & conditions of success

2. Lessons learnt & conditions of success (1)

- **Define a sound, long-term, stable non- (or bi-) partisan energy policy, to which stakeholders can refer with confidence**

- **Safety must be the top priority**
  - Ensured by control by an independent safety authority with the requisite competencies, & responsible operators with an established safety culture and review processes

2. Conditions of success (2)

▪ Competitiveness: depends on sound industrial & regulatory frameworks

- Clear & consistent procedures for licensing design & authorisation procedures for siting ➔ favor long term visibility
- Standardization and building in series will enable industrial operators to benefit from economies of scale and to control costs and construction deadlines

▪ Stakeholders participation in structuring choices to address legitimate concerns about waste management and the safety of installations

- In France, regular meetings of local information commissions near nuclear plants since 1977 ➔ local authorities, NGOs and EDF can address these concerns
- 2 recent public debates: on the construction of a new EPR plant in Normandy and on nuclear waste
- The democratic processes implemented in Sweden and in Finland to take decisions on nuclear waste management point to other interesting approaches

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Financing nuclear investment

3.1 Nuclear investment in the new context of liberalized electricity markets: what are the risks? (1)

a) Risks related to the volatility of electricity prices

Intra-annual volatility and tight demand-supply balance

- primarily affect revenues of peaking units and revenues of baseload plants for only a small share

Risks on annual electricity price over the years

- Merchant plant is not an easy model: CCGT in the US was the major technology to be affected by this risky model
- Nuclear can rely on alternative appropriate models

b) Industrial risks on investment costs

are related to the control of the initial overnight costs & construction lead times of complex technologies (nuclear as well as others)

- Pipelines and LNG terminals for gas
- Industrial uncertainty of CO_2 capture & storage for future coal plants
- Nuclear: lessons from success (France, Belgium, Scandi-navian countries,...) and failures (UK, last US plants in the 80s)

3.2 Nuclear investment in the new context of liberalized electricity markets: what are the risks? (2)

c) Regulatory risks: the main cause of recent crises

Energy and financial crises in California (2000-2001), blackouts New-York (2003) and Italy (2003)

- **Lack of coordination between TSOs (Transmission System Operators) and lack of interconnections**
- **Lack of visibility on long term (10-15 years) electricity supply-demand balance at regional (inter-States) levels**
  - **improve UCTE analyses; extend current national report (7-year Statement from NGC in UK, Generation Adequacy Report from RTE in France) at the European level?**
- **Price-cap and regulated tariffs artificially low that don't allow for the recovering of full costs**
- **Lack of visibility on G & T siting authorisation procedures**
  - **increase the impact of Nimby issues**

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Industrial, Institutional and Political conditions for Renaissance

4.1 Political, Institutional & Industrial Conditions

With thorough governance & appropriate organisational framework, nuclear power can make a key contribution to a sustainable global energy agenda, and should play a key role in a balanced energy policy along with energy efficiency, renewables and clean coal with carbon sequestration

Conditions for successful nuclear power: summary

- **Safety at the top**
- **Stakeholders involvement**
- **Nuclear, more than other technologies, needs a sound, long term, stable and non partisan energy policy**
- **Risks on electricity markets: most required conditions are common to the new baseload power plant technologies, and higher to peak units**
- **Industrial and financial conditions**
  - Large industrial players able to standardize & master total costs of technologies
  - Appropriate WACC
  - Financial design or organizations that provide immunity to interannual price cycles

4.2 IEA World Energy Outlook 2006 Capacity perspectives

	2004		2030 Reference scenario		2030 Alternative policy scenario	
	GW	%	GW	%	GW	%
World	364	9	416	5	519	7
USA	98	10	111	8	127	10
Japan	45	17	66	22	71	26
EU	131	18	74	6	107	11
Russia	22	10	35	12	40	15
China	6	1	31	2	50	4