

AN OUTLOOK ON NUCLEAR ENERGY IN THE WORLD

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Summary

In order to give a complete overview on nuclear energy in the world, the following four different aspects are discussed:

- Nuclear scenario;
- Economic competitiveness of nuclear power;
- Radioactive waste management;
- Social aspects on nuclear power.

Reference is made to three international studies on the contribution of nuclear power to the world energy demand, each considering three different scenarios for economic growth. All the studies agree that coal will be the main source of the global power system until 2020. Reserves of fossil fuel are not an immediate constraint on utilization and economic development and nuclear energy development will be not very strong at least up to 2020. In the longer term, forecasts are rather comforting for nuclear industry; as long as we take climate change seriously, we'll need to rely more on nuclear.

From economical point of view, generation costs are then taken into consideration. Generally, total generation costs can be divided into four main components: capital investment, operations and maintenance, fuel costs, and a fourth part of waste disposal and plant decommissioning costs (this one only applicable to nuclear power plants). All these components are discussed in details mainly for nuclear generation. Total cost is then divided by the total electricity generated over the entire plant lifetime to finally obtain the generation unit cost. Comparison between nuclear power costs and other energy sources is then reported and two international studies are considered. Because of its higher capital investments, nuclear is advantageous if long-term operation can be assured. Another consequence of its capital intensive nature is that nuclear is particularly sensitive to the cost of money. The new sensitivity to global warming and the effort to come up with a new generation of advanced reactors, standardized and cheaper to build, should give nuclear power the opportunity of a second "renaissance".

An overview on what radioactivity is and what type of radioactive wastes are normally produced during a NPP operation is then reported. The problem of the disposal of radwaste is generally managed in the world with two different solutions: surface disposal is a good solution for short-lived low level waste, while long-lived high level waste need to be stored in a very deep and stable geological disposal. Advantages and disadvantages are presented for the two different solutions. Managing of waste is a crucial issue for the defence of the environment and for the future of the nuclear industry. Public opinion will require to know the solution for nuclear waste before accepting the renewal of the NPP park.

Finally, relationship between nuclear and public opinion are considered. Many nuclear projects commonly have to face barriers of resistance from the public and have to operate in a climate of suspicion. This will result in many blockages and delays. A significant gap between risk perception of the experts and risk perception of the public was observed resulting from a subjective, intuitive, emotional perception from the public.

Based on marketing approaches, risk communication has been an attempt to persuade people of correctness of the experts' point of view on risk, but communication is of little help when trust is lacking. The conflict linked to the question of nuclear power acceptability is a direct consequence of a context of decreasing confidence. Restoring this confidence implies rebuilding social trust between public and people running the nuclear system.

1. Introduction

The 1960's and 1970's were characterized by an impressive development of commercial nuclear power world-wide. By the end of the 1970's, 60% of the plants operating today were already fully completed and 80% of the rest had already been ordered. That means that 90% of what is currently in operation has its roots in the period before 1980.

At present, 434 nuclear units are operating in 33 countries and another 36 are under construction. An additional 24 units are either on order or in the final stages of planning, basically in Asia where the current economic crisis might slow down nuclear construction. Some 85% of the world's nuclear capacity is located in 16 countries of the OECD.

In Western Europe the numbers for units in operation or under construction are 153 and 1 respectively, and in Eastern Europe, 66 and 26, totaling 219 and 27 for the whole of Europe. In other words, half of the units now in operation or under construction in the world are located in Europe, but non new nuclear power plants are being seriously contemplated for the immediate future, with the possible exception of four Russian units, two Ukrainian units (Rovno 4 and Khmelnytsky 2) and moderate prospects for a fifth Finnish unit. The share of nuclear power in electricity generation is about 35% in Western Europe, being 25% for the OECD area and 16% for the whole world.

2 Nuclear Scenarios Studies

Several studies have been internationally developed about the contribution that nuclear power can make to face the world energy demand in the next decade taking also into account the environmental issues related to the energy consumption.

Three of the most complete of these studies are:

- *International Energy Outlook (IEO) 1998*, published by the US Department of Energy along with the associated study, the *Nuclear Power Generation and Fuel Cycle Report 1997*;
- *Global Energy Perspectives to 2050 and Beyond* undertaken jointly by the International Institute for Applied Systems Analysis (IIASA) and the World Energy Council (WEC);
- *Energy Technology Strategy 1995-2030: Opportunities Arising from the Threat of Climate Change*, undertaken with financing from the European Commission (EC).

The IEO98 study employs three scenarios for economic growth and three independent scenarios for the development of nuclear power. The underlying assumptions for the nuclear scenarios are:

- the base-case reflects present retirement policies and construction programs;
- the low nuclear case reflects more rapid retirement and slowdown in construction;
- the high nuclear case assumes that the lifetime of existing plant is extended by ten years.

The WEC study involves three main scenarios described as:

A: High Growth

B: Middle Course

C: Ecologically Driven

Scenario A has high growth leading to a rapid turnover of capital stocks.

Scenario C is optimistic about technology and assumes unprecedented economic co-operation on environmental protection. It incorporates policies to reduce global carbon emission to 2 Gt. per year in 2100.

In the third study the base case is intended as a median case in that in every respect the upside should be as probable as the downside. It envisages no major fuel price shocks with fuel oil prices rising steadily to US\$ 31 in 2020. The other scenarios in this study are derivatives of this base case. The changes introduced in the variant scenarios are mostly in the sense of a greater development of respectively, the nuclear power (Nuclear Scenario), the gas (Gas Technology Scenario) or the Renewable Energy.

The assumptions regarding economic growth in the different studies are hard to compare in detail because they vary with time and region, but some general trends are evident. The IEO and EC studies have global growth of somewhat more than 3% per annum with the highest rates in developing countries and growth dropping to around 2% in industrialized countries. The middle-course scenario of WEC is less optimistic; it assumes a 2.2% global growth to 2020 and 2.0% from 2020 to 2050; it is consistent with the other studies in that it foresees the highest growth rates in the developing world.

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Biographical Sketch

Giancarlo Bolognini is Chief Executive Officer of SOGIN, the Italian company responsible for the decommissioning of the Italian nuclear power plants and the management of the radioactive waste. After a degree in Mechanical Engineering (1965) and Nuclear Engineering (1968) in Rome University, Mr. Bolognini had experiences in conventional (CTIP, company of design of petrochemical plants) and nuclear plant engineering and design (ENEL, Equipment Direction: design of nuclear power plants; EDF, (Electricity of France): design and building of Creys Malville nuclear power plants in France), budgeting, programming and control, procurement, technical economical and financial management of industrial companies (SOGIN Administration and Finance Director). Mr Bolognini also covered many tasks in national and international organizations: member of Euratom Advisory Committee, chairman of TPEG (advisory organism of EC about Nuclear Programs of the eastern European Countries), member of the Executive Board of NERSA (European Company for the building and operation of the Creys Malville NPP), member of the Board of Directors of WANO (World Association of Nuclear Operators) of Paris, member of the vigilance advice of OPEN (Organisation des Producteurs d'Énergie Nucléaire) of Paris, manager memberships in other organisation as: EURELECTRIC Nuclear Committee, NEA OCSE's Nuclear Agency, ENS European Nuclear Society, AIN Nuclear Italian Association, FORATOM European Forum of industrial Companies.