NUCLEAR ENERGY SCENARIO OF ASIAN DEVELOPING COUNTRIES

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ABSTRACT

Energy, power and fuel are the critical and essential needs globally for the long-term prosperity of any Nation by establishing sustainable economic stability whether in developed or developing countries. The fulfilments of these needs are associated with issues and concerns about environmental pollution and emissions, climate change, safety and security of humanity in multiple facets, in particular during generation, storage and transportation. At present, the only viable solution to protect the environment appears to be a full scale utilization of all available *renewable energy sources.* These energy sources are freely and abundantly available from the Sun in many ways; alternatively nuclear resources like uranium and thorium are available on the Earth to a large extent as a complement to nuclear energy. However it is a major challenge, to all developing countries to achieve sustainable nuclear energy and electricity or power before the year 2030, *Global Nuclear Year*, considering the economic advantages in addition to its intrinsic uncertainties and liabilities. Issues centre mainly on radioactive waste, decommissioning and reactor operational safety limitations. At present nuclear expansion is focussed more in Asia, where 18 of 32 reactors that were built are now becoming operational. Countries like Japan, South Korea, China and India will become the leading centres of global nuclear power expansion programs. This paper presents a detailed analysis on the current state of art of merits and demerits of Asian Nuclear Development Programs and global compatibility in achieving *Nuclear Sustainability*

Keywords: *renewable energy sources, Global Nuclear Year, Nuclear Sustainability*

INTRODUCTION

The world's population has been increasing for several decades. Electricity needs are also increasing faster than population due to the development of various global industrialization technologies to achieve national economic stability. Even today worldwide 64% of electricity comes from fossil fuels, 16% from nuclear fission and 19% from hydro and the rest from renewable. Harnessing renewable energy such as wind and solar can be considered as a priority in thinking and acting to achieve complete sustainable development. Solar radiation is abundant and freely available on Earth. Full utilization of is energy source has not been achieved in any country so far, to meet the growing demands of power. Adoption of Soar Concentrator Technologies for the erection of small, medium and large power plants, result in no depletion of mineral resources and no direct air or water pollutions. Studies of these concentrator techniques confirm the feasibility of uninterrupted and economic power generation when coupled with the production of hydrogen and disintegrating water at very low temperatures [1, 2, 3]. Presently the global race shows an attention on *Nuclear Power Generation*. Power generation through nuclear devices however remains controversial with regards to environmental issues due to reactor accidents, radioactive waste, nuclear proliferation as well as economic competitiveness. Asian countries took a challenge addressing the above situations by conducting multiple scientific experiments how to optimize, control and eliminate the controversies in achieving safety, security and stability during or after production, distribution and transmission of nuclear energy seeking sustainability [4,5,6]. Growing energy demand from all sectors is one of the major factors driving nuclear power development in Asia.

First Nuclear Power Plant

Obninsk Nuclear Power Station:

On June 27, 1954, the USSR’s Obninsk Nuclear Power Station became the world's first civilian nuclear power plant to generate electricity for a power grid producing around 5 megawatts electric power. It was a prototype design that used a graphite moderator and water coolant serving power for 2000 modern homes. It was in operation from June 27, 1954 till April 2002.

Fig .1: World’s first civil Nuclear Power Station

Calder Hall Nuclear Power Station:

This power station was the first nuclear power station built to produce electricity commercially. It was started in 1953 and connected to the grid in August 1956. The plant was officially inaugurated by Queen Elizabeth II on 17th October 1956. The plant was closed during March 2003 after rendering services for 47 years. This unit was primarily used to produce weapons grade plutonium and secondary for the production of electricity.

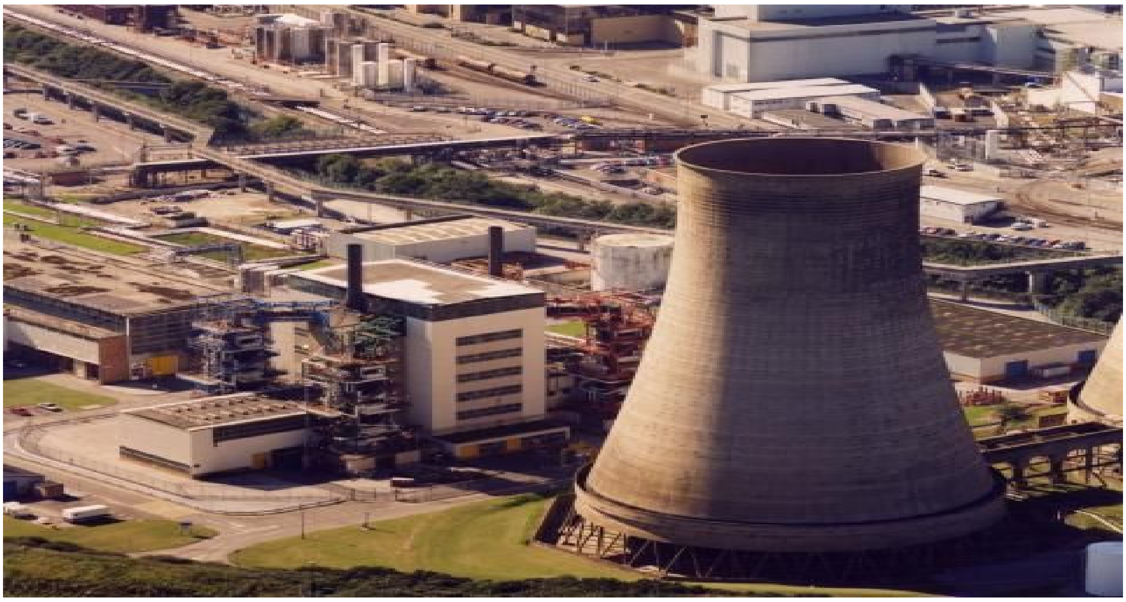

Fig.2: World's first Commercial Nuclear Power Plant.

Nuclear Power Today

Globally there are many countries with a strong vision and commitment to the development of Nuclear power. Together, these countries China, India, Russia, the United States and Japan represent half of the world's population. Future electricity requirements for these countries are extremely high. Fossil fuel resources such as oil and coal are insufficient to meet the future energy demands. Other countries like Canada, Finland, South Africa, Brazil, Argentina as well as Eastern European countries are trying to increase their investment in nuclear power to augment their economies. Other countries such as Indonesia, Egypt and Vietnam have entered into certain agreements for the implementation of Nuclear technologies. Current technological growth and development provides supplements and confirms the energy independence and security of supply of nuclear power. France being the world's largest exporter of electricity obtains 75% electricity from nuclear power for over 60 million people. In comparison to Italy, this does not have nuclear power plants, imports the majority of its power.

The Global picture of energy supply by nuclear means in % and commercial nuclear power are shown in Fig.3 below

Nuclear Power (% of total primary energy supply)

IEA (International Energy Agency 2007)

1. France - 42.6	11. Finland - 17.3	21. Russian Federation - 6.1
2. Sweden - 36.2	12. Ukraine - 16.1	22. Romania -3.8
3. Lithuania - 31.9	13. Japan - 15	23. Argentina - 2.8
4. Armenia - 27.7	14. Czech. R - 14.3	24. S. Africa - 2.3
5. Slovakia - 24.8	15. Hungary - 13	25. Mexico - 1.6
6. Bulgaria - 24.3	16. Germany - 12.3	26. Netherlands - 1.3
7. Switzerland - 22.5	17. Spain - 10.3	27. Brazil - 1.2
8. Belgium - 21.9	18. U K - 9.1	28. China - 0.8
9. Slovenia - 21	19. US - 9	29. India -0.8
10. Korea ® - 17.9	20. Canada - 8.8	30. Pakistan -0.8

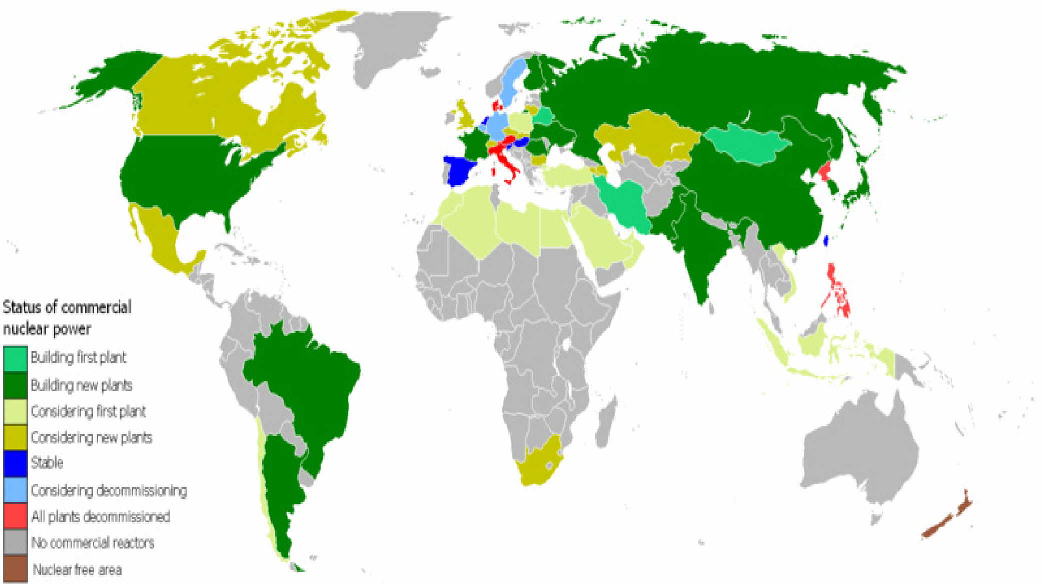

Fig.3: Global status of Commercial Nuclear Power

The map clearly indicates the situation of different countries cited in the above table. France establishes maximum energy supplies compared with other nations.

Nuclear Power in Asia:

In Asia, when compared to the other parts of the world, the generation of electricity is significantly increasing. A total number of 109 nuclear power plants are now in operation, 18 are under construction and 110 plants are at the proposal stage. The major lead countries are China, South Korea, Japan and India.

Japan generates 29% of electricity from nuclear power. Long-term plans are proposed to enhance the power capacity to 90 GWe. These systems are connected to the grid for the improvement of safety considerations. Japan possesses high temperature test reactors to enable thermo chemical production of hydrogen to use 20 GW of nuclear heat by 2050.

South Korea meets 45% of its electricity from nuclear power and proposes to achieve 60% of nuclear power supply by 2035. In collaboration with US companies Korea developed 1000 MWe, Korea Standard Nuclear Plant, which is t be built in house, and proposes to export energy to Indonesia and Vietnam.

In Japan and South Korea, the oil and gas resources are scarce and the population growth is normal and moderate. This reflected the attraction of nuclear power for reducing the green house gas emissions.

China's electricity demand is rapidly increasing by more than 8 % per year. Demand for electricity in the region of Guangdong province significantly exceeds the supply. National plans indicate the requirement of 40 GWe by 2020, projecting 2000 MWe per year additionally. China's long-term goal is to generate 240 GWe by the middle of this century.

India has limited natural recourses of coal, gas and oil. There are major concerns with climate change associated with green house gas emissions from the burning of coal and oil. The expected population growth in India is expected to grow to be 1.5 billion by 2050. Simultaneously electricity needs are also very high. Due to inherent advantages of generating nuclear power in particular environmentally friendly and availability of resources with India possessing more than 61,000 tonnes of Uranium and 25,000 tones of Thorium.

China and India have major similarities in population growth, electricity demands and in increasing economic demands. This emphasizes essential causes for development of new energy sources. The policies of governments therefore reflect as a goal an increase from 5% to 8% power production by 2020.

Taiwan is assisted by GE Nuclear Energy to build two nuclear reactors for the Lungmen power station. Public non-cooperation has become a major problem for the disposal of wastes. However Taiwan government has taken relevant steps to ship the waste to North Korea.

North Korea initially commissioned one small power reactor. Subsequently they took support from the USA and South Korea to commission two *Slandered* Nuclear Power Plants. Due to unforeseen reasons their construction was abandoned. Countries like Indonesia, Thailand, Vietnam, and the Philippine and Bangladesh have begun establishing Research Reactors with support from neighbouring countries such as South Korea and China.

The construction status of power reactors of Asian countries is shown in the Table-1 below:

POWER REACTORS

COUNTRIES	IN OPERATION	UNDER CONSTRUCTION	PROPOSED	RESEARCH	FUEL CYCLE
			–		
Australia				1	U M
Bangladesh				1	
China	10	5	63	13	UM, C, E, FF
India	16	7	19	5	UM, FF, R, WM
Indonesia			4	3	FF
Japan	55	2	12	18	C, E, FF, R, WM
S. Korea	20	1	7	2	C, FF
N.Korea			1	1	C, FF, R
Malaysia				1	
Pakistan	2		4	1	UM, E, FF
Philippines				1	
Thailand				2	
Vietnam			2	1	

UM-Uranium Mining, C-Conversion, E-Enrichment, FF- Fuel Fabrication, R- Reciprocating, WM-Waste Management *Source: WNA reactor table*

Table 1: Nuclear Power and Power Fuel Cycle in Asia

NUCLEAR POWER STATUS SCENARIO

- Nuclear power plants have a productive life of around 45 years. After this period these plants cannot be decommissioned, reassigned and the site redeveloped for other uses.
- Fuel rods used in nuclear plants are actively exothermic for up to 75 years after their removal from a reactor. The Fuel rods require cooling and to be safely stored for this period of time.
- The operation of existing nuclear power plants, labs, facilities has been fraught with accidents, incidents and discharges throughout the past history of nuclear power.
- Uranium, the basic fuel for a nuclear reactor contains abundant concentrated energy in spite of it being non renewable and a mineral. After process it is used in the plant it leaves toxic and radioactive by products that can't be recycled like other metals. 1

gram of Natural Uranium, U235 delivers 500 kWe (units of energy). But the disposal of waste is a big process.

- The perceived risks of nuclear power plants continue to be an issue in technology choices for new generating capacity. Public acceptance is one of the major issues.
- Nuclear power plants generally have high fixed costs but low variable costs. They become more economical when the out put increases. In recent years, it is noted that the world wide average capacity factor increases from 80% to 95%.

A key difference between nuclear and conventional power plants is the heat that must be removed following a full plant trip. All thermal power plants that are run at elevated temperatures require time to shut off the heat source and to cool down metal components without damaging boiler tubes and furnace walls. A nuclear reactor even with the chain reaction completely shutdown, will generate signification heat from fission product decay that persists for a very long time. A worst-case scenario involving the sequence of offsite power with concurrent failure of the onsite power system, and delayed recovery of electric power is a dominant contributor of the core damage risk of all types of Nuclear Power Plants.

ASIAN DEVELOPING COUNTRIES

Most of the developing countries do not have adequate capital for building large scale nuclear plants. In addition they need technical guidance and finances for construction of the plants. In the industrialized countries of Asia, Japan has well established nuclear program, mainly as a means of reducing its dependence on imported fossil fuels. Japan's projected nuclear capacity to a total of 54.1 Gigawatts by 2020.

Electricity demand in India is increasing. In 2005, India produced 599 billion kWh from all natural conventional devices and targeting 25 % of nuclear contribution by 2020. Nuclear power presently contributes only 3% in India's electricity generation. The long term goal of India's nuclear program is to develop an advanced heavy –water thorium cycle. Thorium is more abundant in nature than Uranium. Although it is not fissile itself, Thoriun-232 (Th-232) will absorb slow neutrons to produce Uranium -233 (U-233) which is fissile like Uranium-238 (U-238).

Recent studies and analysis reveal nuclear energy also delivers green house gas emissions to certain extents, in other words it is not emission free. Most popular reactors of LWR and HWR need an average of 0.2 kWh (th) for every kWh electricity generated. The energy intensities are translated into green house gas intensities for the two reactors with an average of 65 g CO_2 emissions /kWh (el) lower than fossil fuel technologies (900 g CO_{2-e} /kWh (el).

CONCLUSIONS

Having a supply of adequate affordable, reliable, safe and cost –effective sustainable energy is a major challenge to mankind for the rest of the 21st century is to have an adequate, affordable, reliable, safe and cost-effective sustainable energy for the present and the future. Energy is one of the essential outputs for any Nation's social and economic development.

At present, in Asian countries more than 60%of the 2 billion people of world's population have not got access to recent developments of modern energy concepts apart from cost factors. In any developing country, supply and production of energy should not be a constraint for their economic growth. It is always recommended to have committed alternatives to nuclear energy for the generation of electricity, such as the development of carbon free technologies, renewable sources and solar-hydrogen power generation devices for supplementing more safety, security and stability in generating an uninterrupted, redundant and economic production of electricity.

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BRIEF BIOGRAPHY OF PRESENTER

Awarded MSc (Mathematical Physics) from Andhra University, Waltair, Andhra Pradesh, India, March 1963 and Diploma in German, Kerala University, Thiruvananthapuram, Kerala State India in 1974.

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- Joined, Indian Space Research Organization, Dep. Of Space, Govt. of India, Thiruvananthapuram, Kerala in June 1971 and rendered services in different capacities till retirement i.e. Dec 2001, as follows:
  - ✓ Took responsibility for Design, development and testing of optical systems to meet the needs of different Electro-Optical Systems / Sensors in particular on Ring Laser Gyroscopes (RLG) and Fibre Optic Rotation Sensors (FORS) for Launch Vehicles / Satellites at Avionics & Mission Dynamics Group (AVMD), Veli Research Complex. (1971 to 1988).
  - ✓ As Principle Design Engineer - Designed, Developed and Implemented the Alignment Techniques and Procedures applicable for Launch Vehicles and Satellites at Inertial Systems Test Facility (ISTF), ISRO Inertial Systems Unit (IISU), Thiruvananthapuram, Kerala State, India.
- Subsequent to superannuation from Indian Space research Organisation, March 2002, settled in Bangalore, Karnataka State, India and established Vignanodai, Research& Development Centre, for the development of systems like “Solar Thermal Power Generation Systems” (STPGS), “Global Satellite Communication Systems” (GSCS), and Design & Development Fiber-optic sensors.
- September 2005, joined as Professor Emeritus at Sir M. Visvesvaraya Institute of Technology, Bangalore, Karnataka State, merging Vignanodai (R&D) activities to the institute in fulfilment of the Mission and Vision of the Institute.
- Design and Research & Development studies pertaining to Small, Medium and Large scale power generation devices and Solar Building Technologies are undertaken, adopting Solar Concentrator Technologies , Rain water harvesting, economic Hydrogen production devices and utilization of Nuclear energy to meet the current and future challenges in electricity demands. Detail analyses on Protection of Earth from Global Warming, Reduction of Carbon dioxide emissions, Role of future Global Nuclear Power scenario and development of Nano-Bio Sensors for different applications, have also been completed successfully.
- Possess a number of National (most of them are Classified) and International Publications, Documents and Reports during these periods.

Memberships:

1. International Solar Energy Society	(ISES)	- Senior Member
2. Instrument Society of India	(ISOI)	- Life Member
3. Indian Science Congress Association	(ISCA)	-Life Member
4. Euro Science	(ES)	-Member