STRATEGIC AREAS FOR NON-ELECTRIC APPLICATION OF NUCLEAR ENERGY IN INDONESIA

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Abstract

An attemp is made to identify strategic areas, whereby non–electric application of nuclear energy may be justified. Subject to further evaluation, particularly on the economic aspects, non–electric application of nuclear energy in Indonesia may have justfiable strategic role in the long term sustainability of the development of the country. The key arguments are: (a) within not too far distant future, domestic resources constraints of oil and natural gas will strongly be felt, especially if the current trend in the rate of production of the two commodities has to be maintained to satisfy the growing demand for energy and to secure foreign exchange earning; (b) nuclear option, in concurrent with coal and biomass options, can provide the need for heat supply required to undertake strategic schemes for (i) improving oil production capacity, (ii) prolong the availability of oil and natural gas by displacing their uses as heat sources in industry, whenever appropriate, (iii) coal conversion to synthetic natural gas (SNG), or synthesis gas, to substitute or at least supplement the use of natural gas as industrial chemical feedstock, and (iv) sea water desalination by evaporation, to overcome shortage of fresh drinking and industrial water supply, as well as to secure its reliability and availability. In terms of carbon emission to the atmosphere, the nuclear option offers an interesting choice.
In view of those, serious consideration for futher technical assessment, and thorough evaluation on the economic viability and social acceptability for the option is recommended.

INTRODUCTION

Within not too far distant future, domestic oil and natural gas resource constraints will strongly be felt by Indonesia, especially if current trend in its rate of production has to be maintained to satisfy domestic oil and gas demand and generation of foreign exchange revenue. Coal is anticipated to be the lead fuel of the Indonesian energy mix in the next century.

The above picture can be appreciated by recognation and observation of the following:

(a) the endowed energy resources of Indonesia; as is shown in Table 1, coal is the most abundant among the prime fossil fuels (i.e. excluding peat).

Table 1. Estimated energy resources of Indonesia (*)

Oil	*48.4 billion barrel*
Gas	*216.8 TSCF *)*
Coal	*36 billion tons*
Peat	*200 billion tons*
Geothermal	*16000 – 19000 MW*
Hydropower	*75,000 MW*
Biomass	*1.035 x 10^6 km^2 forest area, and*
	52.37 mtoe/yr (1990) agro & silviculure wastes
Tidal, wave and ocean thermal	*identified*
Wind	*prospective*
Radio active minerals	*indicated*

(*)Source: CRE–ITB Energy Data, colleted from various sources.

(b) the development of the share of oil and natural gas in the Indonesian energy system for the past 25 years and in the projected 6th Five Year Development Plan, as can be seen in Figure 1 and Figure 2 the two energy commodities occupy a dominant role;

(c) the determining role of oil and natural gas to the sustenance of the Indonesian economy in the past 25 years, i.e. with an annual average GDP growth of 6.8%, the share of the oil and gas sector to the GDP was 24% in 1981 and declined to 13% in 1992, while the export share was 80% to total export earnings in 1981, and dropped to 25% in 1992 (1); even though it is declining, the shares are still very substantial, and in the immediate future, oil and gas will still be determining factors to the economic development of the country.

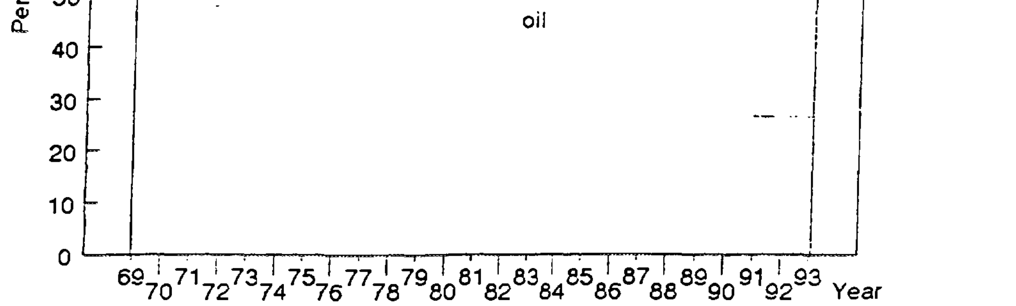

Figure 1. Primary (commercial) energy consumption in the 1st Long Term Development Cycle, 1969–1994
Source: DJLPE, 1994

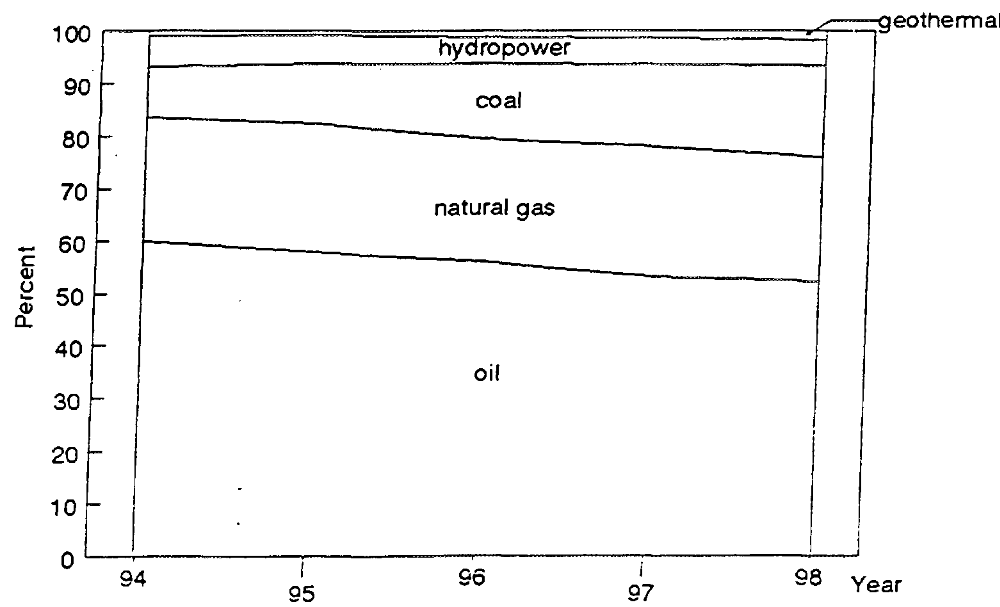

Figure 2. Projected (commercial) primary energy consumption in the 6th Five Year Development Plan, 1994/95–1998/99
Source: DJLPE, 1994

(d) the results of various studies on the Indonesian possible energy futures (2,3), from which one can see that, typically the projected energy mix has a pattern as shown in Figure 3, where the share of coal is wedging as one moves futher into the future; the projected scenario also indicates a fast decline of oil and natural gas resources, if current export rates of oil and natural gas is maintained, as can be seen in Figure 4 and Figure 5.

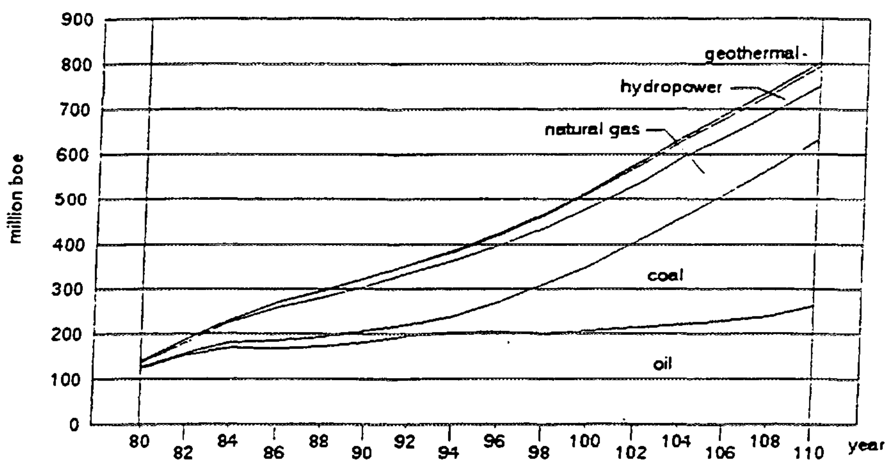

Figure 3. Scenario projection of primary energy supply
Source: Reference 2.

In view of the above observation, aside from conservation measures, investigating and finding avenues to control the rate of use of oil and gas by way of introducing alternative resources to replace their role in the energy and non–energy uses is therefore very relevant with respect to the sustainability of the development of the country and its energy security.

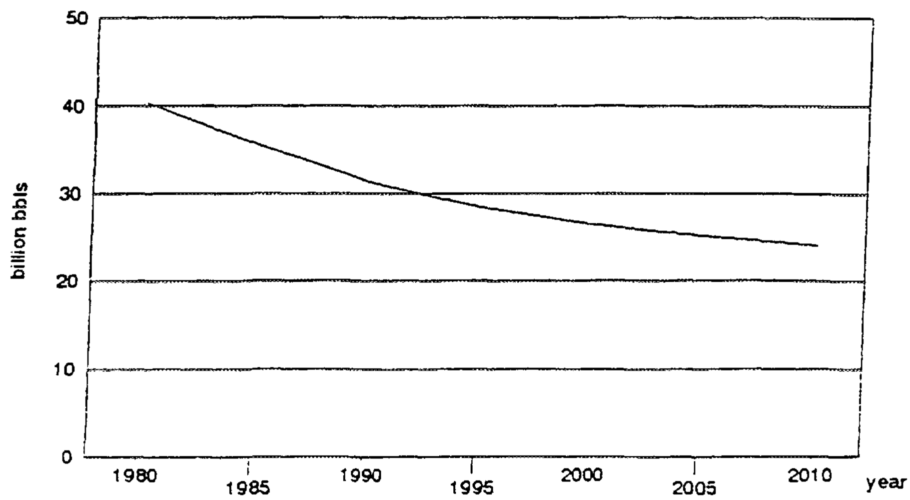

Figure 4. Scenario projection: decline in oil resource
Source: Reference 2.

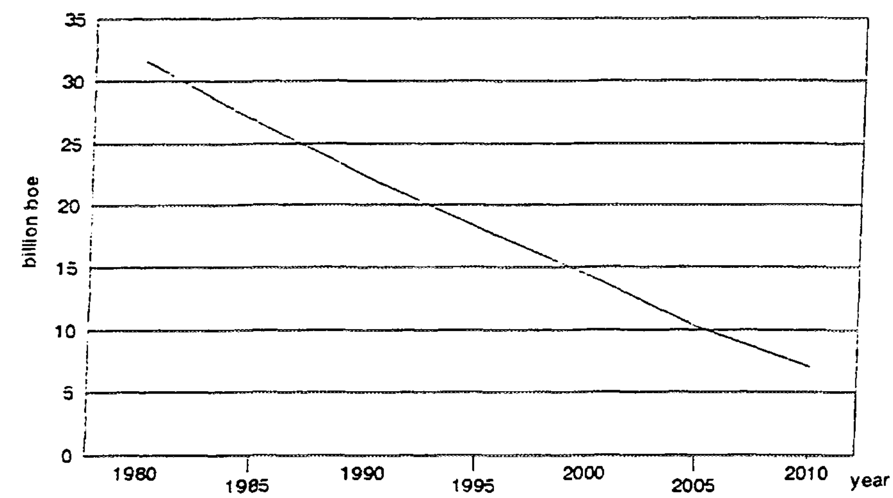

Figure 5. Scenario projection, decline in natural gas resource
Source: Reference 2.

STRATEGIC AREAS FOR APPLICATION OF NUCLEAR HEAT

Although coal can be expected to assume the role as the future major energy supply of Indonesia, there will still be gaps in satisfying the needs of the industry for natural gas as chemical feedstock, and the demand for liquid fuel in the transportation sector. Furthermore there is a global concern on the increasing carbon accumulation in the atmosphere that to some extent impose constraints to direct coal burning.

In response to those developments, there are alternative means that Indonesia can consider and prepare herself to undertake:

a. Implementing enhanced oil recovery procedures to extract remaining oil that are still in place, when such undertaking can be carried out more economically compared to other options, like import of oil.

b. Prolong the availability of oil an gas by way of diversification and conserving the use of oil and gas, not only through demand management and efficiency measures, but also by replacing their functions as sources of heat supply to the industry;

c. Substitute or supplement the use of natural gas as feedstock to the chemical industry, by way of coal conversion to synthetic natrural gas (SNG), or synthesis gas that presently are produced through reforming of natural gas.

All of the mentioned schemes would require substantial heat sources to implement. The use of oil or natural gas to supply such demand, even though could be justified from purely economic consideration, is a self defeating excercise with respect to the underlying motives that was taken as the base for the listed undertakings.

Since for all the above purposes, relatively high temperature heat is required, alternative options that technologically can be considered are to use coal, biomass, nuclear, and solar energy. The technology for the solar energy option, however, is a much more remote choice as compared to the first three. Without implying the elimination of the coal and biomass options, only the nuclear option will be discussed, for the obvious reason that this presentation is addressed to a meeting on non–electric uses of nuclear energy.

Aside from the mentioned area, there is another area whereby non–electric application of nuclear energy could be justifiably considered, namely the supply of clean, fresh water. Clean water supply, either for household, public uses, and industrial uses, as well as in steam power plants is increasingly becoming a serious problem, particularly in densely populatedareas in Indonesia, like in the island of Java, as well as in areas where large industrial complexes are developed and operated.

The water supply problem is partly due to lack of adequate infrastructure for water supply in urban and other settlements. This has triggered wider problem, since the situation leads to wide spread exploitation of deep ground water to fill the large gap in need for water. Another reason is plainly the unavilability of a reliable rate of water supply for large scale and continuous water use of industrial complexes. The problem is also aggravated with the accelerating rate of pollution of surface inland water (rivers, lakes, water ways), and certain costal sea water.

Before massive cleaning operation of those polluted waters can be successfully undertaken, which is not only costly but also socially complex, desalination of sea water is practically the only available option(*). As was previously the case, nuclear generated heat supply is an option that one can justifiably choose, since the need for fresh clean water is a basic need. All steam power stations in Java, as well as refinery and fertilizer plants in East Kalimantan and some other places rely on such installation for their water needs. Oil and gas are currenty used. In some cases, with proper configuration, the supply of heat for water desalination can be a downstream operation of a high temperature process, like reforming, or power plant operated on supercritical steam.

POTENTIAL DEMAND FOR POSSIBLE APPLICATION OF NUCLEAR HEAT

Refering to the identified strategic areas for the application of non–electric nuclear heat in the previous section, some preliminary rough estimates of a few selected areas and their potental demand is made, and presented in Table 2.

(*) This does not imply, however, that massive cleaning program of inland surface waters (lake, rivers, water ways) and coastal sea waters should be put aside. In fact the sea water desalinaton scheme could become a facilitating action in support of that program, as this may reduce deep ground water exploitation and relieve some pressure on the demand for inland waters.

Table 2. Estimated potential demand for possible non-electric application of nuclear energy

Application area	Specific energy consumption [TJ/m³]	Throughput volume [m³/yr]	Estimated heat demand(*) [TJ/yr]	Estimated CO_2 emission reduction(*) [tons/yr]
Enhanced oil recovery (Duri)	0.00738816	12,712,000	93,918	7,269,284
Reforming of natural gas				
a.in fertilizer production (1991)	0.00023	403,191,883	92,517	5,190,215
b.in steel production, ton/yr				
c.in methanol synthesis				
Water supply to power plants (Java) (assuming 1% make up rate)	0.00000225	1,952,654	4.41	341
Water supply to ind'l complexes (Kaltim) (assuming 50 % make up rate)	0.00011293	54,750	6.18	479
Coal gasification				
a. for gaseous fuel				
b. for synthesis gas				
c. for SNG				
Total			186,446	12,460,319

The estimated demand figure, even though of limited coverage, indicates that at least there is potential demand at the level of 186,446 TJ per year, which is equivalent to savings in natural gas at the rate of 176,726,750 MSCF per year. The corresponding CO_2 emission reduction potential due to avoided combustion of oil and natural gas is 12,460,320 tons per year(*).

The tabulated estimates were made by assuming that the heat supply of current and firmly planned installations are to be replaced by nuclear generated heat from HTGR.

If one takes a 20–30 years perspective into the future, one may also consider the potentials of implementaing a scheme whereby coal gasification is undertaken to produce gaseous fuel (medium or high BTU gas), synthesis gas to replace or complementing the need for urea fertilizer production, methonol synthesis, etc.

CONCLUDING NOTES

The spectrum of the areas, whereby non-electric application of nuclear heat can be identified, and the preliminary estimates on the possible demand for such application, indicated that such application has some prospect to Indonesia. The brief analysis on the likely beneficial effects with respect to the prolonged availability for domestic oil and gas supply, implies that such nuclear option would have beneficial effect to the sustainability of the Indonesia economic development and energy security. Furthermore, the approach would contribute to carbon emission reduction, that is currently taken as a global objective. Serious consideration for further technical assessment, and thorough evaluation on the economic viability and social acceptability of the mentioned nuclear option is therefore recommended.

(*) Based on the IPCC most recent published emission coefficients.

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