THE ROLE OF NUCLEAR POWER IN SUSTAINABLE ENERGY STRATEGIES

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The purpose of this paper is to provide an overview of future demand outlooks for energy, electricity and nuclear power, as a background for discussion of the design and operation aspects of advanced nuclear power systems. The paper does not attempt to forecast the actual outcomes of nuclear power programmes, since this will depend upon many factors that cannot be predicted with certainty. Rather, the paper outlines the size of the opportunity for nuclear power, in terms of the expected growth in energy and electricity demands, the need to diversify energy supply options and substitute depletable fossil fuels by other energy sources, and the need to mitigate health and environmental impacts including in particular those arising from the atmospheric emissions from burning of fossil fuels.

During the last decades, world energy consumption has grown steadily and the share of primary energy used for electricity generation has increased in all regions. Since economic development and improved quality of life are closely linked with the services made available by energy and electricity, the demand for both primary energy and electricity will continue to increase, especially in the developing countries. Although changing consumption patterns and lifestyles are likely to lead to more sustainable policies aiming towards demand management and natural resource conservation, population growth, urbanisation, industrialisation and improved living standards will be driving forces for continued increase of energy consumption. Against this background, the results from a number of recent major studies are outlined below.

The World Energy Council (WEC) Commission recently completed a study on "Energy for tomorrow's world - the realities, the real options and the agenda for achievement", which will be officially published in September 1993. Results from the study were reported at the 15th WEC Congress held in Madrid in September 1992, focusing on three projections for energy demand to 2020 [1]. In all three cases energy intensity is assumed to decrease (i.e. the efficiency of energy use will improve) steadily worldwide; however, due to the driving forces outlined above, the total energy demand continues to grow from 1990 to 2020, the increase ranging from a low of about 30% in the "Ecology Driven" case to a high of 95% in the "Enhanced Economic Development" case. Electricity generation is estimated to grow at a rate even higher than total energy demand in all three cases, and nuclear power is projected to increase its share of primary energy supply worldwide.

The Senior Expert Symposium on Electricity and the Environment [2], held in Helsinki in May 1991, developed two outline scenarios for energy and electricity demand to 2050 . In the "Targeted Growth" scenario, the energy demand increases by 135% from 1990 to 2050; in the "Targeted Efficiency" scenario, although energy consumption per capita decreases substantially in industrialised countries and only doubles in developing countries, total energy demand increases by 45% by 2050. Electricity demand growth rates from 1990 to 2050 are respectively 2.2% per annum and 1.4% per annum in the two scenarios. In both scenarios, the energy supply shares of non-fossil sources, i.e. nuclear power and renewable sources, increase substantially.

The scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) [3] give a broad range of possible futures until 2100, based on various assumptions regarding population and economic growth. All the scenarios indicate some increase of the energy demand worldwide, even when "environmental protection" policies and measures are assumed to be successfully implemented. Moreover, only the scenarios assuming a large development of renewable sources and nuclear power lead to a stabilisation, or a marginal decrease, of carbon dioxide emissions in 2100 as compared to the level in 1990.

Health and environmental concerns are high on the international agendas and are sharpening, as there is more evidence of the impacts of human activities on ecosystems and human health. The Rio Declaration on Environment and Development and the Agenda 21 [3], adopted by the United Nations Conference on Environment and Development (UNCED) in 1992, highlight the need to achieve sustainable development by integrating environmental protection in the development process. Agenda 21 stresses the importance of developing increasingly efficient and less polluting processes for energy production. In this connection, the report of the Panel on Energy of the World Health Organization (WHO) and the conclusions and findings of the Helsinki Symposium [see 2] stress the benefits on health and the environment from an increased use of electricity.

The heightened awareness and concern about health and environmental issues have already influenced energy technology developments and deployment strategies. Significant improvements have occurred over the last years in energy production and use policies, including the development of abatement technologies, the implementation of demand management measures and the deployment of more environmentally benign energy chains. Substituting electricity for other energy forms has proven to be an efficient strategy for reducing the environmental impacts from energy production and use [4]. Emissions from fossil fuelled power plants, impacts and risks of hydro power development and safety of nuclear facilities are significant issues which have generally been comprehensively addressed by scientists, technicians and decision makers. When fitted to state of the art technology, all electricity generation chains are able to deliver electricity at relatively low risks to health and the environment.

Sustainability is likely to be a major driving issue for the development of technological options and in the choice of energy mix strategies in the electricity sector worldwide. However, the cost of electricity generation will remain a cornerstone for planners and decision makers in evaluating different options. Recent studies [5,6] show that in many countries nuclear power is the cheapest source for base load electricity generation, especially where solid mineral fuels are not accessible at low production costs. Gas is emerging as a competitive option with the development of highly efficient combined cycle technologies, assuming that gas prices will not increase too rapidly. Renewable sources still require considerable development efforts to reach competitiveness with fossil fuelled, nuclear or large hydro power plants. While renewable sources have an important role to play for supplying electricity in rural areas and geographic locations where grid connection is not the optimal economic solution, they are not likely to contribute substantially to the supply in urban areas and industrialised zones.

Other factors that will influence future strategies in the energy and electricity sectors, besides health and environmental issues mentioned above, include macro-economic and social impacts. Nuclear power offers some benefits in terms of energy independence, stability of fuel cost, contribution to national technological development and highly qualified manpower education and training [7]. Such advantages, combined with the avoidance of health and environmental impacts of fossil fuel burning, are important factors in the assessment of the nuclear option as compared to other electricity generation chains.

The development of advanced nuclear systems will contribute to broaden the potential market for nuclear power and to facilitate its deployment worldwide. New designs under development include reactors of smaller size adapted to countries where the demand for additional capacity in small in absolute value. Advanced systems with simplified designs and more passive safety features will have easier operating and maintenance procedures. Moreover, improved technical performance will leading to reduced costs of investments, operation and maintenance and fuel cycle services.

International co-operation will be essential to facilitate the assessment of the nuclear option, and the planning and implementation of nuclear programmes in countries where it will be assessed as a viable option. Technology transfer and adaptation will contribute to capacity building in developing countries for implementing electricity strategies in line with the requirements for more services and for environmental protection.

The objective of sustainable development can be achieved only through electricity generation strategies relying on a mix of all the options available, based upon a comprehensive comparative assessment incorporating technical, economic, health and environmental parameters. Nuclear power is the main non carbon emitting option that is commercially available, economically competitive and could be deployed on a broader scale. Technological progress should aim towards enhancing the performance of nuclear power plants and enlarging its potential market share in electricity supply, as part of a global strategy for sustainable development in the electricity sector.

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