

Safety and security concerns and peaceful nuclear energy: feasibility for Pakistan

Sumaira Nasir Durrani *

Introduction

Nuclear energy is the cleanest source of energy, and also important for numerous other reasons. Nuclear power has the potential to be employed for weapon production, such as the ‘Atom Bomb’ whose destructive power was demonstrated in Japan and which wiped out two cities in seconds. However, its positive utility is also serving humanity in many ways, such as in the medical, agricultural and industrial fields, and most importantly in the generation of electricity through nuclear power plants. Energy resources are vital for any country, and in this regard, nuclear electricity generation is one of the best ways to strengthen a country’s energy security by diversifying its resources and increasing energy supply options.¹

Developing countries like Pakistan, which is already suffering acute energy shortage, need immediate and permanent solutions. Pakistan desperately needs to develop and secure its energy resources to sustain economic growth, which is already suffering due to this energy crisis. In Pakistan’s “energy mix,” nuclear electricity generation is already playing an important role along with coal, gas, oil and other renewable and non-renewable energy resources. However, nuclear energy has a potential to become a much larger part of this pool.

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Nuclear power plants have concerns related to safety and security, proliferation and waste management. In other words, they stand on the border between humanity’s greatest hopes and its deepest fears for the future.² Pakistan has more than 40 reactor years of operational experience to its credit. During this period, safety has been the hallmark of the country’s nuclear industry,³ but Pakistan is facing discriminatory behavior from the international community as it fails to receive latest and improved technology of nuclear power generation – such as that given to India by the US.

* The writer is a student of Strategic and Nuclear Studies Department of National Defence University, Islamabad. She wrote this paper during her internship from January 01, 2012 to June 29, 2012 at the Institute of Strategic Studies, Islamabad (ISSI).

Peaceful use of nuclear energy is the legal right of all nations under Article IV of the Nuclear Non-Proliferation Treaty (NPT). Nuclear non-proliferation, peaceful nuclear cooperation and nuclear disarmament are the three equally important pillars of the NPT. In future, more and more states will go for nuclear energy to meet their energy needs and gain self sufficiency rather than opting to obtain energy resources from other nations.⁴ Indeed, these are issues inherent in the discourse that must be clarified soon.

International concerns and double standards

Since the dawn of the nuclear age, the international community is attempting to strengthen the nuclear non-proliferation regime. Developed nuclear states, despite promises to promote peaceful use of nuclear energy, are struggling in their endeavors because of the fears that this will lead to weapons programmes. They do not want to see many other developing nations at their own level of development in the nuclear field, preferring instead to retain this global dominance.

Developed nations should in fact support the developing and poor countries. The NPT bounds nations to help each other to promote peaceful nuclear

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technology without any discrimination. However, it is a fact that peaceful nuclear technology is provided only to the “blue eyed” states, e.g., to India through the Indo-US nuclear deal, and to Israel whose so called ambiguous nuclear weapons capability is not looked at with much concern. These western powers have even blocked any effort to unveil Israel’s nuclear weapons ambiguity. On the other hand, they criticize and humiliate states like Pakistan by raising safety and security concerns, and have imposed sanctions on Iran and threatened attack even though there is no official proof that it is developing nuclear weapons.⁵

The promotion of the peaceful nuclear energy is as essential for developing nations as it is for the developed world. If India, being a non-signatory to the NPT, can be given access to resources through the Indo-US nuclear deal without considering its safety and security records, then why are others ignored? Although the international nuclear non-proliferation regime is working for serving the humanity by attempting to limit weapons and the atomic bomb, the US is the main cause of proliferation. It attained the status of “Nuclear Weapons State” by creating the NPT regime in 1967 and fulfilled its own energy needs by

constructing 104 nuclear power plants (20% electricity). Yet it wants to tie the hands of other nations in similar endeavors.

It was the US-USSR rivalry that dragged the situation to a point where other states were helplessly compelled to believe that nuclear weapons are the only source of survival. Previously, during World War II, if the US had behaved like a responsible state, the situation might have been different. Later, initiatives were proposed to shut the mouths of major states by the “Atom for Peace” programme in 1953 under the supervision of the IAEA. At that time few other major powers were already in the process of developing atomic bombs, which resulted in expansion of the nuclear club from one to five within nineteen years after the WWII.

The weaknesses of IAEA safeguard system were unveiled when India conducted its so called Peaceful Nuclear Explosion (PNE) by diverting Plutonium from the CIRUS reactor as fissile material. The Nuclear Suppliers Group (NSG) was made in 1974 in response to India’s nuclear test as a punishment for non-state parties to the NPT. But interestingly in 2008, the same NSG gave a waiver to India and allowed it to access the international nuclear market as a non-state-party to the NPT.

The same NSG which was created to punish India turned friendly to India in September 2008, by modifying its own laws to allow it to commence international nuclear trade under the Indo-US nuclear deal. Since November 2010, the Obama administration has been supporting India's full membership in four multilateral export control regimes, namely the NSG, the Missile Technology Control Regime (MTCR), the Australia Group (AG), and the Wassenaar Arrangement (WA).⁶ Over these years, a number of countries, including Russia, France, UK, Canada, South Korea, Mongolia, Kazakhstan, Argentina and Namibia have become major nuclear supplier to India. An Indian private company also won a uranium exploration contract in Niger in 2010.⁷ As a result of these developments, India now ranks sixth in terms of production of nuclear energy, behind the US, France, Japan, Russia, and South Korea.⁸

On the other hand, Pakistan is a developing nation with significant challenges. Besides economic, social and internal problems, safeguarding national interests and territorial integrity have always been priorities. And with a hostile neighbor in India, Pakistan had no choice except to go nuclear, with one former Prime Minister famously saying that, “We will eat grass but make a nuclear weapon.”

There are many key reasons for a state to become a Nuclear Weapon State (NWS). The major element is its “threat perception,” which compels a state to divert its resources to obtain nuclear weapon capability for survival. Almost

every NWS emerged as a result of this. Russia pursued nuclear capability to cap American nuclear monopoly, the United Kingdom (UK) and France went nuclear to maintain their prestige and hold in the region, while China followed the track feeling threatened by other nuclear powers. Israel kept its nuclear capability ambiguous to keep every concerned state conscious. India claims to balance Chinese nuclear weapons and to get an edge over regional states. Similarly Pakistan has to balance India and Israel. Finally North Korea is another example going nuclear because of threat perception.

Indian and Pakistani non-proliferation policies have been largely driven by their respective security imperatives and threat perceptions.⁹ Pakistan has always supported the international nuclear non-proliferation regime. It presented the proposal for a South Asian Nuclear Weapon Free Zone (NWFZ) before the United Nations General Assembly (UNGA) in the aftermath of India's first nuclear test in 1974. This proposal was based on the expectation that it would bring to bear greater international pressure on India.¹⁰ Subsequently, Pakistan's policies were even more tightly coupled with those of India. It often repeated pronouncements of its willingness to sign the NPT simultaneously with India, and also made its signatures to the Comprehensive Test Ban Treaty (CTBT) contingent upon India's signatures.¹¹ The downside of such an approach has been that Pakistan's policy has remained a virtual hostage to Indian policy and has been defensive to the extent of being apologetic.¹²

Pakistan's position is shaped by its security concerns. It got nuclear capability to balance and counter the growing Indian conventional capability. The direct linkage with India's nuclear programme and policies has created a situation in which Pakistani policies are bound to be affected by the positions taken by India. This resulted in the undesirable possibility of being wittingly or unwittingly sucked into a nuclear and missiles arms race with India.¹³ If Pakistan is reluctant to join the CTBT or the Fissile Material Cut-off Treaty (FMCT), it is only because of the sense of insecurity of its rivals, and the unjustified behavior of superpowers. So far, the US has conducted 1032 hot tests and has the technical know-how (Dawn Super Computers), and yet it has not ratified CTBT and FMCT.¹⁴ Treaties like NPT, CTBT and FMCT were proposed and signed by the states after they obtained the nuclear weapon capability. They accepted the non proliferation regime because it suits them well.

Forty four countries must ratify the CTBT to bring it into force. This includes Russia, USA, China, Egypt, Israel, India, Iran, and North Korea, which have nuclear weapons or atomic programmes. All these countries are also considering Pakistan as a hurdle for a conclusion of FMCT. If they are really interested to cut off the production of fissile material and stop further testing then they should ratify both CTBT and FMCT. Pakistan's firm standpoint about these treaties is enhanced by the international community's discriminatory behavior, trend of

selectivity, vertical and horizontal proliferation and the ineffectiveness of the non-proliferation regime.

Even western leaders recognize their double standards. Texas Congressman and potential presidential candidate Ron Paul said on February 23, 2012 that Iran is encouraged to go nuclear because “we threaten them.”¹⁵ Similarly Russian Prime Minister Vladimir Putin said on February 24, 2012 that, “Western military interventions in various nations, from the invasion of Iraq in 2003 to NATO’s air strikes against Gaddafi’s forces in Libya, were only encouraging nuclear proliferation. Like it or not, it’s a fact that foreign intervention leads to such thoughts that if we have got an atomic bomb, nobody will touch us.”¹⁶

Instead of just criticizing Pakistan, there is a need to understand its problems. A country goes for nuclear weapon option when its security environment is deteriorated. American policy to elevate India as regional power has formed a challenging environment for Pakistan. Apart from Pakistan, all countries have nuclear related deals with each other, but none supports Pakistan in peaceful nuclear technology except China. No one knows how long China will help Pakistan as being member of NSG China also has limitations. Being a responsible state its Pakistan’s right to have civil nuclear cooperation and support of the international community, such as that given to India and Israel. Pakistan’s civil nuclear programme is under the IAEA safeguards, and Pakistan has no intention to divert it for military purposes. Pakistan is also party to the convention of nuclear safety and fulfills all IAEA standards. Currently, for Pakistan, nuclear non-proliferation and nuclear disarmament are not the main issue. Rather, peaceful use and development of nuclear technology is real concern that Pakistan needs to concentrate on.¹⁷

Global trends of nuclear power generation

According to IAEA, there were 442 nuclear reactors operating around the world before the Fukushima nuclear accident. The US is still leading the pack with 104 nuclear reactors. France comes second with 58 nuclear reactors and while Japan was third with 54,¹⁸ after the Fukushima incident the situation has changed. All 54 reactors of Japan are inactive, the last reactor taken offline on May 5, 2012, awaiting approvals to restart.¹⁹ The amount of electricity generated by nuclear power plants worldwide fell by just over 4% in 2011. According to figures from IAEA, total nuclear electricity generation in 2011 was 2518 TWh (Terawatt hour), 4.3% less than the 2630 TWh generated in 2010. World wide average nuclear energy availability in 2011 was 78.7% down from 81% in 2010.²⁰

The global nuclear industry is moving forward at a fast pace and only slightly slowed down after the Fukushima accident when Germany, Switzerland and

Belgium decided to get rid of nuclear power plants.²¹ Yet, six new nuclear power plants were connected to the world's electricity grid in 2011 with the capacity of 4014 MW.²² The IAEA's most realistic estimate is that 90 new nuclear plants will enter in service by 2030.

In the past few years a renewed push for civilian nuclear energy has been seen in several countries all over the world including in the Middle East, North Africa and South America. There is also a race between the US, Russia, France, and China to sign nuclear cooperation deals with countries in the Middle East.²³ Egypt has one of the most advanced nuclear programme in the region. It has a well-established administrative infrastructure and multiple nuclear facilities spread over several locations, including two research reactors and exploratory uranium mining operations.²⁴ Israel is also aiming to build an advanced nuclear reactor in north Negev. Jordan has ambitious plans to introduce nuclear power for electricity generation and water desalination, for which it has undertaken feasibility studies and sought foreign cooperation.²⁵

In June 2011, Saudi Arabia announced an elaborate plan to introduce nuclear power, projecting that it will spend \$300 billion on 16 nuclear reactors by 2030, with the first to be built by 2021.²⁶ In December 2009, Abu Dhabi contracted with a South Korean consortium to construct four nuclear power reactors which are scheduled to be in operation by 2020.²⁷ Similarly, UAE, Turkey, Vietnam, Belarus and North African countries including Algeria, Morocco and Sudan, and South America states Chile, Ecuador and Venezuela are actively considering embarking upon nuclear power programmes.²⁸

Nuclear energy: feasibility for Pakistan

This section will briefly cover questions related to nuclear safety and security concerns raised against Pakistan in a comparison with other NWS. Energy mix options and the current status of energy generation as well as challenges to Pakistan's government will also be highlighted.

Safety and security concerns over Pakistan

An important international concern related to nuclear material is its safety and security. These safety and security concerns range from unauthorized use, theft, sabotage, terrorist or non-state actors, natural disasters, and illicit trafficking. They also include physical protection of nuclear materials and installations.

It was inevitable for concerns to be raised over the safety of Pakistan's nuclear material as the country is suffering from the affects of the "Global War on Terror" since 2001. The A. Q. Khan proliferation episode, regular terrorist

attacks and suicide bombings also compounded the fears of nuclear material going into the wrong hands.²⁹ Despite all this, Pakistan has taken adequate measures to address these concerns and the following are some steps taken by Pakistan to safeguard its nuclear assets.

Pakistan Civilian Nuclear Programme

- Pakistan's civilian nuclear programme is largely regulated under the IAEA safeguards and mechanisms.
- The civilian elements of Pakistan's nuclear programme are overseen largely by the Pakistan Atomic Energy Commission (PAEC) and Pakistan Nuclear Regulatory Authority (PNRA) which was established in January 2001 in order to have an autonomous oversight mechanism to ensure the safety and security of Pakistan's nuclear installations.³⁰
- The PNRA ensures the safety and security of radiological material from the moment it is imported into the country till its safe disposal after it has outlived its useful life.³¹
- The PNRA maintains an updated database of all radiological sources in the country and carries out periodic inspections to ensure that all material is safely stored, does not pose any hazard to and is not vulnerable to theft or sabotage.³²
- The PNRA has also developed a five year National Nuclear Safety Action Plan (NNSAP). Its aim is to protect the public from hazards of radiation in case of an untoward incident. It has already established its emergency response center, which works around the clock, and has started training courses with the assistance of the IAEA, at an academy in Islamabad for the first responders, as well as border control agencies such as Pakistan Customs.³³
- The PNRA is also responsible to locate and secure orphan radioactive sources. Orphan sources are defined as "sources not under regulatory control, either because they have never been under regulatory control or because they have been abandoned, lost, misplaced, stolen or transferred without proper authorization."³⁴

Pakistan Nuclear Weapons Programme

- Pakistan nuclear weapons programme is operated indigenously, and it is outside of the domain of the IAEA safeguards system.
- In 2000, with the establishment of the National Command Authority (NCA) and Strategic Plan Division (SPD) as its secretariat, the

management of nuclear weapons assets became an “institutionalized capability,” with a reassurance that everything is under strict control.³⁵

- The major role of SPD has been to establish oversight, financial and administrative controls over the activities of various strategic entities. This includes arrangements for the physical security of sensitive installations, which comprises multi-layered security perimeters, counter intelligence and personnel security. Additionally, a system of external audit and procedures for Material Protection, Control and Accounting (MPC&A) has been established.³⁶
- In September 2004, a new legislation - Act No. V of 2004 – was enacted to provide export control on goods, technologies, material and equipment related to nuclear and biological weapons and their delivery systems, which fully cover the control lists of the NSG, MTCR and the Australia Group.³⁷ In 2007, the Strategic Control Division (SECDIV) was set up in the Ministry of Foreign Affairs as the authority to implement the 2004 Act. SECDIV is staffed by officials from various departments and Ministries dealing with all aspects of this important task. It includes officials from Ministry of Foreign Affairs, the SPD, PNRA, PAEC, Ministry of Commerce and Pakistan Customs and Custom Intelligence.³⁸

Contours of nuclear command and control

- The 10-member National Command Authority is in charge of all nuclear facilities.
- The President will be the Authority’s Chairman and the Prime Minister its vice-Chairman. The Authority will include Ministers of Foreign Affairs, Defence, Interior, Chairman of the Joint Chiefs of Staff Committee, Chiefs of Army, Navy and Air Force, and the Director General of the Strategic Plans Division, who will also be the Authority’s secretary.
- Standard "Two Man Rule" to authenticate access to nuclear release codes.
- Nuclear Warheads "de-mated" from missiles or bomb casings, and components to be put into operation only with the consent of a National Command Authority.
- Pakistan has developed its own version of "Permissive Action Links," or PALs, a sophisticated type of lock the US uses to prevent unauthorized launching.
- A comprehensive, intrusive Personnel Reliability System (along the lines of one in the US) that monitors employees, before, during and after employment.

- A ten thousand member Security Force team, led by a two-star General, dedicated to guard the nuclear facilities.³⁹ Pakistan has recently added 8000 highly skilled security officials to its already strong security professionals.⁴⁰

Pakistan has made every effort to ensure the safety and security of its nuclear material, weapons, sites and facilities. Pakistan's safety and security measures are equivalent to other nuclear weapon states, and it has a very clean record as compared to other NWS. Even the IAEA praises Pakistan's commitment to safety, and its Deputy Director General Denis Flory has said, "Pakistan is the 10th largest contributor to the Nuclear Security Fund and it clearly demonstrates a

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national commitment and serious approach towards nuclear security through the implementation of the Nuclear Action Plan for Pakistan."⁴¹ He also said that the "relationship between IAEA's office of Nuclear Security and PNRA is not only exemplary, but sets a global precedent of successful partnership between IAEA and member states and the Agency."⁴²

There is not even a single case of theft of nuclear material on Pakistan's record whereas according to credible sources, there have been over 150 cases of uranium theft in various nuclear plants of India since 1984, which have even been registered by Indian police.⁴³ Some of these and other issues that India has faced are listed below.

- Radiation leakage is a weakness of Indian nuclear power plants. Cirus has suffered due to massive leakage of heavy water.
- Fast breeder Test Reactor at Indira Gandhi Center for Atomic Research Kalpakkam was rated unsafe and discarded.⁴⁴
- From 1986 to 1991, the inlets of the Madras Atomic Power Station (MAPS) and its reactor got cracked and it remained shut down because of leakage of tons of heavy water.⁴⁵
- The Rajhistan Atomic power plant (RAPP) met severe design faults and had to shut down many times from 1980 to 1994 due to cracks.
- Uncontrollable fire in the Narora Atomic power station (NAPS) took place in 1993 and caused total melt-down.⁴⁶

These are just a few cases and there is a long list of leakage, radio active waste containment, dissatisfaction measures, and expulsions in Nuclear Fuel Complex in 2002 Hyderabad.⁴⁷ Then there is a list of Indian scientists who were caught or arrested on the charge of sending blueprints of specialized value,

sensitive nuclear documents, transfer of uranium enrichment technology, and nuclear secrets. These include the following:

- In October 2003 nuclear scientist Sitaram Rai Mahadeven was arrested for sending blueprints of specialized value, a critical part for nuclear plants, to North Korea.⁴⁸
- Mr. Rabinder Singh, director RAW, fled to US with sensitive nuclear documents in 2004.
- Three main scientists namely Dr. Y S R Parsad, Dr. Surrender and Dr. Mahesh assisted Iran in the building of its nuclear power plant through the transfer of uranium enrichment technology and later through transferring missile technology.⁴⁹

These are just few incidents in Pakistan's neighbourhood. However, given the discriminatory behaviour of the nuclear world, it is not surprising that the safety and security of India's nuclear materials has not been a major concern. If a quarter of these incidents had occurred in Pakistan, the international media "would have been beating the drums of war, reminding the world how dangerous and unstable Pakistan is."⁵⁰ India is not alone in experiencing such weaknesses. Nuclear related accidents in other developed nuclear weapons states include the following:

- Plants such as Japan's Fukushima-Daiichi facility (2011), Russia's Chernobyl (1986) and the United States Three Mile Island (1979) remain black spots for the nuclear power industry.⁵¹
- In November 2011, eight cylinders containing 73.5 kilos of uranium ore were stolen from a radioactive materials storage depot in northern Romania. The Commission for the Control of Nuclear Activities (CNCAN) was informed on October 26 that eight 3.5 metre long cylinders containing 73.5 kilos of uranium ore disappeared from the depot at Stei, but the news of the theft was concealed. Though the quantity at large is a fraction of what would be needed to make a bomb, international investigators point to it as evidence that a black market in poorly secured sites in the former Soviet Union is still alive.⁵²
- In 2002 Yuri Vishnevsky, head of Gosatomnadzor or GAN, which is Russia's nuclear regulatory agency said that small amounts of weapons and reactor-grade nuclear materials had been disappearing from the country's atomic facilities over the last ten years.⁵³
- Mr. Hahn Choong-Hee Sous Sherpa, Spokesman for the 2012 Nuclear Summit in Seoul mentioned in a seminar on January 19, 2012, that, "From 1993 the IAEA is collecting data on safety and security of nuclear material. According to IAEA International "Illicit Trafficking Database" (ITDB) about two-third of reported cases since 1995 is related to radioactive substances; moreover around 200-250 incidents of theft and loss of radiological materials occur every year."⁵⁴

- In February 2012 the American San Onofre nuclear power plant was shut down after leak in a steam generator.⁵⁵

The question to be asked is why then is the focus only on Pakistan despite the fact that its command and control and custodial systems are second to none, and have led to strong safety, security and export control systems.⁵⁶ These concerns have generated suspicions that such a campaign is part of a plan to try to destabilize Pakistan and to neutralize Pakistan strategic assets and nuclear deterrence capability.⁵⁷ The reality is that there is no credible threat to Pakistan's nuclear assets, and potential threats are under control. It can also be said that international concerns are closely linked to a lack of comfort at Pakistan, a Muslim state, having nuclear capability.⁵⁸ Otherwise, it is not just the matter of being non-signatory of the NPT led regime. India and Israel are at the same status, but have no international pressure and are given support. The US and western misperception indeed is baseless and self centered, spread by anti-Pakistan lobbies and led by media and ill-informed scholars.⁵⁹

Energy Mix: Status of Pakistan

Currently Pakistan is passing through a severe shortage of energy resources, which is handicapping its economic growth. Security of energy resources can bring Pakistan out of many problems and low cost energy alternatives can meet its growing industrial and consumer demand for electricity.

It was estimated a few years ago that “Pakistan is most likely to face a major energy crisis in natural gas, power and oil in the next three to four years that could choke the economic growth for many years to come”.⁶⁰ Pakistan has rich reserves of coal, but because of insufficient funding, it has not achieved its potential. Gas reserves are depleting. Oil has to be imported and is expensive. But nuclear energy does not depend on fossil fuels and is not affected by fluctuating oil and gas prices.⁶¹ Although nuclear power reactors are expensive to build when compared to coal-fired and gas power plants, they are the least volatile and lead to low share of fuel cost.⁶²

According to the PNRA current “Electricity Generation Capacity of Pakistan is:

	Installed MW	Available MW
Oil/Gas	14,429	12,219
Coal	165	45
Hydro	6,634	3,676 - 6,634
Nuclear	745	690
Total MW	Available MW	Peak Demand
21,690	16,330 - 19,588	21,063 MW

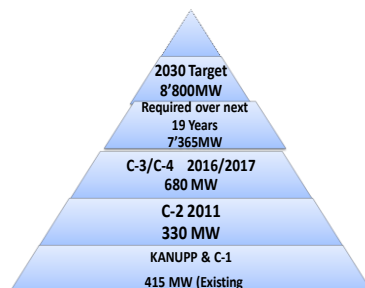
Shortage of electricity supply is primarily due to de-rated capacity of some plants, shortage of natural gas due to additional uses, furnace oil due to expensive import (because country has limited oil and gas reserves), and seasonality of hydro electricity (capacity factor drops 50% in summer). Socio-political and project financing issues in hydro projects are common and renewable resources are in initial stages of development and unable to meet the base-load electricity requirements. All these factors result in load shedding and the shortfall has been exceeding 6000 MW this year.⁶³

Nuclear power generation forms a vital part of Pakistan's energy mix. It is also an important development imperative. Pakistan has a small nuclear power programme, with 745 MW capacity, but plans to increase this substantially. Pakistan is not party to the NPT, but does have its civil power reactors and two research reactors (PARR 1 & 2) under item-specific IAEA safeguards.⁶⁴ Because Pakistan is outside the NPT, it is largely excluded from trade in nuclear plant or materials, which hinders its development of civil nuclear energy.

Pakistan has the Chashma Nuclear Power Plant I (CHASNUPP-I) located at Kundian, Punjab. Chashma Nuclear Power Plant II (CHASNUPP-II) was completed on April 10, 2011.⁶⁵ At the inauguration, Prime Minister Yusuf Raza Gilani said that, "The generation of additional 330 MW would provide immediate relief to a section of consumers, adding that two more power plants Chashma Nuclear Power Plant III & IV (C-3 & C-4) already under construction at this site would help in paving the way for PAEC to meet the government assigned target of 8800 MW by the Year 2030."⁶⁶

Pakistan's "Energy Security Plan" includes a target of 8,800 MW from nuclear sources by 2030. Existing identified resources of uranium are supposed to be adequate to stimulate the worldwide nuclear capacity requirements only up to 2050. However the life of uranium resources can be extended through reprocessing of spent fuel in form of Generation IV fast breeder reactors. The new designs of nuclear power plants are safer than before, but uncertainties about waste management and proliferation still remain. According to its Vision 2030, the Planning Commission of Pakistan has proposed a new regime whereby such plans are treated as any other power plants being set up by the private sector, which can build, operate and own these plants under IAEA safeguards while selling the electricity generated at mutually negotiated tariff. The supplier would be fully responsible for fuel and waste management.

The following pyramid gives a detailed account of Pakistan's current nuclear generation status and future requirement;



Pakistan is a pioneer developing country in using nuclear technology for producing electrical energy.⁶⁷ Growing energy needs and inadequate indigenous energy resources necessitate large scale use of nuclear power in Pakistan.⁶⁸ Despite international embargoes, the nuclear power programme in the country is moving forward slowly but steadily. Safety remains a top priority⁶⁹ and Fukushima provides an even bigger drive to enhance safety and develop emergency response programmes.⁷⁰

Pakistan has qualified manpower and professionals and it is now constructing fourth and fifth nuclear power plants and has more than 40 reactor operational years of experience to its credit. During this period, safety has been the hallmark of the country's nuclear industry.⁷¹ Pakistan needs energy mix option rather than to rely on a single option. All options must be taken in account to combat the rising energy shortage and meet future demands.

Challenges ahead

The energy crisis in Pakistan that started in 2007-2008 took a serious turn during 2009-2010. Without technical and economic assistance Pakistan cannot achieve the desired goal of 8800 MW through nuclear energy by 2030.⁷² In an article published in *The News* on January 24, 2011 DR. A. Q. Khan rightly pointed out that to meet this target Pakistan would require either 29 nuclear reactors of 300 MW each or ten nuclear reactors of 900 MW each.⁷³ This seems impossible given the current economic situation of the country because a 300 MW reactor costs about \$1 billion and requires eight to ten years for commissioning. A 900-MW reactor would naturally cost proportionately more and would take the same time.⁷⁴

In the energy mix option, bilateral negotiations are taking place among Iran and Pakistan for the IP Gas Pipeline agreement. Recently the project of a gas pipeline among Turkmenistan, Afghanistan, Pakistan and India (TAPI) has been signed after twenty years of negotiations. The 1,700-kilometer TAPI pipeline aims to transport over 30 billion cubic meters of gas annually from the Dauletabad gas fields in southeast Turkmenistan and would serve Pakistan well in the coming years.

Pakistan and Iran signed the Gas Sale and Purchase Agreement (GSPA) in June 2009 as well. The Government of Pakistan has already determined that the imported natural gas from Iran would provide the cheapest and most suitable fuel for power generation. It has been estimated that 750 mmcf/d (millions of cubic feet per day) of gas would help generate around 4,000 MW of electricity, besides providing job opportunities in the backward areas of Balochistan and Sindh. Iran has already laid the 56-inch diameter pipeline for a distance of 900 km from Assaluyeh to Iran Shehr. The remaining 200 km to bring the pipeline to the Pakistani border are likely to be completed in the next two years.⁷⁵ In February 2012 Iran offered to inject 1,000 MW power in Pakistan's transmission line,⁷⁶ which was also very positive for Pakistan.

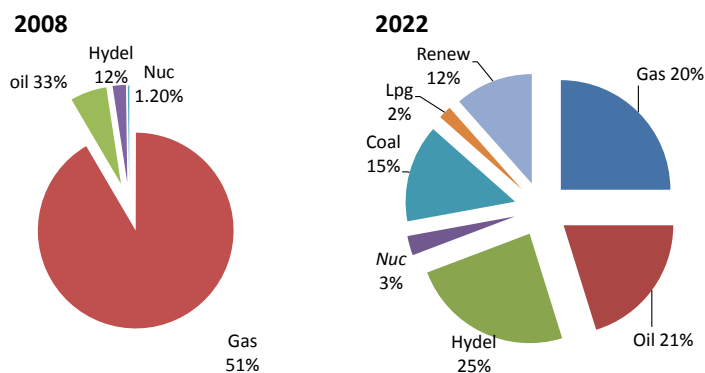
Similarly India has also offered supply of electricity. The offer was made by Indian Prime Minister Manmohan Singh in a brief meeting with Prime Minister Gilani at Seoul in March 2012. Negotiations are underway to get 500-1,000 MW of electricity from India. Pakistan is also interested to import oil from India. According to the Petroleum Secretary Ijaz Chaudhry, Pakistan will get 35% cheaper oil from India because of low transportation charges. India has offered to build pipeline to Wagah border to supply 50 million tonnes of oil a year⁷⁷ and Pak-India energy and trade discussions are also encouraging in the overall bilateral relations.

While Pakistan is facing major energy crises today, in a large part this is due to lack of investment in the past. Imtaz Qazi, the Water and Power Secretary noted that "the government is dependent on thermal and rental power plants [as] no power generation capacity has been added for the last nine years," He also confirmed that the government had struck a deal with commercial banks to exchange about Rs. 151 billion of the energy sector's liabilities which are effectively unfunded at the moment, for bank loans.⁷⁸ The injection of hard cash into energy sector companies will allow them to pay off their liabilities to each other and reduce the stock of "circular debt" which the government estimates is currently over Rs. 300 billion. Power companies will then be able to buy more fuel and run their power plants at closer to full capacity, reducing the durations of the nationwide outages.⁷⁹

The contribution of renewable and alternative energy in the overall energy mix in Pakistan is negligible at present. The Alternative Energy Development Board (AEDB) has been established to facilitate development of renewable energy projects. At least 5 % of the total electricity generation capacity of the country is targeted to be based on these sources by 2030.⁸⁰ Prime Minister Gilani said on March 7, 2012 in a briefing related to the energy crisis that “Pakistan has the potential of energy generation by wind, solar, geo thermal and bio fuel energy” and that it has the potential to generate 350,000 MW by wind, 2,900,000 MW by solar and 2,500 MW by geo thermal energy.⁸¹ On May 30, 2012 Pakistan’s first on-grid solar power generation system started working with the financial assistance of Japan.⁸² Pakistan seeks more investment in renewable energy to combat a power crisis which has adversely affected economic growth.

The energy mix demand and the expectations of the “Energy Expert Group”, Ministry of Finance, indicate the direction in which Pakistan should move towards in order to create greater self reliance in energy generation from 2009 till 2022. The ideas put forward are depicted in the graphics below.

Energy Mix Generation



According to the plan, the government is seeking self sufficiency in energy generation but this requires major initiatives. After 3 years of this plan, no change has been observed in growth of energy generation. Time will tell what the long-term outcomes of government policies are on the future of the power generation in Pakistan.

Recommendations

There is a need for international cooperation, promotion and support to enhance the use of peaceful nuclear energy for the sake of our next generation.

- Fears of the diversion of nuclear material towards violent means represent a narrow view as it looks only at the possibility of non-peaceful use while ignoring the necessity of energy resources that will be depleted after few decades. Current predictions are that we may hit the highest point of production of oil and gas within the next decade, after which production levels will decline worldwide.
- There should be a mutual solution by which the issue of diversion and safe waste disposal can be handled and nuclear energy can be promoted. There is a need to take some effective steps to counter the issue of diversion by strengthening IAEA safeguards mechanisms. Capping peaceful nuclear potential would be unfair and equal opportunities and support by powerful states for all is needed.
- The non-proliferation efforts of international powers should continue but peaceful nuclear energy for developing nations should also be promoted as nobody has the right to stop a country from access to this reliable and stable source of energy.
- Pakistan needs to enhance interaction and engagement with the international community to rectify misperceptions of security and safety of nuclear material.
- For Pakistan there is a need to have multilayered plans to overcome the energy crisis. The crises evolved over years and cannot be solved in days, but the government has to work on short, medium and long term plans in which it should categorize the energy needs as per its immediate demand and resources.
- The government is trying to get immediate energy supply of 1,000 MW from Iran, and similar deals should be explored with other neighboring countries like China, Tajikistan, and India. This kind of immediate insertion of energy can be availed for short term plans until permanent solution are sought. The TAPI pipeline has been finalized after a long period, but the IP gas pipeline should be completed sooner. Coordination and cooperation needs to increase among neighboring countries for further proposals and deals so that they can be finalized in smaller time frames.
- In the nuclear sector China is Pakistan's only supporter. China is currently building four AP 1000⁸³ Generation III+ nuclear reactors with the cooperation of South Korea. South Korea is also seeking to export its nuclear technology with a goal of exporting 80 nuclear reactors by 2030. South Korean companies are interested to build research reactors even in India. Pakistan should also make efforts to make similar deals with South Korea.

- Pakistan should continue its efforts to make the world realize that Pakistan also deserves civil nuclear cooperation just as NPT and NSG members have given India, since both India and Pakistan have the same status in the region. The Indo-US nuclear deal proves that it is not now obligatory to be a signatory of NPT to gain access to the international market for nuclear technology.
- Pakistan is not utilizing its hydel power potential. Delays in implementation of mega hydel projects leads to shortage of supply. Pakistan needs to focus on small hydro projects. Setting up small dams and run-off-river⁸⁴ projects as short term plans, which are economical and feasible for immediate requirements can make significant contribution to the country's energy supply.
- In Pakistan, the use of coal, nuclear and renewable energy sources is very low compared to the world energy production. Pakistan has large coal reserves but only produces 0.2% of its electricity by coal. Thar Coal can produce 20,000 MW of electricity for the next forty years while managing to avoid load-shedding and the government should show seriousness in this matter.

Conclusion

Larger electricity utilization is desirable for Pakistan for social and economic progress. But currently Pakistan requires the electricity production that is economical and also environment friendly. Nuclear power in Pakistan is an important source of energy. Pakistan sustains safety and security records and urges world cooperation in nuclear energy production. Pakistan has the potential to generate energy by various means but instead of investing money in new sectors to create energy resources it would be economical to work in a sector in which it has the expertise and the experience. However, global support is needed if Pakistan is to use this viable source to enhance its energy mix and see itself out of the current energy crisis.

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