NUCLEAR POWER DEVELOPMENT IN THE CURRENT ECONOMICAL CONTEXT

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The paper is aimed to provide an overview of the status of the nuclear industry in the framework of the actual economic and energy environments outlining main paths forward, some of challenges, new approaches and developments, with a focus on financing and management of some of new construction main risks, to further catalyze nuclear power contribution to the world energy mix of the 21st century.

Keywords: nuclear, power, development

1. Introduction

In the context of increasingly open electricity markets and the "unbundling" of generating companies from former utility monopolies, nuclear power has to compete directly with other electricity suppliers. In this way the market risk for the energy companies is increasing, although the request for electricity will continue to increase.

International capital markets were globalized and became more competitive. There was developed a diversity of new instruments and financing schemes in order to assure investors a higher profit and to attract more investors. The biggest recent change - one which nobody could have foreseen some years ago- has been the global economic crisis. There is much discussion about what effect this unprecedented crisis will have on plans for nuclear energy.

The present article is intended to present the status of the nuclear energy issue, the possible impact of the current economical problems on the nuclear development programs and some new approaches on managing the specific commercial and financial risks related to the contracting and financing nuclear projects in the present economical context.

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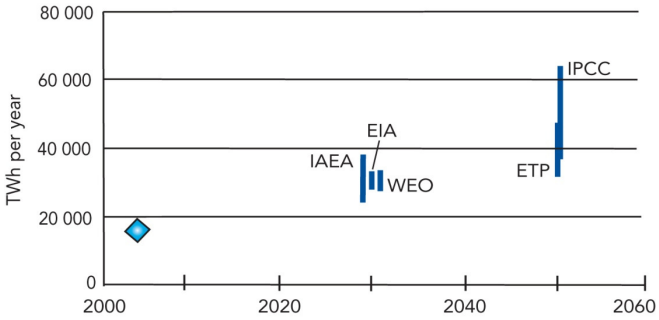
2. International Energy Context

The current forecast of energy and electricity demand evolution, fueleld by strong economic growth in many developing countries and a projected 50% increase in the world population, shows an increase of up to 100% energy and up to 150% electricity, while CO_2 emissions per unit of energy consumption must be reduced by a factor of 4. The world needs more energy with less CO_2 emissions.



Legend

EIA- International Energy Agency
WEO- World Energy Council
IPCC –Intergovernmental Panel on Climate Change
ETP-Energy Technology Perspectives

Fig. 1 Projected increase in electricity demand worldwide (OECD) [1]

The main characteristics of the energy problem at the beginning of the 21st century are: security of supply, competitiveness and no CO_2 emissions. Electricity actually contributes worldwide with about 40% of the CO_2 emissions associated to energy.

There are three ways forward, none of them sufficient by itself: Energy Efficiency/Conservation (Behaviour + Technology), Energy Mix Diversification (Nuclear + Renewables) and Upgrading + Carbon Capture and Storage (CCS) when mature (coal is back).

The main drivers for the renewed interest in nuclear energy are: oil and gas are becoming scarce and expensive, the need to diversify energy supply sources for the security of supply and CO_2 emissions neglectible.

Under these circumstances nuclear energy has a strong potential to play an important role in the future energy mix. About 20 countries are now seeking to develop nuclear power programmes. Nuclear will only be part of the big picture if the entire nuclear industry gears up to the challenge now.

On short term the most immediate effect of the financial and economic crisis on the power sector has been a lowering of electricity demand, particularly in industrial applications, in almost all countries, estimated at 3.5% in 2009, the first decrease in global electricity demand since 1945. Estimations have suggested that new power plant orders worldwide could fall by as much as 50% in 2009, although large equipment manufacturers have quoted figures closer to 30% [2]. It

is broadly accepted that, in the medium and long term, global demand for energy will continue to increase significantly as countries everywhere seek to improve living standards.

3. Nuclear Industry Status and Prospects

Currently there are in operation 436 nuclear power reactors, in 30 countries, with a total nameplate power of 370 GWe, providing about 16% of the electricity generated worldwide, and providing around half of the electricty produced without CO2 emmissions. In Europe nuclear provides 31% of the total electricity production and more than 50% of the baseload one.

In construction phase there are 55 nuclear reactors, out of which 8 in European Union (Bulgaria -2, Finland -1, France-1, Romania -2, Slovakia -2) with a total installed power of 48 GWe.

It is to be mentioned that during 1990–2004, the total increase in nuclear electricity output was approximately 714 TW·h (approximately 40%) due to a combination of three factors — an improvement in the availability of existing power plants, new construction, and uprating of existing power plants. Improved availability factors were the leading contributor (improving from 72.3% to 83.2%), accounting for 57% of the increase. Next in importance was new construction (36%) and finally plant uprating (7%) [3].

2008 was the first year since 1955 without at least one new reactor coming on line, but there were ten construction starts, the most since 1985.

The nuclear reactor industry has been continually restructuring and consolidating, and currently we have a relative small number of commercial nuclear power plants suppliers (Fig 2). China jointed the nuclear power plants exporting countries and India will join soon as it signed the NPT Treaty.

Nuclear Safety is a paramount for an effective nuclear power programme. Operational safety indicators, such as those published by the World Association of Nuclear Operators (WANO) improved dramatically in the 1990s (–two of them are shown in Fig. 3).

Currently there is a transition to the 3rd generation of nuclear reactors which is a further development of the generation II designs incorporating evolutionary design improvements, including sixty year life; inclusion of safety and reliability considerations at the earliest stages of design; safety system design guided by risk assessment; simplicity, by reducing the number of rotating components; increased reliance on passive systems; addition of severe accident mitigating equipment; complete and standardized designs with pre-licensing and core damage frequency in the range of 10-6 to 10-7 significantly lower then for the reactors built in the ’80-90s (Fig 5).

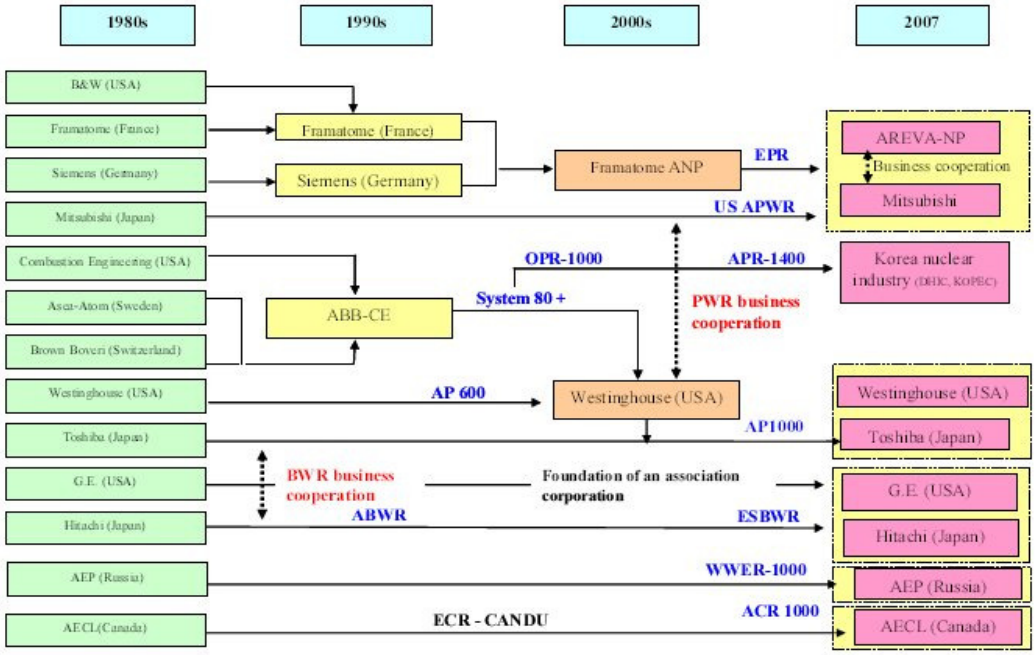


Fig. 2 Evolution of the nuclear reactor industry (IAEA) [4]

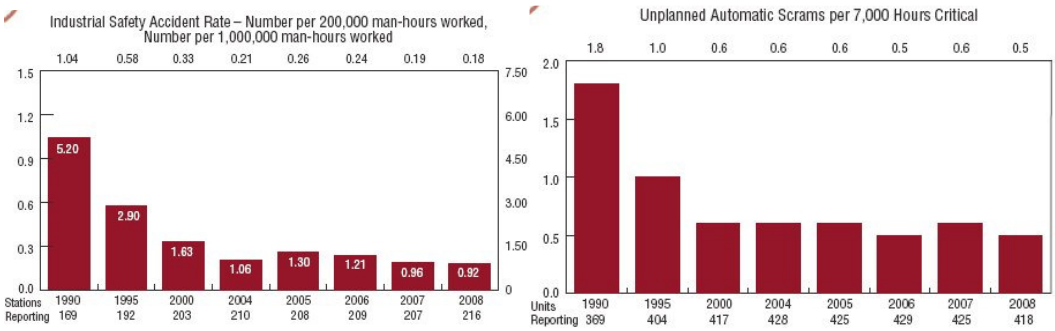


Fig.3 Industrial Safety Accident rate and Unplanned Automatic Scrams (WANO) [5]

In accordance with the forecasts made by IEA, in 2050 we'll have a capacity of between 600 GWe (low scenario) and 1400 GWe (high scenario) installed in nuclear power plants. The same trend is reflected also in the IAEA forecasts for 2030- 500 GWe and respectively 800 GWe (high and low scenarios). This last one, which represents a two fold increase of actual installed power, implies a pace of construction of about 20 units of 1000 MWe each, a pace the nuclear industry was able to deliver in the past. All these projections were made before the financial crisis in late 2008. Currently, no projections had been published considering the consequences of the crisis for nuclear power.

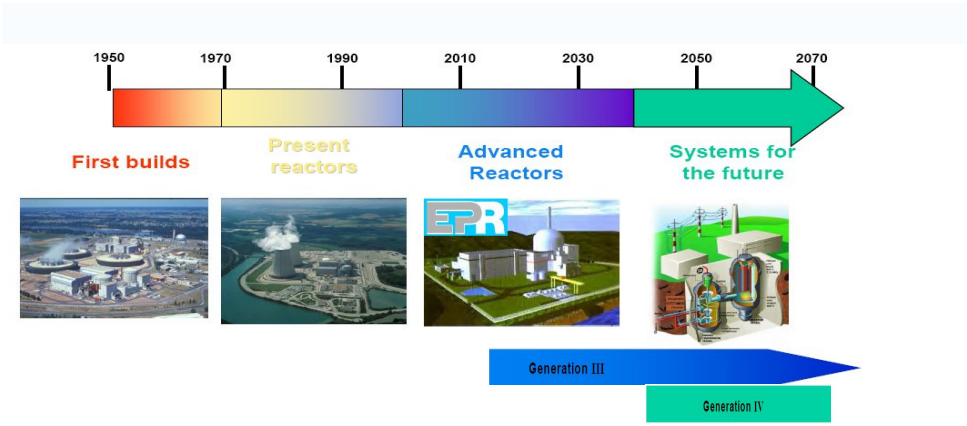


Fig. 4 Evolution of the nuclear reactor technology

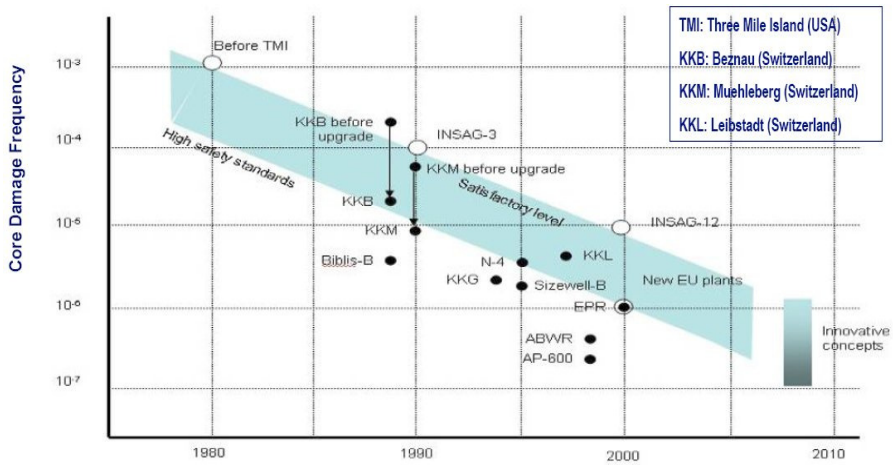


Fig. 8 Evolution of the core damage frequency requirements [6]

In Romania, SN Nuclearelectrica SA (SNN), a state owned company, operates 2 Candu Units at Cernavoda (the only nuclear power plant in Romania), 700 MWe each, generating about 18% of the total electricity consumption. In accordance with the National Energy Strategy, there were selected 6 investors (Arcelor Mittal, CEZ, GdF Suez, Enel, Iberdrola si RWE) which together with SNN established a new company EnergoNuclear, owned 51% by SNN, which is proceeding with the development of Cernavoda Units 3 and 4 business case with the objectiv to complete the units in 2015-2016.

To meet the requirements of the 21st century nuclear industry has to find right approach some important challenges: nuclear safety, waste management, Uranium resources, proliferation resistance, and implementation in developing countries, developing of adequate infrastructures and economic competitiveness and financing. In the next section the focus is on competitiveness and financing.

4. Economic competitiveness and financing

The economic challenges of nuclear power relate to investment funding rather than the levelized cost of generation [7].

NEA's 2005 international comparison of the levelized costs for nuclear, coal and gas power plants [8] showed nuclear to be competitive with coal and gas, with some dependence on local circumstances; since then, oil prices have quadrupled (June 2008) and currently are almost double, with other fossil energy prices following them upwards. The European Sustainable Electricity (EUSUSTEL) Study [9] on Comprehensive Analysis of Future European Demand and Generation of European Electricity and its Security of Supply for the period 2010-2030 for EU25 shows that nuclear electricity generation is projected to stay the most competitive technology till 2030.

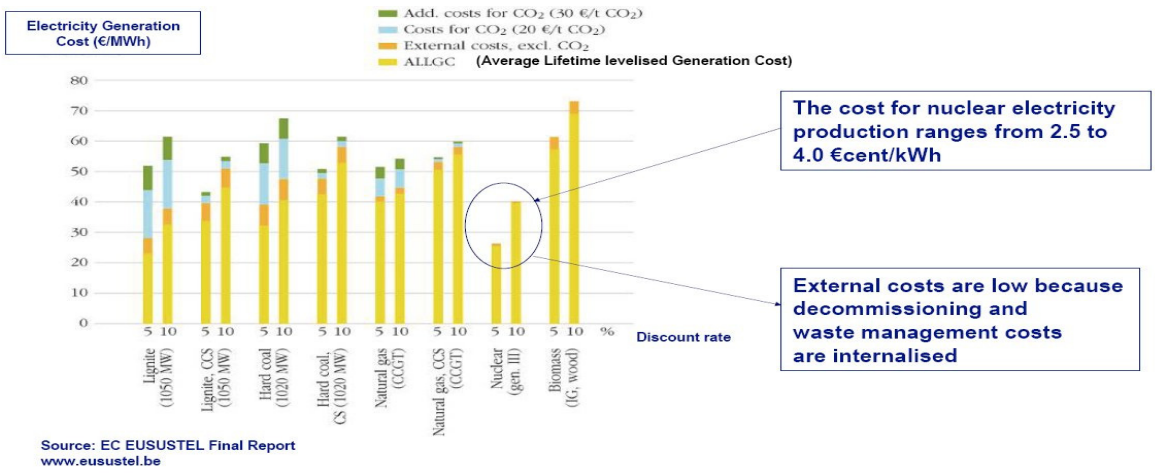


Fig. 9 Total social costs for selected generation technologies [9]

The huge capital requirements combined with risks of cost overruns, regulatory uncertainties, long construction and capital recovery periods make investors and lenders very cautious, even when demand growth is robust. The industry is developing new approaches on contracting new built, financing and managing the risks to decrease their costs some of them being summarized below.

Sharing equity risk: increase number of the investors to share the project risk to include partners who could provide equity in kind, or for important customers to become shareholders as a way of ensuring security of supply (such as in Finland and Romania).

Phased financing: financing a project in stages – construction and operation – so the capital cost for each phase would reflect the risks only of that phase, so that the high costs of construction risks are not carried over throughout the operation stage. Once the plant completed, investor risks are essentially reduced to operational and market risks, much lower than construction one. Two financing phases may also have different capital structures. It may facilitate government participation in a private sector project, since a government could choose to finance or guarantee only a part of the project and then privatize its share of the plant [10].

Sharing the construction risk between owner and contractor: allocation the schedule and budget risk could make a significant difference in the overnight investment cost. In principle, risk is most efficiently allocated to the party that can best control the risk. Contractors are generally best equipped to absorb the risk of construction delays and owners and financial institutions prefer turnkey Engineering, Procurement and Construction (EPC) with fixed construction schedules and fixed price, however at a high price as EPC contractors end up with no asset: they view construction of the plant as a 'one shot' contractual opportunity for profit, with no later opportunity to recoup losses. If risks are assumed by the owners through a reimbursable or "cost plus" contract types, then cost of the risk might be lower as successful completion of the plant results in ownership of a profitable 60 year asset for the utility, for which it is appropriate to take key risks [10].

Unconventional contracting schemes: a) Engineering, Procurement and Contract Management (EPCM) type contracts: A professional services contract including design, procurement of materials /equipment and management and administration of the construction contracts. If compared with EPC, EPCM contractor is not a constructor but only Owner's agent who creates direct contractual relationships between the Owner and the suppliers/ contractors [11].

b) "Convertible" contracts: In order to overcome mainly the need for fast track execution under much larger project uncertainties, several owners and E&C Contractors, have started adopting hybrid, combined and "convertible" reimbursable/lump sum contracts for the execution of the entire Front End, some Detail Design (FEED)/EPC project sequence with the single E&C company under a single contract. Under these schemes, the initial project phases are executed on a reimbursable basis; at a certain point the contract is "converted" into a Lump Sum mode [12].

State warranty for the loans: In the United States, DOE provides guarantees, up to a certain ceiling, for the new build as incentives to take the risks associated with first-of-a-kind projects. At EU level state guarantees for electric utilities are considered state aid and permitted only under special circumstances.

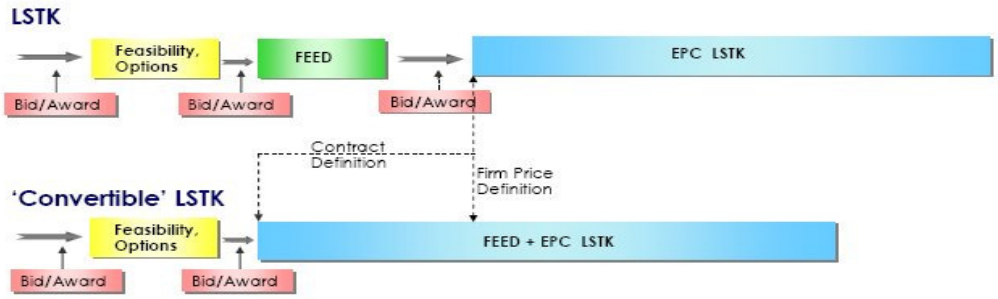


Fig. 10 Convensional Turnkey and Convertible Lump Sume Turnkey Approaches [11]

6. Conclusions

The world is gearing up to a larger use of nuclear energy worldwide and most of the expansion will come from highly populated developing countries, many of them "newcomers" in nuclear power business. Countries already operating large fleets of nuclear plants will increase their capacity with Gen III reactors and prepare Gen IV systems. Continues improvement through international cooperation, sharing experience good practices and lessons learned is a major key for increasing nuclear performance, including its economic competitiveness.

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