

The Role of Nuclear Energy in Indonesia in The 21st Century

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Abstract

In this paper the prospect of the nuclear power plant for electric power generation or co-generation in Indonesia is discussed. Form the current situation of Indonesian electric power generation and consumption map the installation of new electric power plant in most of the areas in Indonesia is urgently needed. For Java-Bali area large and medium nuclear power plants are a good option in the future, but for outside Java-Bali area, due to the electric line network limitation, small and medium nuclear power plants are better option. Ship based nuclear power plant can help stabilitation of electric generation especially for outside Java-Bali area. And, for very small electric power generation, an Accelerator Driven System(ADS) is a possible candidate.

KEYWORDS : electric energy consumption, nuclear power plant, nuclear energy option, Reactors, ship based nuclear power reactors, ADS

I. Introduction

Economical crisis crushing many countries in Asia including Indonesia around 1997-1998 has changed many planning dramatically, including electrical power plan planning. Many investment in electrical power plant has been suspended along with the decrease of electrical consumption at that time. However 3 years later the electrical consumption grows fast steadily so that the balance between electrical production and consumption become critical. In many area outside Java Island the pereodic cut of electricity in turn has appeared. On the other hand some additional obstacle for stable electrification sometimes occur such as that appeared in Madura Island few years later, i.e.the total cut of electricity in the whole Island when a ship hit electrical instalation there.

The electrical line network in Indonesia usually divided into two groups: Java-Bali area, and the outer area. In Java-Bali area, the electrical network is relatively stable. Therefore installation new large electrical power plant is a good option to add production capacity. However for outside area the consumption rate is relatively small, global electrical line network is not yet establish and widespread in large area. Therefore the installation of small electrical power plant becomes realistic option to add production capacity for this area..

In some area the electrical line network is not stable enough so that there is still probability of the occurrence of the trouble with this line network, especially for the outer area. Therefore building

mobile electrical power plant becomes good option to anticipate such situation.

The above situation give us a description about the possibility to introduce nuclear power plant to increase the electrical production capability. For the Java Bali Area the small or large nuclear power plants are both possible, but for the outer area the small or medium power plants area the best choise. In addition, the mobile nuclear power plant based on the ship can be best solution to anticipate temporal electrical energy deficit in many part of outer area.

II. The Characteristic of Electrical Energy in Indonesia¹

The basic characteristic of electrical energy consumption in Indonesia is shown in Table 1. As shown in the above figure, Java-Bali Island which consist of about 7% land area, has electrical consumption more than 75% of total electrical consumption in Indonesia. This is because the population of Java-Bali is about 65% of that in Indonesia. As the consiquence the electrical network system in Java-Bali area can be established. On the other hand to build electrical network around the Kalimantan Island is not economical. Threfore for the area outside Java-Bali the electrical network is basically local and each sub area mush have their own small electric power plants.

Table 1 : The Growth of Electrical Energy Consumption in Indonesia

Description	2001	2002	2003	2004	2005	2006
Jawa-Bali						
-Energy Sales (TWh)	69,12	74,82	81,74	89,27	97,47	106.22
-Growth Rate (%)	11,5	6,5	6,7	7,0	7,3	7,2
-Peak Demand (GW)	13.326	14.174	14.862	15.844	16.965	18.168
-No.Of Customers (Mio)	20.12	20.78	21.74	22.80	23.95	25.16
Outer Island						
-Energy Sales (TWh)	16.41	17.63	19.39	21.41	23.72	26.28
-Growth Rate (%)	7.3	7.4	10.0	10.4	10.8	10.8
-Peak Demand (GW)	3.85	4.12	4.52	4.98	5.50	6.07
-No.Of Customers (Mio)	9.48	9.95	10.69	11.50	12.38	13.32

Source : Indonesian Electric Company (PLN) web site, June 10, 2003

However in term of electric consumption growth outside Java-Bali for 2003 tend to be larger, i.e. about 10% compared to about 7% for Java-Bali.

At the present time electric power plant in Java-Bali is dominated by oil, gas and coal electric power plant. The others, hydro power plant contribute 14% while geothermal contribute 4% of total Java-Bali electric generation capacity.

Table 2 : Power Plant Type of Java-Bali System

Power Plant Type	Installed Capacity	
	MW	%
Oil Fired Power Plant	4,240	23
Gas Fired Power Plant	4,417	24
Coal Fired Power Plant	6,650	36
Hydro Power Plant	2,536	14
Geothermal Power Plant	765	4

Source : Indonesian Electricity Company (PLN) web site, June 10, 2003

The distribution of customer and its growth is shown in Table 3. Though Indonesia still not completely recovered from the moneter crisis, in general the customer is tend to increase from year to year. Therefore Indonesia should prepare to increase the electric power generation capacity in the coming years steadily.

III. The Prospect of Nuclear Power Plant in Indonesia

In 1997 Indonesia prepared to introduce nuclear power reactors which according to the prediction of electric power consumption at that time must be implemented at 2007 or earlier. However due to the crisis all of the planning was cancelled.

Few years after the start of the crisis the electrical energi consumption tend to increase unpredictably. Therefore the general energy planning then revised, including reconsideration of the nuclear power plant. In January the seminar on “National Energy Planning with Nuclear Energy Option” has been performed. The Energy and Mineral Resources Ministry has planed to introduce first Nuclear Power Plant in 2016.

On the other hands, the use of nuclear energy for desalination has better progress. In October 2001 Indonesia and South Korea signed memorandum of understanding to develop nuclear power plant for desalination in Madura. The design study on this topic is still in progress.

Another prospect for introduction of nuclear energy in Indonesia is by introduction of small nucelar power plant (20 -100 MWe) to be installed in outside of Java-Bali. At the present time some area has electrical energy deficit. This data is shown in the following table.

By considering the trend of electrical energy consumption growth the small nuclear power plant with capacity 20-100Mwe will match to most of the province in Indonesia out side Java and Bali. The Autonomous policy in Indonesian government give

Table 3: Customer Growth

Tariff Group	1997	1998	1999	2000	2001	Share (%)
Residential	23,199,115	24,903,376	25,833,618	26,796,675	27,885,612	93.5
Business	793,055	847,940	982,281	1,062,955	1,172,247	3.9
Industry	51,046	43,088	42,575	44,337	46,014	0.2
Others	597,371	639,085	666,138	691,418	723,855	2.4
TOTAL	24,640,587	26,433,489	27,524,612	28,595,385	29,827,728	100.0

Source : Indonesian Electricity Company (PLN) web site, June 10, 2003

Table 4 : Some critical area in electrical energy production capacity

No.	Area/Province	Capacity	Peak Load	Deficit
1.	Aceh	31	46	-15
2.	West Sumatra and Riau	210	234	-24
3.	South part of Sumatra	654	665	-11
4.	Bangka Belitung Island	19	23	-4
5.	West Kalimantan	30	36	-6
6.	East Kalimantan	150	165	-15
7.	South & Central Kalimantan	161	204	-43

Source : Indonesian Electricity Company (PLN) web site, June 10, 2003

head of local government flexibility to arrange their own energy policy. Some rich province with electrical energy shortage such as in many part of Sumatra and Kalimantan maybe will consider the introduction of small nuclear power plant in their area.

The introduction of small mobile nuclear power plant operated on the ship is another option of introduction nuclear power plant in Indonesia. When the Madura around 1998 Island black out crisis occur Indonesian government has searched ship based nuclear power plant to overcome the problem but at that time the government could not obtained that. Meanwhile Indonesian government is studying the possibility of introducing ship based nuclear power plant such as KLT-40 as emergency energy resources.

IV. The Characteristic of Nuclear Power Plant Suitable for Indonesia²⁻⁷

Considering the situation in Indonesia the introduction of nuclear power plant in Indonesia should be planned carefully. The Chernobyl nuclear accident has wide negative impact in public opinion about nuclear power plant. The opposition to use of nuclear power plant in Indonesia is also supported by many organization. Therefore we consider here that the type of nuclear power reactor which will be introduced in Indonesia should has the following characteristics.

1. Highly reliable and high utilization factor

The introduction of small nuclear reactors in outside Java-Bali area is basically to overcome the energy shortage due to the high growth of electric energy consumption and the cancellation of some new electric power plant due to monetary crisis. Considering that the electric distribution line network is rather limited outside Java and Bali Islands, the long maintenance period will possibly create trouble to the customer. Innovative long life water reactor, long life high temperature reactor, or long life lead or lead bismuth cooled LMFBR can be considered as good candidates.

2. Inherent safety capability

Due to Chernobyl accident the public acceptance to the nuclear power plant need to be improved. By introducing the inherently safe small nuclear power plant is expected to increase this public acceptance level. The possibility of super prompt critical accident should be eliminated. Innovative high temperature gas cooled reactor which can survive to hypothetical accident such as depressurization accident, severe rod withdrawal accident, and other severe accident is expected to be good candidate. Innovative small water reactor which can survive severe LOCA and UTOP accident is also considered as good candidate. Finally innovative lead or lead-bismuth fast reactors are also strong candidate. For very small reactors, especially of lead or lead bismuth cooled fast reactors the use of

high internal conversion factor to control the reactivity to be well below one dollar is very useful to avoid super prompt critical accident. However it is usually limit the size of core during power reduction approach. Therefore to achieve good economical aspect (i.e. small core size with not so low power density : around 100 W/cc) innovative method may be needed to avoid reactivity swing during very long operation without refueling.

3. Long life operation without refueling and shuffling

This factor is to support very high utilization factor and also non proliferation characteristics. By such type of core there is no need to open the reactor core in operation area therefore enhance proliferation aspect. Movable reflector and other means of reactivity control out side the core may be considered as long as there is no possibility to create more than one dollar of reactivity in all possible position of the reflectors.

4. Proliferation resistant

As mention above, the design of the reactor core so that there is no need to open the reactor vessel in the operation area is considered as one important way to improve proliferation resistancy. However many paralel steps also need to be performed such as the choose of fuel so that there is no possibility to easily use it for nuclear weapon. For plutonium fuel high content of Pu-240 will improve the

operation capability without refueling or shuffling, proliferation resistant, and economical. proliferation resistant characteristics. The use of particle bed with strong coated is also an alternatif.

5. Economical

This aspect is of course very important consideration. The proposed nuclear power plant will be benchmarked to any other electric power plants such as gas, oil, and coal based electric power plants. However the standar price for electric power generation in out side Java-Bali area is significantly higher than that in Java-Bali. This aspects will help the possibility to introduce small nuclear power plants which in many cases need larger operational cost per kwh.

6. Mobile⁸⁻¹⁰

This criteria is just for those reactors set to be emergency electric generation system, especially that reactors can be moved by a ship or can be operated on the ship. This situation need that the reactor is still be possible to be operated in small

sea wave environment. In severe accident should have inherent safety characteristics, and no possibility of the occurrence of recritical accident. Floating Water Cooled Nuclear reactors is among candidate to be considered.

For very small electric power plant, an ADS is an alternative candidate due to higher safety (no possibility for super prompt critical) and smaller size. With enough margin from critical (multiplication factor is set well below 1.0) we can make sure that the ssystem will not go to super prompt critial situation or even in critical situation. And with much smaller multiplication factor we can in principe build smaller system compared to the nuclear reactor with the same material and technology. The economical need to be considered in optimization.¹¹

V. Concluding Remark

Indonesia need many new investment in electric power generation to overcome energy deficit especially in outside Java-Bali area, and also to anticipate the growth of electric energy consumer. For Java-Bali area, the introduction of nuclear power plant in the future is possible for large or medium nuclear power plant.

For outside Java-Bali area, due to the limitation of electric line network, small or medium nuclear power plant is a good option but the nuclear power plant should have specific characteristic: reliable and high load factor, inherently safe, long life operation without refueling, proliferation resistant, economical and mobile.

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