AN OVERVIEW OF DEVELOPMENT OF NUCLEAR TECHNOLOGY IN MALAYSIA AFTER 2008

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ABSTRACT

Over the past three decades, nuclear technology has gained stability in the country, with development of main infrastructures, both technical and administrative, in place. In this paper, we present an overview of the development of nuclear technology in Malaysia after 2008. We found that, with regards to technical sectors, the use of nuclear technology in medical sector outweighed the non-medical sector for seven consecutive years since 2009.

ABSTRAK

Sejak tiga dekad yang lalu, teknologi nuklear telah mencapai tahap stabil di negara ini dengan terdapatnya pembangunan infrastruktur utama, samada dari segi teknikal dan pengurusan. Kertas kerja ini mempersembah liputan pembangunan teknologi nuklear di Malaysia selepas tahun 2008. Didapati, penggunaan teknologi nuklear di bidang perubatan melebihi penggunaan dibidang bukan perubatan untuk tujuh tahun berturut-turut sejak 2009.

INTRODUCTION

About a year after the discovery of x-rays by Sir Wilhelm Röntgen in Germany, irradiating apparatuses were brought to Malaysia by Mr Wray, who demonstrated the use of x-rays in Taiping, Perak on 3rd February 1897. This disclosure initiated a chain reaction on installation of x-ray equipment in the country. The earliest records of x-ray therapy in Malaysia show the acquisition of a Crokes x-ray tube in Singapore in 1914 and Coolide tube in 1920. In the 1950's, the external beam therapy was delivered using Philips Dermopan 50 kV superficial x-ray machine (Philips NV, Eindhoven, Netherlands), 200 kV Muller x-ray machine and 250 kV rotating Muller x-ray machine in Kuala Lumpur. While the first nuclear medicine department was started in 1962 as part of radiotherapy services at General Hospital Kuala Lumpur (Tajuddin AA, Bradley DA, 1995).

Malaysia utilises radioactive materials and irradiating apparatuses for a wide variety of peaceful purposes. They are not commonly known to the general public as they rarely get publicised. The linkage between its peaceful usage and its dark side and attempt of exploitation of the later gets the better publicity in the country. This linkage is pivotal in shaping its international posture and the various regimes that regulate nuclear technology transfer and acquisition (MNA, 2010).

The setting up of Tun Ismail Atomic Research Centre (PUSPATI), presently known as Malaysian Nuclear Agency (Nuklear Malaysia) in 1972 with 1 MW TRIGA Mark II research reactor has been a catalyst for the use of nuclear technology in various fields in Malaysia. It was established as a preparation for Malaysia to embark on a nuclear power program. The program however was postponed due to the discovery of petroleum reserves in mid-1980s and the subsequent development of national petroleum industry. Nuklear Malaysia as the national premier research organisation then refocuses its activities in other technical sectors than energy.

With regards to the governance of the nuclear technology in the country, the Radioactive Substances Act 1968 was the first legislation in Malaysia governing all activities that deal with nuclear technology. It was then repealed by the Atomic Energy Licensing Act 1984 (Act 304) in June 1984. Hence, the Act 304 paving the way for the establishment of the Atomic Energy Licensing Board (AELB) as a separate entity, in February 1985.

uclear technology has contributed in many ways to the sustainable development in the country. The effective development of their applications, as well as the safe and economical maintenance of existing technologies, rely on a thorough understanding of the underlying nuclear science principles, related to physico-chemical processes and nuclear data.

In 2010, Nuklear Malaysia, after more than three decades of the development of nuclear technology in the country, has carried out a study on the impact of nuclear technology to the national socio-economy for 2006 to 2008. The result shows that the nuclear technology percentage share of national Gross Domestic Product (GDP) increased from 0.024 percent in 2006 to 0.032 percent in 2008 (MNA, 2010).

This paper aims at presenting an overview of the development of nuclear technology in Malaysia after 2008.

ECOSYSTEM OF NUCLEAR TECHNOLOGY

Over the past three decades, nuclear technology has gained stability in the country, with development of main infrastructures, both technical and administrative, in place.

Figure 1 shows the ecosystem of nuclear technology in the country. The use of nuclear technology is divided into six technical sectors, namely, industry, medical and healthcare, agriculture, environment, energy and, safety and security. Many usages involve irradiating apparatuses, sealed sources with radioactive materials firmly contained within a suitable capsule. Some involves radioactive materials as an unsealed form.

Since 1982, Malaysia has only one 1-MW TRIGA Mark II research reactor, located at Nuklear Malaysia, used for research purposes. The other available main facilities include Gamma Green House (GGH), Cyclotron and Radioactive Waste Treatment Centre.

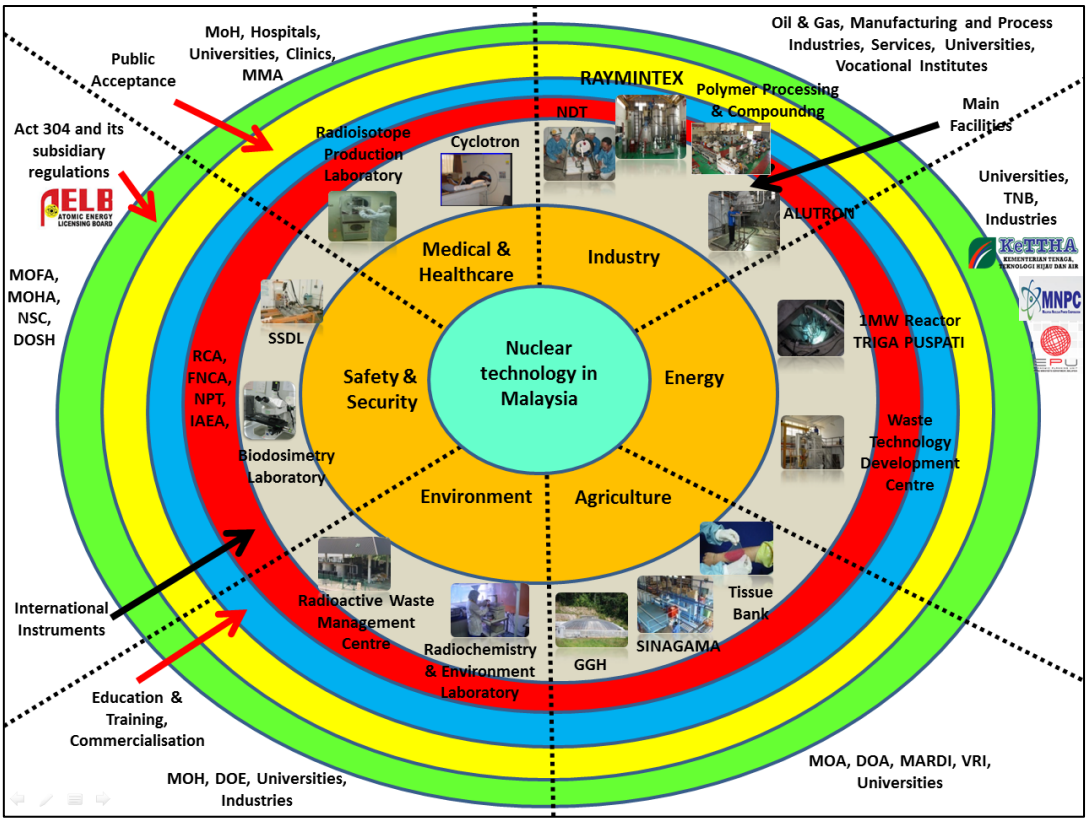

Figure 1. Ecosystem of nuclear technology in Malaysia.

Note:

MOH: Ministry of Health, MMA: Malaysian Medical Association, NDT: Non-Destructive Testing, TNB: Tenaga Nasional Berhad, KETTHA: Ministry of Energy, Green Technology and Water, MNPC: Malaysia Nuclear Power Corporation, EPU: Economic Planning Unit, MOA: Ministry of Agriculture and Agro-Based Industry, DOA: Department of Agriculture, MARDI: Malaysian Agricultural Research and Development Institute, VRI: Veterinary Research Institute, DOE: Department of Environment, MOFA: Ministry of Foreign Affairs, MOHA: Ministry of Home Affairs, NSC: National Security Council, DOSH: Department of Occupational Safety and Health, AELB: Atomic Energy Licensing Board

In all technical sectors, education and training is an important element, to upgrade employee's skill and reduce radiation risk. Nuklear Malaysia and AELB are two main training providers for nuclear technology in Malaysia. As applications of nuclear technology in Malaysia become more developed, certain level of expertise need to be enhanced. Thus, Malaysia will continue to further develop its technical capabilities and expertise to further enhance new applications of nuclear technology.

Under the Act 304, the governance of medical activities is delegated to the Director General of Health, Ministry of Health. While, the governance of the non-medical activities is under the purview of AELB.

National and international networking and collaboration with all relevant stakeholders is recognised as a key strategy for advancing nuclear technology in the country. At the international and regional levels, Malaysia participates as an active member to various organisations, including the International Atomic Energy Agency (IAEA), Regional Cooperative Agreement (RCA), and Forum for Nuclear Cooperation in Asia (FNCA).

PROGRESS OF NUCLEAR TECHNOLOGY AFTER 2008

The nuclear technology has been an integral part of the country's economic development, providing a certain impetus to technological innovation as well as to socio-economic development. All users of nuclear technology are required to adhere to the regulations and safety standards stipulated by the Act 304.

AELB has issued about 2000 licenses for non-medical application by middle February 2017 (The Sun, 2017). It was reported that there were 4247 licensed and registered medical premises by middle 2017 (MOH, 2017).

Table 1 shows that the largest number of users of nuclear technology in non-medical activities from 2009 to 2015 is in the use of nuclear gauges, followed by sellers and industrial radiography. While Table 2 shows that for years 2009 to 2015, the largest number of users for medical activities is in dental clinics, followed by general medical practitioners and hospitals.

Table 1. License Holders for Non-Medical Activities for the year of 2009 - 2015

Type of activities/ Licence holders	Year						
	2009*	2010#	2011+	2012**	2013##	2014++	2015***
NORM/TENORM	5	17	20	23	29	24	25
Sellers/Vendors	185	211	265	288	229	278	277
Industrial Radiography	44	57	71	71	74	83	82
Education and Research	31	37	41	44	43	48	48
Gauges	418	611	661	697	751	785	785
Explorations	8	10	10	10			
Maintenance	7	6	6	6			
Radiation Processing	6	7	7	7			6
Training Agencies	6	1	5	5			5
Research reactors	1	1	1	1			1
Consultants	6	5	5	5			6
Irradiator					5	5	
Total	717	963	1092	1157	1131	1223	1235

Note: *: AELB (2009), #: AELB (2010), +: AELB (2011), **: AELB (2012), ##: AELB (2013), ++: AELB (2014), ***: AELB (2015), NORM: Naturally Occurring Radioactive Material, TENORM: Technologically Enhanced Naturally Occurring Radioactive Material

Table 2. License Holders for Medical Activities for the year of 2009 - 2015

Number of Licensed Premises	Year						
	2009*	2010#	2011+	2012**	2013##	2014++	2015***
Hospital	266	270	279	283	302	323	329
General Medical Practitioners	1040	1050	1077	1127	1207	1252	1277
Radiology Clinics	96	51	110	48	65	61	59
Specialists Clinic (other than Radiology Clinics)				62	82	84	84
Nuclear Treatment / Nuclear Medical Centres	20	23	20	22	23	26	27
Radiotherapy Centre	28	30	25	27	28	32	36
Health Clinic	177	199	208	216	239	247	255
Dental Clinic	1378	1563	1461	1534	1620	1694	1830
Veterinary Clinic	48	50	54	54	64	73	87
Army Medical Centre	26	27	29	22	31	35	38
Cyclotron	2	2	2	2	2	2	2
Blood Irradiation Center			6	6	7	7	7
Consultancy Firm (H Class)	10	8	8				
University		32					
Laboratory	2	5					
Total	3093	3310	3279	3403	3670	3836	4031

Note: *: AELB (2009), #: AELB (2010), +: AELB (2011), **: AELB (2012), ##: AELB (2013), ++: AELB (2014), ***: AELB (2015)

Table 1 and Table 2 show that the number of licenses is increasing yearly, from 2009 to 2015, for both medical and non-medical activities. This indicates the increase level of acceptance of nuclear technology in the country. It also indicates that the nuclear technology can readily be incorporated with other conventional technologies. Both tables also show that the use of nuclear technology in medical sector outweighed the use in non-medical sector for seven consecutive years since 2009. This indicates shifting of priority of nuclear technology application in the country.

The diversity of usage of nuclear technology rests on the multiple roles of nuclear radiations. Depending on its type, energy, exposure, exposure rate and the materials it interact, radiation can kill micro-organism without leaving harmful residue, which is a property exploited for sterilisation processes; it passes through solid objects – a property used to see the internal structure of objects and components which is used in quality control, quality assurance, medical imaging, and nuclear gauges; it modifies material properties through cross linking process – a property that is responsible for the production of many new materials that are used in diverse and demanding applications. The same property is used in the production of new, better plant cultivars in agricultural sector. Radiation from radioisotopes can be assimilated in different media in specific systems such

as harbours, lakes and even combustion chambers and mixing vessels (MNA, 2010). In the medical field, irradiating apparatuses and radioisotopes are used for imaging and treatment purposes.

ECONOMIC SECTORS OF NUCLEAR TECHNOLOGY

Since 1970, Malaysia has based its economic development strategy on three long term policies namely, the New Economic Policy (NEP) 1970 to 1990, the National Development Policy (NDP) 1990 to 2000, and the National Vision Policy (NVP) from 2001 to 2010 (Z A Yusof & D Bhattasali, 2008). It was then followed by the New Economic Model from 2010 to 2020.

The development of nuclear technology can be an indicator to economic development as well as improved environmental quality. Nuclear technology has progressed in Malaysia and positively contributed to socio–economic development of the country. Among others, it contributes to the creation of business, creates employments and uplifts the quality of medical and healthcare services in the country.

In addition, the positive economic impact and increasing demand of nuclear technology has motivated local companies to incorporate nuclear technology into their existing products or services. This in turns has enhanced the competitiveness of local companies in exporting their products and services to international market as well as meeting the international standards and requirements.

In the Republic of Korea, the major application of nuclear technology is in power sector including atomic and thermal power generation, general machinery and equipment, repair and electric power plant construction. Currently, Republic of Korea is operating 24 nuclear power reactors which provide one-third of Republic of Korea's electricity.

It was reported that Malaysia lags by three to eight folds in magnitude behind the Republic of Korea, in terms of nuclear technology contribution to GDP (MNA, 2010). However, using the only available data at the time of this study, we present a comparison of the level of activities of nuclear technology in Malaysia against the Republic of Korea as shown in Table 3.

Table 3 also highlights that both countries have common similarities in utilising nuclear technology in particular radiochemistry, NDT, siting, research reactor and nuclear medicine, even though the degree of utilisation varied depending on country circumstances and priorities.

Meanwhile, since Malaysia does not has any nuclear power reactor yet, the application of nuclear technology in Malaysia is solely concentrated in medical and health services, agriculture, forestry and fisheries. The application of nuclear technology is also widely used to provide cost effective solutions in industrial sector, such as NDT, food irradiation, mutation breeding, fertilizer, radiochemistry and radiation processing.

Table 3. Comparison of economic sectors and related nuclear activities between Malaysia and the Republic of Korea

Sector Name	Related Nuclear Technology	
	Republic of Korea (IAEA, 2009)	Malaysia
1 Agriculture, forestry and fisheries	Food processing	Food irradiation, mutation breeding, fertilizer
2 Mining and quarrying	N/A	Naturally occurring radioactive materials
3 Food, beverage and tobacco	Food processing	Food irradiation, Nuclear gauges
4 Textile and leather products	N/A	N/A
5 Wood and paper products	N/A	Nuclear gauges
6 Printing, publishing and reproduction of recorded media	N/A	N/A
7 Petroleum and coal products	N/A	Well lodging, radiotracers
8 Chemicals and allied products	Radiochemistry	Radiochemistry and radiation processing
9 Inorganic basic chemical products	Nuclear fuel fabrication	Radiochemistry and radiation processing
10 Non-metallic mineral products	NDT	NDT
11 Primary metal products	NDT	NDT
12 Fabricated metal products	NDT	NDT
13 General machinery and equipment	Manufacturing of main components and other machinery	NDT
14 Electronic and other electric equipment	Manufacturing of instrument and control devices	Nuclear gauges
15 Precision instruments	NDT	NDT
16 Transportation equipment	N/A	N/A
17 Furniture and other manufacturing products	N/A	Surface coating, radiation chemistry
18 Water power	N/A	N/A

generation		
19 Thermal power generation	External electricity supplied to nuclear power plant in operation	N/A
20 Atomic power generation	Nuclear power plant operation	N/A
21 Self-power generation	N/A	N/A
22 Gas and water supply	N/A	NDT
23 Repair construction	Construction related to the operation and maintenance	NDT
24 Electric power plant construction	Construction of new nuclear power plant	NDT
25 Wholesale and retail trade	N/A	N/A
26 Eating and drinking places, and hotels and other lodging places	N/A	N/A
27 Transportation and warehouse	N/A	Transportation and storage of radioactive sources
28 Communication and broadcasting	N/A	N/A
29 Finance and insurance	Finance and insurance of nuclear power plant	Finance and insurance of facilities
30 Real estate agencies and rental	Siting	Siting of facilities related to nuclear technology
31 Business services	Architecture engineering	Radiation protection services
32 Public administration and defence	N/A	N/A
33 Educational and research services	Research reactors	Research reactor
34 Medical and health services, and social welfare	Nuclear medicine	Nuclear medicine, radiotherapy, diagnostic radiology and nutrition
35 Social and other services	N/A	N/A
36 Dummy sectors	N/A	N/A

Note: N/A: Not available, NDT: Non-destructive testing

CONCLUSION

In conclusion, we presented an overview of the development of nuclear technology in Malaysia after 2008. We found that the use of nuclear technology in medical sector outweighed the non-medical sector for seven consecutive years since 2009.The study also found that nuclear technology can readily be incorporated with other conventional technologies in the country.

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