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Necessity of nuclear power for Pakistan

By

ENGR. ARSHAD M. KHAN

Pakistan Atomic Energy Commission, Islamabad

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Arshad M. Khan*

INTRODUCTION

Pakistan is passing through a phase of socio-economic development, for which Government of Pakistan is, very rightly, emphasising on industrial and rural development. But these ambitions can only be fulfiled if adequate energy supply is ensured at reasonable costs. For the last few years, Pakistan is facing acute shortages of energy supplies, particularly of electricity, which are not only hampering the economic gwoth but are also creating social unrest by affecting the general population. At the same time the oil import bill has been consuming 50-70 per cent of our exports earnings, resulting in serious balance of payment problems. There is thus an urgent need to formulate well-considered long-term plans to cope with future requirements of energy and electricity that do not commit the country to a massive dependence upon energy imports.

EXISTING POWER GENERATION CAPACITY AND FUTURE REQUIREMENTS

The installed power generation capacity in Pakistan as of June 1986 was 6,225 MW, consisting of 2,898 MW hydro, 2,125 MW gas/oil steam, 1,050 MW gas-turbines, 15 MW coal and 137 MW nuclear. Due to seasonal variation in hydro generation capability (more than 50% reduction in relation to installed capacity during low water level months: March/April) this capacity was not adequate to meet the peak demand and load-shedding to the tune of about 800 MW was necessary.

The demand of electricity over the last 20 years has been growing at a rate of about 10.4% whereas growth rate of GDP during the same period was about 5.7%, resulting in an imcome elasticity of electricity demand as 1.8. For future estimates if we take the income elasticity of electricity demand as 1.3, in line with the World Bank estimates for oil improting developing countries, the capacity requirements for the year 2000 will be 18,5000 MW, 22,000 MW and 26,5000 MW corresponding to 5%, 6% and 7% GDP growth rates respectively.

In the following paragraphs, we will examine all possible options and analyse their potential for meeting the above estimated capacity requirements in the year 2000.

SUPPLY OPTIONS BASED ON FOSSIL FUELS AND HYDRO

Natural Gas: Our known reserves of natural gas now amount to 16.3 trillion cubic feet equivalent to about 290 million TOE. The present production is 950 million cft/day meeting about 38% of the total energy requirements. At present about 2500 MW power capacity is based on natural gas a part of which has to be operated on oil during winter when gas demand increases in other sectors. Further expansion in gas supplies is planned but its consumption will be restricted to more profitable uses such as in fertilizer industry. As such no gas fired capacity in excess of 2500 MW is planned/proposed by WAPDA overthe next 15 years. It may also be mentioned here that no significant additions to gas reserves have been made over the last 8 years inspite of increased exploration effort, with the result that the prospects of sizable gas discoveries in the foreseeable future are rather dim.

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Oil: The recent estimates of known oil reserves in Pakistan including those discovered in Southern Sind (Badin, Hyderabad) and North Potwar region amount to only 150 million barrles (22 million TOE). The present production is about 40,000 barrels/day which is equivalent to about 25% of the oil requirements of the country.

Although there has been a considerable increase in exploratory activity during the last five years (17 exploratory wells/year during each 1984-85 and 1985-86, as compared to 3-4 wells/year in he late 1970s), the present level still seems to be too low to lead to anything close to self sufficiency in oil by the year 2000. As such no hopes can be pinned to domestic oil for use in power generation in the coming decades.

Coal: Recent estimates of coal resources (including the indicated and inferred categories) in Pakistan are about one billion tons (equivalent to 300 million TOE) but the proven reserves are only 135 million tons (37 million TOE). Essentially all of the present production (about 2.5 million tons) is being consumed by the brick kiln industry. The Lakhra coal field with proven reserves of 110 million tons (about 30 million TOE) can support the 30 years operation of upto 700 MW power generation capacity. But the quality of coal at Lakhra is very poor: It is lignite with high ash, mositure and sulphur content, and with a BTU value equivalent to about 40% of that in good quality coal. Government of Pakistan with the help of US AID and the World Bank has recently carried out detailed feasibility studies for mine development and 600-700 MW power plant construction at Lakhra coal field. It was found that the levelized production cost of coal will be about $ 34/ton (equivalent to about $ 125/TOE and the electricity production cost will be 5.35 cents/KWh (all costs in terms of 1985 US dollars) which is about the same as estimated for power generation based on imported coal. As for use of imported coal for power generation the main bottle-necks are (i) shortage of port handling capacity (ii) inadequate railway facilities for up-country transportation of coal. Keeping these in view WAPDA's latest power system expansion programme envisages only 2000 MW capacity based on imported coal, all located around Karachi, to be built by the year 2000.

Hydropower: Pakistan's theoretical hydro power potential is estimated as about 35,000 MW of which 2,900 MW has already been developed, 3,100 MW is planned for development by 1995 through extensions of Mangla and Tarbela, while not more than another 10,000 MW potential would be economically exploitable unless the price of oil increases (in real terms) to two to three times the present price ($ 12/bbl). However, the exploitation of this additional potential is beset with several problems e.g. population dislocation, submergence of agricultural land, seismological activity, remoteness from demand centres, difficult terrain, impact on water flows to various provinces, strategic considerations etc.

A new dam (3600 MW) is planned for construction at Kalabagh site but the progress is held up due to some socio-political differences in opinion at national and regional levels. Even if these difficulties are sorted out soon and the actual construction starts without too much delay, it seems unlikely that more than the first stage of the dam (2,400 MW) would be completed by the year 2000. Another large dam (3,400 MW) is proposed for Basha site but it is still at pre-feasibility stage and its construction is not likely to start until mid-nineties. WAPDA is also planning to install about 400 MW capacity on canals by the year 2000. Thus, if all goes well, the total hydro capacity available in the year 2000 will be about 8,800 MW.

POWER SYSTEM EXPANSION UPTO YEAR 2000

From the above analysis it is quite clear that the domestic resources can at best be stretched to support about 12,000 MW capacity by the year 2000, consisting of 8,800 MW hydro, 2,500 MW based on gas and 700 MW based on domestic coal. In addition to this the existing oil-fired capacity of about 500 MW is also likely to remain operational by the year 2000. If the proposed plans for building 2000 MW capacity based on imported coal materialise the total capacity in the year 2000 will still be only 14,500 MW. This will be short by about 4,000 MW, 7,500 MW and 12,000 MW respectively compared to capacity requirements estimated for the year 2000, corresponding to 5%, 6% and 7% GDP growth rates. The only options available to Pakistan for filling this gap are to build either thermal power plants based on imported oil or to use nuclear power.

ECONOMIC COMPARISON OF OIL-FIRED AND NUCLEAR PLANTS

The recent slump in oil prices (from $ 28/barrel to $ 12/barrel within this year) has created doubts in some quarters about the relative economic advantage of nuclear power over electricity generation based on imported oil. However, as most of the experts all over the world feel the present low oil prices are a transitory phenomenon and that within a matter of next 3-5 years the oil prices in the international market will stabilise at 20-25 US dollars per barrel and increase thereafter at 2-3% per annum in real terms. Even if the oil prices were to remain around $ 12/barrel till 1993 (fuel oil to cost $ 125/ton including freight and port handling charges etc.,) the per unit electricity generation cost for a 900 MW nuclear plant starting operation in mid-1993 will still be about 7% lower than for an equivalent oil-fired plant. And if oil prices stabilise by 1993 around $ 29/bbl (fuel oil supply to power plant costing around $ 180/ton), the electricity generation cost from the oil-fired plant will be about 35% higher than that from the nuclear plant (see Table 1).

CONCLUDING REMARKS

The above analysis clearly shows that, inspite of a much accelerated effort towards their development, our domestic resources of fossil fuels and hydropower will not be able to cope with the country's requirements of power generation in the coming decades. With these resources being able to support only about 12,000 MW installed capacity in the year 2000, as against the requirements of 18,500 – 26,500 MW corresponding to GDP growht of 5-7% p.a., the capacity shortfall in that year will lie in the range of 6,500 – 14,500 MW. Assuming that the existing 500 MW oil-fired capacity will be kept operational and also coal-fired capacity based on imported coal will be developed, as per WAPDA's plans, to the extent of 2000 MW over the next 15 years, there will still remain a gap of 4,000 – 12,000 MW that will have to be filled either by building power plants based on imported oil or through the use of nuclear power.

It has been shown that even if the oil prices are to remain as low as $ 12-20/barrel in the year 1993, a 900 MW nuclear power plant starting operation in that year will still produce electricity 7-35% cheaper than an equivalent oil-fired plant using imported oil. Thus the use of oil for electricity generation will not only be more expensive, it will also increase the country's dependence on imported oil and make the economy vulnerable to possible future international oil-crises. It is, therefore, imperative for Pakistan to fill the expected capacity short-fall through the use of nuclear power to the maximum extent consistent with its technological capability and environmental and security considerations.

TABLE-1

Power Generation Costs for July 1993 PLANT Start up
(Costs in U.S. Dollars of 1993)

	Nuclear 973 MW	Oil-fired 882 MW
Specific Capital Cost $/KW	2,175	1,005
Generation Cost (mills/KWh)		
Fixed Charges		
Interest	36.36	16.88
Depreciation	0.87	1.04
O & M Cost	3.32	1.72
Fuel Cost	6.28	30.58[a]-44.94[b]
Total:	46.84	50.22[a]-63.68[b]

a) and b) correspond to Fuel Oil prices in 1993 as $ 125/ton and $ 180/ton respectively.

Assumptions:

Plant Factor 68.5%

Nuclear Fuel Costs in 1993 (assumed to remain the same as in 1986):

Uranium	$ 29.75/lb U_3O_8
Conversion	$ 5.5/Kg U
Enrichment	$ 125/SWU
Fabrication	$ 200/Kg.

Escalation Rate 6.5% p.a. from 1985 onwards for capital and O&M costs.

Interest Rates 9% for foreign component and 12% for local component.