

The Legal Framework for Nuclear Energy and the Nuclear Program in the Hashemite Kingdom of Jordan

Saleh Al-Sharari¹

¹ Dean of Scientific Research and Graduate Studies, Department of Media and Strategic Studies, College of Art, Al-Hussein Bin Talal University, Ma'an, Jordan

Correspondence: Saleh Al-Sharari, Dean of Scientific Research and Graduate Studies, Department of Media and Strategic Studies, College of Art, Al-Hussein Bin Talal University, Amman, Jordan. E-mail: dr_saleh_sh@yahoo.com

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Abstract

This study aims to shed light on the nuclear law of the Hashemite Kingdom of Jordan, (referred to as Jordan), and that of United States of America (referred to as USA) for comparison purposes. It also presents Jordan's nuclear power plan and program to alleviate its dependency on imported energy sources, mostly natural gas from Egypt, as well as to meet its future electricity demand which is expected to double by 2030. Despite the fact that the study reveals that national legislation provide legal protection for nuclear power generation and Jordan is in good standing with respect to its international obligations, further efforts are still required to ensure safety, radiation protection, adequate nuclear waste management and environmental protection.

Keywords: nuclear energy law, nuclear program, legal framework, pollution, international conventions, agreements, capacity building

1. Introduction

Operation of the first commercial nuclear reactor started in Britain in August 27, 1956 with a total capacity of 50 MW, followed by the USA which managed to run the first commercial nuclear reactor by the end the year of 1957 with a total capacity of 60 MW in the State of Pennsylvania. Also, the first French nuclear reactor operated in April 1959 and reached a total capacity to 40 MW (De Saillan, 2010).

Since the operation of the first nuclear plant in the 1950s, nuclear power has played a vital role in providing an alternative global source of energy other than those produced by non-renewable sources such as oil, gas and fossil fuel. Since then, the demand for nuclear energy has demonstrated continuous increase to satisfy the technological, industrial, agricultural and other economic activities advancement and development.

Currently, there are over 430 commercial nuclear power reactors operable in 31 countries, with over 370,000 MWe of total capacity. About 70 more reactors are under construction. They provide over 11% of the world's electricity as continuous, reliable base-load power, without carbon dioxide emissions. 56 countries operate a total of about 240 research reactors and a further 180 nuclear reactors power some 150 ships and submarines (World Nuclear Association website, 2014).

In 1957, the International Atomic Energy Agency (IAEA) was established in response to international fear of the misuse of the controversial nuclear energy technology that can be used either as a useful source of energy or as mass destructive weapon. The IAEA creation was proposed by US President Eisenhower's address to the General Assembly of the United Nations in 1953, Atoms for Peace Speech, The Statute of the IAEA was open for signature on 26 October 1956 by all States Members of the United Nation, and 81 nations unanimously approved it in October 1956.

Since then, international efforts were exerted to reach international conventions and legal binding agreements, to foster peaceful adoption of nuclear technology and to inhibit the spread and use of nuclear weapons (International Atomic Energy Agency (IAEA) website, 2014).

Jordan, and as any other country in the world, aims to alleviate its dependency on imported fuel to generate its electricity, lower electricity prices, and attain greater energy security. Currently, Jordan imports over 95% of its energy needs from neighbouring countries at a cost of one-fifth of its GDP. And since Jordan has significant

uranium resources, some in phosphorite deposits, Jordan aims to have a 1000 MWe nuclear power unit in operation by 2021 and a second one in operation by 2025 (World Nuclear Association website, 2014).

1.2 Research Design and Procedure

This research is qualitative. Theoretical approach and analytical examination of the national legislation (the Nuclear Energy and Radiation Protection Act No. 29 of 2001, the Law of Nuclear Energy No. 42 of 2007 and the Law of Radiation Protection and Nuclear Safety No. 43 of 2007) and international conventions and agreements that Jordan is a signatory and has ratified, was followed, in comparison with the USA nuclear experience and relevant legal framework. Furthermore, review of relevant sources and references was conducted.

1.3 Research Difficulty

A major difficulty encountered while conducting this research is the scarcity of Arabic literature on the subject matter. Arab, and Jordanian experience in specific, in the field of nuclear energy and establishment of nuclear reactors is very recent in the region, thus existing literature addresses only national legislations that govern the creation of Atomic Energy bodies, nuclear safety requirements, licensing and permits' granting.

2. The Importance of Nuclear Energy to Jordan

Many Arab countries had participated effectively in the development of nuclear power programs or announced its intention to do so in the future in order to keep pace with global technological progress and the increasing demand for energy. The report of the International Atomic Energy Agency published in 2008 indicated that fourteen countries in the world are in the process of starting the building of forty-four nuclear reactors to meet their increasing energy demand, and seven other countries are planning to create about forty-eight other reactors, some of which are from the Arab Region (De Saillan, 2010). For example, a country like the United Arab Emirates (UAE) cannot rely only on its current energy supply to meet the continuous increase in energy demand for its industrial, petrochemicals industry and its water desalination projects. The UAE expressed the necessity to include nuclear power in its energy mix to meet future energy needs. Similarly Jordan, Syria, Egypt and Morocco, as well as other countries in the region, had expressed their interest in the development of nuclear programs as a solution to future increase in energy demands.

Jordan, in particular, would like also to reduce its large reliance on energy imports, thus ensure security of its energy supply. The country plans to build a 2 x 1000 MWe nuclear power plant (NPP) at the Amra site, about 70 km east of Amman, in cooperation with the Russian Federation, which will also make a significant investment in the nuclear power plant. To alleviate national and international fear of its nuclear program, the government of Jordan was the first country to invite an Integrated Nuclear Infrastructure Review (INIR) mission in 2009 to assist Jordan in developing its nuclear program. A second INIR was recently conducted from 4 to 14 August 2014 to assess the status of the national infrastructure needed for introducing nuclear power. The recommendations made by the INIR team included finalizing national policies and government commitment, improving coordination between the various Ministries, strengthening the legislative framework, and finalizing pre-investment activities (IAEA website: Top stories & Features, 2014). In addition, Jordan had been keen to be party to international conventions and treaties, the application of nuclear safety standards and working closely with the IAEA.

These intentions have been considered by some of the countries in the international community as an alarm for danger, especially that the Arab region is prone to conflict and instability. To alleviate these fears the Arab countries are committed to the Treaty on the Non-Proliferation of Nuclear Weapons and agree to a Middle East as a zone free of nuclear weapons and limits the use of nuclear energy for peaceful activities only.

2.1 Reasons for Utilizing Nuclear Energy

Global demand for energy, especially for electricity, is witnessing a continuous increase due to the growth in global population and economies in modern and developing states. It is noted that with the rising population on earth to 9 billion over the next fifty years we will be in dire need to search for sources of clean energy. And since renewable energy sources will not provide more than 6% of the world's electricity, and will continue to drop, nuclear power is the ultimate alternative to secure the increasing energy demand to meet residential and various economic activities' needs. This may be referred to as the "Nuclear Renaissance in the world" (Badran, 2014).

Emerging industrial countries is looking into implementing peaceful nuclear programs; whilst established nuclear countries continue to conduct scientific research to advance their technology and minimize nuclear related risks and threats. In addition, these countries became exporters of this technology to be used solely for peaceful purposes. Their experts exert great efforts to overcome the fundamental challenges that face importing countries to implement nuclear programs. This assistance is not limited to dealing with production related

matters such as ensuring adherence to safety standards and resolving technical issues and ensuring the avoidance of the possibility of a nuclear leak, but also may take a form related to helping in establishing political legitimacy (Stoett, 2003). A major nuclear expertise exporter is the USA which had emerged from the field of local manufacturing of nuclear power centuries ago, to enter the field of exporting their expertise to other countries including Canada, Mexico, Australia, India, Pakistan and many others (Stoett, 2003).

The World Energy Council predicts that the global demand for electricity will be doubled to three times during the next fifty years posing a pressure on countries to produce more electricity. Because of the continuous rise in the cost of obtaining electricity from fossil fuel stations in contrary to the fact that the cost of producing electricity from nuclear power stations is relatively more stable since the cost of Uranium enrichment constitute a relatively small part of the total cost of production of electricity in nuclear power station, more countries are looking into creating nuclear energy. It is also worth noting that existing electricity generating stations that use fossil fuels (oil and gas) emit nearly 52 billion tons of carbon dioxide in the atmosphere annually, which is equivalent to about 70 million tons per day, or close to (800) tons per second, and such massive amounts of gas will enhance the global warming phenomenon (Parsons, 2011).

Jordan is already facing financial challenges with respect to meeting its energy demand and heavy reliance on imported fuel. The annual energy bill is about (6.4) billion Jordanian Dinars, equivalent to \$US (9.0) billions, paid in foreign currency and constitutes about 83% of the national revenue from export activities. Subsequent increase in fuel prices will impose further stress on the country's fiscal budget and meeting annual deficit, which has a direct impact on the quality of life of the Jordanian citizens.

In addition to financial burden, the current political situation and recent unrest in the region pose a threat to Jordan's energy security since it imports over 95% of its energy needs from neighbouring countries. For example, the Al-Arish pipeline that supplies Jordan with 80% of its needs of natural gas from Egypt was bombed by militants more than 20 times since 2011 Egyptian revolution, which caused a tremendous shortage of energy in Jordan (Omar, 2014).

Accordingly, there is an urgent need for Jordan to develop and implement a nuclear energy program, as an alternative source of energy (Badran, 2014). Jordan is seeking to acquire a nuclear reactor to generate electricity for peaceful purposes, which is an important step for a state with limited resource. Jordan has begun to prepare the legal framework to move towards the peaceful entry of the nuclear club, where the House of Representatives approved two projects for nuclear energy laws and radiation protection as well as nuclear safety and security. The Arab countries were not keen to keep pace with the nuclear development until the widespread of the use of nuclear energy in the world. In 1964, the Arab World Joint Council for the Peaceful Uses of Atomic Energy, decided to create a Scientific Joint Arab Council. The Arab League Secretariat was then tasked with the draft of a convention for Arab cooperation in the use of atomic energy for peaceful purposes, and the formation of the Council of Scientific joint Arab. The majority of Arab countries had appointed permanent delegates in this Council, and held its first round in four sessions, including the development of a draft Convention on the Arab cooperation on the use of atomic energy for peaceful purposes. The convention was signed by delegates of Jordan, Algeria, Iraq, Syria and the United Arab Republic, Kuwait (Abolkheir, 2014).

2.2 The Distinctive Characteristics of Using Nuclear Energy in Jordan

The nuclear energy is currently providing about 15% of total energy, and contributes to the saving of nearly 34% of the electrical energy produced in the EU countries, and each of the USA, France and Japan produces about (56.5%) of the nuclear energy in the world. The responsible personnel for Jordan's nuclear program confirm that the strategies of this program aim to benefit from the exploitation of uranium to support the national economy and nuclear energy will be the main economic source for power generation and water desalination in Jordan. In addition to meeting the need of increasing demand for electric power, and to promote the diversity of energy sources and safe production as well as the independence in the field of power generation, it will promote the transfer of technology and participating in all its stages, supporting a competitive national industries that depend on the energy in the building capacities and national competencies in nuclear science and technology (Parsons, 2011).

2.2.1 Strategic Energy Security and Elimination of Electricity Price Fluctuation

According to the Updated Master Strategy of Energy Sector in Jordan for the period (2007-2020), demand for primary energy will rise to 17108 thousand TOE in the year 2020 at an annual growth rate of 6.2%. As mentioned earlier, Jordan depends on imported fossil fuels from neighboring countries to generate its required energy needs which poses a threat to the country's national energy security, and exhausts its annual budget, where the Jordanian economy remains exposed to price fluctuation of fossil fuel, which could constitute an enormous

burden in times of rising prices. The prices of coal and gas have more than doubled since 2002 and until mid-2008 in all regions of the world. Jordan spends almost 1/5th of its GDP, on imported fuel.

Before the Gulf war, Iraq provided Jordan with all its oil needs at preferential prices and much lower than market prices. This preferential treatment ceased and Jordan started purchasing its oil needs at market prices.

In addition, Jordan has limited options for replacing petroleum products by natural gas. Jordan, with limited supply of natural gas in the southern region of the country, imports its gas needs from Egypt through a pipe that passes through Israel. Egypt controls the selling price of the gas; currently selling it to Jordan at a preferential price, but this is not guaranteed in the future and the fear that Egypt might set limits on the quantity sold to Jordan as well (Badran, 2014). Furthermore, the political instability in the region poses a real threat to the supply of oil and gas to Jordan. Thus, having an alternative source of energy is not a matter of choice in the long term.

2.2.2 Utilizing Local Natural Resources.

Jordan- as estimated – has about 65 thousand tons of uranium oxide from sources in the central region of the country, in addition nearly one hundred thousand tons of uranium can be extracted from the Jordanian phosphate. Furthermore, a new reserve of uranium in the region of “Alhasa” has also been recently discovered. Preliminary estimate of the quantity is equivalent to twenty thousand tons of uranium oxide. These quantities and reserves are concentrated in the central Jordan, Bahja Valley, Alsaheb Alabyad Valley, and Alorishid (Abu Ayyub, 2011).

The Jordan Energy Resources Incorporated –JERI a was established as a Jordanian company authorized to explore and mine for uranium, thorium and other heavy metals, extract uranium from phosphates, grind and treat nuclear heavy minerals and provide the required nuclear material for nuclear energy production. In 2008, an agreement between JERI and the French company "AREVA" was signed to start mining for uranium in the central region of Jordan. In February 2010, this agreement was amended and provided AREVA with mining rights to cover an area of one thousand four hundred square kilometers in the central region of Jordan (Badran, 2014).

3. Jordan Nuclear Energy Related Legal Framework

3.1 Features of Nuclear Energy Law in Jordan

Nuclear energy industry is considered as one of the industries that require the highest levels of safety and security in accordance to the international standards to protect workers in this field, citizens and the environment. In addition, it necessitates a high technical and technological standards and expertise during the different phases of setting up, operating and retiring a nuclear power plant. This industry can't tolerate errors and does not allow any chances of nuclear incidences leading to disasters since safety considerations are of top priority and supersedes any other considerations (Badran, 2014).

In 2001, the Government of Jordan passed the Atomic Energy and Radiation Protection Law No. 29 of 2001 with the purpose to provide direction, infrastructure and establish projects necessary to utilize nuclear energy for peaceful purposes, whilst ensuring public safety, human health and protection against radiation, etc. The law called for the creation of an independent and effectively empowered body called the Jordanian Nuclear Energy Commission (JNEC) to attain these objectives. In 2007, this Law was annulled and two new laws were enacted: 1) the Nuclear Energy Law No. 42 for the year 2007 and 2) the Radiation, Protection and Nuclear Safety and Security Law No. 43 for the year 2007.

The Nuclear Energy Law No. 42 for the year 2007 primary objective is to introduce the peaceful uses of nuclear energy to the country mainly for electricity generation, water desalination and medicine, and setting up investment projects. The Law called for the creation of the Jordan Atomic Energy Commission (JAEC, as a financial and administrative independent legal entity reporting directly to the Prime Minister. JAEC main mandate is to transform Jordan from a net importer for energy by the year 2030, and alleviating the direct reliance on fossil fuels to alternative sources of energy, and the peaceful utilization of nuclear energy. To fulfil this purpose, and in accordance to Article 5 of this Law, JAEC has the authority and power to:

- a. Conduct and disseminate scientific research on nuclear technology and ionization radiation, and ensuring that latest information and technological advancement in nuclear science and technology is acquired and shared with concerned persons in the country.
- b. Define technical criteria and specifications, in cooperation with the concerned public and private sector, for the mining and exploitation of uranium, thorium, and Zirconium elements in the country.
- c. Manage the handling, storage, transport, treatment, and disposal of nuclear fuel and waste.
- d. Create, in cooperation with public and private sector, investment projects and/or companies to establish

nuclear plants for peaceful uses including the generation electricity, desalination of seawater, medical and agricultural use, etc.

- e. Coordinate the relationship among various concerned stakeholders on national, regional and international level with respect to the utilization of nuclear power.
- f. Participate, and represent the country in Arab, regional and international nuclear energy related initiatives and forums.
- g. Draft regulations required for the execution of this Law.

The Radiation, Protection and Nuclear Safety and Security Law No. 43 for the year 2007 created the Jordan Nuclear Regulatory Commission (JNRC), as a successor to JNEC, and as a legal entity that has full financial and administrative independence that is directly to the Prime Minister. The JNRC was established to implement comprehensive nuclear and radioactive related safeguards and create a system for and control of all nuclear materials (Sharaf, 2010). The Law also stipulates the duties and powers of the Commission, the constitute of the Board of Directors (BOD), roles and responsibilities of the BOD, its Director, financial resources of the Commission, prohibitions and compliance requirements with regards to establishing, operating or managing any nuclear facility in the Kingdom and related matters without obtaining the necessary licenses to be provided by the Commission, in additions to defining penalties in the case of violation.

Pursuant to Article 4 of the same Law and its amendments, the primary objectives of Commission are to *“regulate, monitor, and control the use of nuclear energy and ionizing radiation, protect the environment, human health and properties from hazards of contamination radiation and exposure to ionizing radiation, in accordance to the provisions of this Law, and ensure the fulfilment of requirements of public safety, radiation protection, and nuclear safety and security”*.

Whereas, Article 5 specifies the duties and powers of the Commission which are:

- a. *“Granting licenses and permits for radiation institutions, nuclear facilities, and workers in the radiation and nuclear fields.*
- b. *Checkup of the commitment of the licensees to implement the terms of this law, and regulations and instructions issued accordingly.*
- c. *Control on the implementation of the terms of this law and conduct inspection for any installation or body for this purpose.*
- d. *Contact institutions and commissions concerned with regulating and control of nuclear energy, radiation protection, and nuclear safety and security in the Arab and foreign countries to benefit from the expertise, scientific research, and assistance in their field of work.*
- e. *Participate in Arab, regional and international projects concerned with nuclear energy, radiation protection, and nuclear safety and security, related to expertise or research with the consent of the cabinet.*
- f. *Regulate relations between Jordanian entities concerned with radiation protection, and nuclear safety and security; and relevant international, regional and Arab organizations and agencies.*
- g. *Implement comprehensive safeguards, and create a system to account for and control of all nuclear materials subject to these safeguards”*.

JNRC has the right to build and operate facilities necessary to prevent radiological risks from materializing and ensuring nuclear safety and protection of the environment from the dangers of radioactive contamination, as well as engaging stakeholders to develop national emergency plans to handle incidents of radiological and nuclear accidents (Parsons, 2011).

Also, pursuant to Article 7 of the Law, the Board of Directors (BOD) of JNRC is granted the power to set the standards, specifications and general safety requirements to protect public health and the environment from the dangers of pollution and exposure to ionized radiation. Furthermore, JNRC has the mandate and the authority to install monitoring devices throughout the country, and in radioactive waste treatment plants to measure radiation levels and ensure adequacy of the treatment and disposal of radioactive waste, and that it in compliance with the national standards, and safety controls and procedures set by JNRC.

The Law mandates the BOD, in cooperation with concerned stakeholders from the public and private sectors, to provide the country with qualified manpower and expertise in the field of nuclear energy, radiation protection and nuclear Safety, examine nuclear and radiation accidents and/or environmental pollution caused by radiation leak to determine the causes and take the appropriate actions to remedy the situation. Furthermore, the JNRC is

required to draft regulations necessary to execute this Law

With regards to radioactive waste, the Law prohibits any person to enter it into the country for use or disposal purposes. In addition, the disposal of local radioactive waste resulting from the different applications in the country, or burial in its land must obtain the consensus of JNRC's Board, and to be conducted under the supervision of the Commission and in the sites licensed by the Commission and allocated for by the Ministry of Environment.

With respect to the working force in this field, the Law forbids licensed entities to employ or train any person under the age of 18 years as a radiation worker. In the case of accidents or a person contracting a disease or suffers disability or dies as a result of radiation exposure, the licensed entity will be responsible for compensation for his/her damages.

As stipulated by this Law, sanctions against violators range from administrative penalties such as revoking the license or closure of the nuclear establishment and confiscating all radioactive sources, materials, equipment or radiation devices to criminal penalties which may include imprisonment and fine payments depending on the violation. However, when these penalties were assessed, one can conclude that they might not be sufficient to deter individuals from contravening this Law. For example, the penalty for a person bringing nuclear waste for use or disposal purposes into the country will be punished by imprisonment for at least one year but not more than three years, or shall be liable to a fine of not less than ten thousand Jordanian Dinar (equivalent to \$US14, 100) and not more than thirty thousand Jordanian Dinar (equivalent to \$US42, 300). It is important for Jordan to revisit its penalties and fines in order to ensure compliance with the law and deterrence of violators.

With regards to issuing the regulations mandated by the the Nuclear Energy Law No. 42 for the year 2007 and the Radiation, Protection and Nuclear Safety and Security Law No. 43 for the year 2007, to be able to adequately regulate and manage the nuclear sector in the country, Jordan issued few regulations to date which are:

- 1) Employment regulation of the JAEC (No.87 of 2009): scope covers all matters related to personnel, employee, experts, consultants, and advisors such as hiring conditions and requirements, salary scale, incentives and other related employment matters.
- 2) Financial, supplies and work affairs of the JAEC (No.88 of 2009).
- 3) The safe use of nuclear energy (No. 43 of 2014).
- 4) Basis and conditions for granting licenses and permits for the radiation work (No. 8 of 2013).
- 5) Fees for licenses and permits for the radiation work (No. 9 of 2013).

Regulations yet to be drafted and issued by the Cabinet:

As per Article 15, Law No. 42 for the year 2007(for JAEC)

- 1) Matters related to employing researchers.
- 2) Saving fund for all the workers in the Commission.

As per Article 26, Law No. 43 for the year 2007(for JNRC)

- 3) Safety and security of radiation sources.
- 4) Radiation protection.
- 5) Management and treatment of radioactive waste and spent fuel.
- 6) Transport of radioactive materials.
- 7) Extracting, mining and processing of the nuclear materials.
- 8) Employment regulation for JNRC
- 9) Financial, supplies and work affairs of JNRC
- 10) Saving fund for all the workers in the Commission

3.2 Features of Nuclear Energy Law in the USA

The USA is considered the leader in the nuclear field and among the first countries that have contributed significantly to the expertise and scientific work of building nuclear reactors and the development of its different uses. The USA possesses alone nearly a quarter of the nuclear reactors in the world built for different purposes including peaceful uses in the medical, scientific research, and in the areas of electricity generation and agriculture (Squassoni, 2009). The use of nuclear reactors the U.S.in the field of industry, which is known as the fourth

Generation (GIV) of Nuclear Reactors, have many characteristics such as the reduction of running cost and minimizing environmental risks resulting from operations, in addition to applying a high degree of nuclear safety measures (De Saillan, 2010). As for military uses, the USA developed this technology significantly over the past decades, and owns the largest number of nuclear war heads in the world (Squassoni, 2009).

The USA owns numerous nuclear reactors operating for civic purposes. As of August 2014, the USA had 100 operable nuclear power reactors, 5 under construction, 5 planned and additional 17 proposed; “*Operable = Connected to the grid; Under Construction = first concrete for reactor poured, or major refurbishment under way; Planned = Approvals, funding or major commitment in place, mostly expected in operation within 8-10 years; Proposed = Specific program or site proposals, expected operation mostly within 15 years*” (World Nuclear Association website, 2014).

The USA was a pioneer and still is a leading country in establishing and applying nuclear control systems to monitor, control and manage nuclear materials and wastes. During the manufacturing of the first atomic bomb, the USA was keen to measure every gram of nuclear material used in order to control nuclear materials. And when there was an increase in the production volume and demand for nuclear material in 1950s, the USA created its first Atomic Energy Commission, as well as the Department of Control of Nuclear Materials with purpose to set the safeguards principles of monitoring and control of nuclear material quantities being traded, handled, transported and etc. to prevent loss, and leakage of unaccounted nuclear materials. However, this system ineffectively began in 1961 (Sultan, 1998).

Interests in the legislative laws of nuclear power started in 1946 when the Congress signed the Nuclear Energy Act, and was amended in light of the administration of President Roosevelt in 1950 which regulated the use of nuclear power and special technology for the production of electrical energy, which came into force in 1954 (Stewart, 2008). This Law declared the policy of the USA to use, develop, and monitor and control the production of atomic energy in the country. The Law also called for the creation of a special committee tasked with the management and control of the materials related to atomic energy, as well as the management and oversight of nuclear technology, in accordance with bilateral agreements or international conventions. In addition, the Law defined the procedures for negotiating nuclear related agreements with other countries, naming the Ministry of Foreign Affairs as the concerned body and mandating that the agreement should be reviewed by the USA Congress prior to signature. Furthermore, this Law specified the standard procedures necessary for the export of nuclear materials and technology (Rennack, 2010).

As mentioned earlier, in 1946, the USA issued the US Atomic Energy Act, which laid the foundations for dealing with and managing nuclear activities in the country. This Act was replaced by the Nuclear Energy Law of 1954. To keep pace with major developments in nuclear power and building nuclear reactors fields, other countries followed suit and in 1946 and 1964 the law of Control of Atomic Energy of Canada and the Atomic Energy Act of England were passed. The Nuclear Energy Law of 1954 became the primary source and reference for the draft of other countries’ national nuclear laws since it is very comprehensive, detailed oriented and addresses all aspects of organizing and managing the nuclear sector such as licensing conditions and requirements for establishing nuclear plants, monitoring and control of nuclear materials and wastes, establishing adequate safeguards systems, defining responsibility in case of nuclear accidents and etc. (Abolkheir, 2014).

The Price-Anderson Nuclear Industries Indemnity Act (commonly called the Price-Anderson Act) was passed in 1957 and was amended several times since then. The main objective of the Act is to partially indemnify the nuclear industry against liability claims arising from nuclear accidents while still ensuring compensation coverage for the general public. The Law mandates that the operator to have liability coverage of at least \$US60 million dollars to compensate for any damages and harm resulting from nuclear incidences. But since not all companies can afford to insure their operations for the required value due to their size, a US Insurance Fund was created under this Act, which currently has \$US12.6 billion in reserves. Companies that are members in this Fund, has access to its money to pay compensations without exposing or draining their company’s finances. Many nuclear countries followed the United States in the insurance nuclear fund, to cover damages caused by nuclear accidents such as Germany and Belgium. The Fund can also bear the cost of compensation arising from accidents caused by another party other than the nuclear operator (Faure, 2008).

To manage the risks of nuclear radiation emitted from nuclear reactors, the USA adopted flexible advanced policies and programs such as nuclear radioactive waste management program and the law of Nuclear Policy which was discussed and passed by US Congress in 1982. Pursuant to this Law, the Nuclear Waste Management Office was established in the Ministry of Energy. The office was tasked with the responsibility to draft and implement a nuclear waste management regulation and system manage the wastes resulting from nuclear civic

activities caused by the burning of nuclear fuel. In addition, pursuant to the provisions of this Law, procedures regarding the selection of nuclear waste burial sites, and determining the responsible parties for each risk were issued.

It is worth mentioning that various US organizations are entrusted to manage the licensing and managing civic, nonmilitary, nuclear related matters in the country. For example, the Nuclear Regulatory Commission licenses the nuclear reactors and selects, in coordination with concerned parties, nuclear waste burial sites. Also, the Environmental Protection Agency (EPA) is entrusted with the development and implementation of adequate environmental protection against nuclear radiation in addition to assessing the environmental regulations and procedures related to environmental protection (Cantlon, 1996).

3.3 *International Conventions and Agreements*

Most countries that utilize nuclear power are governed by a set of international and national regulations and binding requirement. For example, the Paris Convention of 1960, which was held under the auspices of the International Atomic Energy Agency, which is concerned with the responsibility for the nuclear dangers, as well as the International Convention on nuclear Safety, signed in 1994, which requires an adequate level of safety precautions and safeguards for nuclear uses. Also, countries, that use nuclear energy, are expected to take into considerations the non-binding recommendations put forward by the International Atomic Energy Agency which were adopted by Member States in 1993, specifically those around the safety of nuclear sites, transfer of nuclear materials and/or burial of nuclear waste resulting from the use of nuclear fuel. It is worth noting that the USA plays a major role achieving the intended objectives of these conventions and recommendations, in collaboration with concerned international institutions (Bredimas & Nuttall, 2009).

National regimes is heavily depending on those general rules which are internationally recognized, which often are the product of a joint effort between the major countries and the international community. Jordan has been keen to achieve Nuclear Safety consistent with its international obligations, and in July of 1998, Jordan signed an Additional Protocol to the Agreement between the Hashemite Kingdom of Jordan and the International Atomic Energy Agency for the application of safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (Abutaleb, 2010). On the contrary, and even though the USA was a pioneer in drafting nuclear energy related legislation, and championed the call for international mechanism to regulate and control nuclear materials and the use of nuclear power since the 1950s, the USA did not necessarily sign and/or ratify all the international agreements. For example, the USA is not a party to the Vienna Convention on Civil Liability for Nuclear Damage that came into force 12 November 1977. Additionally, the USA may sign an international convention or treaty, but may delay its enforcement, for example the USA signed the Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management in September 1997 but entered into force in July 2003 (IAEA website, 2014).

Jordan's status in Relation to International Instruments (Jordan Nuclear Regulatory Commission website, 2014):

- 1) Signed and ratified/ accessed:
 - a) Convention on Physical Protection of Nuclear Material (CPPNM)
 - b) Convention on Nuclear Safety
 - c) Convention on Early Notification of a Nuclear Accident
 - d) Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency
 - e) The Comprehensive Safeguards Agreements Between Jordan and the Agency for the Application of safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons and the Additional Protocol
 - f) Treaty on the Non-Proliferation of Nuclear Weapons (NPT)
 - g) Comprehensive Test Ban Treaty
 - h) Agreement on the Privileges and Immunities of the IAEA
- 2) Signed but hasn't ratified yet:
 - a) International Convention for the Suppression of Acts of Nuclear Terrorism,
 - b) Convention for the Suppression of Acts of Nuclear Terrorism
 - c) Co-operative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA)
 - d) Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water, Partial Test Ban Treaty 1963
 - e) Treaty on the Prohibition of the Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof,

- f) Revised Guiding Principles and General Operating Rules to Govern the Provision of Technical Assistance by the Agency; - Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA)
- 3) In the process of signature/ accession:
- a) Vienna Convention on Civil Liability for Nuclear Damage
 - b) Or Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention
 - c) Or Convention on Supplementary Compensation for Nuclear Damage
 - d) Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

4. Jordan Nuclear Energy Program

Programs related to nuclear energy passes through two stages; the first stage is the preparation phase, which includes the conduction of a comprehensive feasibility study of the intended program, and defining the legal (national and international) governing framework. The program is then approved by the Government and the political leaderships in the country, upon the recommendation of the Commission. The Government then seeks international approval in order to guarantee access to nuclear technology, expertise, material and funding. As such, the state exerts internal and external efforts to ensure the execution of the nuclear program (Ahmed, 2010).

The second phase includes the actual implementation of the program.

Jordan's nuclear program includes (Badran, 2014):

- 1) The construction of a nuclear power plant to produce electricity and water distillation using nuclear reactors.
- 2) A project to exploit radioactive natural resources in Jordan, specifically uranium.
- 3) Plan to build a second nuclear reactor in two to three years after commencing the work on the first one to be constructed for the purpose to provide energy for the desalination and transfer of water from the Red Sea to other parts of the country.
- 4) Long-term plans to build four other nuclear reactors to generate electricity in the next two decades, with the aim to satisfy Jordan's future energy needs, and export surplus electricity to neighbouring countries.
- 5) The buildup and operation of a research reactor with a capacity of (5:10) MW, as an integral component of nuclear technology infrastructure for the nuclear science and technology center. The research reactor will be used to train a new generation of Jordanian nuclear scientists and engineers and provide necessary support to the medical, health, agricultural and industrial services.

It is worth noting that in October 2013, the Chairman of Jordan Atomic Energy Commission, announced that Jordan has chosen two Russian companies to build and operate the first nuclear power plant in the Kingdom for peaceful purposes, specifically for electricity generation and water desalination. The selected Russian companies Atomstroyexport (Атомстройэкспорт), the Russian Federation's nuclear power equipment and service export company, and Rusatom Overseas as a strategic partner, investor and operator of the nuclear power plant, in accordance to the Jordanian initial agreement to be concluded between the governments of Jordan and Russia. It is also expected that the completion of the project will be in two phases, the first phase will be completed in two years which encompass the conduction of the detailed studies of the site. The second phase includes the finalizing and signing of the agreement between Jordan and Russia, and the implementation and execution of the project. The project includes the buildup of two nuclear reactors with a capacity of (1000 MW). The first reactor is planned to operate in 2021, and the second reactor after two years (Al Ahram newspaper, 2013).

In 2012, there has been media driven controversy with regards to Jordan's nuclear program. Opponents in the lower house of parliament, and among tribal leaders, are concerned with safety, public health and the cost of the reactors, securing the funds to construct the reactors and determining suitable locations for them. They are calling to look into other alternative sources of energy such as wind and solar. Environmental groups raised their concerns, but gained little attention for their issues from the parliament.

5. Nuclear Programs and Environmental Hazards

Three months after the nuclear bombing Japan during the Second World War, the USA, England and Canada attempted to find a control system to ensure nuclear safeguard. These countries announced that the military use of nuclear energy depends to a large extent, and must be consistent with industrial usage. They also tried to restrict the use of nuclear power in the world and prevent other countries from the implementation of nuclear programs unless they have an effective control system for nuclear safeguard. The USA have also established a committee for the American atomic energy, which in 1953, introduced to the United Nations assembly a plan known as the Baruch

Plan. The plan called for the creation of an international authority to develop the use of nuclear energy in the world in order for countries to be able to fulfill their energy needs. The U.S President, Eisenhower, also introduced a proposal under the name of Atoms for Peace (Sultan, 1998).

There is no doubt that the use of nuclear power may pose serious environmental risks. There is also no doubt these risks rise with the buildup and operation of more nuclear reactors, which mean that more hazardous nuclear material need to be handled, transported, stored and disposed as well as to deal with radioactive waste which is currently either buried in the soil or dumped into the sea. This radioactive waste may take millions of years to decay to background levels (World Nuclear Association website, 2014); as such countries try to store the waste in a place so that the environment won't be contaminated. This issue poses both political and technological challenges. In terms of politics, no one wants it stored near them or on their soil. So there's much dispute as to where radioactive waste should be stored. In addition, storing so much waste is a major technological challenge.

In the case of Jordan, there are significant and major environmental challenges to the development of its nuclear program since the country is earthquake prone and water poor. In addition, Jordan does not have sufficient trained personnel and limited nuclear research and education infrastructure (IAEA website, 2014).

However, according to the World Nuclear Association, "*the amount of radioactive wastes is very small relative to wastes produced by fossil fuel electricity generation, and nuclear wastes are neither particularly hazardous nor hard to manage relative to other toxic industrial wastes*". Furthermore, "*safe methods for the final disposal of high-level radioactive waste are technically proven; the international consensus is that this should be geological disposal. Each year, nuclear power generation facilities worldwide produce about 200,000 m³ of low- and intermediate-level radioactive waste, and about 10,000 m³ of high-level waste including used fuel designated as waste. In the OECD countries, some 300 million tonnes of toxic wastes are produced each year, but conditioned radioactive wastes amount to only 81,000 m³ per year*" (World Nuclear Association website, 2014).

6. Conclusion

It is important for Jordan to develop a peaceful civilian nuclear program to face future energy challenges, the accelerating growth for electricity demand, attain greater energy security, alleviate dependency on oil import by diversifying its energy mix, reduce financial burden as a result of the cost of imported oil and gas, and create an opportunity to generate revenue by exporting excess electricity to neighboring countries.

It is critical for Jordan to ensure that it has adequate capacity building of JNRC for it to be able to fulfil its obligations mandated by the law, infrastructure, required investment, expertise, trained personnel and most importantly strong legal framework to manage and implement its nuclear ambition and programs to avoid adverse impacts on the environment, public health and nuclear accidents.

Even though Jordan has two laws concerned with the utilization of nuclear power, a more comprehensive nuclear energy law that covers all the project's elements needs to be drafted. In addition, the Cabinet has to issue relevant regulations as soon as possible as mandated by the aforementioned Laws to be able to regulate and manage the nuclear power sector in the country. It is important for Jordan to bench mark against leading nuclear countries such as the USA when developing its legal framework.

Jordan has a good standing with respect to international conventions and agreements, and has been a pioneer in seeking international advice and expertise in implementing its nuclear strategy and program. Jordan was the first country in the world to voluntarily invite the IAEA to conduct an integrated nuclear infrastructure review.

7. Recommendations

- Review comparative legislation and regulations, specifically with leading nuclear countries, to build a balanced adequate legislative framework for the appropriate and safe use of nuclear power in the country.
- Draft of a new comprehensive nuclear energy law that covers all the nuclear project's elements including recommendations for a suitable organization structure.
- Draft all the regulations and instructions mandated by the laws No 42 and 43 of the year 2007.
- Develop a capacity building program for judges to ensure that they have the right expertise, capabilities and resources to consider nuclear related cases.
- Ensure the necessary measures are in place to avoid and prevent nuclear accidents and/or environmental disasters including an adequate risk management plan where risks are identified, managed and mitigated appropriately.
- Draft a comprehensive emergency preparedness and nuclear disaster recovery plans.

- Similarly to the USA, encourage the creation of nuclear accidents insurance fund to provide compensations in case of accidents.
- Enhance national efforts in the building and qualifying personnel in the field of nuclear energy.
- Encourage national scientific and Arab institutions to conduct scientific research in the field of nuclear energy and to promote the profession in this field to create specialized regional cadres.
- Ensure the development and implementation of sufficient safeguards and control and monitoring systems to minimize the likelihoods of nuclear accidents and leakage.
- IAEA recommendation: based on the August 2014 INIR mission, the experts recommended establishing a Jordanian nuclear electricity company as soon as possible and continuing with the infrastructure and environmental impact studies.
- Conduct a national awareness program with an emphasis on the benefits of the nuclear program to the country, and address national public health, safety, environment and economic challenges, and demonstrate the public, private and legislative role in tackling these challenges.

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