

## **LEGAL PERSPECTIVES ON NUCLEAR ENERGY AND SUSTAINABLE DEVELOPMENT IN MALAYSIA**

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### **ABSTRACT**

This paper explores the potential of nuclear energy, particularly in the power sector, to solve energy challenges and to address the pertinent issues regarding energy sustainability in Malaysia. The deployment of nuclear energy in various developed and developing countries has conspicuously helped sustaining energy security and sustainability due to its compatibility and protection of the environment. In addition to energy security, nuclear energy also offers significant benefits to socio-economic aspects. Thus, nuclear energy in developing countries, including Malaysia, has the potential to emerge as a new prospect in the energy sector using sophisticated technology and expert personnel to maximize the energy benefits with the least environmental risk. This step would certainly meet future energy demands and help accelerate the country's development with optimum energy generation in the country. Therefore, Malaysia should aim to resort to nuclear power generation whereby the current power sector is mainly generated by traditional means, with only a small fraction of it being renewable energy. With no experience in this field, Malaysia needs to establish collaboration with some country rich with nuclear-resource in order to build, maintain nuclear reactors and treat nuclear wastes. The development of such facility should also comply with the requirements of the International Atomic Energy Agency. Moreover, Malaysia has to introduce legislation and policies related to future nuclear energy. Thus, this paper discusses some of the pertinent issues related to the prospects of nuclear power generation in the country towards achieving Sustainable Development Goals (SDGs).

**Keywords:** Atomic energy, energy security, governance, sustainable development.

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## 1.0 INTRODUCTION

Nuclear energy is regarded as one of the cleanest energy sources on the earth. Although the recent Fukushima incident in 2011 shook the world, many countries still depend on nuclear power generation. Ali, Daut, and Taib (2012) asserted that nuclear energy was classified as Malaysia's sixth fuel in the energy mix for power generation. In order to explore the aspiration led to the Fuel Diversification Policy, which was first introduced in 1981, the country has anticipated nuclear potential as future energy security for power generation (Ali et al., 2012). Nevertheless, current energy supply in Malaysia is still dominated by natural gas, followed by oil and coal which are the primary energy supply from 2013 to 2017 (Table 1). Currently, Malaysia still heavily depends on fossil fuels for electricity generation and has not explored the potentials of nuclear energy. Table 2 below specifies energy generation by sources from 2013 to 2017. Currently there is no electricity generated from nuclear energy and Malaysia heavily depends on fossil fuels.

Table 1: Primary energy supply in Malaysia from 2013 to 2017

| Year | Primary Energy Supply (ktoe) |                       |                |                     |                 |           | Renewable<br>Energy<br>(Solar,<br>Biomass &<br>Biogas) |
|------|------------------------------|-----------------------|----------------|---------------------|-----------------|-----------|--|
|      | Crude<br>Oil                 | Petroleum<br>Products | Natural<br>Gas | Coal<br>and<br>Coke | Hydro-<br>power | Biodiesel |  |
| 2013 | 27154                        | 5320                  | 39973          | 15067               | 2688            | 341       | 188  |
| 2014 | 26765                        | 6657                  | 40113          | 15357               | 3038            | 256       | 300  |
| 2015 | 24971                        | 4194                  | 39364          | 17406               | 3582            | 282       | 389  |
| 2016 | 27757                        | 3570                  | 37980          | 18886               | 4499            | 315       | 389  |
| 2017 | 27471                        | 1909                  | 34217          | 20771               | 6240            | 328       | 379  |

Table 2: Electricity generation in Malaysia from 2013 to 2017

| Year | Electricity Generation (ktoe) |                  |        |       |
|------|-------------------------------|------------------|--------|-------|
|      | Hydro                         | Thermal Stations | Co-Gen | Total |
| 2013 | 1003                          | 10627            | 424    | 12054 |
| 2014 | 1152                          | 11075            | 402    | 12629 |
| 2015 | 1346                          | 11047            | 317    | 12710 |
| 2016 | 1722                          | 11222            | 535    | 13479 |
| 2017 | 2287                          | 11416            | 452    | 14155 |

Fossil fuels are virtually exhaustible in duration and are often associated with environmental problems and global warming. Contrarily, renewable energy comes from sources that replenish naturally. However, the technology to harness renewable energy is expensive. As reflected in Table 1, renewable energy sources are still underexploited compared to the other energy sources in the country. Thus, the development of cost-effective nuclear power plants is essential to meet the growing demand for clean, sustainable and safe use of nuclear energy. Prior to venturing into a nuclear power program, Malaysia should test small scale pilot plant before confidently developing larger power plants (Foo, 2015). This suggestion was also supported by Mohan and Babu (2013), who also added that any risk linked with nuclear energy should be sensibly analysed, development of a well-designed structure in terms of technical equipment, and the need for competent management force supported by the proper regulatory framework.

In light with the growing popularity of nuclear energy, the Government introduced the National Nuclear Policy in 2010 where the Malaysian Nuclear Power Corporation was set up, although nuclear energy received a lot of criticism and opposition during the early years. However, due to the Fukushima tragedy in 2011, the national nuclear program was halted. As of 2014, oil and natural gas remained and represented more than half of the total world energy supply at 31.3% and 21.2 % respectively (International Energy Agency, 2015). There is a similar energy atmosphere in Malaysia, as natural gas is the dominating source for power generation. Nuclear power has yet to form part of Malaysia's energy mix. The Malaysian Government has shown interest in building nuclear power plants as it was included in the 11<sup>th</sup> Malaysia Plan 2016-2020.

The target to have a nuclear plant in the near future has been deferred several times as it is not easy for a developing country like Malaysia. Malaysia can successfully develop a nuclear plant only with the help of a nuclear rich country to build nuclear reactors and maintain

them. To date, in the ASEAN region, Vietnam will be acquiring the technology in the near future with the help of China. However, a developing country like Malaysia cannot have an enrichment program but could possibly obtain enriched material. Although nuclear plants are now quite safe to operate, the question regarding the treatment of nuclear wastes remains a challenging issue (Ansari, 2018).

On the other hand, Malaysia needs to meet the international requirements of having a competent legal and institutional framework supported by a competent technical and administrative workforce prior to owning a nuclear plant. These legal and institutional frameworks have to abide by the requirements of the international standards, as they'll be subjected to the scrutiny of the International Atomic Energy Agency, the watchdog for atomic energy. Malaysia has already started working in that direction, building a competent legal and institutional framework (Ansari, 2018). In addition, Malaysia has also ratified the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). This international agenda is a plea for action from all countries to expand partnerships to accomplish comprehensive goals for the people, the planet, prosperity and peace. It is crucial for Malaysia to integrate SDGs in the country's effort to strengthen energy security especially in the power sector and to combat climate change.

## **2.0 THE LINK BETWEEN NUCLEAR ENERGY, ENVIRONMENT, HEALTH AND ECONOMIC GROWTH**

Generally, atomic or nuclear energy has always been a controversial issue in most regions. Most developed countries including the USA generate energy from this source, with developing countries such as Thailand and Vietnam eager to build a nuclear power plant. Energy demand, scarcity of sources, sustainable development, and energy security are inextricably linked concerns. In managing the operation of nuclear power plants, energy policy, legislative implementation, institutional practice and monitoring systems should be uniformed. In addition, national and regional policies and legislation should be aligned with international conventions. Thailand is among one of the ASEAN countries with the intention and commitment to generating electricity from nuclear power. Without the development of nuclear power plants, Thailand is expected to face a shortage of electricity supply, which will trigger adverse impacts on public facilities and the economy (Pongsoi & Wongwises, 2013).

Einstein, A. mentioned the importance of nuclear or atomic energy for consumption as "the release of atomic energy has not created a new problem. It has merely made more urgent the necessity of solving an existing one" (Rowe & Schulmann, 2007, p. 373). In line with the

United Nations Framework Convention on Climate Change (UNFCCC) and other international conventions on climate change, many countries have opted to generate electricity from nuclear power as it is an emission-free clean energy that will indirectly assist in reducing greenhouse gas (GHG) emissions and help combat global warming (Pongsoi & Wongwises, 2013). The UK government has also acknowledged the use of nuclear energy in power generation in order to reduce carbon intensity and to face climate change. Several advantages of nuclear energy in the country are identified as follows:

- i) Secure energy supply and meets the energy demand;
- ii) Less gas emission produced from a power plant;
- iii) High investment costs but lower operating costs

(Dahlan, Ibrahim, Rajemi, Nawi, & Baharum, 2014)

As the demand for nuclear power increases, many countries strive to develop high-efficiency plants. These efforts have led to the improvement of nuclear technology, especially on aspects concerning efficiency and safety (Pongsoi & Wongwises, 2013). Although the operational costs of nuclear power plants have increased since the Fukushima incident, it will not stop nuclear power from being a part of the global energy mix. Regardless of the incident, China, India, Russia and South Korea are expected to continue with their nuclear-programs (Khatib, 2012).

Keeping such incidents in mind, the public should be exposed and educated regarding nuclear deployment to gain their confidence. This task should be the responsibility of the environmental agencies. Moreover, the International Atomic Energy Agency functions to observe nuclear power plants operations and support international cooperation in the use of nuclear energy for peace. Besides, the roles of national organisations and agencies are crucial in supporting nuclear energy programme. The Sandia National Research Institute in the United States is one example of such laboratories and research centres which support the development of nuclear power plants (Pongsoi & Wongwises, 2013).

A study by Canada's Atomic Energy Control Board reported that nuclear energy contributed the lowest risks to human health. The data indicated that many incidents and adverse implications to health occurred due to renewable technology installations including solar PV and wind turbines. Furthermore, modern biomass and biofuel developments were also seen as a threat to sustainable development (McCombie & Jefferson, 2016). Apart from nuclear power plants, renewable power generation such as geothermal, hydro and wind energy

will also be affected by natural disasters. Examples of these effects include dam failure and heavy rain which can lead to floods such as those that happened in China, in 1975; in India, in 1979; Pakistan, in 2005; and Turkey in 2012; Italy, in 1923; USA, in 1976; and Brazil, in 2006 (McCombie & Jefferson, 2016).

On the other hand, nuclear power plants produce less waste compared to fossil fuel plants (McCombie & Jefferson, 2016). In the case of *Calvert Cliff Coordinating Committee Inc v Atomic Energy Commission* 449 F2d 1109 (DC cir 1971), the Department of Energy in the United States (AEC) granted a permit to build nuclear power plants to Baltimore Gas and Electric and required the company to prepare an Environmental Impact Statement (EIS). Unfortunately, the AEC failed to observe the compliance of the EIS prior to permitting the license. The allegation over AEC's violation of the National Environmental Policy Act (NEPA) was brought by a local environmental group, the Calvert Cliff Coordinating Committee (CCCC). In an appeal, the court found that AEC procedural rules did not comply with the Congressional policy as enunciated in the NEPA.

Despite the Fukushima incident, nuclear energy continued to expand due to the significant increase in energy consumption and issues on energy security. Many countries have developed nuclear programs and plant ownership. Other major drivers of this progress are due to political, military, security, and strategic considerations (Csereklyei, 2014). In an effort to explain the mishap, the Japanese government revised its energy policy and reformed both nuclear and electrical industries as a whole. The Japanese government also planned to establish a more independent nuclear regulatory body to work with the existing one.

With the growing issues on the impacts of climate change, the international community conventions have vacated a room for renewable energy generation, as a part of clean energy solutions to mitigate climate change impact and to achieve sustainable development goals. Many countries submitted their National Determined Contributions (NDC) through the Paris Agreement to the UNFCCC for knowledge sharing and technology transfer, in order to provide clean energy and reduce GHG emissions. Malaysia has also signed and ratified the accord in 2016 and is consequently trying to reduce 45% of the GHG emissions' intensity by 2030. Therefore, the global traditional coal power plants have undergone a major phase-out stage since they possess limited technology for carbon capture and storage (CCS) (McCollum et al., 2018).

Prior to the Paris Agreement, Malaysia was a non-Annex I Party to the UNFCCC, having signed the Kyoto Protocol in 1999 which was later ratified in 2002. Since the diversification of energy in the generation mix has become the government's agenda, Malaysia

became the 144th signatory of International Renewable Energy Agency IRENA's Statute on April 2010, where the same statute was ratified in December 2010. Moreover, through the enactment of the Renewable Energy Act 2011 (Act 725) and the establishment of the Sustainable Energy Development Authority (SEDA), Malaysia has strived to accelerate the development of renewable energy share in the national energy mix. Despite these continuous efforts, Malaysia still fails to achieve its target and is still unconvinced of the idea that renewable energy could be an alternative source to replace fossil fuels.

According to McCollum et al. (2018), low-carbon investments in the energy sector is one of the important components in realising the commitments under the Paris Agreement and SDGs, by focusing on renewable electricity, as well as nuclear power and fossil energy equipped with CCS. Apart from environmental advantages, nuclear energy also supports the decarbonisation of economies and climate change mitigation efforts (Filipovic, Jovanović Popović, & Nešić, 2017). Therefore, the deployment of nuclear energy might assist Malaysia in executing its promise to international conventions. For instance, Malaysia participates in the development of the SDGs, which commenced in 2014. Through the 2015 Agenda, the international community was expected to make efforts to eradicate social issues like poverty, limited access to clean water and energy, apart from responding to the challenge of climate change, promoting world peace and security.

SDGs propose the global community to improve several basic needs and social rights which are classified under 17 indicators. Among the indicators for SDGs are clean water and sanitation, affordable and clean energy, industry, innovation and infrastructure, and sustainable cities and communities. The 7<sup>th</sup> Goal of the SDGs is to ensure access to affordable, reliable, sustainable and modern energy for all with the stipulated timeframe for all targets is 2030. Deployment of nuclear energy could help mitigate climate issues, Goal 13 in the SDGs. In 2016, Malaysia ratified the Paris Agreement as part of its commitment to climate change mitigation. In remaining steadfast towards the agreement despite the withdrawal of the United States, Malaysia is required to take various steps including tracking, reporting and achieving targets as required by the National Determined Contribution (NDC). Pursuant to that, Malaysia intends to reduce 45% of GHG emissions intensity, comprising of 35% on an unconditional target basis, with the other 10% to be achieved by 2030. However, Gielen, Boshell, and Saygin (2016) in their study contended that although nuclear power is helpful in accomplishing SDG, it should only be considered as the best options by countries with high population densities and no alternatives.

Although nuclear energy is yet to be deployed in Malaysia, its content to reducing dependency on fossil fuels and its standpoint for GHG emission reduction targets are crucial. The SDGs are not only intended for non-developed and developing countries. Though, Goal 7 explicitly focuses on securing access to clean and affordable energy, where the targets and indicators for Goal 7 emphasize on improving energy efficiency and accelerating renewable energy, not all countries are blessed with an abundance of reliable renewable sources. In Malaysia, as enumerated in Table 1, renewable energy is still far from the target, despite the Government's launch of numerous incentives such as Feed-in Tariff (FiT), auctions for Large Scale Solar (LSS) Programme and Net Energy Metering (NEM). Thus, depending on renewable energy per se is not sufficient to create a sustainable energy sector.

Therefore, in order to support the deployment of nuclear energy in the power sector, the current study is of the view that the Green Climate Fund should be available for any member country which wishes to commence a project for alternative energy. Such international assistance is imperative for improving the energy sector and reducing GHG emission. It also aligns with the SDGs agenda to promote mechanisms for raising capacity for effective climate change-related planning and management under Goal 13. Moreover, strategies towards the realisation of SDGs on clean energy and climate action are not only connected to one another, but are also associated with other SDGs such as good health and well-being (Goal 3), industry, innovation and infrastructure (Goal 9), and sustainable cities and communities (Goal 11). Hence, national development strategies should highlight climate mitigation policies and actions at the domestic level in order to meet international commitments on climate change. The interactions between commitment for achieving SDGs as well as local strategy and policy are highly path-dependent. Thus, connecting SDGs and development plan for a nuclear power for electricity generation should be executed in a way to accomplish a local optimum goal.

### **3.0 NUCLEAR ENERGY DEVELOPMENT IN MALAYSIA**

As previously discussed, nuclear energy is known as one of the cleanest energy sources which could contribute to environmental sustainability. Under the Energy Commission Act 2001, nuclear energy was regarded as one of the non-renewable sources. Nuclear energy has the potential to generate power in order to keep up the country's socio-economic development. This energy can secure national energy supply and assist in reducing total national GHG emissions (Chua & Oh, 2010). To date, nuclear energy is being used in three ways, namely as a weapon, in power generation and other scientific applications including medicine, agriculture and other sectors.



Apart from nuclear energy, coal also has the potential to contribute to the energy mix. However, some environmental issues arise pertaining to the use of coal. Malaysia has a small coal reserve, so, it depends on imported coal. On the other hand, a study revealed that if nuclear energy was included into Malaysia's generation mix with a target of 17.8% in 2030, Malaysia would be able to save resources to build more power plants. It was estimated that the generation mix without nuclear energy would need an additional five power plants compared to a generation mix with nuclear energy. Moreover, with nuclear power plants, Malaysia will be able to reduce coal exploitation and reduce carbon by two folds compared to the total carbon reduction without nuclear energy in the generation mix.

In an effort to build a nuclear power generation plant, the Malaysian Institute for Nuclear Technology Research (MINT) was established in 1994. However, it did not address any issues concerning nuclear energy, but it was working on other types of energies (Ansari, 2011). In 2006, the entity was officially renamed as the Malaysian Nuclear Agency (Nuclear Malaysia). Nuclear Malaysia's roles are to conduct research and development, to encourage application, transfer and commercialise nuclear technology, and to coordinate and manage the national and international nuclear affairs.

On the other hand, the Atomic Energy Licensing Board (AELB) was established in 1985 pursuant to the Atomic Energy Licensing Act (Act 304) prior to Nuclear Malaysia. The AELB's role was to enforce Act 304 and subsidiary legislation made under the Act. In the case of *Tan Boon Tet & Ors v Lynas Corporation* [2013] 3 CLJ, the plaintiffs representing the organisation of Save Malaysia Stop Lynas requested for a court injunction to stop granting a temporary operating license issued by the AELB to Lynas due to the fact that the plaintiffs had the right to access the Report of Radiological Impact Assessment and the Report of Environmental Impact Assessment submitted to the plaintiff. In April 2012, the High Court dismissed the organisation's application for the permission to seek judicial review on the decision of AELB. The dismissal was made pursuant to section 29 of the Government Proceedings Act 1956 and the Specific Relief Act 1950, which protects public officers to carry out their duties.

The nuclear energy program faced political opposition in the 1980s up to the early 2000s. However, this view began to change after 2003. The government devised a national nuclear policy in 2010 and established the Malaysian Nuclear Power Corporation to facilitate the construction of nuclear power plants. Nevertheless, Malaysia put its nuclear program on hiatus after the Fukushima disaster due to the fear of environmental and radioactive contamination that occurred in the 1990s (Bower, Hiebert, Pumphrey, Poling, & Walton,

2012). Table 3 enumerates international conventions and treaties related to nuclear energy deployment and waste management. However, the list did not comprise any convention related to the nuclear weapon as it goes beyond the scope of this study.

Table 3: Malaysia's status on the international conventions related to nuclear energy

| No. | International Conventions  | Status                                      |
|-----|--|---|
| 1   | Antarctic Treaty 1959  | Signed on October 2011                      |
| 2   | The Vienna Convention on Civil Liability for Nuclear Damage 1963   | Not a party                                 |
| 3   | Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter 1972                       | Not a party                                 |
| 4   | Convention on the Physical Protection of Nuclear Material 1979   | Not a party                                 |
| 5   | Convention on Early Notification of a Nuclear Accident 1986  | Joined and enforced in 1987                 |
| 6   | Convention on Assistance in the Case of a Nuclear Accident Or Radiological Emergency 1986                      | Adopted in 1987                             |
| 7   | The Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention 1988          | Not a party                                 |
| 8   | Convention on Nuclear Safety 1994  | Not a party                                 |
| 9   | Convention on Supplementary Compensation for Nuclear Damage 1997   | Not a party                                 |
| 10  | Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management 1997 | Not a party                                 |
| 11  | Additional Protocol to the IAEA Comprehensive Safeguard Agreement 1997   | Signed on November 2005 but no ratification |

#### 4.0 COMPLIANCE WITH INTERNATIONAL REGULATIONS

The International Atomic Energy Agency (IAEA) was established in 1957 as an independent entity from the United Nations to promote the peaceful use of nuclear energy. The IAEA outlined 19 infrastructure conditions in developing a nuclear power plant, which include

national position, nuclear safety, management, funding and financing, legislative framework, safeguards, regulatory framework, radiation protection, electrical grid, human resource development, stakeholder involvement, site and supporting policies, environmental protection, emergency preparedness, security and physical protection, nuclear fuel cycle, radioactive waste, industrial involvement and procurement (Cook, 2012). In addition, the promulgation of national nuclear policy is one of the fundamental aspects of developing a nuclear power program. The policy should adhere to five critical elements which are peaceful use commitment, participation in the global nuclear community, the primacy of nuclear safety, disclosure and transparency and the principle of justification (Cook, 2012).

In general, the establishment of legal and regulatory aspects are vital in power generation. Hence, compliance and implementation of international conventions related to nuclear energy at the national level are obligatory for a country to receive international cooperation regarding nuclear development. The IAEA recommended countries operating nuclear program to adapt to the international nuclear conventions and treaties. Apart from the above international conventions, Malaysia may also opt to apply for the Codes of Conduct under the IAEA including (Bidin, 2016):

- i) Code of Conduct on the Safety and Security of Radioactive Sources (2003);
- ii) Code of Conduct on the Safety of Research Reactors (2004);
- iii) Physical Protection of Nuclear Material (INFCIRX.225/Rev. 5) (2011);
- iv) Governmental, Legal and Regulatory Framework for Safety, IAEA General Safety Requirements Part 1 (2010).

Furthermore, a nuclear regulatory framework needs to assemble a distinctive and unequivocal legal foundation, *intra vires* the regulatory body's goals and objectives, and a *simili* to the best practice in science and technology that have been adopted. Currently, there are a few legislations related to nuclear energy in Malaysia, namely, the Atomic Energy Licensing Act 1984 (Act 304) Regulations & Approvals, the Radiation Protection (Licensing) Regulations 1986, the Radiation Protection (Basic Safety Standard) Regulations 1988, the Radiation Protection (Transportation) Regulations 1989, the Radiation Protection (Appeal) Regulations 1990 and the Import & Export Guidance for Radioactive Material (Categories 1 & 2). However, these are supplementary to Malaysian nuclear energy law as there is no electricity generation from nuclear energy in Malaysia yet. These regulatory instruments contribute to a broader Malaysian regulatory architecture in an effort to diversify energy sources in the generation mix.

Among the several factors that have driven countries to deploy nuclear energy as one of the alternative energy in their energy profiles is the volatile price of oil and coal compared to nuclear energy. The abundant source of uranium has also encouraged the development of nuclear energy since uranium has not been much exploited. Furthermore, it needs no burning process, which reduces carbon emissions (Petinrin, & Shaaban, 2015). Most of the nuclear energy power plants in the world are owned by developed countries. Many developing countries are currently working on developing their own plants as oil and natural gas will deplete in no time, whereas uranium reserve is estimated to last for 241 years (Ansari, 2011). Nuclear energy is an effective option to mitigate the scarcity of fossil fuels while safeguarding energy security and diversifying energy sources. Therefore, it is vital to develop an affordable, sustainable and safe nuclear energy in order to accommodate the increasing needs for energy (Foo, 2015).

Thus, nuclear energy deployment can be a wise option for Malaysia to achieve the target in carbon emissions reduction. With the aid of advanced technologies, the generation of electricity can be optimised, as the construction of the power plant would not consume much space that will likely harm the environment and biodiversity (Foo, 2015). In addition, the Nuclear Power Development Steering Committee was established in 2009 to conduct studies on the potential of nuclear energy as part of the Nuclear Power Infrastructure Development Plan (NPIDP). The plan was initially to be completed by 2013, where, several potential sites for the power plants would be acknowledged through the plan. A governing body to monitor activities related to nuclear energy for generation is among the key requirements to safeguard operations in the nuclear facilities. The effectiveness and efficiency of the regulatory body must be in line with the principles of good governance (Bidin, 2016). MINT (later known as Nuclear Malaysia), Tenaga Nasional Berhad (TNB) and a few other entities conducted several feasibility assessments towards the preparation for a nuclear power programme (Mohamed & Lee, 2006).

However, prior to engaging in nuclear power for electricity generation, the government should analyse the factors and impacts of nuclear energy generation from international perspectives. The deployment of nuclear energy to sustain energy for the future requires a thorough implementation and safeguard of international doctrines including intergenerational justice, effective independence principle, precautionary principle, polluters pay principle, cradle to grave principle, public consultation and good governance. These principles are vital in guiding the architecture of the legislation and international conventions related to the management of nuclear and radioactive waste.

Public acceptance is one of the biggest issues in developing a nuclear power plant. The Nuclear Power Program Development Working Committee has embarked on a Public Acceptance program to assist in increasing the public awareness and understanding regarding nuclear power generation and to alleviate the misconception of embellished information on nuclear energy risks. A database containing comprehensive information regarding nuclear energy should be established to provide easy access for the public to obtain reliable data (Bidin, 2016). Moreover, in order to increase the awareness of the benefits of nuclear power, public consultation is required to engage the public, especially at the beginning stages of nuclear power projects. This process has been well implemented in developed countries such as the United Kingdom, Canada, New Zealand and Australia. Through this process, the public is regarded as one of the important stakeholders and it is a method to promote effective drafting and decision making (Jaafar, 2014).

Radioactive waste management is one of the main public concerns over nuclear energy generation in Malaysia. In *Woon Tan Kan & others v. Asian Rare Earth Sdn. Bhd.* [1992] 4 CLJ 2299, the court granted an injunction to the community living nearby the industrial area of Bukit Merah, Perak. The court ruled that Asian Rare Earth's operations are much likely to produce hazardous gas and radioactive wastes that would cause adverse impacts on health and the environment. Moreover, the court found that the defendant failed to manage harmful radioactive waste properly. However, in the appeal, the decision was reserved as the court found that the hurdles to implementing a mandatory injunction to clean toxic waste and radioactive waste within fourteen days would cause hardship to the shareholders and investors of this company. One of the objectives of waste management is to safeguard the rights of future generations through effective radioactive waste disposal, which is parallel with two principles under international law, namely the Precautionary Principle and Sustainable Development.

According to the IAEA, the radioactive waste from the Fukushima incident entails a long-term measure for life-cycle management of all generated waste. This issue should be taken into account and should be a lesson for Malaysia to prepare for the worst-case scenario, in the unwanted event it happens, should Malaysia wish to pursue the bid for a nuclear power plant. In respect to radioactive waste management, the government should ensure that future nuclear energy policy is transparent, which will likely increase the public's trust. Public consultation regarding the disposal of radioactive waste is crucial and engagement of the local community will contribute to nuclear energy development as well as the environment (Jaafar, 2014).

## **5.0 IS MALAYSIA READY FOR NUCLEAR ENERGY?**

The Malaysia Nuclear Power Corporation (MNPC) and Potomac Communications Group (PCG) conducted both qualitative and quantitative research in 2014 and 2015 in search of public opinion on nuclear energy. The results demonstrated that the majority of Malaysians vigilantly opted for nuclear energy as a future energy source, especially in the power sector (Jaafar, Nazaruddin, & Lye, 2017). More than 40% of the respondents opposed nuclear energy, while 15.4% believed that it emits the lowest carbon dioxide (CO<sup>2</sup>) footprint when generating electricity. Nevertheless, 40.10% of the respondents chose nuclear energy as a future energy source after solar energy and hydroelectric (Misnon, Hu, Rahman, & Yasir, 2017).

As discussed earlier, the proposed idea to include nuclear energy as part of the national energy mix has received much opposition from the public and political parties. Nuclear energy is known for its benefits towards the environment, as it will not lead to air pollution or acid rain and assist in combating global warming. Moreover, uranium is available abundantly (Abdul Hamid, 2018).

Nuclear Malaysia, Atomic Energy Licensing Board and other government entities have initiated several programmes in relation to the development of the nuclear power plants for electricity generation in line with the Eleventh Malaysia Plan (2016-2020). If the authorities wish to pursue for nuclear energy in the country as a choice and last resort to when the country falls short of traditional sources of energy in the future, they need to fulfil all international requirements, including ratifying all international conventions related to the deployment of nuclear energy (Ansari, 2018).

However, with intense effort and support from the Government and other stakeholders, renewable energy is preferred over nuclear energy for the generation of electricity in the country. The Renewable Energy Act 2011 (Act 725) was enacted to support the development of renewable energy in Malaysia. The promulgation of the law was to overcome failure in the Small Renewable Energy Power (SREP) Programme. Generally, renewable energy is perceived as an excellent choice to sustain the energy sector (Petinrin & Shaaban, 2015; Kardooni, Yusoff, & Kari, 2016; Moriarty & Honnery, 2016), yet some require a combination of fossil fuels, renewable energy and nuclear for their energy policies (Pfenninger & Keirstead, 2015).

Although the Fukushima nuclear disaster involving the Fukushima Nuclear Power Plant in 2011 was primarily caused by the tsunami and the Tohoku earthquake, many countries began to phase out their nuclear power plants. This move by those countries left a negative perception

of the public. According to Kim, Kim, and Kim (2013), 42 countries revealed that public acceptance of nuclear energy following the Fukushima incident declined significantly. A similar trend was also documented in other studies (Tsujikawa, Tsuchida, & Shiotani, 2016; Guo & Ren, 2017; Choi & Kim, 2018), while some indicated conditional acceptance for the deployment of nuclear energy (Ho, Looi, Chuah, Leong, & Pang, 2018) and public acceptance over the issue has improved over the years (Kristiansen, Bonfadelli, & Kovic, 2016).

Despite the mixed acceptance of nuclear power program, TNB and Korea Electric Power Corporation (KEPCO) conducted a study to estimate the cost to develop a nuclear power plant. Approximately US\$ 2000/kW to US\$ 4500/kW is needed to build a unit of 1000 MW nuclear plant. Nuclear power plant construction is comparatively more expensive than other fossil fuel-based plants due to the complexity of technology and standards. However, the operating cost of a nuclear power plant is more economical and the total production cost for a nuclear plant is still lower compared to coal, oil and gas (Ali et al., 2012).

In light of the current Eleventh Malaysia Plan, nuclear energy was instigated as a source for electricity generation in order to reduce dependency on fossil fuels. Moreover, the implementation of the Nuclear Power Infrastructure Development Plan and the Nuclear Power Regulatory Infrastructure Development Plan will become the drivers to develop nuclear power. Furthermore, an independent atomic energy regulatory commission will be established to pursue the goals. Following the 2018 General Election, Tun Dr Mahathir Mohamad announced that Malaysia will not use nuclear power plants to generate energy, as science has yet to find ways to manage nuclear waste and the effects of radiation (Abdul Hamid, 2018). Although the deployment of nuclear energy is vital to sustaining the energy system, the country should be ready to meet the challenges of having and maintaining nuclear power plants. Malaysia will also have to ensure the sustained supply of nuclear materials alongside the storage and treatment of nuclear wastes generated from reactors (Ansari, 2018).

In an effort to promote nuclear energy, IAEA introduced the IAEA Milestones Approach to help any country intending to include nuclear energy into their energy mix. Through this approach, the country's readiness would be appraised, where public consultation is required prior to embarking on this programme. Nevertheless, this agency cannot interfere with the country's decision. Still, the IAEA plays a crucial role to ensure a country follows their guidelines to safeguard the safety and security of such programme (Gil, 2018). Therefore, it is crucial for the Government to involve public consultation and educate the public on the importance of nuclear energy to achieve a sustainable energy sector as well as to show Malaysia's commitment towards international conventions in reducing GHG emissions.

Through nuclear energy deployment, the Government may be able to keep the promise made by Malaysia to the United Nations under the Paris Accord. Inclusion of nuclear energy as part of the national energy mix is in line with international commitments.

## **6.0 CONCLUSION**

To date, Vietnam is one of the most active countries in Southeast Asia that is profoundly developing its own nuclear power plant. Malaysia has a similar interest to build its own nuclear power plant as an effort to diversify energy sources in the country. Yet, no nuclear power generation plant has been built, while Nuclear Malaysia is not fully utilised for that purpose as it focuses more on other sources of energies. Since Malaysia is still able to cope with the energy demand using traditional energy sources, there is no urgent need for the development of a nuclear power plant. However, nuclear power is deployed in the medical and scientific applications in Malaysia such as in the agricultural sector. Contrary to Malaysia, Vietnam has limited energy sources and they had improved energy efficiency before moving towards nuclear energy, while Malaysia is still struggling with several issues like limited local competency, lack of public awareness and the negative perceptions of nuclear power.

Many objections were received concerning nuclear energy development, especially after the incident in Japan, which caused many countries to phase out and even abandon their nuclear power plant programs. Nevertheless, the Government has yet to close the door on nuclear generation in the future. The idea of building a nuclear power generator should not be dismissed. The Fukushima incident should be a good lesson for the country, especially regarding the safety and security of the power plant. It should be admitted that the incident was beyond the knowledge and power of human ability as the earthquake scale was the worst in history. One could not simply disregard the importance of embarking into nuclear power for electricity generation in Malaysia as nuclear energy is regarded as one of the “cleanest energy sources” on Earth.

Notwithstanding the introduction of nuclear energy initiatives and other instruments in Malaysia, the implementation of local nuclear energy regulation must be coordinated by regional law and policy. Developing nuclear energy does not mean that conventional energy sources should be abandoned. Fossil fuels are still needed in order to meet Malaysia’s current energy demand. At the same time, nuclear power technology could be developed as technology needs some time to mature, and Malaysia’s energy market requires a long timeframe to be responsive to this alternative energy’s needs and requirements for expansion.



It should also be noted that although nuclear energy is a good option to overcome the energy crisis and to cater to the increased demand for electricity to achieve SDGs, there are still environmental burdens that have to be carried out to monitor all nuclear energy life cycles. The deployment of nuclear energy may not be practical as it will take considerable time and cost to build a nuclear power plant. The authors are of the opinion that the Malaysian approach to having nuclear energy in future should be a balanced one. Almost five years after the implementation of the SDGs, Malaysia has a long way to go in achieving full implementation of SDGs, especially Goal 7 and 13, which will be able to improve the livelihood of the society as well as the environmental protection and conservation. By considering these SDGs and their interactions, the Government should take a step beyond general mapping in the current energy sector. Evidently, the contributions of SDGs to improve global needs should not be limited to targets instilled in its agenda. The architecture of this global agenda, especially with regards to nuclear power as alternative energy, should be aligned with the realisation of rights of the future generation to access clean and sustainable energy.

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