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sIntroduction of Nuclear Power Plants to Sri Lanka: National Growth and Security Perspectives

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Abstract- Nuclear technology is a vibrant application in the power and energy sector all over the world. At present more than 450 nuclear power plants (NPP) are contributing more than one-tenth of electricity generation all over the world. However, few concerned the use of NPP as their power source. Being a developing country, the energy demand in Sri Lanka is ever-increasing. Frequent power crises highlight the necessity of having reliable power sources to cater the base load of the country comfortably to achieve the national growth of the country. Nuclear power can be considered as one such alternative to introduce electricity mix for Sri Lanka. Other than the higher capital cost and complexity of technology, the nuclear safety, and security aspects are the other main concerns which negate the nuclear favour. Energy security is an element of national security and a pre-requisite of the development process of a country due to the nexus between national security and national growth.
Keywords*: Nuclear, Security, National Growth*

Introduction

Energy security is one of the major elements of national security. The stability of national security is essential for the steady growth of any country. US politician and senator Tom Allen emphasize the nexus between energy security and national security by stating that 'the national security of a country depends upon the energy security of that country'. The irresistible competition over the countries is mainly occurred due to the scarcity of energy. Accordingly, the assurance of energy security has become one of the important responsibilities of the government of that particular country.

Different types of energy sources are being used by humans since their beginning and this has been changed as per the availability of access to those resources. Accordingly, fossil fuels became the most popular source of power all over the world especially during and after the industrial revolution began in the 18th century. The energy requirement also exponentially increased all over the world and due to the scarcity and diminishing nature of non-renewable fossil fuels, the necessity of alternative power sources was highlighted. Renewable energy became a good competitor in these aspects. Cleanliness, low-cost maintenance capability, free or low cost for raw

materials were the main pros for most of the renewable energies such as hydropower, wind, solar, thermal and tidal or wave energy. However, there were many cons also about renewable energies such as unreliability, non-availability in large quantities, and higher capital cost.

The necessity of sustainability of the energy sector is of the utmost importance to gain and maintain steady and healthy economic growth in a country. As per the former Chief Executive of oil and energy company BP Mr. Anthony Bryan Hayward, it has become the biggest challenge in the world today to satisfying ever-growing energy demand in a sustainable way.

Being a developing country, Sri Lanka needs to concentrate on the country's future energy requirement. At present, the energy mix is consisting mainly of fossil fuels, hydropower, and a few amounts of solar, wind, and other renewable energy sources. Since Sri Lanka does not have a considerable amount of fossil fuel within her territorial limits, some experiments have found the possibility of having a considerable amount of fossil fuels in the Mannar area. Discussions are in progress to Commercialize Natural Gas discovery in the Mannar basin with the initiative of Cairn Lanka Pvt Ltd (Reuters, 2017). However, their quantities and whether they can be used adequately for industrial purposes have not been verified. Hence, it is of paramount importance to

find alternative sources which easily can be replaced with fossil fuels.

Despite various renewable energy sources added to the capacity mix of Sri Lanka, achieve the development targets and national growth has been shattered due to the incapability of available capacity to meet the baseload especially during dry season mainly from February to April in most of the years. This has been experienced in 2018 as well as 2019 creating an energy crisis in the country. The main aim of establishing of Sustainable Energy Authority in Sri Lanka (SEASL) by enacting the Sustainable Energy Authority Act No. 35 of 2007 of the parliament of the Democratic Socialist Republic of Sri Lanka is to pave the way for Sri Lanka to gain energy security by protecting natural, human and economic wealth. Embracing the best sustainability practices by generating energy indigenously and use them efficiently are the objectives of the inception of SEASL.
Introduction of Nuclear Power Plant (NPP) to Sri Lanka to cater to the baseload of the country has been discussed among the experts in relevant sectors in Sri Lanka from the beginning of this millennium. However, this has not been discussed adequately among the general public to become a debatable topic. Other than the financial constraints that could be a probable barrier, the unjustifiable fear over using nuclear energy is the main barrier to table this topic for discussion among the general public, and policymakers are too reluctant to take up the matter due to some reason. However, it is unfair to comment on acquiring nuclear energy to fulfill the energy requirement of Sri Lanka without examining the pros and cons of the use of nuclear energy in depth. The worthiness of examining the initiatives taken by GoSL to introduce NPP to Sri Lanka, the necessity of NPP, and its impact on national growth and security aspect of Sri Lanka were identified during preliminary studies. Hence, this research will focus on the introduction of NPP to Sri Lanka and its impact on national growth and security of Sri Lanka.

Methodology

General observation made during data collection process were utilized to develop a suitable mechanism to solve the security concern w.r.t. introduction of NPP to Sri Lanka. Due to the limited number of resource personnel, and lesser knowledge on the general public on subject, the research was carried out with referring the available resources, resource personnel, and case studies on the experience of other countries. Hence, a qualitative methodology with inductive approach was used to complete the research.

In-depth interviews, field notes and focus group interviews were used as primary data collection tools. Study on previous reports, research papers, publications and works done by the national committee to work on 19 infrastructure issues (introduced by IAEA to be solved before introducing NPP) were used as secondary data sources.

During preliminary interviews independent and dependent variables were identified together with interview guide. Accordingly, nuclear security and safety, energy diversity, reliability of energy source, availability of alternative sources were considered as independent variables whereas energy security was identified as the dependant variable. The impact of energy security over national growth and national security is considered as directly proportionate. Unstructured, semi-structured open-ended questions were mostly used during interviews. Those questions were subjected to evolve, reform or continues review while conducting research.

Focusing on objectives of the research, three research questions were derived in above chapters. Non directional wordy research questions were used to describe the situation rather than compare the groups or relate them with identified variables.
The main concern of the research was narrowed to the Sri Lankan scenario. However, some of the impacts to be evaluated considering the neighbouring countries or world scenario. For example, the environmental issues and its impact on security and concern of external actors such as states and non-state actors over such issues were studied to understand the direct and indirect impact of them over security and national growth.

A. Operationalization of Research

The data collection was carried out based on variables and research guide. Descriptive responds received were quantitative analysed using thematic analysis method. All the answers were coded and filtered to reduce unnecessary

data and analysed their content based on identified themes. This division of data helped to to derive conclusions and recommendations.

A method moreover similar to stratified sampling method was used to select the resource personals. The academia, IAEA/SLAEB members, CEB members The researcher entertained the freedom of altering the questions while conducting the research and particularly interviews considering the feedback and level of interaction on the relevant matter. As per the requirements that arise while analysing the data, the same interviewees were re-interviewed, or survey data has been recollected for better data analysis.

Factual data collected mainly from IAEA a WEA The accidents happened at Three Mile Island in the USA, Chernobyl in Russia and Fukushima in Japan studied in-depth to understand the security nexus with the individual incident.

Due to the sensitivity of the subject area and its impact on individuals, some of the reputed intellectuals, academia, and appointment holders preferred to express their opinion anonymously. The informtions which are highly sensitive and related with national security or personnel security were not published in this paper.

B. Research Design

Considering the literature available, the research gap was identified, and objectives were derived as per the research problem. Subsequently, the economic and security aspects were studied to realize whether the introduction of NPP to Sri Lanka is an impact on national growth and security positively or negatively. Accordingly, the recommendations were given to mitigate the negative impacts.

Discussion

A. Nuclear Safety and Security.

Nuclear safety is the main aspect when considering the introduction of NPP to any country. The attack on Hiroshima and Nagasaki during the latter part of World War II to conclude the war and its impact has deterred the world to be favour on the application of nuclear technology even for peaceful usages. More than the direct impact, the indirect impact on human being even many years after the attacks created a distance among the general public and this technology.

1). Effect of High loss of Thermal Energy – The thermal efficiency of the nuclear power plant is only 33 % whereas the same thermal power plant is 40%. Two third of total energy production by the NPP is lost as heat. Due to this reason, NPP required a large amount of water with a sophisticated cooling system. Countries which are having a cool climate can use this excessive heat to heat their water system whereas Sri Lanka should think about this differently. The reason for the Fukushima NPP accident is the breakdown of the cooling system due to the flooding of the stand-by generator compartment. Hence, the connection between higher loss of thermal energy in the system and nuclear safety and security is evident.

2). Accidents and Lessons Learnt. - Considerably very minimum number of accidents have been reported related to NPP throughout history. The death reported or fatal injuries that happened due to those accidents are also very less compare to other alternative sources. As per the findings of Prof Mark J Perry, the reported death per one TWh due to nuclear is only 0.04 whereas the same due to coal is 101.0 deaths.

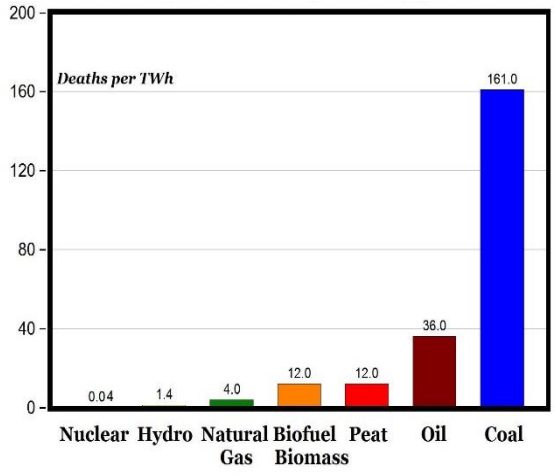

Figure 3. Deaths per TWh by Energy Source.
Source: Next Big Future by Professor Mark J Perry

3. International Nuclear and Radiological Event Scale (INES). Lack of knowledge on the fatality of accidents, experience, and social influences such as films and TV series on nuclear disasters has exaggerated the fear of nuclear threat. To control it, IAEA has introduced INES in 1990 to create proper awareness and understanding of

the magnitude of nuclear/ radiological accidents (Speigelberg, *2008).*

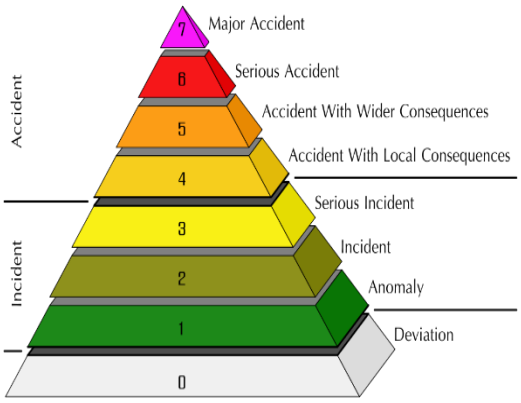

Figure 2. International Nuclear and Radiological Event Scale
Source: IAEA, 2019

B. NPP and Security Nexus

The security aspects related to NPP are two-fold and can be distinguished as follows;

1). Nuclear safety, security, and its impact on National Security.

2). Use of NPP to ensure national security through energy security.

The above two are different aspects of the introduction of NPP and necessity to examine in both ends distinctively to have a holistic approach to security aspects w.r.t introduce NPP to Sri Lanka.

C. Energy Security through Proper Energy Diversity

Due to the instability of most of the energy sources, it is paramount important to make the capacity mix of a country with different energy sources. This may allow more assurance to the energy sector of a particular country. Crude oil price is more volatile and highly sensitive to international affairs and situation while renewable energies are depending on the climate situation. Hence, depending on such energy sources lonely may threaten energy security. NPP will provide more assurance to run with the baseload of any country with more reliability and sustainability. This may enhance energy security and same ensure national security and economic growth.

During drought season in 2018 and 2019, Sri Lanka had to face frequent interruption in electricity supply due to the reduction of power generation capabilities of hydropower plants. At present Norechcholei has become the main power producer for the country with 3 x 300 MW capacity. It was experienced sudden breakdowns more than 34 occasions as of May 2018 due to various reasons. Once it shut down, it takes nearly two days to add to the national grid.

Considering the above, the introduction of sustainable, reliable power sources such as NPP would be a better option for developing countries like Sri Lanka to achieve her national growth targets. If cheaper and reliable electricity is available in a country sufficiently, it would give many advantages including the following:

1). Easily attract investors including FDIs.

2). Living standards of individuals may increase with having the luxury to use electricity for comfort. This may increase efficiency.

3). Public transport can be developed with electric trains and busses reducing traffic jams in cities.

4). Productions of the country can be increased with a higher profit margin for manufacturers.

5). Can reduce the carbon footprint by using electricity for electric vehicles etc. (this benefit can be gain only by introducing non-fossil or low-carbon technologies as electricity sources)

All above are directly connected with the national growth of the country and they would be necessities to achieve sustainable development goals. WNA emphasized the requirement of this mix finding an optimal balance between the need for human development and the protection of the natural environment. They target 1000 GWe of new nuclear capacity to be added by 2050, so that nuclear would supply to be increased up to 25% of global electricity from the present share of 10% from world energy production.

D. Advantages of NPP over other Energy Sources

Many advantages can be identified with nuclear power over other energy sources. Some of them are as follows:

1). Higher Capacity Factor: The ratio of actual output over a period to its potential output (full nameplate capacity) considered as the capacity

factor. This means the efficiency and performance of a particular plant. Higher the capacity factor means lesser the energy wastage. The capacity factor of NPP is high as 92% and this s a very high rate compared to many other alternative sources. The CF of power sources in the USA as per the records of US Nuclear Energy Institution and US Energy Information Administration are as follows:

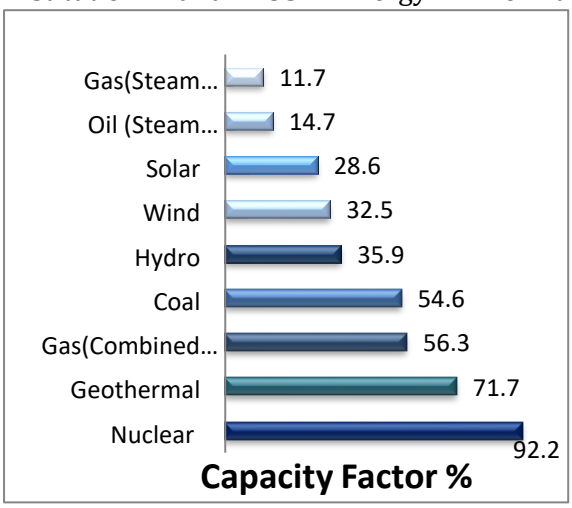

Figure 4. Capacity Factor of Energy Sources in USA, 2015
Source: US EIA and NEI, 2015

2). *High Reliability*. The reliability of the power source is the utmost important factor to be considered. Nuclear is having high reliability whereas other alternative sources such as solar, wind, and hydroelectricity are having very little reliability. Sri Lankan dependency on hydroelectricity has endangered the country on several occasions in the recent past with inevitable planned power cuts which threaten all other sectors in the country. This was caused to lower economic growth and a threat to national security.

E. The Necessity of Alternative Power Source

Hydroelectricity generation in Sri Lanka cannot be increased further due to the non-availability of waterways in large quantities. Under the "Soorya Bala Sangramaya" GoSL attempted to increased solar electricity to the national grid. The inherent issue with solar in the uncertainty and high capital cost. Liquid Natural Gas (LNG) has become one of the competitive candidates to serve as an energy provider to Sri Lanka. The non-availability of LNG within the country, its dependability on other countries, and its impact on the environment are some of the bottlenecks to consider the LNG as a sustainable alternative energy source.

F. NPP as an Alternative Source of Power

There are pros and cons to every energy source. The reliability of NPP is higher than fossil fuels and many renewable sources. It generates more energy using a fewer quantity of fuel. The reports on the availability of radioactive substances in Sri Lanka soil also a positive factor in favour of the commencement of NPP in Sri Lanka. Further, NPP needs very less maintenance.

Other than the environmental issues and health issues that are related to the generation of nuclear power, being a developing third world country, unavailability of skilled personnel, technology, and financial restrictions are the major barriers in using nuclear power in Sri Lanka. Since, the country has undergone many calamities, insurgencies in history such as LTTE for 30 years and twice with JVP in the recent past, the vulnerability of nuclear plants for incursion and ensuring the security of the plant to be considered in depth. Before implementing NPP, the cultural, political, social, diplomatic, and technological issues are also to be addressed within the country.

G. National Growth and Energy Security Nexus

Despite many other supporting elements, energy security can be considered as the most significant aspect of the economic growth of a country. Per capita, electricity consumption, and per-capita energy consumption are considered significant indexes to measure the development of states in the contemporary world. The development of industries may cause to increase in the power demand of a country. The availability of energy in sufficient quantities with lower rates and reliability and stability of the energy sector may attract much needed local and foreign investments which caused to development a country.

The correlation between economic development and electricity usage has been studied by many scholars and has found a strong correlation. (R Ferguson et al, 2000). Due to the heavy drought experienced in Sri Lanka in the year 1996 country experienced severe power crises as well as an economic downfall. The per capita electricity consumption reported in the year 1995 was 217 kWh and it has reduced up to 206 kWh in 1996.

The same was experienced in the years 2000 and 2001 with frequent power interruptions caused to reduce per capita electricity consumption from 296 kWh in the year 2000 to 292 kWh in the year 2001. The GDP of Sri Lanka also decreased in 2001 up to 15.75 Billion US Dollars from 16.33 Billion US Dollars which was in the year 2000.

The bi-variant relationship between electricity generation and Gross Domestic Production in Sri Lanka has exhibited an extra economic output within the range of Rs.88,000.00 to Rs.137,000.00 due to the increment of every 1MWh in the national grid in 2001 (Morimoto & Hope, 2004).

H. Nuclear Neighbours

Neighbours nearby such as India, Pakistan, Vietnam are also equipped with operational NPPs whereas Bangladesh is having a research reactor which can be considered as the beginning to introduce NPPs to a country. Even though Sri Lanka does not have NPPs within her soil, the impact of leakage of radioactive from available operational power plants in India (especially in Kudankulam in South India) may severely affect Sri Lankan waters, soil, and its people. As per the data poses with the World Nuclear Association, the list of nuclear power plants available in Asia are as follows:

Table 1. Nuclear Power Plants in Asia

Sr.No.	**Country**	**Power Reactors**			**Research Reactors Operable**
		Op	**Under Con.**	**Plan**	
1	Bangladesh	-	1	1	1
2	China	38	20	39	16
3	India	22	6	19	4
4	Indonesia	-	-	1	2
5	Japan	42	2	9	1
6	Kazakhstan	-	-	0	4
7	S. Korea	24	4	1	2
8	N. Korea	-	-	0	1
9	Malaysia	-	-	0	1
10	Pakistan	5	2	1	2
11	Vietnam	-	-	4	1
Total		131	35	76	36

Source: World Nuclear Association 2019

I. Sri Lankan Initiatives

NPP has been considered by Ceylon Electricity Board as a possible candidate in the electricity generation mix in Sri Lanka (LTGEP, 2018). The World Nuclear Association has recognized that Sri Lanka has expressed interest in considering, plan, and start nuclear power plants. However, as a country, Sri Lanka has not forwarded country paper on her enthusiasm over nuclear power prospects (World Nuclear Association, 2018). Other than that Sri Lanka has signed bilateral agreements with India in 2015 and Russia in January 2018. To promote nuclear technology in the country, the government has instructed all the higher educational institutions to include subjects related to nuclear energy to the curriculum. Accordingly, necessary steps have been taken to amend the syllabuses of Advance Level and educate instructors, lecturers, and school teachers on nuclear energy via student/ staff exchange programs with Japan, Korea, the USA, and the UK. (Ranaweera, 2018)

Conclusion

Energy demand will increase further in the future with the continued development of Sri Lanka. To reach the SDGs and to gain steady national growth, it is essential to have a proper capacity mix and use of sustainable and reliable energy source to run the base load of the country. There are several alternative sources and among them, considering the pros and cons of use, nuclear also has been considered as a possible candidate in the future in Sri Lanka. Higher capacity factor, reliability, environment friendliness availability of fuel in sufficient quantity, lesser maintenance are the pros while uncertainty in nuclear safety and security, higher capital cost, and technological lapses are the main barriers with the introduction of NPP. However, researches have found that the death per unit of energy in very minimum with nuclear compare to other energy sources. Most of the neighbouring countries in the region also have acquired NPP at present and they have eased up their energy crisis to some extent. Energy security is an essential part of national security and an effect on all other security aspects directly or indirectly. The national growth also depends on national security. Hence, the nexus between energy security and National growth is evident and the

introduction of NPP to Sri Lanka would be a better option in the future to Sri Lanka. However, it is essential to ensure the safety and security aspects before introducing NPP to Sri Lanka and for that, it is necessary to work according to a stiff framework with sheer determination.

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